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BIOPLATE transfer letters are no longer available, and will not be restocked unless there is a strong demand from our authors.

A FESTSCHIRIFT IN HONOR OF HARRY ID. THUERS

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PREFACE

January 22, 1989 marks two occasions in the life of Harry D. Thiers, his 70th birthday, and more importantly, his retirement from 30 years of teaching at San Francisco State University. A teacher often measures his success by that of his students, therefore we hope that this volume of 20 research papers on mycology and lichenology by his students will bring Harry pleasure and a sense of accomplishment.

Festschrift projects often have the reputation of being far more timeconsuming and difficult than the organizers envision at the outset. We admit to spending more time on this one than we thought we would, even with the help of XyWrite III+ and a laser printer. However, we have found the rewards of the project to be far greater than the time invested; we have renewed contact with many old friends, chuckled over forgotten anecdotes, and expanded our mycological and editorial horizons.

In the process, we learned something about Harry Thiers as well. . . he must be one of the world's most inquisitive people. We resolved to keep this Festschrift secret from him as long as possible. During our semi-annual visits to San Francisco over the last two and a half years we have tried many times to accomplish Festschrift-related business through a furtive poke in the herbarium or a hushed conference in the corner. More often than not, the Festschrift Honoree would catch us in the act, and some fancy footwork was needed to misrepresent our activities convincingly. Only Ellen Thiers proved to be cunning and cool-headed enough to succeed in ferreting crucial data from under Harry's nose.

In the introductory section to this volume, many fine and well-deserved tributes are paid to Harry. We know he would want us to reiterate here something he has said many times: he feels extraordinarily lucky to have had such a fine assortment of students. They are every bit as special to him as he is to them.

We wish to give our warmest thanks to all of the Festschrift participants. Special thanks are also due to Ernst Both, Director, Buffalo Museum of Science, for donating the cover artwork (*Leccinum manzanitae* Thiers) executed by Patricia Eckel, and to The New York Botanical Garden for helping to manage finances of the project. Generous financial contributions from W. P. Jordan, B. K. Tamm, and an anonymous donor are very much appreciated. Richard P. Korf, Managing Editor of MYCOTAXON was extremely helpful and accommodating at every step of the project, and we are very grateful to him for making this volume possible.

Roy E. Halling Barbara M. Thiers Guest Co-editors Bronx, NY

HARRY D. THIERS - REMINISCENCES ABOUT A TEACHER AND FRIEND

I served as laboratory assistant for HDT beginning in my sophomore year at Texas A & M in College Station, Texas. Harry supervised two beginning botany labs simultaneously. During the laboratory on stems, I was charged with giving the introduction to the class in one of the labs. I confidently showed the class where the cambium was located in a corn stem. HDT came into the room and very courteously took over the class, and relectured monocot stems from the same chart. I was very embarrassed, but as usual, he was very patient, and on we went. My first mycology course was with Harry. He was an excellent instructor, and the laboratories were very well planned. The lab with the water molds was amply supplied with examples of discharging zoosporangia. This was the first time I had seen the discharge and the zoospores swimming about. I stayed a long time looking at this material, and got so excited that I had to go home to bed to recover. [Don Reynolds].

As an undergraduate at San Francisco State, I was assigned an advisor in the Department of Biology, one Robert Sweeney. I was something of an annoyance to him because I continually brought mushrooms I'd collected in the environs of the campus to our scheduled meetings. Bob's response, invariably was, "I don't know anything about those damn things." One afternoon, Bob stopped me in the hall and informed me that the department had just hired a mycologist, and I should talk to him about those damnable mushrooms.

Bearing a freshly collected specimen, I promptly presented myself to Harry Thiers. Harry, looking a bit frazzled, was busy emptying many boxes of books. Nevertheless, he greeted me and my mushroom with great enthusiasm. As is so typical of him, rather than simply identifying the mushroom for me, Harry feigned ignorance, reached into his collection of books, and introduced me to the dichotomous key. We keyed out the mushroom together.

Harry's response to me and my interest was all the encouragement I needed. Almost daily I would bring in specimens to identify. Soon, we began to take short trips together looking for fungi. The very next semester, Harry set me up in the tiny back room to his office. I was provided with a microscope, a bottle of Melzer's, a straight razor, and a mimeographed copy of Alex Smith's "Preliminary key to the Fleshy Fungi." I remember Harry taking great delight watching me trying to section a minute Mycena without simultaneously removing the end of my finger.

We took many trips then....Land's End, Crystal Springs reservoir, the Presidio, Skyline Drive....anywhere a mushroom might grow. Each trip would end with a mini lecture on morphology or taxonomy, and, in a pattern that typifies Harry's lab even to this day, hours of keying out mushrooms. These were exciting times for me and irreversibly directed my path to a career in mycology. [Jerry Motta]

In the later 1950's, the science faculty of San Francisco State required all Biological Science students--regardless of their major interest--to experience a few Botany classes. As a neophyte biological science major with a presumptive interest in zoology, Botany would not have been one of my elective choices. The required first semester course did little to change my mind and convinced me to complete my botany requirements as quickly as possible by taking the second semester of the introductory course rather than the alternative--an upper division Botany elective at a later date.

Walking into that second semester Botany class with only 14 other students in the room, when there had been nearly 50 in the first semester course, I quickly began to wonder what I had gotten myself into! The first day's lecture in the class consisted of an overview of what we were going to cover during the semester, with review, wherever it fit in, of terms and concepts we had "learned" in the previous course. Unusual? No. But, Dr. Thiers, the instructor, who had recently come to S. F. State from Texas, didn't just lecture. He started almost immediately to involve the class in the process by requesting definitions, asking questions, etc. And, much to my surprise, he was calling on people that first day in class by name--often without even turning around from the blackboard!! (I learned later that many of the others in class had been in Professor Thiers' laboratory section the semester before--I had not). Realizing that my learning of the first semester's material was less than adequate for this approach, I became quickly aware that if I was to survive this experience, something had to be done--and fast!! Extra Botany books were obtained from the library; notes were recopied, embellished for clarity, and repeatedly reviewed; vocabulary lists, constantly being upgraded, were always in hand. Botany between classes, Botany at meals, Botany on the bus commuting to and from work. Sometime early in the semester, the "chore" of studying became a joy. Through Dr. Thiers' enthusiasm and excitement, Botany came alive for me in that class and my life was forever changed.

In my graduate school days at San Francisco State in the mid-1960's, the herbarium was a home away from home. Converted from a small storeroom in the original square Science building, it served as the Botany graduate student office, work-study area, and general meeting place. The five to six graduate students had work spaces sandwiched between, around, and behind the seven or eight herbarium cases; one had a desk looking into the unused freight elevator door! Closeness created life-long friendships. Often arriving before others in the morning, HDT was always there to answer our questions, offer advice and support, and share in the excitement of our discoveries. Like the coffee always brewing, the love of Botany, of science, and of knowing, was rich there. [Walter J. Sundberg]

I first met Dr. Harry Thiers in 1960 when I left a high school teaching job to further my education. It was a fortuitous meeting for me! During 1960-1961, he was the nucleus of my forming career, and ever since then, the impression of his wonderful enthusiasm for everything, especially fungi and students, has helped me shape my teaching and research career.

When I came to SFSU in 1960, I hoped that I could get a masters degree, possibly in marine algae under Dr. George Oberlander. My chagrin at learning that he was on sabbatical leave (in Australia) was quickly alleviated when I met Dr. Thiers. Although his primary interest was fungi, he was flexible and quite amenable when I came up with a plan on ferns. So that fall term, I began growing fern gametophytes on liquid media and testing their responses to various levels of nitrogen and other inorganic nutrients. Things finally jelled, and by the end of the academic year I wrote a thesis and underwent an oral exam to get my degree. Dr.

Thiers was tremendous in the help he provided, even though he was far from an

expert on fern gametophytes.

In the fall, I took his mycology course, in which the labs were superbly full and well-organized--a multipaged guide for each lab. The spring phycology course was another matter. Dr. Oberlander was nowhere around, so it fell to Dr. Thiers to teach the phycology course that spring. It was a joy! I have never enjoyed a course as much. Dr. Thiers gave the standard lectures, but the labs were for us to identify and learn about as many freshwater algae, and then marine algae, as possible. And I still feel that identifying organisms is a wonderful way to learn about them. Well, that phycology course in the spring of 1961 convinced me, without question, that I was destined to become a phycologist. In fact, unless my memory fails me, I think that it was when Dr. Thiers took the class on a field trip to Monterey that I got irreversibly turned-on to marine algae. That is where I still am today, 27 years later. [Bill Johansen]

In the fall 1961, Harry Thiers, two graduate students, and the mycology class made a weekend field trip to Jackson State Forest in Mendocino. Through the kindness of the California Division of Forestry, Harry and his students staved in a wooden ramshackle building at the old fire station on Little Lake Road. The wooden facility consisted of a large dormitory-like room, a rustic washroom, and a large kitchen. I have fond memories of the kitchen for it was there that we would put out our collections on a wooden table and review identifications together. Harry would answer all of our questions with patience and would repeat the answers as often as necessary. It was in that room that he was the ultimate teacher; an enthusiastic and wonderfully invigorating person.

One of the most memorable experiences with Harry happened in the dormitory. Each side of the dormitory was lined with metal bunks-- two bunks to a tier--each bunk with metal springs that had absolutely no give to them, and a nearly non-existent, thin, hard, bumpy mattress. In that room, Harry and all of his students would roll out their sleeping bags on



Demonstration of wave action on Nereocystis.

those bunks. One of our most favorite pastimes was to collect mushrooms after dinner by flashlight in the dark. After one such lovely collecting trip during which we had spent the evening becoming exhilarated by the sights of the gloriously shaped and beautifully colored mushrooms illuminated in the night by flashlight, we returned to the fire station in a festive mood. We had been kidding Harry the entire evening and he was giving as much as he was taking; however, we thought we were getting the upper hand. After we returned, Harry went to the kitchen, so I decided to take this golden opportunity to collect at least 100 Douglas Fir cones and put them inside Harry's sleeping bag. All of the students knew what was happening and as a group we decided to really badger Harry, including throwing Russulas at him in the kitchen. Eventually all became quiet and all retired to bed; of course with Harry the last to arrive. In silent anticipation, we waited for Harry's response as he climbed into his sleeping bag full of cones. All of us shouted gleefully as Harry let out numerous loud, uncommonly used verbs after getting into his bag. We all laughed uncontrollably as he got up and proceeded to empty his bag outside. Eventually it became sufficiently calm to go to sleep. I was snuggled deep in my bag with the top pulled over my head when at two o'clock I was unceremoniously shoved into the bottom of my bag as someone proceeded to lift the bag into the air with me still inside. I struggled frantically but to no avail and felt myself thrown into the air and then landing with a thud on some branches. After about five minutes of vigorous struggling to get out of my bag, I finally extricated myself. All of the time there was this furious uproar from inside the dormitory. As I looked up into the window through which I was thrown, the first person I saw was Harry Thiers, the person who had picked me up and thrown me out the window. With a jovial laugh and a twinkle in his eye, Harry said, "See, Dave, I told you I would get you back!" [David L. Largent] (Now we know why HDT later chose to sleep in his car. Eds.)

I had just returned to San Francisco for Fall registration in 1961 and was informed that I needed an upper division elective in Botany as a graduation requirement in Biological Sciences. I didn't view this as a critical career decision because the main career tracks at S.F. State College were elementary and secondary education. Holding to my undergraduate view that nothing should interfere with afternoon athletic practice, I signed on for Mycology because it was offered in the morning and my other option wasn't. At our first class meeting, I sensed something was different about this group. Not only were the two graduate assistants (David Largent and Harriet Burge) absolutely 'lunatic fringe' about the fungi, but some of those taking the course (e.g., Jerry Motta) were similarly afflicted and had been preparing months in advance. Fortunately for me, HDT knew how to guide the rookies while continuing to challenge the 'fringe.' Classwork lost the dimension of time. By November, when our Cross Country team won the Far Western Conference Championship at Reno, Nevada, there I was exposing Martin's Rose Bengal agar plates for airborne fungal spores at the Washo County golf course. My teammates played a practical joke by placing rabbit dung in some of the plates, a sign of things to come.

That winter, as rains came to northern California, the mushroom collecting assignments began in earnest. Two women in HDT's life, Ellen and Barbara (age 6, then), were present for many of the local collecting trips. Barbara could accurately name, to species, the different mushrooms we struggled to identify using taxonomic keys. Ellen collected various cryptogams of interest and worked in the Herbarium across the hall. How very thoughtful were Ellen's efforts at providing refreshments for special occasions. This class was becoming a family. It soon became apparent

to me that HDT's extended family was also around evenings and weekends. This was not the 9-5 world of my parents and neighbors. HDT didn't play college professor, he lived it.

As other memories fade, one event remains fixed in my mind. Mendocino was the big December collecting trip and HDT guaranteed that we would complete our required collections of fleshy fungi. The drive was several hours duration and we arrived well after nightfall. Sleeping bags, collection baskets, drying racks, and kitchen supplies were unloaded and I looked around for a bunk. Then at 9:30 PM, the 'fringe' got out their flashlights and went outside to collect mushrooms. In a few minutes, they returned with dozens of *Laccaria laccata* that were found fruiting on the forestry station grounds. David Malloch (then a music major) and I shared a similar look of disbelief. Come on now, how could anyone be that hooked on the fungi? [Donald T. Wicklow]

My first contact with Harry was as a very unsuccessful undergraduate student taking my first botany course in my senior year. As usual, I was starting the year off in a new major and found that as a prospective, if somewhat unenthusiastic, entomologist, I was required to take botany. BOTANY!! Of all the balderdash that I might be subjected to, I could not figure out why I needed botany. To my surprise, botany, as presented by Harry Thiers, was the most interesting course I ever took. Harry actually singled me out and invited me to go with the mycology class on a weekend field trip to Mendocino, which, along with other later Thiersians, converted me to mycology. The field trip was especially notable for the quantity of fungi encountered and Harry's unbounded enthusiasm for them. This field trip was also notable because it was the weekend that a well-known organization of mycophiles discovered the bounties of Mendocino. As the members of this club gleefully filled the trunks of their cars with mushrooms, Harry speculated out loud on a number of topics relating to this discovery.

Later I was tied down by an evening and weekend job and could not attend these wonderful outings. Instead, I absorbed what I could in the lab, which of course, was much. I discovered that Harry could not remove a glass of water inverted on the table near his manuscript on boletes without removing all of the papers and then spilling the water. It was a fascinating discovery until I found that he seemed to have no ability whatsoever for preserving marine algae, and instead,

stored these on my desk next to my notes.

In spite of this inability to properly dispose of algae, he was remarkably able to identify such things; indeed, he was able to identify algae, mosses, lichens, various sorts of vascular cryptogams as well as a long list of fungi. This indiscriminate interest in all sorts of cryptogams rubbed off on his students, including me, and sentenced most to a lifetime of teaching lower division classes that botanists usually avoid because of their more modern specialized training. A sentence maybe, but with Harry as a model, something of a challenge as well....and maybe even a reward. I hold Harry directly responsible for the fact that I get to spend two wonderful weeks each August in New Brunswick teaching Marine Biology while my colleagues at home are attending the year's first staff meetings.

Staff meetings......who of Harry's students can forget Harry after he had been to a staff meeting? Red faced, breathing rapidly and muttering epithets to himself or muttering epithets loudly to any student who was foolish enough to confront him. After a staff meeting, his rate of speech increased several-fold. Lectures that normally lasted an hour could be delivered in 20 minutes, pictures and all, and thus had to be followed by the next day's lecture to fill in the time. This could possibly have been avoided if we had asked a lot of questions, but who would have dared

ask Harry a lot of questions after a staff meeting? There was at the time, a pearshaped boy, who *did* ask questions at the wrong time and sometimes bore the brunt of the after-meeting effusions. This was the same kid who had his mother phone Harry to check out the dangers inherent in going to Mendocino and who finally upset the authorities to the extent that they threatened withdrawal of cooperation. This kid bothered Harry more than the one who cruised rapidly up and down the main street of Mendocino in a flatulent Volvo with SFSC boldly written on the back window.

All of Harry's students have such recollections and fond memories. From San Francisco they have gone out into the world and have maintained, consciously and unconsciously, the spirit they received from him. They remain a close-knit group that reassembles whenever possible to exchange the stories, experiences and knowledge that they possess because of their short time with this man. I am grateful and proud to be a member of this exclusive club. [David Malloch]

In 1964, as a biology major in my junior year at SF State, I enrolled in a class called Cryptogamic Botany. I am pretty sure I had no idea what a "cryptogamic" was, but with the real and imagined demands on my time, I fit classes into available time slots. It was there that I first experienced Harry D. Thiers, seductive master of the well-planned lecture. He almost never used notes. I recall one time when he actually apologized for their use, while extracting a single 3 by 5 notecard from his shirt pocket, notations on one side only.

Harry also commanded amazingly interesting laboratories; the aura of which I struggle to attain in my own classes today. Components of the essential ambiance include somewhat untidy conditions created by stray lichen fragments, crumbled sheets of waxed-paper and discreet mounds of woodland debris, as well as the lingering fragrance of drying mushrooms; but most importantly, the drama of discovery was always present.

For me, there are many characteristics which comprise the image of HDT. The most compelling, and the one that establishes him as a world class mentor, is the natural ease with which he makes plants alive and students important. [William Paul Jordan]

It is important and valuable to reflect, from time to time, on how one began his professional career. Certainly for a researcher and/or teacher, or any other professional, there are several factors to consider and weigh, one against the other, in determining just how it is that the present situation came about. Typically, a person is influenced by one, or perhaps a few outstanding individuals, who he has encountered during his early years.

For myself, I can say with certainty, that Harry D. Thiers was most influential in my becoming a teacher and a researcher. He was among the best teachers that I had as a university student, and his enthusiasm for learning, and teaching others, greatly influenced my decision to become a teacher. He also was my first adviser at San Francisco State. I am exceedingly grateful to Harry for his influence and guidance during my years at SFSU!

Harry Thiers introduced me to mushrooms and his area of research, even though I was not "officially" one of his students. He even selected the genus Cortinarius for me to work on. A genus that I have been struggling with for some twenty years, and something for which I will never forgive him!

It happened something like this: When I was an undergraduate student in Biology, I asked Dr. Thiers if I could informally attend his mushroom taxonomy course to learn a few basic things about fleshy fungi and absorb a few mushroom

names. Of course, he said that would be fine. Actually, I was intimidated by the mushrooms, the seemingly knowledgeable graduate students, and even Professor Thiers himself. I learned a few names, somewhat slowly I admit, and realized very quickly that these organisms were indeed poorly known and difficult to identify.

During the class, I heard something about mushroom descriptions and how important they were in making a final and correct determination of a collection. So I decided to ask Professor Thiers how to prepare one. He quickly and efficiently got the idea of a mushroom description across to me, but it wasn't until the following summer, when I was in Idaho, that I actually tried to write a description of my own. Looking at my notes from that period clearly shows that they are practically useless. However, it did get me interested in mushroom taxonomy, and so I decided to try and write a few more descriptions to improve my skills.

An approach that seemed logical to me at the time, was to work on one genus for awhile, and then on another, to learn something about each one. So I went to Professor Thiers and asked him which genus might be a good one to start with in terms of doing descriptions. Of course, I made it clear to him that I would do this as a learning experience, and that he could have the collections and notes if they were useful. He agreed that this was a good idea. He thought about an appropriate genus for a few seconds, and then, with that characteristic smile on his face and more than ample encouragement (I should have been suspicious), he quickly suggested the genus Continarius as a starting point. He said there were a lot of them around (a true statement) and that it would be helpful to him if I wrote up some of the collections. I agreed to get started at the first opportunity. Twenty years and some hundreds of descriptions later, I'm still working on Cortinarius and the closely related genus Dermocybe! Actually, I enjoy it very much and I am exceedingly thankful to Harry Thiers for keeping me busy all these years. [Joseph F. Ammirati]

Unlike many college freshmen who vacillate between majors from semester to semester, my decision had been made several years before I stood in line on that first registration day at San Francisco State College. My plan was to eventually lead me to a career in high school teaching, that is until I met Harry Thiers.

My first, and probably most memorable course, from Harry was Cryptogamic Botany. I can remember being somewhat apprehensive about being in this class, probably for two reasons: first, I had heard from other students that Dr. Thiers was a demanding teacher, and secondly, my older brother Don was also in the class. For the first week he wore a perpetually worried look, certain I was going to say or do something to embarrass the family name! As that semester went on, my apprehension turned to confidence and it became clear that my plan was changing and that I was going to do many more botany courses. Harry has a way of making each student feel important and unique. He is an unmerciful tease, a generous teacher, and a kind, thoughtful human being.

The field trips, especially the weekend trips, have to be the most memorable part of any Thiers course. In particular, I remember Jackson State Forest in Mendocino where we collected mushrooms at spots known as "Mushroom Corners," "Aleuria Glen," and "Amanita Avenue," stayed in an old wooden dormitory affectionately called "The Villa," and shopped for food in the village of Mendocino at a little market called Mendoza's. Harry was at his best on these trips; leading forays, reviewing his collections, "supervising" the shopping, answering questions, "arguing" with his graduate students, helping with identifications, harassing the cooks, teasing us for our mistakes, appreciating our individuality, and

encouraging our successes.

Dr. Harry Thiers nurtured our interest in the living world, shared with us his wonder of learning, and taught us with energy, humor, and commitment, and because of that our lives have been forever enhanced. [Marcia Wicklow-Howard]

I first attended San Francisco State University in 1965. Shortly thereafter I took my first course from Dr. Thiers on the recommendation of several other students. I was overwhelmed with Dr. Thiers' enthusiasm and knowledge of the subject material as well as his personal interest in all of his students. We all felt that we were special and that our education was very important to him. My feelings may have been somewhat influenced by his somewhat unethical approach of bribing his students with cookies and other treats during class meetings.

One area of concern to all students is grades. Dr. Thiers shared that concern with his students. His exams were fair and straightforward, no trick questions. This approach allowed us to be more relaxed and able to present more of our knowledge of the subject material. His evaluations took into account individual weaknesses. This special caring helped many of us develop the academic foundation to continue our education. I am sure that without his overwhelming support and guidance some of us would not have gone on to accomplish as much as we did.

For this I am truly indebted to Dr. Thiers.

The most enjoyable years of my life were spent at San Francisco State University as Dr. Thiers' student. The herbarium life was wonderful - open 24 hours a day. It seemed like Dr. Thiers was always there. I am sure this could be substantiated by Ellen Thiers. The academic environment and the camaraderie in the herbarium that existed among a wonderful group of graduate students will always be with us. Thank you Dr. Thiers for a true quality education. [Bob Keller]

I was 21 and in my junior year at San Francisco State when I met Dr. Thiers. He taught a general botany course which I had taken to satisfy a college requirement. Dr. Thiers taught the course many times, but when he lectured, he made me feel as though it were the first time he was sharing the information with a class. His approach was enthusiastic. When he talked of various organisms, "curious" was a term he often used to describe them. Curious is exactly what I became.

His approach in lecturing was clear and scholarly, and his approach towards the students was friendly and encouraging. He encouraged questions and answered even the most elementary ones without belittling the student. He knew when a student was struggling and made himself available for help. Except when teaching classes, Dr. Thiers was in his office actively working on research and keeping abreast of the changes in his field. His door was open, and he was never too busy to talk with his students. He would counsel, encourage, and listen.

At the end of the semester of general botany, I changed my major from German to biology. I took several other courses from Dr. Thiers, each time finding them challenging and enjoyable. I have gone on to pursue the study of plants professionally. Without the enthusiasms and encouragement of Dr. Thiers, I might not have entered the field in which I have been so successful. [Barbara Keller]

My first introduction to Dr. Harry Thiers was in the fall of 1972. At the time, I was not a student at SFSU, but my husband, Jim, was taking General Botany from Dr. Post. That semester, a botany retreat was held at Mendocino Woodlands and I tagged along. Since it was my first exposure to mushrooms, it seemed as though every time I turned around, there were 10 more new mushrooms. I followed Dr. Thiers all weekend trying to absorb all the names and characteristics. I was very impressed with all the information there was to learn about each mushroom, besides whether or not it was edible! The beauty of these organisms was overwhelming - it was better than an Easter egg hunt. Eventually, I participated in countless more cryptogamic forays as an undergraduate, and then as a graduate student at SFSU under Harry Thiers. Now, long after finishing school, I still spend much of my free time botanizing and greatly appreciate being able to tag along with Dr. Thiers and his students, and all the while still learn from this wonderful man. [Mona Bourell]

As a new undergraduate at San Francisco State, I well remember HDT's enthusiasm for mycology, and for the teaching of it. Harry was generally patient and generous with us as we struggled with esoterica which were second nature to him. I remember that he could also be gruff, at least in response to "whippersnapperisms," my term for the awkwardly inappropriate remarks I seemed to be able to make all too frequently and obliviously.

When the chips were down though, Harry was unfailingly gracious and supportive. There were the lesser tragedies, such as our trying to clean the laboratory glassware after semester's end. If we had asked how to operate the dishwasher properly, we probably would not have created the hurricane that pulverized a great quantity of HDT's dearly-bought labware. But then it would not have been a sur-

prise. He took it all in stride.

A larger tragedy than an electrical fire in a herbarium drier should not even be contemplated. I experienced such a fire, which, in addition to seriously damaging the Biology building, destroyed about one third of my research collections and field notes, as well as material on loan from the New York Botanical Garden. For 90 hideous minutes, we thought that all the western Agaricus holotypes might have vaporized. After the dust settled, Harry scraped my ego off the basement floor and gave me a major pep talk that helped me decide to stay in the game.

Small goofs were usually digested relatively easily. I guess we forgot to tell HDT we were fixing a Mexican-style breakfast one morning at the Branscombe reserve. I didn't know anyone could mistake salsa picante for strawberry jam, but I do now. I believe he ate the entire English muffin anyway, after that first poignant,

pungent realization.

There were other moments of grace under stress (his or mine), too numerous to mention here. If you know HDT at all you can imagine them as well as I could relate them. Well, I do remember one gruff response I provoked after complaining one time too many, that the Agaricus keys with which he had furnished us were miserable and useless testaments to human folly and ineptitude. "Well," he said, or rather glowered, "if you think that you can do better, then by all means be my guest." Or words to that effect. I like to think I spied a crafty glint behind that stern visage. I don't so much mind being conned, but there are times when I wished I'd complained about a different genus. [Rick Kerrigan]

As with many other students of Harry Thiers, I'm one of those who will never forget my first field trip with him. After my first five days in graduate school at SFSU, I was invited, along with two other students, to show up on Saturday morning in front of the Biology Building at 6:00 AM ready for a collecting trip to the Sierra Nevada. Much to my chagrin, my alarm clock failed me, and after a five minute sprint (with basket on arm) from the dorm to the designated rendezvous, I found HDT pacing Holloway Avenue like an expectant father. After minor harassment, we were underway in HDT's VW camper. Taking my duty as "shotgun rider" nonchalantly, I quickly learned not to offer hot coffee and sweet rolls to the driver (Harry) until after the Livermore interchange. Unfortunately, by the time we

reached Livermore, the coffee was nearly gone and the sweet rolls were but a fond memory to us students. At this point, HDT initiated a pointed discussion about graduate student eating habits, whereupon our destination (Silver Lake Campground) seemed several lightyears distant. Having chosen as a thesis project to work on Sierra Nevada boletes (a wise move I thought), I believed I now could redeem my tardiness and gluttony by showing my vast knowledge of Sierran boletes. After five minutes collecting, I soon realized that Boletus rubripes was not B. edulis, Gastroboletus turbinatus was not diseased, and that I should never again let myself be tricked into tasting B. calopus. When HDT made the suggestion to return to the car for lunch, I felt some relief. Finally, I thought, something I know how to do. On the way from the car to the picnic table, however, I dropped the jar of mustard (Grey Poupon no less) on the asphalt parking lot, prompting comments about the usefulness and qualities of today's graduate students, and instigating instant flashbacks of all my previous blunders that day. Extraordinary caution the rest of the trip prevented further damage to my bruised ego. Nevertheless, I felt challenged.

During the next two years, there were many more trips, especially to Silver Lake. These were times that I remember fondly and believe I was particularly lucky to have a chance to benefit from HDT's expertise in the field. His jesting that demanded rebuttal, frankness, enthusiasm, and overwhelming interest in a student's welfare inspired confidence to meet the challenges. Fortunately, I learned, among other things more academic, the appropriate times for drinking coffee and eating pastry in the car. [Roy E. Halling]



Supervising the collection of hypogeous fungi near Yuba Pass.

I recently returned to visit SFSU 10 years after receiving my Master's degree under Dr. Harry Thiers. As I drove to the campus, it appeared that nothing had changed in those intervening years. I parked my car in the same place I had always parked it and felt distinctly odd not carrying any books as I walked to the Botany building. To reach the graduate student desks in the herbarium, one must walk through a complex maze of herbarium cases which I found I could still negotiate on remote control. I have such a strong association with the aroma of naphthalene and dried mushrooms from my student days that it seemed as though each case I passed removed one of the last 10 years.

The arrangement of the herbarium was exactly as when I'd been there, and my old desk was in its same place - I almost walked over and sat at it. Not only that, but nicknacks from a party 12 years ago were still decorating the room. Dr. Thiers has always been famous for the annual Christmas and end-of-the-year parties. One holiday season, we were required to make a gift to exchange with another graduate student. The only requirement was that it be made out of cryptogams. With the imagination typical of graduate students, we all went to work on these projects. The results ranged from freeze-dried mushroom arrangements to bracelets made out of Lactarius subdulcis to a mobile made out of lichens and mosses. The mobile is still tacked to the ceiling with a thumb tack!

Dr. Thiers was also the same as ever; warm, friendly, welcoming and always ready with a joke or a mildly sarcastic quip. The first time Dr. Thiers teases a new student is like a rite of passage or the beginning of acceptance in the ranks of grad students. He used to tease George Wong for sleeping at his desk, Janelle Curlin for her diminutive stature and I got it once when we were going on a trip in northern California. Another student and I were driving together and missed the turnoff. We didn't notice that we'd gone too far until we saw the "Welcome to Oregon" sign. This gave HDT sufficient fuel for teasing to last several days. For some reason, Roy Halling was labelled the "penultimate authority" during his time at State. Dr. Thiers was always quick to emphasize the penultimate nature of it. When a beginning student asked HDT for identification of some common mushrooms, he'd often say to take those to the penultimate authority and he might know what they were.

Another major source of memories from SFSU were the numerous field trips and forays we took. We covered nearly every part of California, and beyond, in search of fungi, mosses, lichens and higher plants. As long as I've known Dr. Thiers, his expectations of students always seemed equitable, regardless of gender, when it came to setting up tents, cooking, building fires or hiking over any kind of terrain in search of the elusive mushroom. I look back very fondly on the years I spent studying under the exceptional guidance of Dr. Thiers. [Betty K. Tamm]

I wonder if any one of us knew, as we luxuriated amidst the incredibly rich labs of Dr. Thiers' classes, just how many levels of learning there were. I had no idea until I began to teach labs myself at the University. There I poured over his class notes, read and reread his marvelous lab handouts and slowly began to understand what an extraordinary education had been mine. Everything was organized around a deceptively simple formula: compare, contrast, synthesize. This was a formula for learning and it was also a formula for teaching. Now I understand why so many of us later taught. That is what HDT meant for us to do. He was never selfish with his vast knowledge and he did not mean for us to be selfish.

The openness and generosity that HDT showed his students extended to other teachers and researchers as well. I look on my hours in the herbarium as the most intellectually stimulating time of my life to date. Dr. Thiers' bottomless coffee urn drew students and professors studying bees, butterflies, ecology, algae, plant chemistry, bryophytes and more. The list is a long one. It was in the herbarium that I learned about open sharing of ideas, frank admission of research problems, and to see the relatedness of all the natural sciences. Sharing, not secrecy, was the power of the herbarium. "When my students win, I win," he often said. HDT brought the great names in the field to our herbarium gatherings to share their knowledge, discuss our work and often contribute to our bulging herbarium.

Now I understand how important it is for a teacher to respect students, for students to be taught to respect each other, and the power of humility in the face of greatness. HDT's philosophy of life has stayed with me as surely as his beautiful labs in pathology, lichenology, lower vascular plants, mushrooms and soil fungi. It

is a rich inheritance. Thank you, Sir. [Janelle M. Curlin]

One morning in 1978 as a middle-aged reentry student working towards a masters in biology, I found myself in a large general botany lecture hall. I was much impressed with the energy and enthusiasm of the professor, Dr. Harry Thiers, and thought to myself, "Wow! This guy must have been teaching this subject for 20 or 30 years and yet he still makes non-vascular plants sound like the best things that ever happened. And at eight o'clock in the morning!"

A year later, I had a desk in the herbarium and was one of Harry Thiers' graduate students, specializing in lichenology. It was a privilege to enter into this association. The atmosphere in the herbarium was unique. There was much hard work, great field trips, fine parties, and Harry Thiers always present to help with our questions and problems. He was incredibly generous with his time, talents, and equipment. At the same time, he encouraged and prodded each of his students to accomplish as much as possible, largely by example. Thank you, Harry, for the "Herbarium Experience." [Janet Hoare Doell]

A course taken from Dr. Thiers is a course never to be forgotten. Each one has at least one field trip; usually there are four or more. Such a wealth of information, and presented in such an interesting and organized manner, his teaching abilities are beyond comparison. Not only in the classroom, but in the field, this man is full of unique knowledge as well as wonder and a yearning to discover more. Anyone who has had the pleasure to spend some time with Dr. Thiers, knows this is easily bestowed upon them. Whether it be in Marin, Sonoma, Mendocino, Humboldt, Del Norte, Siskiyou, Shasta, Sierra, Santa Clara, Santa Cruz, San Mateo, or San Francisco Counties in California, or perhaps another state, the experience is always greatly enhanced by his generosity and enthusiasm.

He has such wonderful stories from years past taking place in Michigan, Montana, Idaho, Arizona, Texas, and the southern U.S. I wish I had taped these during his lectures. Though I may never get to one, I will always know how to walk

in a Sphagnum bog after his brilliant demonstration!

As can be seen from this volume, Harry Thiers' contribution to mycology is enormous, invaluable, and something to be so proud of. And finally his contribution to education is noteworthy, whereby many of his former students have gone on to be fine teachers. [Michelle Seidl]

I first met Dr. Harry D. Thiers in the fall of 1973 while he was engaged in the identification of mushrooms for the Mycological Society of San Francisco's fungus fair. Early the following year, I signed up for an evening class Harry offered to members of the mycological society who were interested in learning the technical ins and outs of mushroom identification. I soon discovered, via this informal class,

Harry's gifted teaching talents, and his tremendously vast knowledge of fungi. Although our class only met for a few hours once a month, my guided discovery and fascination with the microscopic features of fungi quickly led to the purchase of a

microscope and a number of technical monographs.

It was not until the spring of 1982 that I took the first formal course from Harry through the San Francisco State University extension system. This course, "Higher Fungi of the Sierra Nevada," first offered in June 1982, was held at San Francisco State's Sierra Nevada Field Station, near Yuba Pass, California. The course was attended by about 20 students, including Dr. Walter Sundberg, Dr. Andrew Methven, Dennis Desjardin, and Janelle Curlin, all of whom were either past or current students of Dr. Thiers. By the end of the week, our class had collected and identified some 220 species associated with the melting snowbanks and spring runoff in the Yuba Pass region. It was through this class that I got my first real taste of mycological taxonomy and encountered the tremendous pleasure of discovering the fascinating realm of the snowbank fungi. Harry continued to teach this class up through June 1987, finishing with a class size of just over 40 students.

In January 1985, through a fortuitous change in jobs, I was able to re-enter college, and begin a course of study under Harry's guidance. Admitted as a junior, I was able to attend full time for only the first semester. That summer, after Harry's class at Yuba Pass, I found another job which would allow me to continue as a part time student, while working full time to support my family. Aware that Harry was to retire in January 1989, I knew that I would need to take all of his courses quickly if I was to fit them in my schedule prior to his retirement. I feel fortunate indeed that I have been able to complete all of the classes that he offered during this time, and am particularly grateful to Harry for rescheduling some of these classes to

meet during hours which I could attend.

Harry takes a great deal of pride in each of his students, following their varied careers with interest and enthusiasm. His prior students often visit, write or call him to chat about current projects, career moves, etc. just to keep in touch. His correspondence desk has a transparent cover under which he keeps a large number of photographs of his students and close associates. He even hosts an annual reunion dinner for his prior students each summer at the MSA meetings. I see him react not unlike a father to many of his students, giving advice, guidance and direction when called for, providing a strong foundation upon which to build a future career. He often displays prominently in the herbarium letters from his former students for the current crop of botany students and staff to read, so that they too feel as part of his family. I am proud to have Harry as a very respected friend, and feel fortunate that he has played a major role in my life and education. [Herb Saylor]

Sharing the laboratory with Harry D. Thiers is an integral part of the experience of an education in taxonomy. Dr. Thiers is a sight to behold, especially when he is working on taxonomic projects. I have had the privilege of observing him during his most recent endeavor with California Russulas. Nothing pleases Harry more than a drier full of specimens, spore prints already made, and preliminary notes written. The initial result of a successful collecting trip is an herbarium full of discarded wax bags, and assorted debris scattered on counter tops and the floor. The atmosphere in the herbarium at this point reflects Harry's expansive mood. Later, when his microscopy starts in earnest, he becomes a different man. Quiet studiousness reigns during these weeks, while he buries himself in the wide, unforgiving bosom of his oculars. "Got six done this afternoon!" indicates a moderately good session. "Why don't you give up those Cladonias of yours?" is a playful

statement of his own frustration, and a challenge to spar. "I've got to go down to the bank," or more ominously, "Take a look at how neat everything is down at my end [of the herbarium]!" portends a struggle with intransigent pleurocystidia or spore ornamentation. Following a major cleaning session, during which the shelves holding Mycologia or The Bryologist are meticulously put in order and lined up, correspondence conquered, and reprints filed, the herbarium is slowly emptied of talkative students. Not until Dr. Thiers has safely returned to his microscope do the students filter back in.

Despite his immense objectivity and scientific discipline, Harry has been known to reflect on a few of his major successes. One of these is that he convinced Alex Smith of the phylogenetic significance of hypogeous fungi in the Sierra Nevada. Another source of pride is his mycologist's sense of smell and taste; the "green corn" [pronounced 'cam' until recently -Eds.] odor is known to all his students. I can boast of a minor accomplishment in this realm, convincing Harry that he can smell atranorin in certain lichen species.

Some ways born of a harsh west-Texas boyhood die hard. Five o'clock marks the suspension of all work, be it in the field or laboratory, for the requisite happy hour. An hour or two of relaxation is inevitably balanced by a return to work. Nights find Dr. Thiers burning the candle until at least nine or ten PM. Even on damp field trips to Patrick's Point State Park or Jackson State Forest, he finds an empty picnic bench after dinner to set up his specimens for spore prints.

His late afternoon sabbatical works in tandem with another habitude, the extension of warm and heartfelt hospitality to all who enter the herbarium. While I worked at SFSU with Harry Thiers, people from all parts of the world were welcomed and assisted in their scientific pursuits. This marks the greatest quality of Harry as a taxonomist and teacher: his desire and ability to share with others. His sense of wonder, curiosity, and generosity continue to benefit all who cross his path. [Samuel Hammer]



Discussing collecting strategy at Yuba Pass.

REMEMBERING THE MOREL GROWER: RON OWER, 1939-1986

Ronald Dean Ower was born on 15 May 1939, and died on 23 March 1986, victim of a murder-robbery. Ron was a long-time member of the San Francisco Mycological Society, who, after selling his sign-painting business, became a graduate student of Harry Thiers at San Francisco State University in the fall of 1977. He wanted to grow morels (*Morchella esculenta* L.) in artificial culture, and this was the topic of his master's degree research. He was not successful in inducing his cultures to fruit during the course of thesis work, which he concluded in the spring of 1980 with a thesis entitled "Cultural studies of morels". However, after completion of his degree, Ron was permitted to continue his culture work at the University. On 14 December 1980, he first detected the development of ascocarps that later developed to maturity. These were subsequently harvested on 11 January 1981, and deposited in the San Francisco State University Herbarium (SFSU). After duplicating his results, he published a brief article on the achievement: Notes on the Development of the Morel Ascocarp: *Morchella esculenta*, Mycologia 74: 142-143. 1982.

Ron then began work on scaling up his technique, in order to develop commercially viable cultivation. He entered into an association with Neogen Corporation, a biotechnology firm in Lansing founded by Michigan State University in 1982. On 17 June 1986, a federal patent was granted to Neogen (Patent #4,594,804) for the "Cultivation of Morchella." Ron Ower was credited with development of the technique. Tragically, he died three months before the patent was granted. The following are recollections about Ron and his work by three students of Harry Thiers who were contemporaries. [Barbara M. Thiers].

I remember Ron's first spring with Dr. Thiers as a time when Ron frequently would be out in the field, camping in some likely but frigid spot, waiting for the first *Morchella* primordia to appear. It was apparent that Ron's approach to understanding reproductive initiation in *Morchella* was to be thoroughly familiar with the natural history of the phenomenon. To this end he assiduously applied himself, and we saw rather little of him for several weeks. I could tell before arriving at the herbarium whether he had returned from such an expedition; he and I parked in the same peripheral sector of the SFSU environs, and one could not miss the large signs for the "Morchella Co." which adorned the doors of his truck. He would show us what, if anything, he had found, and make taxonomic predictions about it, before setting to work on culturing the new material.

As his work progressed he shifted his focus to laboratory work. He explored the genetics of sexuality in *Morchella* with the help of a micromanipulator, spending long hours on "ascus stroking," as he called it. He explored anamorphteleomorph connections in these organisms, but did not submit his findings when a similar report appeared in the literature. Most of his later work at SFSU focused on cultural techniques for inducing reproductive growth in *Morchella* under controlled conditions, and, as is well known, he was the first to succeed in achieving this. Subsequently he explored the morphology of the developing ascoma of the morel.

Ron Ower was somewhat of an enigma to me. He could at times be surprisingly candid, while at others he was very reserved. From the outset of his research career at SFSU he realized the commercial potential of his research objectives; as a result he became less communicative over time, to the point where I couldn't say I knew his personal or professional side very well. By that time I was employed in the commercial mushroom industry, at one point with a firm who was negotiating with Ron for rights to his morel-growing process, which explains why Ron may have experienced a conflict as regards the nature of our communications.

I remember Ron as a relaxed and genial individual, never the center of attention, almost playful in his approach to social behavior and to life in general. When one was aware of his presence he was usually make some positive contribution to a conversation in the herbarium or a meal on a field trip. He accomplished his initial scientific objective of fruiting the morel, and after years of effort he also met with reasonable financial success in exploiting the commercial aspects of his process. I last spoke with him about a year before his death when he referred to the continuing experiments on *Morchella* culture that he was conducting in his small private laboratory in San Francisco. He was intrigued and optimistic. [Richard W. Kerrigan]

I was obsessive about cleanliness. Ron thought that was a waste of time. We shared a growth chamber. The combination could have been a disaster. Instead, it was fun and occasionally even exciting. Like the day Ron announced that wild morels did not fruit in sterilized soil, and that was probably why his were not fruiting. After that, my marine fungi shared their growth chamber with trays and trays of horse sweeping from Golden Gate Park, unautoclaved.

My marine fungi were never contaminated. Ron's morels fruited right on schedule for HDT's farewell party as he left for Australia on sabbatical.

Ron and I confided our fears of aging, poor memory, loneliness, and money troubles. He gave my various boyfriends nicknames. One I particularly remember was dubbed "Old Abe Lincoln." Our favorite conversation topic was HDT (of course). Ron said that two hours of conversation with HDT could provide him with weeks of good ideas. We tried to figure him out. Why was he so intellectually stimulating? Why did we all work so hard for him? How could we ever be like him? Did he really care as much as he seemed to? How could he get so much done on his own research when he spent so much time teaching? What was the secret of his encyclopedic memory? It was a topic we never tired of discussing.

My slide collection contains many slides of Ron and his collecting finds. He had a sixth sense in the field and not only for morels. I treasure those slides of a man who really enjoyed fungi and whose big smile conveyed his delight. [Janelle Curlin]

Ron Ower sat facing me in the lichen lab and when I think of him I picture his very round eyes and open countenance. He was not enchanted with lichenology and especially disliked memorizing all the names, something he could not do well.

He was a conscientious student and tried valiantly to study each collection in detail. He was conscientious in other ways as well and it bothered him that his parents had to help support him while he was devoting so much time to his morel growing project. *That* was an interesting semester. We cheered at every 1/8 mm of growth, grieved over the ones that did not survive, and considered it an honor to be invited into the inner sanctum to take a peek.

However, he agonized in the succeeding weeks and months as he tried to turn his discovery into a livelihood. He was depressed more than once, but always

grabbed eagerly at hopeful developments and was happy to talk about them whenever we ran into each other after graduation. He was adamant about not leaving San Francisco and that added to the difficulty of working out something in Michigan.

Ron was something of a loner. He enjoyed an occasional meal at our home, including holiday dinners, and rarely seemed to have other commitments. He was a gentle person. It is hard to imagine him suffering such a violent death. He deserved something much better. [Janet Hoare Doell]



Ronald Dean Ower: 1939-1986.

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DERMOCYBE, SUBGENUS DERMOCYBE, SECTION SANGUINEAE IN NORTHERN CALIFORNIA

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ABSTRACT

Five taxa in the genus <u>Dermocybe</u>, subgenus <u>Dermocybe</u>, section <u>Sanguineae</u> are fully <u>described</u>. These <u>include D</u>. sanguinea and <u>D</u>. semisanguinea; a new species, <u>D</u>. sierraensis; and two new combinations in <u>Dermocybe</u>, <u>D</u>. californica and <u>D</u>. phoenicea var. <u>occidentalis</u>. A key to these taxa is provided.

INTRODUCTION

In all earlier publications by the author <u>Dermocybe</u> was considered to be either a subgenus or section of <u>Cortinarius</u>. Here, <u>Dermocybe</u> is recognized as a genus with <u>limits</u> as defined in <u>Singer</u> (1986). In this paper only the section <u>Sanguineae</u> is treated. Furthermore, only those species recorded to date by the author from northern California are described below. A more extensive, but still incomplete treatment of section <u>Sanguineae</u> for North America, can be found in Ammirati and <u>Smith</u> (1984).

In this study all microscopical data was taken from sections or pieces of dried basidiomata which were mounted in a 3% aqueous solution of potassium hydroxide. Capitilized color notations are from Ridgway (1912). Uncapitilized color terms are regarded as useful approximations. Terms such as moderate reddish orange are from Kelly and Judd (1965). All cited collections are deposited in the San Francisco State University Herbarium (SFSU) unless otherwise noted by use of an abbreviation from Index Herbariorum.

BRIEF SYNOPSIS OF SECTION SANGUINEAE

Basidiomata small to medium sized; pileus surface silky to innately fibrillose, appressed fibrillose, or minutely squamulose, dry to moist, usually not hygrophanous or hygrophanous to subhygrophanous, color deep to rich red. purple-red, reddish brown to brownish orange, or less commonly yellow-brown to somewhat olive-brown; context thin to moderately thick; lamellae when young dark to rich red, purplish red, rich brownish red, reddish orange or brownish orange, rarely truely orange or yellow; stipe usually slender, equal or the base somewhat enlarged. silky to fibrillose, variously colored, often, but not always, concolorous with the pileus surface and lamellae; interhyphal pigment deposits often lacking, when present usually occurring as small deposits or particles; basidiomata rich in anthraquinonic pigments (see Keller and Ammirati, 1983); potassium hydroxide (3% aqueous solution) applied to pileus surface of fresh basidiomata dark red. purple-red, purple or blackish purple; basidiospores ornamented; cheilocystidia either present, and not well differentiated, or absent.

Type species: <u>Dermocybe sanguinea</u> (Wulf. : Fr.) Wünsche

KEY TO SPECIES AND VARIETIES

- Pileus surface color usually yellow-brown to dark yellow-brown, at times more yellowish, orange-brown, or olive-brown; KOH (3% aqueous solution) instantly changing the pileus surface to purple or blackish purple when applied to fresh specimens; lamellae rich red to purple-red; stipe typically some shade of yellow, pinkish or reddish tones may be present on the base, and similarly colored fibrils may sparsely coat the surface D. semisanguinea
- Basidiomata not as described above; pileus lamellae, and often (but not always) the stipe, purple, red, red-brown, orange-red or more orange in color . . . 2
- Pileus surface color deep red to rich red or deep red-brown; lamellae deep purple-red to deep red or bright red; stipe ground color yellow to ochraceous to dingy buff, the stipe base similarly colored or

| | pinkish to reddish, and reddish to pale ferruginous red or brownish fibrils may or may not coat the stipe surface |
|----|---|
| 2. | Pileus, lamellae and stipe basically more or less concolorous when fresh, usually some shade of purplered, red, or orange-red to brownish orange (yellowish to ochraceous colors may be present on the stipe base) |
| 3. | Stipe ground color some shade of yellow, base or surface fibrils may be colored reddish or pinkish <u>D. phoenicea</u> var. <u>occidentalis</u> |
| 3. | Stipe ground color more dingy buff, surface sparsely to more heavily coated with reddish fibrils see discussion under $\underline{\textbf{D.}}$ phoenicea var. occidentalis |
| 4. | Pileus surface appressed silky to silky fibrillose, hygrophanous or not hygrophanous, color reddish orange, reddish brown, brownish red-orange or brownish orange |
| 4. | Pileus surface appressed fibrillose to minutely squamulose, not hygrophanous, color deep red to rich red, vivid red or purple-red 6 |
| 5. | Pileus surface appressed silky, more or less hygrophanous, color reddish brown to reddish orange, fading to brownish orange; stipe surface some shade of orange to reddish orange with a more or less concolorous base (often orange-red); basidiospores verrucose, 8-9.5 x 5-6 um in size D. californica |
| 5. | Pileus surface silky to fibrillose, not hygrophonous, color brownish orange to brownish red-orange; stipe deep vinaceous to almost concolorous with pileus surface, base vinaceous not (yellowish or ochraceous); basidiospores verruculose, 7.5-9 (-9.5) x 5-5.5 (-6) um in size |
| 6. | Pileus, stipe (except for base), and lamellae rich to deep red or blood red <u>D. sanguinea</u> |
| 6. | Pileus, stipe (except for base), and lamellae more vivid red to purple-red see discussion under <u>D. sanguinea</u> |

DESCRIPTIONS OF TAXA

Dermocybe californica (Smith) comb nov.

BASIONYM: Cortinarius californicus Smith, Contrib. Univ. Mich. Herb. 3:37-38. 1939.

PILEUS 16-85 mm broad, obtusely conic to companulate becoming broadly companulate, umbonate to broadly umbonate; margin typically decurved, appressed against the stipe at first; surface smooth, glabrous to appressed silky, more or less shiny, moist to dry, more or less hygrophanous, color moderate reddish brown (Bay, Hay's Russet) to dark reddish orange (Vinaceous Rufous) or strong brown (Kaiser Brown) at first, fading to brownish orange (Cinnamon Rufous), with the disc often remaining darker. Context moderately thick on the disc, watery at first, moist to dry, concolorous with surface of moist or faded pilei, often pale reddish ferruginous; odor and taste not distinctive or slightly fungoid-raphanoid.

LAMELLAE adnate becoming slightly adnexed, narrow to moderately broad (5-7 mm wide), often more or less ventricose, subdistant, color dark reddish orange to moderate reddish orange (English Red, Mars Orange) or deep orange (Orange Rufous) at first, becoming deep orange (Burnt Sienna) or ferruginous brown; edges long retaining the original color, fimbriate or slightly serrulate.

STIPE 50-150 (-200) mm long, 5-15 (-22) mm thick, the base often 10-20 mm thick, terete, equal or more frequently the base slightly enlarged to clavate, occasionally narrowed below; surface dry appressed silky or sparsely fibrillose, subshiny, color dull orange, dark reddish orange to moderate reddish orange (Ferruginous) or moderate orange (Flesh-Ochre), sometimes with orange fibrils from remains of cortina, basal mycelium often orange-red. Context solid becoming hollow, color pale moderate orange (pale Flesh-Ochre) to rusty red near the surface, unchanging. CORTINA profuse, fairly persistent, color pale moderate orange (pale Flesh-Ochre).

BASIDIOSPORES (7.4-) 8-9.5(-11) x (4.8-)5-5.8 (-7.0) um, in profile view elliptical to broadly elliptical, at times somewhat fusiform or more or less amygdaliform, in face view elliptical to broadly elliptical or fusiform,

more or less verrucose, ornamentation coarser toward distal end, yellow-brown with darker brown ornamentation. BASIDIA 4-spored, 24.1-32.9 x 5.8-8.0 um, elongate-clavate to clayate or broadly clayate, hyaline to faintly purple or pinkish, often containing deep purple to red-purple granules, some containing brownish to yellow-brown pigment. PLEUROCYSTIDIA absent. CHEILOCYSTIDIA 21.9-38 x 6.6-13.1 um, more or less cylindrical to cylindrical-clavate, clavate, broadly clavate or somewhat ventricose, thinwalled, color similar to basidia, usually mixed with basidia but sometimes in groups. TRAMAL HYPHAE OF LAMELLAE subparallel, somewhat interwoven, 3.3-29.2 um wide, cylindrical to more or less inflated, hyaline to slightly pinkish or purplish, some containing purple, red-purple or pinkish purple granules. CUTICULAR HYPHAE OF PILEUS interwoven, more or less radially arranged, cylindrical to inflated, 3.7-26.5 um wide, in surface layer mostly 3.7-8.8 um, the broader, inflated hyphae more common in the subcuticular region (this often appears as a distinct hypodermium between the surface layer and trama), thinwalled, some encrusted, hyaline, yellowish, light brownish or yellowish brown in the surface layer, in the subcuticular region similar to tramal hyphae of pileus; no pileocystidia seen. TRAMAL HYPHAE OF PILEUS interwoven, more or less radially arranged, especially in upper trama, cylindrical to inflated, 5.1-29.2 um wide, color similar to tramal hyphae of lamellae. CLAMP CONNECTIONS of the normal or medallion type, present throughout the basidiomata. INTERHYPHAL PIGMENT DEPOSITS absent (some small interhyphal granules may be present but no large deposits).

Solitary or gregarious to caespitose in mixed hardwood-conifer and conifer forests; October into December.

COLLECTIONS EXAMINED. California. Del Norte Co.: B.F. Isaacs 506 (WTU); J.F. Ammirati 140, 141; A.H. Smith 8957 (holotype, MICH); H.D. Thiers 14308, 14496. Humboldt Co.: J.F. Ammirati 148. Mendocino Co.: J.F. Ammirati 717, 6185, and 6186, (both MICH); J. Motta ID 328; H.D. Thiers 9628, 18460, 21751, 30464, 30825, 33177, 35602, 40601; G. Wong 359. Siskiyou Co.: H.D. Thiers 46798. Tuolumne Co.: H.D. Thiers 46934. Yuba Co.: H.D. Thiers 47143.

Dermocybe californica is one of the most common and widespread species of section Sanguineae in Northern California. In general it occurs along the west coast from California into Canada and east as far as northern Idaho.

Its overall coloration (reddish brown, reddish orange, brownish orange), more or less silky, usually hygrophanous pileus, and coarsely ornamented basidiospores, easily separate it from all other Sanguineae. It is very closely related to Dermocybe cinnabarina (Fr.) Wünsche, differing primarily in its preference for coniferous forests. D. cinnabarina occurs in Europe in deciduous forests with Fagus, Quercus or Carpinus.

Dermocybe phoenicea var. occidentalis (Smith) comb.

BASIONYM: Cortinarius phoeniceus var. occidentalis Smith, Contr. Univ. Mich. Herb. 2:30-31. 1939.

PILEUS 30-80 mm broad, broadly convex, becoming expanded, more or less umbonate; margin usually decurved; surface moist to dry, innately silky becoming appressed fibrillose at maturity, often cracking radially in age, color evenly dark red to rich red (0x-Blood Red to Garnet Brown) or dark mahogany red. Context rather thin, firm, color buff, with reddish tints near the cuticle and olivebrown coloration near the stipe; odor and taste none or not distinctive.

LAMELLAE adnate to adnexed, subdistant to distant or appearing close in small pilei, broad, equal, color deep purplish red (Bordeaux) to deep red, sometimes with brighter red (almost Carmine) edges, with a changeable or metallic sheen when viewed at different angles, becoming more or less rusty in age.

STIPE 40-110 mm long, 6-15(-30) mm thick, equal or sometimes clavate to ventricose, surface moist to dry, color evenly yellow (Mustard Yellow) to dull yellow (Chamois, Honey Yellow), or dull ochraceous, with a coating of yellowish fibrils, mycelium around base and in soil ochraceous to ocher-yellow (Yellow Ocher) or tinged reddish to vinaceous red. Context light yellowish olive (Old Gold), becoming sordid brownish in age.

CORTINA scanty, dull yellow (Chamois), light ochraceous or yellow-buff.

BASIDIOSPORES $(6-)6.5-8(-9) \times 4-5(-5.5)$ um. in profile view elliptical, in face view elliptical, verrucu-lose, pale brownish with darker brown ornamentation. BASIDIA 4-spored, 24-31 x 6.5-7.5 um, clavate, thin-walled, hyaline or reddish to pinkish, some containing hyaline or reddish granules. PLEUROCYSTIDIA absent. CHEILOCYSTIDIA apparently absent. TRAMAL HYPHAE OF LAMELLAE subparallel to slightly interwoven, cylindrical to inflated, 5-18 (-23) um wide, hyaline to pinkish or light reddish vinaceous. CUTICULAR HYPHAE OF PILEUS interwoven, more or less radially arranged, cylindrical to inflated, 5-18 um wide, thin-walled, faintly colored or light brownish, light reddish to light vinaceous, or containing a concentrated reddish purple to bluish purple pigment and often purplish granules; pileocystidia absent (apex of end cells rounded to tapered). TRAMAL HYPHAE OF PILEUS interwoven, more or less radially arranged, cylindrical to inflated, 3-31 um wide, hyaline, yellowish, yellowish brown, or pale vina-ceous. CLAMP CONNECTIONS of the normal type, present throughout the basidiomata. INTERHYPHAL PIGMENT DEPOSITS present in the pileus trama, the stipe cortex, and among the hyphae of the universal veil, in KOH yellowish, brownish orange, orange, or reddish orange.

Caespitose to gregarious or scattered in conifer or mixed woods (Picea, Pinus, Pseudotsuga, Tsuga). October to mid-December or sometimes as early as August in the higher mountains.

Collections examined. California. Del Norte Co.: A.H. Smith 8339, 8591, 8997, 55937 (all MICH). Humboldt Co.: J.F. Ammirati 8550 (WTU); H. Lamphere 34 (MICH); A.H. Smith 8679, 56057, 56228, 56282, 56517 (all MICH). Mendocino Co.: J.F. Ammirati 6213, 6215 (both MICH); H.D. Thiers 30399, 30429, 30862, 33278, 38386, 40483, 41649, 43935. Monterey Co.: H.D. Thiers 32169, 39598. Yuba Co.: H.D. Thiers 44130, 47142.

Dermocybe phoenicea var. occidentalis is the most frequently encountered member of section <u>Sanguineae</u> on the Pacific Coast, extending from California into Alaska. It also occurs in the mountains of the interior, where it can be found in some years as early as August. It prefers coniferous woods, but also occurs in mixed forests of conifers and deciduous trees.

As described by Smith (1989), D. phoenicea var. occidentalis has a dark red to rich red, silky to appressed fibrillose pileus, deep purplish red to deep red lamellae. and a yellowish to ochraceous stipe with a coating of yellowish fibrils. The stipe base being either ochraceous or tinted reddish. This is the most common form of this variety. On the Pacific Coast there is a less frequent form which has a dingy buff (Cinnamon-Buff) stipe coated with pale ferruginous red fibrils (for examples, A. H. Smith 56282 and 56517). This is not recognized here formally for two reasons. Firstly, these collections may simply represent one end of a color spectrum where the stipe ground color has lost the yellow coloration and the surface fibrils are more reddish. A similar pattern of variation can be seen in a close relative D. semisanguinea in both North America and Europe. Secondly, D. phoenicea var. occidentalis needs to be more carefully compared with European material of D. phoenicea var. phoenicea (Bull. ex Maire) Moser, to determine if they are really parts of the same species. Once this is accomplished variation in D. phoenicea var. occidentalis can be better evaluated and additional infraspecific taxa established it this is appropriate. D. phoenicea var. phoenicea, which has a more brownish to brownish red pileus, is not particularly common in North America and may occur only in eastern North America.

Dermocybe sanguinea (Wulf. : Fr.) Wünsche, Die Pilze. 125.

BASIONYM: Agaricus sanguineus Fr., Systema Mycologicum. I. 229.1821.

SYNONYMS: Cortinarius sanguineus (Fr.) S.F. Gray, A
Natural Arrangement of British Plants. I.
629.1821.

Cortinarius sanguineus (Fr.) Fr. Epicrisis Systematis Mycologici. 288.1838.

PILEUS 18-45 mm broad, somewhat obtuse to convex or plane, disc more or less depressed; margin incurved to decurved; surface appressed fibrillose to minutely squamulose, sometimes radially rimose on the margin, color on disc rich red (Garnet Brown) to deep red (Maroon to deep

Garnet Brown) or tinted with colors of the margin, on margin rich red (Garnet Brown to Ox-Blood Red) or duller red (Coral Red), sometimes streaked deep red to fuscousred (Maroon to Victoria Lake). Context watery deep red (Maroon to Garnet Brown), where faded or beneath cuticle lighter red (near Coral Red); odor somewhat fragrant, mild or raphanoid; taste mild to raphanoid.

LAMELLAE sinuate to broadly depressed with a more or less decurrent tooth, close, more or less ventricose when mature, at first rich red (Ox-Blood Red, dull Carmine or Garnet Brown), becoming shaded rusty brown to dusky brown from the basidiospores; edges uneven.

STIPE 45-85 mm long, apex 3-9 mm thick, equal or the base slightly enlarged; surface fibrillose, shiny, rich red (Garnet Brown, Ox-Blood Red) or duller red (Coral Red), sometimes with watery deep red (Maroon) streaks, base or lower third dull ochraceous (Ochraceous-Buff) or the ochraceous coloration slightly tinted orange to reddish. Context stuffed to narrowly hollowed, rich red (Garnet Brown to Ox-Blood Red) throughout or deeper red (Maroon) in the lower portion, where faded paler red.

BASIDIOSPORES $6.5-9(-10) \times (3.5-)4.5-5(-5.5)$ um, in profile view elliptical, in face view elliptical to ovate, verruculose, color brownish to fulvous. BASIDIA 4-spored, 15-25 x 6-7.5 um, broadly clavate, clavate, or more or less ventricose, hyaline to pinkish. PLEUROCYSTIDIA absent. CHEILOCYSTIDIA 12-23 x 7-10 um, clavate to broadly clavate, thin-walled, color similar to basidia. TRAMAL HYPHAE OF LAMELLAE subparallel to slightly interwoven, cylindrical to more or less inflated, 5-25 um wide, hyaline, pale pinkish or light vinaceous, CUTICULAR HYPHAE OF PILEUS interwoven, more or less radially arranged, cylindrical to inflated, 8-30 um wide, thin-walled, pale pinkish to pale vinaceous or containing a more or less concentrated reddish to reddish vinaceous pigment; pileocystidia absent (hyphal end-cells with rounded to tapered apices). TRAMAL HYPAHE OF PILEUS interwoven, more or less radially arranged, cylindrical to inflated, 7-30 um wide, color as for the tramal hyphae of the lamellae or containing vivid red pigment and granules. CLAMP CONNECTIONS of the normal type, present throughout the basidiomata. INTERHYPHAL PIGMENT DEPOSITS present as small yellow to orange particles in H2O, in KOH none observed.

Gregarious in mixed woods, mixed conifers, and Douglas fir stands. Mainly November through mid-January.

COLLECTIONS EXAMINED. California, Humboldt Co.: J.F. Ammirati 6187 (MICH); H. Lamphere 56 (MICH); A.H. Smith 3747, 9156 (both MICH); H.D. Thiers 14358, 14427. Mendocino Co.: H.D. Thiers 9944, 14684.

Dermocybe sanguinea is widely distributed in North America and almost always occurs in coniferous woods. It is characterized by rich to deep red basidiomata that have ochraceous to orange-ochraceous mycelium over the stipe base. The pileus surface is typically appressed fibrillose with minute squamules or scales, especially on the margin. Along the Pacific Coast a more vivid red (Rose Red) to purplish red (Bordeaux) variant occasionally has been collected, for example, A.H. Smith 79922 (MICH), Tillamook Co., Oregon. Since its coloration integrades with that of typical D. sanguinea, and it does not differ significantly from the latter in other features, it is not recognized here as a separate taxon. Species in section Sanguineae, which might be confused with D. sanguinea, are D. sierraensis and D. california. Check descriptions of these taxa before making a final determination.

Dermocybe semisanguinea (Fr.) Moser, Schweiz. Z. Pilk. 52:129. 1974.

BASIONYM: Agaricus cinnamomeus L.: Fr. var. semisanguineus Fr.

Cortinarius semisanguineus (Fr.) Gillet, Les Hymenomycetes. 486. 1874.

PILEUS 15-50(-70) mm broad, conic-campanulate to rounded-conic becoming convex to plane, umbonate to subumbonate; margin slightly inrolled at first becoming incurved to decurved; surface appressed fibrillose to fibrillose-scaly, sometimes more or less rimose on the disc, moist to dry, not hygrophanous, color on disc yellow-brown (Ochraceous-Tawny) or orange-brown (Amber Brown) or dark yellow-brown (Sudan Brown), on margin typically yellow-cinnamon to ochraceous brown or ochraceous-buff, sometimes when young tinted orange-buff (Apricot Buff), in age tinted or streaked with colors of disc, occasionally the

overall coloration tinted with light olive-brown (Old Gold, Tawny Olive). Context solid, firm, dull whitish to light dull yellowish or slightly brownish, often becoming more or less sordid; odor and taste raphanoid or indistinctive.

LAMELLAE adnate to adnexed or emarginate, seceding in age, close to subcrowded, up to 9 mm broad, more or less ventricose mature, dull red (Dragon's-Blood Red to Brick Red) to deep red (near Morocco Red) or purple red (Bordeaux) becoming brownish to brownish orange in age; edges even to wavy.

STIPE 25-80 mm long, 4.5-15 mm thick, equal to more or less clavate or ventricose; surface appressed fibrillose, sometimes with a slight fibrillose annular zone near the apex, color pale yellow (pale Empire Yellow) to dull yellow, more or less concolorous with the pileus margin, or sometimes rusty-brown from the basidiospores in age, the base colored as above or with light reddish (Peach Red) to dull pinkish tones, becoming olivaceous in age in some specimens, some surface fibrils may be tinted brownish to reddish or pinkish. Context stuffed becoming hollowed, yellowish white to dull yellow or more or less concolorous with the surface, developing a watery olivaceous cast in age, in some the cortex of the stipe base has a reddish to reddish orange cast. CORTINA yellowish, evanescent.

BASIDIOSPORES in deposit moderate yellow-brown (near Snuff Brown), $(5.5-)6-8.4(-11.7) \times 3.8-4.8(-5.8)$ um, in profile view elliptical, in face view elliptical to broadly elliptical, verruculose, light brownish with darker brown ornamentation. BASIDIA 4-spored, 20-31 x 5.5-7 um, clavate to more or less ventricose, hyaline or reddish purple to purple. PLEUROCYSTIDIA absent. CHEILOCYSTIDIA apparently absent. TRAMAL HYPHAE OF LAMELLAE subparallel to more or less interwoven, cylindrical to inflated, 5-15(-20) um wide, hyaline or more commonly light purple, vinaceous purple, or reddish purple, some containing purplish granules. CUTICULAR HYPHAE OF PILEUS interwoven, more or less radially arranged, cylindrical to more or less inflated, 5-16 um wide, thin-walled, some encrusted, brownish to faintly colored or frequently containing more or less concentrated purple, bluish purple, or light vinaceous purple to bluish pigment and granules; pileocystidia absent (apex of end-cells rounded to tapered). TRAMAL

HYPHAE OF PILEUS interwoven, more or less radially arranged, cylindrical to inflated, 6-25 um wide, some encrusted, hyaline to pale yellowish or dingy yellow or in upper portion some similar to cuticular hyphae. CLAMP CONNECTIONS of the normal type, present throughout the basidiomata. INTERHYPHAL PIGMENT DEPOSITS present as small deposits or particles in the pileus, lamellae, and stipe, and among the cortinal hyphae, yellowish to orange or reddish.

Solitary, scattered, gregarious or caespitose in conifer and mixed woods, occasionally on rotten conifer wood. Rarely found in California, look for it in the autumn season, October thru December.

Collections examined. <u>California</u>. <u>Humboldt</u> <u>Co.</u>: H. Lamphere 33 (MICH).

Dermocybe semisanguinea appears to be a rare species in California; only one collection seen by the author to date. It is found across North America, typically in coniferous forests, but also in mixed forests. The distributions of D. semisanguinea and D. phoenicea sensu lato overlap in North America. However, the frequency with which one encounters the two species in western and eastern North America is striking different. D. seminanguinea is much more common in eastern North America than D. phoenicea. The latter rarely occurs there. D. semisanguinea is much less frequently found in the west, particularly along the Pacific Coast. Instead one finds D. phoenicea var. occidentalis as the common representative of this group. As one goes down the Pacific Coast into southern Oregon and Northern California D. semisanguinea is so infrequent that it is truely a rare find!

Dermocybe semisanguinea is a highly variable species in North America and is still under investigation. The description here represents a fairly broad concept of the species based on a number of collections. The closest relative of <u>D. semisanguinea</u>, <u>D. phoenicea</u> var. occidentalis, differs from the former primarily in its pileus color. In the former the pileus is usually some shade of yellow-brown while in the latter it is dark to rich red.

Dermocybe sierraensis sp. nov.

SYNONYMS: Cortinarius sanguineus (Wulf.: Fr.) S.F. Gray var. sierraensis G. Keller & J.F. Ammirati nom. prov., Mycotaxon 18(2):364. 1983.

Cortinarius sanguineus (Wulf.: Fr.) S.F. Gray var. sierraensis J.F. Ammirati & A.H. Smith nom. prov., McIlvainea 6(2):62. 1984.

PILEUS 20-40 mm latus, novus convexus, maturior plano-convexus, denique planus; margo incurvus, demum decurvatus vel planus; superficies sicca, glabra vel adpresse sericeo-fibrillosa, serius nitida, brunneo-aurantiaca. Contextus roseolus, 1-2 mm crassus, sapor odorque haud proprii.

LAMELLAE adnatae vel adnexae, angustae, atrorubrae, margines integri, concolores.

STIPES 20-40 mm longus, 2-4 mm crassus, aequalis, siccus; superficies pannis veli exceptis glabra, obscure vinacea in pili superficie colorem abeuns, mycelio basim versus vinaceo; panni veli cum superficie concolores; contextus solidus, cum superficie concolor.

BASIDIOSPORAE 7.7-9.1 (-9.5) x 4.8-5.5 (-5.8) um, facie obliqua elliptica, nonnumquam plus minusve reniformi vel enormi, verruculosae. BASIDIA quadrispora, 24.1-35.6 x 6.6-8.8 um, clavata vel aliquantum enormiter clavata, succum diffusum pallide purpureo-carneum continentia vel paulum carnescentia vel hyalina. CHEILOCYSTIDIA specie nulla. PILEI HYPHAE CUTICULARES plus minusve intertextae, aliquid per radios ordinatae, stratum distinctum efformantes, plerumque 2.9-13.1 um latae, cylindricae vel aliquatenus inflatae, succum diffusum pallide vel dilute purpureo-carneum vel carneo-rubrum continentes, denique in hyalinum pallescentes, tenuiter tunicatae, partim subtiliter incrustatae; pileocystidia nulla. PIGMENTUM INTER HYPHAS nullum in dilute KOH observatum.

In solo sub Pino contorta gregarii, altitudine 6500 pedum s. m., mense Augusto.

HOLOTYPUS: H. D. Thiers 32671, comitatu Alpine, respublicae Californiae, in herb. SFSU conservatus.

PILEUS 20-40 mm broad when fully expanded, convex when young becoming plano-convex to more commonly plane when fully mature; margin incurved becoming decurved to plane, entire, no veil fragments attached to edge and no apparent veil fragments on surface; surface dry, glabrous to appressed silky-fibrillose, usually shiny with age, color brownish orange to brownish red-orange (Cinnamon Rufous to Tawny) during all stages of development. Context pink, unchanging when exposed or bruised, 1-2 mm thick; taste and odor not distinctive.

LAMELLAE adnate to adnexed, narrow, somewhat wavy when mature, close (based on dried specimens), thin, several tiers of lamellulae, color dark red (Hays Russet to Grenadine Red) during all stages of development; edges entire, concolorous with faces.

STIPE 20-40 mm long, 2-4 mm thick, equal, dry; surface glabrous except for patches of veil tissue, color deep vinaceous to almost concolorous with the surface of the pileus, vinaceous mycelium at base; veil fragments concolorous with the surface. Context solid and concolorous with the surface.

BASIDIOSPORES $7.7-9.1(-9.5) \times 4.8-5.5(-5.8)$ um, in profile view elliptical, some more or less reinform or somewhat irregularly shaped, in face view elliptical to broadly elliptical, verruculose with coarser ornamentation towards distal end, light Ochraceous Tawny to light yellow-brown with darker brown ornamentation. BASIDIA 4-spored, 24.1-36.5 x 6.6-8.8 um, clavate to somewhat irregularly clavate, containing a light purplish pink diffuse pigment or slightly pinkish to hyaline. PLEUROCRYSTIDIA absent. CHEILOCYSTIDIA apparently absent. SUBHYMENIAL HYPAHE compactly interwoven, cylindrical, mostly 2.9-6 um wide, color similar to tramal hyphae of lamellae. TRAMAL HYPHAE OF LAMELLAE subparallel, more or less interwoven, cylindrical to inflated, mostly 3.3-25.6 um wide, at first pale to light pinkish purple or pinkish red, often fading to paler or hyaline, some with purplish red granules. CUTICULAR HYPHAE OF PILEUS more or less interwoven, some-what radially arranged, forming a distinct layer, mostly 2.9-13.1 um wide, cylindrical to somewhat inflated; containing diffuse pale to light dull purplish pink to pinkish red pigment, eventually fading to hyaline, thin-walled, some finely encrusted; scattered hyphal end cells present but no true pileocystidia seen. TRAMAL HYPHAE OF

PILEUS interwoven, more or less radially arranged, 2.9-29.9 um wide, cylindrical to inflated, reddish pink to purplish red-pink or pale pinkish purple at first, fading to hyaline or nearly so, scattered hyphae with light yellow-brown pigment. CORTICAL HYPHAE OF STIPE longitudinally arranged, subparallel to somewhat interwoven, 2.9-18.3 um wide, cylindrical to inflated, purplish red to purplish pink fading to hyaline; hymenial elements decurrent on stipe apex, some more or less differentiated as caulocystidia, 16.1-42.3 x 10.2-13.1 um (some additional hyphal end-cells scattered over surface), clavate to broadly clayate more or less cylindrical, or more spherical, occasionally catenulate, pale pinkish purple to hyaline. CORTINAL HYPHAE cylindrical, mostly 3-5 um wide, color similar to cortical hyphae of stipe (few observed). CLAMP CONNECTIONS of the normal type, present throughout the basidiomata. INTERHYPHAL PIGMENT DEPOSITS not observed in KOH.

Gregarious in soil under lodgepole pine, 6,500', August.

Collections examined. California. Alpine Co.: H.D. Thiers 32671 (holotype, SFSU). Mariposa Co.: H.D. Thiers 21106.

Dermocybe sierraensis appears to be a rare species of the western mountains. So far it is only known from the higher elevations of the Sierra Nevada Mountains. Studies of its pigmentation (Keller and Ammirati, 1983) show a close relationship to D. sanguinea, except that the former contains much less emodin and dermocybin in the material studied to date. D. sierraensis is distinguished from D. sanguinea by its silky fibrillose, brownish orange to brownish red-orange pileus, the lack of ochraceous mycelium on the stipe base, and somewhat larger basidiospores. Dermocybe sanguinea var. vitiosa Moser has some characteristics (more red-brown color of the pileus, rose colored basal mycelium and absence of emodin) in common with D. sierraensis, but an overall comparison indicates that they are not the same taxon.

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LICHENS OF MOUNT DIABLO STATE PARK, CONTRA COSTA COUNTY, CALIFORNIA

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SUMMARY

A preliminary catalog of the lichens of Mount Diablo State Park is presented with updated nomenclature and comments. Fifty-five genera are reported, including 140 species (nine are new additions). Most abundant are Parmeliaceae, which include nine genera and 24 species.

INTRODUCTION

Mount Diablo rises to 3849 ft in Contra Costa County, California, about 40 mi ENE of San Francisco. Because of its height and location along the western edge of California's large inland valley, United States surveyors selected Mount Diablo as a base meridian (37°53'N) used today in legal descriptions and maps.

In 1965, when my study began, Mount Diablo State Park did not include North Peak or Eagle Peak, which were added during the acquisition of additional parcels of land (lichens from these areas are included in the list). The state park now covers 18,000 acres.

According to Pampeyan (1963), most of Mount Diablo is underlain by a plug of broken and jumbled Upper Jurassic sedimentary, igneous, and metamorphic rock of the Franciscan formation, which was thrust upward through surrounding rocks and lubricated by serpentine veins present on the north side. Exposures of greenstone, chert, graywacke, shale, limestone, schist, and conglomerate comprise most of the northern end of the mountain, including the summit. Three ridges on the northern side of the mountain are North Peak to the northeast (3563 ft), of greenstone, pillow basalt and fine-grained basalt; Eagle Peak to the northwest (2369 ft), of diabase; and Deer Ridge, just south of Eagle Peak, a grassy area supporting lichens on soil. The southwest side of the mountain consists mainly of fossiliferous clastic marine beds ranging from late Jurassic to late Miocene. Sandstone is abundant, consisting of 33-50% feldspar, of granitic origin.

On the north-facing slopes of the summit, Quercus chrysolepis Liebm. grows with occasional Umbellularia californica Nutt. On lower north-facing slopes on the southern side of the mountain, there is an association consisting of Q. agrifolia Nee and Aesculus californica (Spach) Nutt. with some Arbutus menziesii Pursh. Umbellularia californica and Acer macrophyllum Pursh are found in canyons. An association of Q. douglasii H. & A. and Pinus sabiniana Dougl. occurs on dry slopes. A chaparral cover on the south side of the mountain consists chiefly of Adenostema fasciculatum H. & A. and Salvia mellifera Greene, with Arctostaphylos glauca Lindl., A. auriculata Eastw., and A. manzanita Parry in areas more protected from the fires that occasionally sweep through the area. (An extensive fire occurred in 1968). A chaparral association of Q. durata Jeps. and A. glauca occurs mostly at low elevations along canyons (Bowerman, 1944). Juniperus californica Carr. is frequent on rock outcrops, especially at ca. 2990 ft, and along a series of chert outcrops from the summit to the margin of the chaparral

1000 ft lower (Bowerman, 1944). Other chaparral plants include Q. wislizenii A.DC. var. frutescens Engelm. and Ceanothus cuneatus (Hook.) Nutt. Lichens were also found on Salix sp., Q. dumosa Nutt., and Pinus coulteri D. Don.

Mount Diablo has a Mediterranean climate. Annual temperature averages 59.3°F, with average annual extremes between 26.1°F and 103°F, normally 43-46°F (rainy winter, with occasional snow) to 73-82°F (dry summer). Fog from the west, which may occur 0.2 of the year on the westerly slope, also encompasses a mixture of smog that may limit lichen growth. However, the influence of smog on Mount Diablo lichens has not been studied. Many *Usnea* thalli exhibit excessive formation of fibrils, an apparent indicator of unfavorable growth conditions, many of which probably involve environmental factors detrimental to growth (Tavares, pers. com.).

A comparison of the following list with Herre's (1910) enumeration of the lichens of the Santa Cruz peninsula reveals the absence of many coastal taxa as well as taxa characteristic of the North Coast Ranges [e.g., Nephroma laevigatum Ach. and Sphaerophorus globosus (Huds.) Vainio]. A comparison with Hebert and Meyer's list (1984) of lichens of the San Joaquin Experimental Range reveals the presence of some taxa found on the eastern slopes bordering the Central Valley of California [e.g., Lecidea atrobrumnea (Ramond in Lam. & DC.) Schaerer]. Other taxa from the Sierra Nevada foothills have not been found on Mount Diablo [e.g., Peltula zahlbruckneri (Hasse) Wetm., Rhizoplaca glaucophana (Nyl. ex Hasse) W. Weber, and R. marginalis (Hasse) W. Weber. On the other hand, Bryoria and Usnea were not reported from the San Joaquin Experimental Range.

LIST OF LICHEN SPECIES ON MOUNT DIABLO

In the following list, an * indicates a new record not included in Baltzo (1970). All lichens on the list were found within the present park boundaries except Lecidea fuscoatra from Marsh Creek Springs. For nomenclature see Egan (1987) and Tucker and Jordan (1978). The name used by Baltzo (1970) or in a published record is indicated in parentheses when it differs from the lichen name currently used. Voucher specimens are in the author's herbarium.

Acarospora chlorophana (Wahlenb. ex Ach.) Massal. Literature report (as Lecanora chlorophana, Tuckerman (1882).

- *A. fuscata (Nyl.) Arnold. Medium to dark brown, shiny to dull, one to several apothecia in each areole-squamule. C* fleeting red (section, on bruised cells just under brown cortical cells). On rocks in sun. (Baltzo 4992c-82FF).
- A. schleicheri (Ach.) Massal. Pale sulphur yellow (as contrasted to lemon yellow of A. chlorophana). Apothecia darker than thallus. On sunny rocks. Actinogyra see Umbilicaria.

Alectoria see Bryoria.

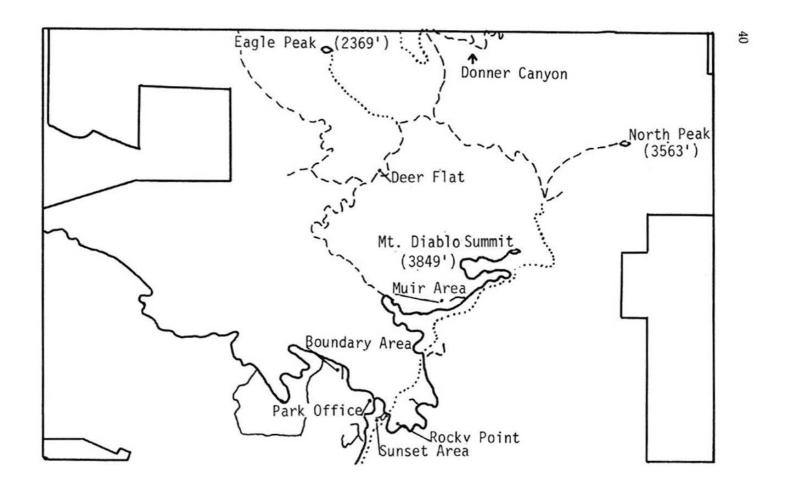
- *Aspicilia calcarea (L.) Mudd. Flat to convex, medium gray areoles, dark fimbriate hypothallus, cortex K*. On red Franciscan chert. (Baltzo 4990-82FF).
- A. cinerea (L.) Koerber. On shale (as Lecanora cinerea). On rock (as Lecidea tesselata).
- A. gibbosa (Ach.) Koerber (as Lecanora gibbosula). On sandstone, unspecified rock.
- A. laevata (Ach.) Arnold (as Lecanora laevata). On jasper-like rock, sandstone.
- Bryoria oregana (Tuck. ex Willey) Brodo & Hawksw. (as Alectoria oregana). Poor specimen, on Adenostoma (collected before 1968 burn), 2500 ft.

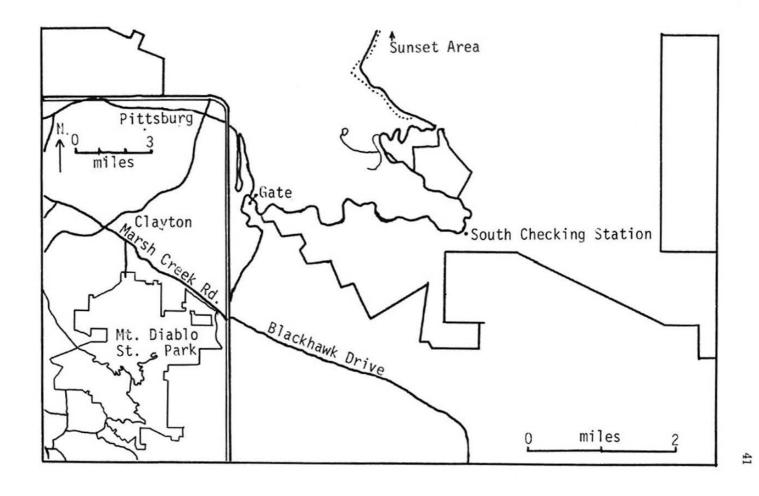
Buellia punctata (Hoffm.) Massal. On Pinus sabiniana.

Caloplaca bolacina (Tuck.) Herre. Thallus dark lemon yellow, apothecia orange, spores 12-16 × 6-8 μm. On sandstone. 1400 ft.

- C. chrysophthalma Degel. On bark.
- C. decipiens (Arnold) Blomb. & Forss. On sunny siliceous shale, serpentine, jasper; widespread.
- C. ferruginea (Huds.) Th. Fr. On bark of deciduous Quercus, chaparral.
- C. laeta Magnusson. On sandstone.
- C. stanfordensis Magnusson. On old Salix.

- C. sp. (as C. elegans), sect. Gasparrinia. Dark red-orange, long narrow lobes to 6 mm long and 0.3 mm wide, not spreading at tips; spores ellipsoid to almost lemon shaped, 4.8-6.4 x 10-12.8 μm. On jasper-like rock in sun, serpentine.
- C. spp. (as C. murorum). Thalli vary from orange with orange pruina to dark orange or two-toned red to orange, the lobes 0.5-1 mm wide, 2-3 mm long. On serpentine, non-calcareous rock.
- Candelaria concolor (Dickson) B. Stein. On bark of most trees, dead and down wood, sandstone, widespread.
- Candelariella vitellina (Hoffm.) Müll. Arg. On soil, moss, rock, sandstone.
- Catapyrenium lachneum (Ach.) R. Sant. (as Lecidea lurida). In noncalcareous soil crevice of North Peak saddle.
- Cetraria see Tuckermannopsis.
- Cladonia cervicornis (Ach.) Flowtow. ssp. verticillata (Hoffm.) Ahti (as C. sub cervicornis). syn. C. verticillata (Hoffm.) Schaerer. P+ yellow to red, K-. On sandy soil. ±1500 ft.
- C. chlorophaea (Floerke ex Sommerf.) Sprengel. Variously P⁺ dark red, orange; K'; KC'; C'. (chemical species not separated). On sandy soil, sandstone, soil and moss, 1400-1600 (-3000) ft, North Peak area.
- C. fimbriata (L.) Fr. On soil, 1500 ft.
- C. macilenta Hoffm. On Pinus, ±2100 ft.
- C. ramulosa (With.) Laundon (as C. pityrea). On shaded sandstone, 1500 ft.
- Collema furfuraceum (Arnold) Du Rietz. Pointed isidia. On bark, base of Quercus agrifolia, on Juniperus californica, on Sambucus, ±1500-2900 ft.
- C. nigrescens (Huds.) DC. Isidia granular to globular when present; many apothecia. On Quercus bark, ±1500-2100 ft.
- Dermatocarpon miniatum (L.) Mann. On rock, near waterfalls and moist vertical surfaces, ±2200 ft.
- D. reticulatum Magnusson. On rock near summit, ±3849 ft.
- *Dimelaena oreina (Ach.) Norman. On rock, between Muir Area and North Peak, 2970-3563 ft (Baltzo 777-69R).
- Diploschistes muscorum (Scop.) R. Sant. (as D. actinostomus). On sandstone, Cladonia, and on moss.
- *D. scruposus (Schreber) Norman. On rock, Boundary Area (Baltzo 1605-78CC).
- Evernia prunastri (L.) Ach. (as E. prunastri var. sorediifera). Esorediate to sorediate or isidiate; juvenile with aspect of Pseudevernia, white below, lobes flat, expanded, curled when sorediate; widespread on dead wood; chaparral (Quercus, Adenostoma).
- Flavoparmelia caperata (L.) Hale (as Parmelia caperata). With pustulate or powdery laminal soralia, no pseudocyphellae, rare apothecia with sorediate margin. On Quercus bark, sandstone, ±1500-1600 ft, widespread.
- Flavopunctelia flaventior (Stirton) Hale (as Parmelia flaventior). Pseudocyphellate, differing from Punctelia subrudecta by more yellow-green color and dark brown underside. On bark, dead wood, sandstone, Acer, chaparral (Arctostaphylos, Quercus), widespread.
- Hypocenomyce scalaris (Ach.) ex Liljeblad) M. Choisy (as Lecidea scalaris). On burnt wood of Pinus coulteri, ±1500 ft.
- Hypogymnia imshaugii Krog (as H. enteromorpha). Variable in form: small thalli with lobes 1-2 mm wide, slightly flattened, regularly dichotomous with pointed tips, internodes 1-2 mm long, cortex P⁺ yellow to orange, K⁺ yellow, on twigs of Adenostoma; more typical elongate form, gray, lobes 1-3 mm wide, well developed, black to dark brown below, almost channeled but hollow, elongating tips pointed but not flattened, internodes 4-6 mm long, apothecia large, on Quercus wislizenii var. frutescens, Umbellularia californica; narrow, dark gray or brown, lobes 1-1.5 mm wide, regular, not flattened, with perforations below near tips, internodes to 5 mm long; or compact, light gray-brown, lobes to 2 mm wide, becoming wrinkled-inflated or pustulate centrally, internodes to 2 mm long, on Quercus, Pinus bark.
- H. tubulosa (Schaerer) Havaas. Tubes with tips of soredia around edge. On bark, Ouercus.





Koerberia biformis Massal. On Aesculus, 2150 ft.

Lecanora see also Aspicilia.

- L. caesiorubella Ach. ssp. merrillii Imsh. & Brodo (as L. pallida group). On bark, twigs. Also literature report (Imshaug & Brodo, 1966).
- L. hagenii (Ach.) Ach. On sandstone, ±1500 ft.
- L. mellea W. Weber (as L. bolcana, L. muralis var. diffracta, L. garovaglii). Rich, dark honey color, the lobate margins with thin black edge, the lobes breaking up into several thinner lobe tips, thallus very variable, apothecial disc and margin same color as thallus, inconspicuous. In sun on jasper-like rock, quartz, igneous rock, shale, often in association with Aspicilia sp. Also literature report (Weber, 1975).
- L. muralis (Schreber) Rabenh. (in part as L. muralis var. versicolor). On sandstone, iasper and other rock.
- L. pacifica Tuck. or similar to it in appearance. No crystals in the apothecia. Thallus K⁺ yellow. On twigs, 2500 ft.
- L. rupicola (L.) Zahlbr. Pruinose, pale. On rock, 2380 ft.

Lecidea see also Aspicilia, Hypocenomyce, Lecidella, Pannaria, Psora.

- L. atrobrunnea (Raymond in Lam. & DC.) Schaerer. Shiny red brown thallus, areole-squamules thin to thick and convex; waxy epicortex is thin; cortex UV⁺ yellow-cream; medulla I⁺. Apothecial discs smooth in appearance. Similar to Rhizocarpon bolanderi, which is UV⁻ and has much smaller areoles and rough apothecial discs. On shale.
- *L. fuscoatra (L.) Ach. Semi-shiny to dull dark brown thallus, areole-squamules thinner than in L. atrobrunnea, with more intervening space showing black hypothallus; squamules becoming irregularly crenulate and turned up marginally, UV; apothecia may be pruinose. Between Sunset Area and Rocky Point, 2200 ft (Baltzo 90-65C); collected outside the State Park, on volcanic plug at Marsh Creek Springs (Baltzo 9048-87JJ) (several volcanic plugs were mentioned by Pampeyan, 1963, northeast of the base of Mount Diablo along Marsh Creek Rd.).
- L. mannii Tuck. Literature reports (Tuckerman, 1888; Herre, 1910). Thalli on "volcanic rock," "Diablo" (Bolander 208a,b: see Tuckerman, 1888) (FH) are dull medium brown to pale brownish cream color, the areoles crowded, their edges turning downward; hypothallus not clearly visible between areoles. Cortex UV; medulla thick, white, UV pale greenish, I. Precise collection locality not known and rocks vary.
- Lecidea sp. (as L. mannii). Much darker brown than L. mannii of Bolander; shinier, UV, medulla I (Baltzo 110-65C).
- *Lecidea sp. Pale cream, dull; large slightly convex, crowded areoles, paler than Bolander specimens of L. mannii and having larger areoles. With Rhizocarpon bolanderi, near summit. Dull rusty orange under UV, perhaps because of lack of a dark brown pigment. On rock.
- *Lecidea sp. Medium gray brown granular surface broken into areolate segments; apothecia black. On sandstone.
- Lecidella euphora (Floerke) Hertel (as Lecidea glomerulosa). C., K. On Juniperus twigs, Pinus, dead or down wood.

Lepraria neglecta (Nyl.) Lettau. On sandstone, 1500 ft.

Leptochidium albociliatum (Desmaz.) M. Choisy (as Polychidium albociliatum). On moss and soil, among grasses, mossy rock.

Leptogium californicum Tuck. On shaded sandstone.

- L. corniculatum (Hoffm.) Minks (as L. palmatum). On moss, soil, rock.
- L. furfuraceum (Harm.) Sierk. On Acer, Aesculus.
- L. lichenoides (L.) Zahlbr. On moss, soil.
- L. minutissimum (Floerke) Fr. On soil.
- Letharia columbiana (Nutt.) Thomson. On burnt bark, Pinus sabiniana; immature, isidiate, nonsorediate.
- Lichinella stipatula Nyl. Literature report (Henssen, 1963; W. A. Weber collection).
- Melanelia fuliginosa (Fr. ex Duby) Essl. (as Parmelia glabratula). Medulla C⁺ red, shiny cylindrical isidia. On bark of Quercus, Pinus.

- M. glabra (Schaerer) Essl. (as Parmelia glabra). Medulla C⁺ red, thallus minutely pubescent, lowerside dark brown to black. On bark of Quercus, Pinus, Sambucus, Adenostoma, Juniperus, chaparral, widespread. A form referred to as "subglabra" differed by its paler olive-green color perhaps due to shady conditions, its lower side pale in a broad band on the margins and medium brown centrally. Loosely adnate on mosses on bark.
- M. glabroides (Essl.) Essl. (as Parmelia "pseudoglabra"). Medulla C⁺ red, KC⁺ red; lobes shiny scalloped-crenulate, reticulate-ridged, lacunose, in cushions. On sandstone, soft shale, moss, easily removed from substrate.
- M. incolorata (Parr.) Essl. (as Parmelia elegantula). Medulla C^{*}, warts not prominent; isidia ±round at first, not pinched at base, becoming cylindrical, sometimes in clusters, infrequently branched. Thallus sometimes pruinose. On bark, twigs, sandstone.
- M. multispora (A. Schneider) Essl. (as Parmelia multispora). Medulla C^{*}, thallus like M. subolivacea but thinner, asci with more than 8 globose to subglobose spores. On bark, Quercus.
- M. subargentifera (Nyl.) Essl. (as Parmelia subargentifera). Medulla C⁺ red; marginal labriform soralia, minutely pubescent upper side. On sandstone, moss.
- M. subaurifera (Nyl.) Essl. (as Parmelia subaurifera). Medulla C⁺ red; soralia laminal, punctiform, tending to yellowish to greenish; isidia cylindrical, short. On bark, Quercus; frequent.
- M. subelegantula (Essl.) Essl. (as Parmelia "pseudoaspera"). Medulla C; warts with white area a top that is sometimes depressed; starting at thallus margins, warts be come transformed into dull cylindrical isidia in center; isidia may becom coralloid or lobulate and drooping. On bark, Quercus sp., Q. wislizenii, Pinus, Ceanothus cuneatus, Umbellularia, to 3849 ft.
- M. subolivacea (Nyl. in Hasse) Essl. (as Parmelia subolivacea). Medulla C^{*}; warts on mature thalli irregular in shape, never isidiate-coralloid or lobulate. On bark, Quercus.
- Neofuscelia loxodes (Nyl) Essl. (as Parmelia isidiotyla). Medulla C^{*}; cortex C⁺ dark blue gray; isidia coarse, dull, globular clusters that may break to show white medulla or resemble soredia. On rock, shale, sandstone.
- Normandina pulchella (Borrer) Nyl. Minute pale green ear-like squamules that become sorediate on the edges. On bark of Acer and sandstone.
- Ochrolechia subpallescens Vers. Thallus and thick apothecial margin C+ red. On bark, Acer and Quercus.
- upsaliensis (L.) Massal. Literature report (Herre, 1910). Thallus C^{*}. On sandstone and over mosses.
- Pannaria leucophaea (Vahl.) P. Jørg. (as Lecidea demissa). Minute, dull, medium brown. On sandstone.
- *P. leucostictoides Ohllson. Pale tan, becoming bluish pruinose; isidia blue-gray. On Quercus (Baltzo 47b-65A).
- P. praetermissa Nyl. in Chyd. & Furuhj. (as Parmeliella praetermissa). Dark brown; isidia dark gray. On moss on rock.
- Parmelia see also Flavoparmelia, Flavopunctelia, Melanelia, Neofuscelia, Parmelina, Parmotrema, Punctelia, and Xanthoparmelia.
- P. saxatilis (L.) Ach. Isidiate. On bark of Quercus, moss, sandstone.
- P. sulcata Taylor. Sorediate on ridges. On bark, Quercus, Pinus, Juniperus, on shaded sandstone, widespread.
- Parmeliella see Pannaria.
- Parmelina quercina (Willd.) Hale (as Parmelia quercina). On bark, Quercus sp., Q. wislizenii, Pinus, Juniperus, Umbellularia, widespread.
- Parmotrema arnoldii (Du Rietz) Hale (as Parmelia arnoldii). Medulla K.; soralia on small lobes, submarginal. On bark of Quercus agrifolia.
- P. chinense (Osbeck) Hale & Ahti (as Parmelia perlata). Medulla K⁺ yellow; soralia on revolute lobe tips. On Quercus.
- P. stuppeum (Taylor) Hale (as Parmelia stuppea). Medulla K^{*}; soralia linear on raised margins; cilia long; lobes wide. On sandstone.

Peltigera collina (Ach.) Schrader. On moss on sandstone in shade.

Peltula euploca (Ach.) Ozenda & Clauz. On rock, 3700 ft.

Pertusaria albescens (Huds.) M. Coisy & Werner. On Quercus.

P. amara (Ach.) Nyl. Bitter taste. On bark, Quercus.

P. chiodectonoides Bagl. ex Massal. On rock.

P. lecanina Tuck. On Quercus, bark.

Phaeophyscia orbicularis (Necker) Moberg (as Physcia orbicularis). On bark, Quercus, Juniperus, Aesculus.

Phlyctis argena (Sprengel) Flotow. On bark.

Physcia adscendens (Fr.) H. Olivier. Hooded soralia. On Quercus, Juniperus, widespread.

P. aipolia (Ehrh. ex Humb.) Fuernr. White-spotted, cortex K⁺ yellow. On Acer, Aesculus, Juniperus.

P. alba (Fee) Müll. Arg. var. obsessa (Mont.) Lynge (as Physcia alba). On dead wood (Juniperus?).

P. albinea (Ach.) Nyl. On red jasper-like rock.

P. callosa Nyl. On shale, shaded sandstone, moss on rock.

P. cascadensis Magnusson. On Quercus.

P. mexicana B. de Lesd. On Quercus agrifolia.

P. millegrana Degel. On heavy rock with quartz.

P. phaea (Tuck.) Thomson. On Quercus agrifolia. Also literature report (Thomson, 1963).

P. semipinnata (J.F. Gmelin) Moberg (as P. leptalea). On Adenostoma.

P. stellaris (L.) Nyl. On Adenostoma, Quercus, Juniperus, chaparral. Four forms.

P. tenella (Scop.) DC. in Lam. & DC. On Quercus, Juniperus, over other lichens.

Physconia detersa (Nyl.) Poelt (as Physcia grisea f. detersa). On sandstone.

P. distorta (With.) Laundon (as Physcia pulverulenta). On bark of Quercus, Acer, Juniperus, Umbellularia, chaparral. Three forms.

P. enteroxantha (Nyl.) Poelt (as Physcia grisea f. enteroxanthella). On Quercus, Sambucus, shaded sandstone.

P. grisea (Lam.) Poelt. On Juniperus, Quercus, Umbellularia, sandstone.

P. muscigena (Ach.) Poelt. On dead and down wood, soil, moss.

Polychidium see Leptochidium.

Pseudocyphellaria anomala Brodo & Ahti. On moss at base of Quercus agrifolia.

P. anthraspis (Ach.) Magnusson. On base of Quercus agrifolia.

Psora californica Timdal (as Lecidea globifera). On soil in rock crevice.

P. globifera (Ach.) Massal. Medulla K⁻. See Schneider (1979), Timdal (1986). On soil, sandstone.

P. nipponica (Zahlbr.) Schneider (as Lecidea novomexicana). In rock crevice.

Punctelia subrudecta (Nyl.) Krog (as Parmelia subrudecta). Differs from Flavopunctelia flaventior by mineral blue-gray-green color and pale beige underside. On bark of Quercus, Pinus, Adenostoma, chaparral.

Ramalina farinacea (L.) Ach. Typical form with narrow laciniae 1-2 mm wide, branching at 4-5 mm intervals, marginal soralia P⁺ rusty orange, medulla P⁺ rusty orange, cortex with two layers, K⁺ yellow, on bark of Quercus agrifolia and Acer. Shorter tufted form, branching at 3-4 mm intervals, soralia only P⁺ rusty orange, cortex without inner layer, on bark. Short form to 4.5 cm long, non-fistulose, expanding finger-like soraliate apices with marginal isidioid outgrowths, no inner cortex, on Quercus sp., Q. agrifolia. Broad form, laciniae to 2 mm wide, soralia on laciniae and margins, medulla P⁺, soralia P⁺ pale orange, no inner cortex. On Q. agrifolia.

R. leptocarpha Tuck. On bark.

R. menziesii Tayl. Coarse, rigid nets. On bark or draped on branches, infrequent.

*Rhizocarpon bolanderi (Tuck.) Herre. Thallus shiny, dark red-brown, similar to Lecidea atrobrunnea. Apothecial disc appears rough. On rock near summit, 3800 ft. (Baltzo 892b-69T).

R. ferax Magnusson. On rock, 2200-3849 ft.

Rinodina hallii Tuck. On bark.

Sticta fuliginosa (Hoffm.) Ach. On shaded sandstone, Quercus, Pseudocyphellaria anomala.

Thelomma mammosum (Hepp in Hartung) Tibell (as Cypheliopsis bolanderi). On sunny rocks.

Tuckermannopsis chlorophylla (Willd. in Humb.) Hale (as Cetraria chlorophylla). On Adenostoma, shaded sandstone.

T. merrillii (Du Rietz) Hale (as Cetraria merrillii). On Adenostoma, Quercus bark.

T. orbata (Nyl.) Lai (as Cetraria orbata). On bark, on Quercus.

Umbilicaria phaea Tuck. On sandstone, metamorphic rock, shale, widespread.

U. polyphylla (L.) Baumg. On rock.

U. polyrrhiza (L.) Fr. (as Actinogyra polyrrhiza). On shaded rocks, 3000 ft.

Usnea arizonica Mot. s. lat. Medulla K+ red. On bark of Acer, Quercus agrifolia.

U. cavernosa Tuck. (as U. trichodea). On Quercus.

Usnea spp. (tufted and pendent taxa). On Quercus, chaparral, 1500-2500 ft.

Xanthoparmelia cumberlandia (Gyelnik) Hale (as Parmelia cumberlandia). On sandstone, shale, in sun, 2100 ft.

- X. lineola (Berry) Hale (as P. lineola). On sandstone, quartz, jasper.
- mexicana (Gyelnik) Hale (as P. mexicana). On sunny rock, sandstone, quartz, or iasper.
- X. novomexicana (Gyelnik) Hale (as P. novomexicana). On shale.
- X. taractica (Kremplh.) Hale (as P. ioannis-simae, P. taractica). Loosely attached to soil on rock, on crumbly shale, on quartz.

Xanthoria candelaria (L.) Th. Fr. On Quercus, Umbellularia.

- X. fallax (Hepp in Arnold) Arnold. On moss and rock, sandstone.
- X. lobulata (Floerke) B. de Lesd. On calcareous sandstone.
- X. parietina (L.) Th. Fr. On bark (Quercus?), 2700 ft; on Aesculus, Donner Canyon.
- X. polycarpa (Hoffm.) Rieber. On Quercus agrifolia, other Quercus spp, Pinus sabiniana.

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THE GENUS RHODOCYBE: NEW COMBINATIONS AND A REVISED KEY TO SECTION RHODOPHANA IN NORTH AMERICA

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ABSTRACT

Entoloma trachyosporum and its varieties are placed in Rhodocybe. Rhodocybe carlottae var. carlottae is considered a synonym of R. trachyospora var. trachyospora, while R. carlottae var. vinacea is placed in R. trachyospora as a new variety. A key to Rhodocybe section Rhodophana in North America is presented.

KEY WORDS: Rhodocybe, section Rhodophana, nomenclature, key to species for North America.

INTRODUCTION

It is appropriate that this report concerns a furthering of our knowledge of fungi of the Pacific Northwest, since the scientist honored by the collection of papers in this festschrift has spent most of his distinguished professional career working towards that end. We hope this latest addition to our knowledge of the California mycota will please him.

The genus Rhodocybe Maire has recently received careful attention in North and Central America (Lennox, 1979; Baroni, 1981; Halling & Baroni, 1985; Redhead & Baroni, 1986; Ovrebo & Baroni, 1988) because the species of Rhodocybe can occasionally be a distinctive, though usually not a prominent, part of the mycota of a given area. Although a

revision of *Rhodocybe* (Baroni, 1981) has helped clarify the unique features that circumscribe this member of the Entolomataceae Kotlaba & Pouzar, there still remains much to be learned about the number, distribution and phylogeny of species in *Rhodocybe* for North America, and on a world wide scale.

In this past collecting season, during the months of November and December in Humboldt and Mendocino Counties of California, we had the opportunity to collect all of the varieties of Entoloma trachyosporum Largent, i.e. E. trachyosporum var. trachyosporum, E. trachyosporum var. griseoviolaceum Largent and E. trachyosporum var. purpureoviolaceum Largent. An examination of the unusual basidiospores of each of these collections revealed to the senior author that these taxa clearly belong in Rhodocybe.

TAXONOMY

In the sense of Singer (1986), Rhodocybe is one of three genera placed in the Entolomataceae (Clitopilus and Entoloma sensu lato are the other two, but see Largent & Benedict, 1971; Baroni, 1981; and Baroni & Petersen, 1987). All taxa placed in the Entolomataceae possess the following suite of characters: spore deposit pinkish, flesh, vinaceous or rarely grayish; spores always distinctly angular or rounded angular in polar view, or the spores are angular in all views; spore walls evenly cyanophilic. Rhodocybe can only be accurately identified and separated from Clitopilus and Entoloma sensu lato by the unique, mostly isolated pustulate or tuberculate-warty ornamentation of its basidiospores. The basidiospores of Clitopilus are never angular in profile view, but possess distinct to obscure longitudinal ridges running the length of the spores, while the basidiospores of Entoloma sensu lato are provided with short interconnected ridges, which make the basidiospores distinctly angular in all views. The basidiospores of Entoloma sensu lato never have isolated pustulate or tuberculate-warty ornamentation.

After a study of the macroscopic and microscopic characters of all the collections of *E. trachyosporum* available to us, it became apparent that the recently described *Rhodocybe carlottae* var. carlottae Redhead & Baroni (Redhead & Baroni, 1986) from the Queen Charlotte Islands of British Columbia is conspecific with *E. trachyosporum* var. trachyosporum. However, in the case of *R. carlottae* var. vinacea Redhead & Baroni, the colors of the stipe, the lamellae and the pileus context indicate that this taxon is yet another distinct color variant of *E. trachyosporum* from the Pacific Northwest of North America.

The following new combinations and synonymy are necessary:

Rhodocybe trachyospora (Largent) Baroni & Largent comb. nov.

- ≡ Entoloma trachyosporum Largent, Madroño 22: 369. 1974.
- = Rhodocybe carlottae Redhead & Baroni, Canad. J. Bot. 64: 1451. 1986.

- Rhodocybe trachyospora var. griseoviolacea (Largent) Baroni & Largent comb. nov.
 - Entoloma trachyosporum var. griseoviolaceum Largent, Madroño 22: 370. 1974.
- Rhodocybe trachyospora var. purpureoviolacea (Largent) Baroni & Largent comb. nov.
 - Entoloma trachyosporum var. purpureoviolaceum Largent, Madroño 22: 371. 1974.
- Rhodocybe trachyospora var. vinacea (Redhead & Baroni) Baroni & Largent comb. nov.
 - Rhodocybe carlottae var. vinacea Redhead & Baroni, Canad. J. Bot. 64: 1451, 1986.

After referring to our field data, and after a reexamination of the microscopic characters of the type collections of *E. trachyosporum* and its varieties, the following information can be added to the original descriptions (Largent, 1974).

Rhodocybe trachyosporum var. trachyosporum Figs. 1 & 2

Basidiospores 6-8(-9) (without apiculus), 7-10 (including apiculus) \times 6-7(-8) μ m, subglobose to ovoid or short-broad-ellipsoid, often obscurely to distinctly angular in profile view, rounded angular (6-9 facets) in polar view, weakly to moderately undulate-pustulate in all views, walls evenly cyanophilic but weakly so on many older (larger) spores. Caulocystidia present in inconspicuous clusters or scattered at apex of stipe, 22-45 \times 8-10 μ m, often capitate or subcapitate and pedicillate, or clavate or broadly ventricose, thin-walled, hyaline, with clamp connections.

Rhodocybe trachyosporum vars, griseoviolaceum and purpureoviolaceum

The microscopic features for both of these varieties are indistinguishable from those of var. trachyosporum.

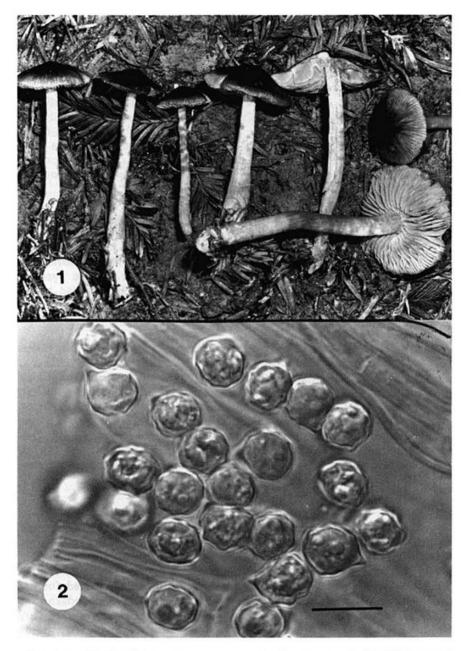
These taxa were originally reported from a number of different counties around the greater Seattle, Washington area (Largent, 1974) as occurring under various conifer species. For example, R. trachyosporum var. trachyosporum was collected from beneath Pseudotsuga menziesii (Mirb.) Franco, R. trachyosporum var. griseoviolaceum was found beneath P. menziesii, Thuja plicata D. Don. and Tsuga heterophylla (Raf.) Sarg., while R. trachyosporum var. purpureoviolaceum was collected beneath T. plicata. The collections of R. trachyosporum var. trachyosporum (Baroni 5794, 5801 and 5802) and var. griseoviolaceum (Baroni 5803) from California were typically found under Picea sitchensis (Bong.) Carr. or P. sitchensis mixed with Sequoia sempervirens

Endl., while R. trachyosporum var. purpureoviolaceum (Baroni 5856) was found under a mixture of P. menziesii. T. heterophylla, S. sempervirens and Lithocarpus densiflora (H. & A.) Rehd. It appears then that these Rhodocybes may be found under various kinds of conifers throughout the Northern Coastal Coniferous Forest and the Redwood Forest (Munz, 1970) of California and the Pacific Northwest.

Using the infrageneric classification scheme of Baroni (1981), this group of taxa would be placed in Rhodocybe section Rhodophana (Kühner) Singer based on the presence of clamp connections and the lack of hymenial pseudocystidia. Rhodocybe trachyospora and its varieties would be closely aligned with R. mycenoides, R. speciosa and R. priscua due to their subglobose basidiospores, which are often angular in profile view. Rhodocybe mycenoides is known only from South America, while these other taxa with subglobose basidiospores are found in North America.

Key to North American taxa of Rhodocybe section Rhodophana

- - Under sitka spruce, western hemlock, Douglas fir, western red cedar, redwood, etc. (but not under pine) on needle beds or



Figs. 1-2: Rhodocybe trachyospora var. trachyospora. 1. Basidiomes, $\times 1$ (Baroni 5794). 2. Basidiospores, scale bar = 10 μ m (Largent 2169, HOLOTYPE).

- 7. Stipe dark blue to bluish gray; lamellae bluish gray at first; pileus context deep blue to bluish gray.....

For complete descriptions of these taxa refer to Baroni (1981), Ovrebo & Baroni (1988), Redhead & Baroni (1986) and Largent (1974). All color terms used in the keys are adapted from Kornerup and Wanscher (1978) and Rayner (1970).

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QUALITY CONTROL FACTORS FOR ALTERNARIA ALLERGENS

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Alternaria species are among the best known and most clinically important sources of fungal allergens (Lehrer, et al. 1983). To assess the role of environmental exposures to these allergens in human disease, fungus materials are grown in culture and extracted in aqueous media to produce reagents used for skin testing or in-vitro tests for the presence of allergen specific antibodies. The same materials are often used for desensitization therapy (immunotherapy). However, methods used in the production of Alternaria allergen materials for diagnosis and treatment as well as research utilize single isolates often without expert identification and improperly named (Vijay, et al. 1986) in spite of the fact that allergen content is known to vary with species and strain used. (Burge et al 19xx) Most methods are based on mycelial growth and metabolic products rather than spores (Solomon et al, 1980) and fail to take into account the inherent variability that is the bane of mycologists interested in Alternaria taxonomy (Norman, 1982).

We have studied spore-derived allergens from airborne strains of Alternaria alternata and morphologically similar taxa as well as a series of verified isolates of A. alternata known to be stable in culture.

METHODS

Four airborne isolates of Alternaria (entries 1-4 in Table I]: two A. alternata, and two unidentified species that were assumed to be A. alternata by mycologists not trained in Alternaria identification were maintained in culture on Sabouraud's broth (Hoffman, et al. 1981). five occasions (12/84, 2/85, 5/85, 11/85, 5/86) spores and mycelium were harvested separately. Spore preparations, 90-95% pure by microscopic examination, were obtained by the method of Kozak and Gallup (U.S. patent #4,280,000). Briefly, a suspension of spores in distilled water was inoculated onto the surface of Sabouraud's Dextrose Agar (DIFCO, Detroit, MI) and spread evenly over the surface with a flame-sterilized bent glass rod. An overlay of Whatman filter paper #54 and a nondigestible material type TX 1040 (Pallflex Co., Putnam, CN) were smoothed onto the inoculated agar surface. After incubation under room lights at room temperature for three weeks, the overlay growth mat was removed, culture medium discarded, and the overlay growth mat placed back in the petri dish and allowed to dry for 3-4 days. Spores were harvested by scraping the overlay surface with a dull knife. The resulting spore/mycelium mixture was separated in a 45 micron sieve (USA Standard Testing Sieve, Dual Manuf. Co., Chicago, ILL.) on a shaker at 2,000rpm. When the appearance of material in the sieve changed from the black dust of spores to the lighter color of broken mycelium, sieving was stopped.

Five A. alternata strains that had remained morphologically stable in culture for at least one year (Simmons 34-016, 34-039, 35-056, 35-193, 38-066) were maintained on 20% V-8 juice agar slants. On three occasions (9/29/86, 10/6/86, 10/28/86) spore material was harvested following the procedure of Kozak and Gallup, except that 20% V-8 juice agar was used instead of Sabouraud's medium, and growth time before harvesting spores was 5 days instead of three weeks. Material scraped from the overlay material was not separated by sieving, as microscopic examination revealed the presence of very few mycelial fragments.

Spores of the random air isolates (#1-4) were extracted at 1:10 w/v in 0.02% sodium azide in distilled water for 48 hours at 4°C, centrifuged at 10,800g, filtered through a 0.45um nitrocellulose filter, dialyzed for 48 hours against distilled water at 4°C, concentrated x10 and frozen.

Simmons' spore materials were extracted in the same manner, but each resulting spore extract was lyophilized. The possible differential effects of culture medium and lyophilizing vs concentrating and freezing on the allergen profile of extracts were assessed. Alternaria isolate Al005 was grown on 20 V-8 juice agar and spores were harvested and extracted on two separate occasions, both times dividing the extract into two portions; one concentrated and frozen, the other, lyophilized. Extracts were compared using the following isoelectric focusing (IEF) and Western blot techniques, and allergens detected as described.

For IEF, extracts of isolates 1-4 were thawed and used immediately, while lyophilized material was reconstituted to 10 mg/ml with distilled water. Each extract was focused twice on 0.5mm polyacrylamide gels, pH 3-10, using Pharmacia Pharmalytes (Pharmacia Inc. Uppsala, Sweden). Gels were prefocused for 30 minutes at constant current of 3 milliamps using a Pharmacia Flat Bed Apparatus FBE-3000, Pharmacia 3000/150 power supply and a Sargent water bath cooler (E.H. Sargent & Co., Chicago, ILL). Samples were loaded onto gel surface using Pharmacia applicator strips, 20ul per extract, and focused for 1.5-2 hours at 3 milliamps.

Focused extracts were transferred to 0.45 nitrocellulose paper (Schleicher and Schuell, Keene, NH) by the method of Towbin, et al. (1979) using a Bio-Rad Trans-Blot cell, 250/2.5 power supply (Bio-Rad Laboratories, Rockville Centre NY) and Sargent Cooling Bath. Blotting was carried out in 0.7% acetic acid at 100 volts for 3 hours.

To detect allergens, a human serum pool was collected from 118 patients with 3 or 4+ prick test reactions to a commercial Alternaria extract. Alternaria allergens were detected on the immunoblots using methods described by Turner, et al. (1983) and Kroutil, et al (1987). Briefly, focused extracts on nitrocellulose were washed for 30 minutes in buffer containing 0.1% gelatin to block remaining protein binding sites, and incubated overnight with the specific IgE-containing human serum pool. After washing, the blots were incubated for 4 hours with monoclonal mouse anti-human IgE, followed by 4 hours in alkaline phosphatase-labelled goat anti-mouse IgG (Atlantic Antibody, Charles River Co., Scarborough ME) and developed in fast blue and naphthol magnesium sulfate.

TABLE I. Alternaria isolates:

- A1000 A. alternata-like, but not a perfect match to Simmons' reference strains
- A1002 not A. alternata;
- 3. Al004 A. alternata.
- 4. A1005 not A. alternata
- 5. 34-016 A. alternata (E. G. Simmons)
- 6. 34-039 A. alternata "
- 7. 35-056 A. alternata
- 8. 35-193 A. alternata "
- 9. 38-066 A. alternata "

RESULTS

Initial comparisons between culture media and between concentrated, frozen vs lyophilized extract preparations of Alternaria isolate Al005 revealed essentially identical allergen profiles by the methods described above encouraging comparison among concentrated, frozen extracts and lyophilized preparations of other strains.

A total of 32 different allergens were visualized in spore extracts from the four random isolates with all batches and strains combined (figure 1): 23 in the range pH 3.00-6.57 and 9 in the 6.57-10.00 range. In the five stable A. alternata strains studied, 18 allergens were detected, 15 between pH 3.00-6.57 and three between pH 6.57-10.00 (figure 2).

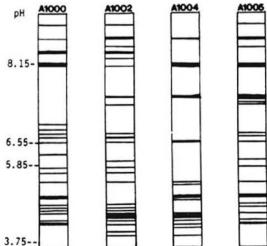


Figure 1. Comparison of IgE Immunoblots from four random Alternaria strains.

Batch to batch variability is displayed in figure 3 in immunoblots from random isolate A1002 (the most allergen rich and least variable <u>random</u> isolate). Figure 4 displays immunoblots of 3 extraction batches each for the most allergen rich (35-193) and for the least variable (34-016) of the stable Simmons isolates.

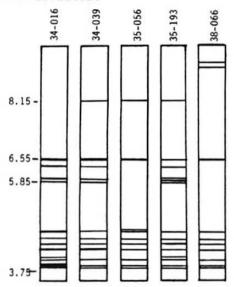


Figure 2. Comparison of IgE Immunoblots from five stable A. alternata strains.

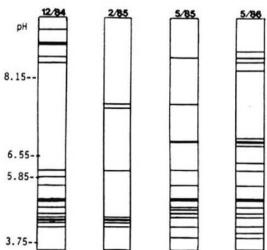


Figure 3. IgE Immunoblot variability in strain Al002.

Considering all extractions, five allergens were demonstrated in all four random strains, but no single allergen was present in all batches. No single strain of these 4 was more allergenically stable than the others during the less than 18 month period in which extractions were made. With all spore batches combined, A1002, the most allergenically complete isolate, still lacked 19% (6/32) of qualitatively identified allergens. A1004 had the most incomplete allergen profile, missing 53% (17/32) of the demonstrated spore allergens.

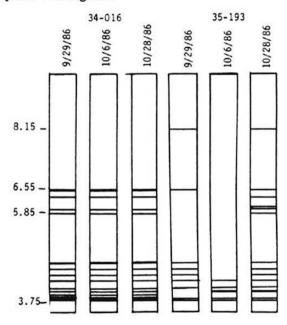


Figure 4. IgE Immunoblot variability in two stable Alternaria strains.

The two strains that correctly represent A. alternata (Al000 and Al004) differed from each other as much as from the two Alternatia strains misidentified as A. alternata.

Five allergens were also present in all five of the stable strains, four of which corresponded to four of the 5 allergens consistently present in the random isolates. Except for the 10/6/86 batch of strain 35-193, these

allergen bands were conserved in every batch of each strain. All batches of 34-016 were allergenically identical. Each of the other Simmons strains had at least one batch which was deficient in three or more allergens other than the five above.

Of the five allergens conserved for each group of strains studied, four of these were probably present in all nine strains, and all of these had migrated in the pI range below 6.57.

DISCUSSION

These findings emphasize: 1) the danger that isolates of Alternaria may be incorrectly identified to form species by an observer inadequately trained in Alternaria taxonomy, 2) that a single randomly isolated strain of A. alternata may show limited allergen expression, 3) that batch to batch differences for single strains may be extremely prominent and, 4) that the use of culturally stable strains can significantly increase the reliability of recovering of expected Alternaria allergens.

Al002, an isolate clearly not A. alternata, was richest in allergens recognized by "Alternaria-sensitive" sera, and, it appears from figures 1 and 3 that the random isolates produced more allergen bands than the culturally stable Preliminary work in our laboratory comparing spore and mycelial preparations indicates that these differences may be due to the higher percentage of mycelium present in the preparations from the random isolates. While every possible attempt was made to exclude mycelium from the preparations, many of the random isolate spores had begun germination either before or during harvest, and the random isolate cultures were more mycelial than the stable strains. It is worth noting that, although spores are the intuitively obvious unit of fungus exposure for most of the population, significant levels of hyphal fragments do occur in air and that allergen activity not shared by spores does appear to be present in mycelium.

The diagnosis and treatment of clinical mold sensitivities has been difficult and, it seems, often better approached by environmental control rather than by immunologic approaches. Methods of allergen preparation based on experience with field collected, easily recognized, and relatively stable plant materials (e.g. ragweed pollen) have not transferred well to fungus materials which can seldom be field collected, are identifiable only by a few specialists, and tend to be pleomorphic and biochemically variable in time (Burge, 1985). Until recently, potential interference resulting from these confounding factors has not been recognized (Helm, et al. 1987). The intrusion of non-medical mycologists into the field of allergy has at least served to alert those doing research on fungus allergens to possible dangers. It is apparent that before the true role of the fungi in human allergic disease can be accurately assessed, methods based on a solid grounding in fungus taxonomy, physiology and biochemistry will have to be developed. This will only be possible when medical researchers become willing to rely on mycological experts, and when students of mycology are willing to become involved in this important and exciting field.

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THAXTEROGASTER THIERSII: A NEW SECOTIOID SPECIES FROM CALIFORNIA

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SUMMARY

Thaxterogaster thiersii sp. nov is described from the coast of Northern California. It is compared to two similar species: T. porphyreum (Cunningham) Singer, which is known only from New Zealand, and T. conicum (Hesler) Singer & Smith of the eastern U.S.

INTRODUCTION

This new secotioid species was discovered during a six year survey of the macroscopic fungi of Audubon Canyon Ranch, a 1000 acre nature preserve located in Marin County at the edge of the Bolinas Lagoon. It was collected in a successional mixed evergreen forest habitat at an altitude of approximately 100 feet, and it is distinguished from related taxa by significant macroscopic and microscopic features as well as by distribution.

THAXTEROGASTER THIERSII sp. nov.

FIGS. 1, 2A, 2C, 3

Gasterocarpi stipitato-pileati. Pileus 2.8-3.5 cm altus, subglobosus vel pyriformis, undulatus, margine incurvato et stipitem affixo, superficie viscida pallida, cristis partem violaceo-tinctis, sulcis pallido-griseo-aurantiaco-tinctis. Gleba loculata, brunneo-aurantiaca, loculis 0.2-1.5 mm longis. Stipito-columella nonnunquam percurrens, parte excurrenti brevi, apicem versus ramificans, laminas tramae radiantes formans, superficie sicco, violaceo. Contextus pallido-albus. Hyphae peridii 2-6 µm latae, tramae (4)6-10(12) µm latae. Basidia (32)40-50(65) × 10-15 µm, tetrasterigmata, sterigmatibus 3.5-6 × 2-3 µm, symmetricis vel semifalcatis, apicalibus vel subapicalibus. Basidiosporae (12.5)14-16.5(18) × 10-12(13) µm, late ellipsodeae, subsymmetricae vel symmetricae, grosse verrucosae, cinnamomeo-brunneae, appendice hili brevi, hyalina. Fibulae nullae. Subhypogeus sub Querco agrifolia et Pseudotsuga menziesii. Holotypus: C. J. Calhoun 80-1475, 20 Jan 1980, Audubon Canyon Ranch, Marin Co., California (SFSU).

Gasterocarps stipitate-pileate. Pileus 2.8-3.5 cm tall, 3-4 cm broad, subglobose to pear-shaped, undulate, margin curving in toward and remaining attached to stipe; surface viscid, glabrous, pallid, ridges partly violaceous-tinged, furrows with pale grayish-orange tints. Gleba loculate, chambers irregular, 0.2-1.5 mm in the longest dimension, colored brownish-orange (5C4, Kornerup & Wanscher, 1978), unchanging on exposure or injury, maturing first near stipe-columella apex, drying

cinnamon-brown. Stipe-columella well-developed, widest below (8-15 mm), tapering upwards, percurrent or not, ±ramifying toward apex into radiating tramal plates; context solid, white-pallid, unchanging on exposure, violaceous-tinged where damaged by insect larvae, stipe portion relatively short, narrowing somewhat toward base; surface dry, glabrous, violaceous. Odor not distinctive, taste not recorded.

Peridium about 250 μ m thick, composed of hyaline, loosely organized, filamentous hyphae, 2-6 μ m wide, lying \pm parallel to the surface within and below a gelatinous matrix; hyphae of the peridium trama up to 12 μ m wide, some with gold-colored encrustations; hyphae of tramal plates (4)6-10(12) μ m wide, subparallel, smooth, hyaline. Oleiferous hyphae present in trama, common in mature gasterocarps, 2.5-6 μ m wide, even or gnarled, hyaline to cinnamon-brown when revived in 3% KOH. Basidia (32)40-50(65) × 10-15 μ m, mostly clavate, 4-spored, with sterigmata 3.5-6 × 2-3 μ m, symmetric to semifalcate, apical to subapical. Pleurocystidia and cheilocystidia absent. Basidioles present, 20 μ m wide. Basidiospores (12.5)14-16.5(18) × 10-12(13) μ m, broadly ellipsoid, axially subsymmetric to symmetric, thick-walled, coarsely verrucose, cinnamon-brown, with a short, hyaline hilar appendage. Stipe hyphae subparallel, smooth, hyaline. Clamp connections absent in all tissues.

Subhypogeous. Collected in mixed woods under Quercus agrifolia Neé and Pseudotsuga menziesii (Mirb.) Franco.

TYPE: U.S.A. California. MARIN CO.: Audubon Canyon Ranch, 20 Jan 1980, C. J. Calhoun 1475 (HOLOTYPE: SFSU).

Additional material examined: U.S.A. California. MARIN CO.: Audubon Canyon Ranch, C. J. Calhoun 80-1447, 80-1603 (SFSU).

DISCUSSION

Thaxterogaster thiersii belongs in section Aporpogaster Singer & Smith (Singer & Smith, 1963). It is distinguished macroscopically by the following combination of characters: a subglobose to pear-shaped pileus with a gently undulating surface and a margin that remains attached to the stipe-columella throughout development; a moderately viscid, pallid-colored, glabrous peridium with light violaceous and pale grayish-orange tints; a finely loculate, brownish-orange gleba which matures first near the stipe-columella apex; a dry, light violaceous-colored, relatively short stipe proper. Distinctive microscopic characters include: the broadly ellipsoid, often axially subsymmetric, coarsely verrucose, cinnamon-brown-colored spores with thick exosporium; basidia up to 65 μ m long, with prominent, apically to subapically attached, straight to \pm curved sterigmata that are often 6 μ m long; the absence of clamp connections from all tissues.

In combination, the macroscopic and microscopic characters of *T. thiersii* distinguish it from the other species in section *Aporpogaster*, namely *T. porphyreum* and *T. conicum*. The following discussion includes observations published by Singer & Smith (1958). *Thaxterogaster porphyreum* (illustrated in Cunningham, 1942) occurs in association with *Nothofagus* species in New Zealand and has a



Fig. 1. Carpophores of Thaxterogaster thiersii (HOLOTYPE), approx. x 1.

globose to globose-depressed pileus with a viscid violaceous-colored peridium. Macroscopically, T. porphyreum differs from T. thiersii in several other respects: the peridium is more highly pigmented; the stipe is comparatively long; the columella, which is often partly free from the gleba, always extends to the apex of the pileus; the context of the peridium, stipe, and columella is light lilac-colored. Some microscopic differences are: the spores of T. porphyreum are narrower [(7.5)9-11 µm (Figs. 2A, 2B)], coarsely verruculose (Cunningham, 1924) with thin epispore, and are mostly axially symmetric; the basidia are 22-32 x (6)10-11 μm; clamp connections are present in T. porphyreum (Horak & Moser, 1965). Thaxterogaster conicum occurs from Ohio to Tennessee, U.S.A., and is found on the ground under Quercus sp. and Pinus echinata Mill. Gasterocarps of T. conicum are "apparently" always fully epigeous at maturity, and the species is considered to be the most agaricoid of the genus. Furthermore, they are generally much larger than those of T. thiersii, and typically have an elongate, conic pileus. Illustrations that show the distinctive stature of T. conicum appear in Hesler (1933) and Singer & Smith (1958). In contrast to T. thiersii, the peridium of T. conicum is innately white-silky-fibrillose, and colored grayish-pallid to grayish-ochraceous with a darker disk that becomes tinged violaceous on exposure; a white arachnoid veil is present; the pileus margin separates early along the entire length of the stipe-

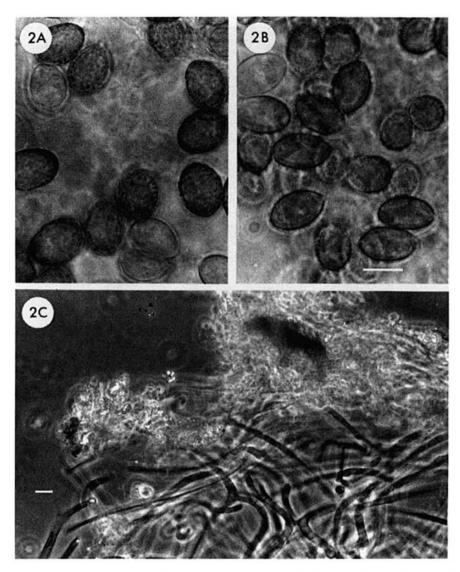


Fig. 2. Spores from Thaxterogaster thiersii (HOLOTYPE), (A), photographed at same magnification as B. (B). Thaxterogaster porphyreum, Cunningham 923 (SYNTYPE). (C). Cross section of peridium from T. thiersii (HOLOTYPE), showing gelatinous matrix and simple septate hyphae. Scale bars = 10 µm.

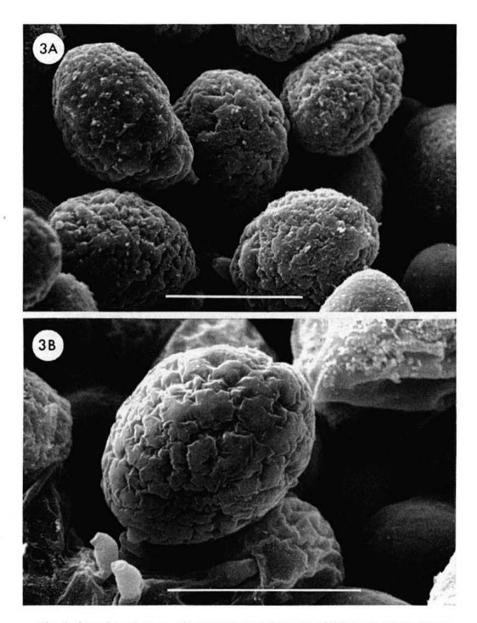


Fig. 3. Scanning electron micrographs, basidiospores of *Thaxterogaster thiersii* (HOLOTYPE). In (A) note hilar appendages. Prominent sterigmata are seen at lower left in (B). Scale bars = $10~\mu m$.

columella, exposing the gleba; the gleba is coarsely loculate (up to 10 mm long) with a lamellate development. The verrucose to warty spores of T. conicum reach 20 μ m and are ellipsoid, while mature spores of T. thiersii rarely reach 18 μ m and are broadly ellipsoid. The basidia of T. conicum are 32-40 × 6-16.5 μ m, while the majority of basidia are $42-50 \times 12-14 \mu$ m in T. thiersii. Hyphae in the trama of the peridium of T. conicum measure up to 22 μ m wide, but only reach 12 μ m in T. thiersii.

ACKNOWLEDGEMENTS

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STUDIES ON MARASMIUS FROM EASTERN NORTH AMERICA. II. NEW SPECIES

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ABSTRACT

Four new taxa in Marasmius are described as new: M. ilicicola (sect. Marasmius), M. ciliatomarginatus, M. paludigenus and M. falcatipes (sect. Sicci). All taxa are illustrated and compared to phenetically similar taxa.

Key Words. Marasmius ilicicola, Marasmius ciliatomarginatus, Marasmius paludigenus, Marasmius falcatipes.

Although significant contributions have been made toward understanding of the genus Marasmius as it occurs in the northeastern United States (Morgan, 1905, 1906; Pennington, 1915; Gilliam, 1975a, 1975b, 1976; Halling, 1983) and western United States (Desjardin, 1985, 1987a, 1987b), no comprehensive taxonomic treatment of the genus from the southeastern United States is available. During the course of preparing a floristic monograph of Marasmius from southeastern North America, extensive herbarium studies and field work have uncovered several new taxa.

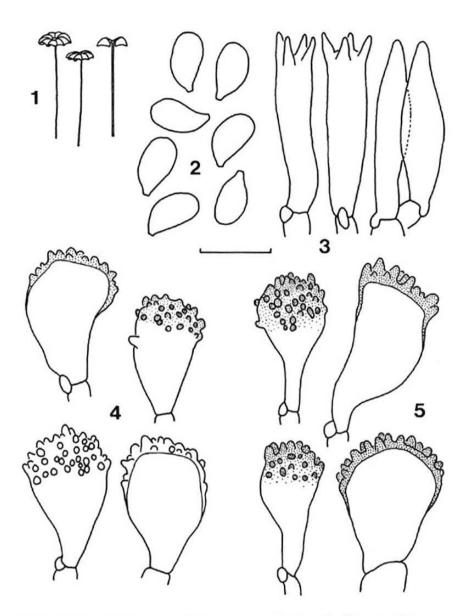
Color terms and notations are from Kornerup and Wanscher (1978). In the sections on material examined, commonly used abbreviations are as follows: GSMNP, Great Smoky Mountains National Park; DED, D. E. Desjardin.

Where five or more specimens of each taxon were available for a comparison of intraspecific variation, we have followed the suggestion of Parmasto and Parmasto (1987: 111) and calculated the 90%-expected tolerance limits of the mean spore size at 90% probability level [TL90(90%)]. Other spore factors determined include: $\bar{\mathbf{x}}$, the arithmetic means of the spore length (L) and spore width (W) in a sample (specimen); $\bar{\mathbf{x}}$, the mean of means where more than one specimen is available; s, standard deviation of a sample (indicated as sL X sW, and sQ), or standard deviation of the mean values where more than one specimen is available; E, the quotient of L and W in any one spore (indicated as a range of variation in n spores measured); Q, the mean of E-values in a sample; $\bar{\mathbf{Q}}$, the mean of Q-values where more than one specimen is available.

MARASMIUS ILICICOLA Desjardin sp. nov. Figs. 1-5.

Pileus 2-4 mm latus, convexus, sulcatus, umbilicatus, subvelutinus, disco atrobrunneus, margine pallidior. Lamellae adnatae, distantes, latae, collariatae, pallidae. Stipes 10-22 mm longus, 0.1-0.2 mm crassus, filiformus, glaber, insititius, atrobrunneus; rhizomorphae atrae. Odor et sapor nullus. Basidiosporae 7.5-9.5 X 3.5-4.8 μm, amygdaliformes, laeves, hyalinae, inamyloideae. Basidia tetraspora. Pleurocystidia nulla. Cheilocystidia elementis pileipellis similia. Pileipellis hymeniformis ex elementis M. rotali similibus; diverticuli pallidobrunnei. Trama ex hyphis inamyloideis, fibulatis. In foliis Ilicis opacae. Holotypus: Mississippi, De Soto National Forest, Perry Co., Black Creek Wilderness Area, 16 Jul 1987, D. E. Desjardin no. 4355 (no. 47625, TENN).

Basidiomata (Fig. 1) marcescent, reviving. Pileus 2-4 mm broad, convex, sulcate, centrally depressed, with or without a broad, low papilla; surface dull, dry, opaque, subvelutinous; central depression or papilla dark brown (6-7F4-8) throughout maturation; margin evenly light brown (6D4-5) when young, remaining so in age or fading to greyish orange (5B4), lacking a whitish zone surrounding the dark central dot; context thin, concolorous with adjacent cuticle. Lamellae distant (9-11 reach the collarium), broad, adnate to a complete, free collarium, pale orange white (5A2) when young, becoming pale brownish orange (5B3-5C4) in age, collarium and lamellar edges concolorous with lamellar faces or darkening slightly when



Figs. 1-5. Features of Marasmius ilicicola [Desjardin 4355, Holotype]. 1. Basidiomata (X3). 2. Basidiospores. 3. Basidia and basidioles. 4. Cheilocystidia.

- Pileipellis elements. Scale bar = 10 μm.

dried, lamellulae absent. Stipe 10-22 X 0.1-0.2 mm, terete, equal, filiform, hollow, shining, glabrous, insititious; apex concolorous with lamellae, base dark brown (6F4-8), darkening overall in age. Rhizomorphs scattered, wiry, black, basidiomata not arising from the rhizomorphs. Odor and taste not distinctive.

Basidiospores (Fig. 2) 7.5-9.5 X 3.5-4.8 μ m [\bar{x} = 8.3 $X 4.3 \mu m$, $s = 0.43 \times 0.26$; E = 1.8-2.1; Q = 1.9, sQ = 0.1; n = 30], ellipsoid or amygdaliform, hyaline, inamyloid. Basidia (Fig. 3) 22-26 X 5.5-6.5 µm, cylindric or subclavate, 4-spored. Basidioles (Fig. 3) fusoid. Pleurocystidia absent. Cheilocystidia (Fig. 4) numerous. similar to pileipellis elements, 16-20 X 8.5-12 µm, hyaline overall or apically pale ochraceous, inamyloid. Pileipellis a hymeniform layer of Rotalis-type elements (Fig. 5), 17-25.5 X 9-16(-20) µm, broadly clavate or sphaeropedunculate, apically pale brown and thick-walled, basally hyaline and thin-walled, diverticula -1.6 X -1.2 um, numerous, apical and subapical, knob-like, solid, pigmented portions inamyloid or weakly dextrinoid, unpigmented portions inamyloid; some scattered elements slightly thicker-walled and more deeply pigmented than average giving the pileipellis a weakly mottled appearance under low magnification. Pileal and lamellar tramal hyphae interwoven, 2.5-8 µm diam, hyaline, smooth or weakly granular-incrusted, inamyloid. Stipe cortical hyphae parallel, 2.5-6.5 µm diam, hyaline to pale ochraceous at the stipe apex, deep olivaceous brown in KOH at the stipe base, with dextrinoid walls up to 1 um thick. Stipe medullary hyphae parallel, 2-8 µm diam, hyaline, inamyloid, thin-walled. Caulocystidia absent. Clamp connections common on tramal hyphae and hymenial elements.

HABIT, HABITAT AND DISTRIBUTION. Scattered on senescent leaves of *Ilex opaca* Ait. in mixed bottomland hardwoods with scattered pines. Mississippi. July. Locally abundant.

MATERIAL EXAMINED. UNITED STATES. MISSISSIPPI: De Soto National Forest, Perry Co., Black Creek Wilderness Area, 16.vii.87, DED no. 4355 (no. 47625, TENN - Holotype).

OBSERVATIONS. Marasmius ilicicola belongs in sect. Marasmius, subsect. Pararotulae (Sing.) Sing. because of the presence of collariate lamellae, institutious stipe and Rotalis-type pileipellis elements. It is microscopically similar to several neotropical taxa, viz. Marasmius scototephrodes Sing. from Mexico, and M. tetrachrous

Sing. from Bolivia. Marasmius scototephrodes differs in having an ash grey pileus with a whitish zone surrounding a grey central dot, dark greyish-marginate lamellae and fruiting habit on sticks and leaves of various dicotyledonous plants but not on Ilex [Holotype: Singer M8299 (F!)]. Marasmius tetrachrous differs by forming smaller (1.5-2 mm diam), bullet-shaped, ferruginous pilei with a pallid zone surrounding a dark central dot, in having shorter and broader basidia and in lacking rhizomorphs (fide Singer, 1976). In eastern North America, M. ilicicola is superficially similar to M. capillaris Morg., in that both species form basidiomes with brownish, sulcate pilei, collariate lamellae and dark filiform stipes accompanied by rhizomorphs. Marasmius capillaris differs, however, in forming pilei with a buff or pale yellowish zone surrounding the central depression, in having more numerous and more closely spaced lamellae and by growing on leaves of Quercus species or rarely on coniferous needles [Lectotype: Morgan, Oct. 1890 (ISC!)]. Of the nearly 100 herbarium collections of M. capillaris we have studied, no basidiomes were observed growing from leaves of Ilex. Field studies also support these data. areas where Ilex opaca and Quercus spp. are sympatric, extensive searches for M. capillaris on Ilex and M. ilicicola on substrates other than Ilex have proved unsuccessful. See Gilliam (1976) for a description of M. capillaris.

If the collarium is overlooked, M. ilicicola might be confused with another macroscopically similar Ilex leaf-degrading taxon, viz. M. ilicis Singer. The latter differs microscopically in having ventricose or lageniform pleurocystidia, thick-walled dermatocystidia similar in shape to the pleurocystidia and interspersed among Rotalis-type pileipellis elements, and in having diverticulate stipe cortical hyphae [Isotype: Singer B88 (MICH!)]. See Singer (1953) for a description of M. ilicis.

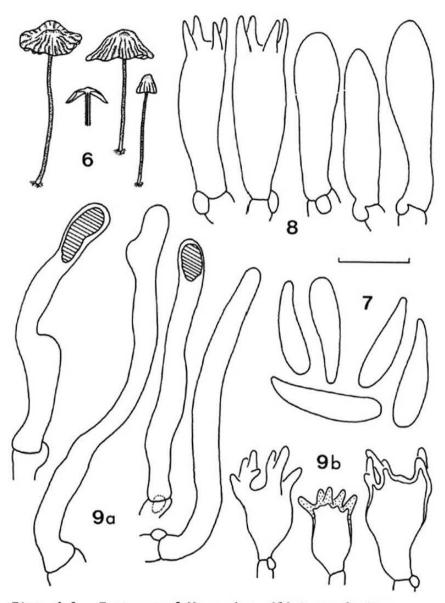
Although Ilex opaca (American Holly) is common throughout the southeastern United States and ranges northward into coastal Massachusetts (Elias, 1980), M. ilicicola is known at present only from coastal Mississippi. It is presumed that the high summer temperatures and humidity plus mild winter temperatures and abundant rainfall characteristic of the gulf coast region are important determining factors in the distribution of M. ilicicola.

MARASMIUS CILIATOMARGINATUS Desjardin sp. nov. Figs. 6-11.

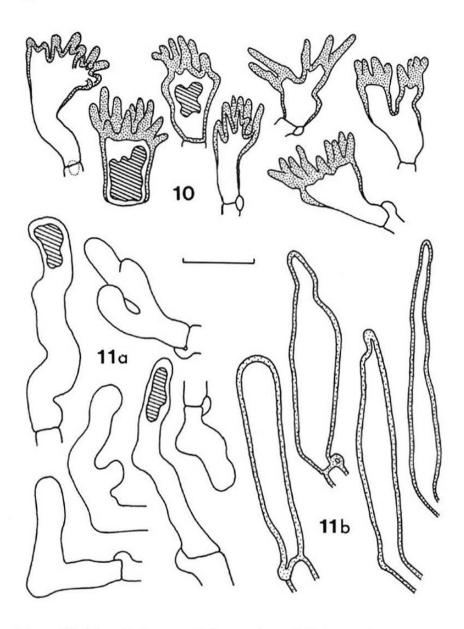
Pileus 5-20 mm latus, campanulatus vel planoconvexus, ruguloso-striatus, subvelutinus, badius vel ferrugineus. Lamellae adnatae, subdistantes, angustae, alboluteae, ferrugineus-marginatae. Stipes 18-45 mm longus, 0.5-1 mm crassus, teres, aequalis, pubescens, non insititius, apice bubalinus, base brunneus, aetate atrans. Odor et sapor nullus. Basidiosporae 13.5-18 X 3.2-4.7 µm, clavatae, laeves, hyalinae, inamyloideae. Basidia tetraspora. Pleurocystidia nulla. Cheilocystidia cylindrica vel flexuosa, gleocystidiodea, contentibus cinnabarinis, rariter elementis pileipellis similia. Pileipellis hymeniformis ex elementis M. sicco similibus; diverticuli ferruginei. Trama ex hyphis dextrinoideis, Caulocystidia cheilocystidiis gleocystoideis fibulatis. similia. Ad folia dejecta dicotyledonum. Holotypus: North Carolina, Macon Co., Highlands, Horsecove, 10 Aug 1987, D. E. Desjardin no. 4414 (no. 47626, TENN).

Basidiomata (Fig. 6) marcescent, reviving. Pileus 5-20 mm broad, conic or campanulate when young, expanding in age to broadly campanulate or plano-convex, often with a low umbo and upturned margin; surface dull, dry, opaque, subvelutinous; disc rugulose, margin rugulose-striate; context thin, buff; color reddish brown (8D6-8), brown (7E7-8) or deep orange brown (7D8) overall when young, disc remaining so in age or fading to brownish orange (7C7-8), margin soon becoming brownish orange and fading in age to light brownish orange (6C5-7) or rarely when old and wet becoming light orange (5A3-4). Lamellae adnate, subdistant to nearly close (20-25 reach the stipe), narrow (<1.5 mm), yellowish white or cream (4A2-3), seldom forked near the margin, interlamellar spaces sometimes venose and assuming pileus tints at maturity; edges granularcrystalline, pale-concolorous with the pileus; lamellulae in 0-2 series. Stipe 18-45 X 0.5-1 mm, terete, equal or seldom with a small subbulbose base, pruinose to pubescent overall, arising from a small ring of buff or creamcolored mycelium; when young, upper half yellowish white (4A2) to dingy buff, lower half brown (6E5-6), hysterochroic, in age upper few mm pallid, base brown (6-7E4-6), reddish brown (8E5-6) or dark brown (7F5-6). and taste not distinctive.

Basidiospores (Fig. 7) 13.5-18 X 3.2-4.7 μ m [\bar{x} = 15.7 X 4 μ m, s = 0.95 X 0.26; E = 3-4.6; \bar{Q} = 3.9, s \bar{Q} = 0.29; n = 30/3 collections], clavate or fusiform-elliptical, often



Figs. 6-9. Features of Marasmius ciliatomarginatus [Desjardin 4414, Holotype]. 6. Basidiomata (X1).
7. Basidiospores. 8. Basidia and basidioles.
9a. Gloeocystidioid cheilocystidia. 9b. Siccus-type cheilocystidia. Scale bar = 10 μm.



Figs. 10-11. Features of Marasmius ciliatomarginatus [Desjardin 4414, Holotype]. 10. Pileipellis elements. 11a. Caulocystidia from stipe apex. 11b. Caulocystidia from stipe base. Scale bar = 10 μ m.

curved in profile, hyaline, inamyloid. Basidia (Fig. 8) 22-30 X 6.5-8.5 µm, subcylindric or clavate, 4-spored. Basidioles (Fig. 8) clavate, ventricose or fusoid. Pleurocystidia not differentiated. Cheilocystidia of two types: 1) numerous gloeocystidioid elements (Fig. 9a), 38-56 X 3-5 µm, cylindric, flexuous or strangulate, obtuse, thin-walled, with or without tawny to reddish orange globular cytoplasmic contents typically congregated nearest the apices of the cells, or with reddish orange globular masses adherent to the external cellular surfaces, walls inamyloid; 2) rare (or absent), scattered Siccus-type elements (Fig. 9b) similar to pileipellis elements, with hyaline or pale orange diverticula. Pileipellis a hymeniform layer of Siccus-type elements (Fig. 10), with rare, inconspicuous, clavate, thinwalled, non-diverticulate cells interspersed; Siccus-type elements 8-16 X 3.2-8 µm, cylindric, clavate or irregular in outline, sometimes lobed, thin- to thick-walled, hyaline or tawny-colored; diverticula 1.5-8 X 0.8-2 µm, apical, irregularly conic or cylindric, subnodulose or not, thick-walled or solid, ochraceous or reddish brown, pigmented portions weakly dextrinoid; some elements with tawny, globular contents; some elements thicker-walled and more deeply pigmented than average giving the pileipellis a mottled appearance under low magnification. Pileal and lamellar tramal hyphae interwoven, 1.5-9 µm diam, cylindric or inflated, branched, hyaline, non-incrusted, inamyloid or weakly dextrinoid, thin-walled. cortical hyphae parallel, 2.5-6 µm diam, dextrinoid, hyaline or pale ochraceous and thin-walled apically, ochraceous or brown and thick-walled below. medullary hyphae parallel or subparallel, 2.5-11 µm diam, hyaline or pale yellowish, inamyloid or weakly dextrinoid. Highly refractive oleiferous hyphae common. Stipe vesture of abundant caulocystidia: at stipe apex (Fig. 11a) 13-32 X 3-5 µm, irregularly cylindric or strangulate-contorted, rarely lobed, obtuse, hyaline, inamyloid, thin-walled, with or without reddish orange globular contents or adherent exudates; at stipe base (Fig. 11b) -40 X 4-8 µm, cylindric to ventricose or acuminate, pale ochraceous, inamyloid, walls -1.2 µm thick. Clamp connections common throughout basidiomata.

HABIT, HABITAT AND DISTRIBUTION. Scattered to gregarious on senescent hardwood leaves or stems (rarely on Rubus stems or hickory nuts) in mixed woods containing Liriodendron, Quercus, Alnus, Cornus, Carya and Ilex with scattered Pinus and Tsuga. Aug. - Sept. Uncommon. NC, TN.

MATERIAL EXAMINED. UNITED STATES. NORTH CAROLINA: Macon Co.: Highlands, Horsecove, 10.viii.87, DED no. 4414 (no. 47626, TENN - Holotype). TENNESSEE: Blount Co.: GSMNP, Cades Cove, 31.viii.86, DED no. 4078 (no. 47628, TENN); Knox Co.: Knoxville, 7.ix.86, DED no. 4154 (no. 47627, TENN).

OBSERVATIONS. Features which in combination are diagnostic for M. ciliatomarginatus include: a) reddish brown or brownish orange, rugulose-striate pileus; b) subdistant, narrow, cream-colored, orange-marginate lamellae; c) pubescent, apically pallid and basally brownish, non-insititious stipe; d) clavate spores averaging 15.6 X 4 µm; e) absence of pleurocystidia; f) flexuous cheilocystidia with reddish orange contents or adherent exudates; and g) cylindric-contorted, nondiverticulate caulocystidia. Collectively, this diagnosis suggests placement in sect. Sicci, subsect. Siccini, ser. Actinopodes Singer (1976). The most distinctive feature of this species is the abundant gloeocystidioid cheilocystidia and relative absence of Siccus-type cheilocystidia, resulting in a lamellar edge morphology unique in section Sicci. Consequently, M. ciliatomarginatus is not likely to be confused with any other members of the section. There are, however, several North American taxa that are phenetically similar in many other respects, viz. M. sullivantii Mont. (widespread in eastern North America), and M. corrugatus var. aurantiacus (Murr.) Sing. (known from Florida and the neotropics).

Marasmius sullivantii differs in having much smaller spores*, abundant pleurocystidia and broom-cell-type caulocystidia [Representative material: DED no. 4342 (no. 47648, TENN)]. Marasmius corrugatus var. aurantiacus differs in having a glabrescent stipe with scattered broom-cell-type caulocystidia, and smaller spores* [Holotype of Gymnopus aurantiacus: Murrill, F17904 (FLAS!)]. See Gilliam (1976) and Singer (1976), respectively, for descriptions of the latter two taxa.

^{*}Spores of M. sullivantii: $6.4-8.8 \times 3.2-4 \mu m$, $\overline{x}=7.6 \times 3.6 \mu m$, $s=0.26 \times 0.12$; E=1.8-2.6; $\overline{Q}=2.1$, $s\overline{Q}=0.05$; $TL90(90\%)=7.1-8.1 \times 3.4-3.9 \mu m$, Q=2-2.2; n=30/8 specimens. Spores of Gymnopus aurantiacus: $7.2-9 \times 3.4-4.2 \mu m$; $\overline{x}=8.2 \times 3.9 \mu m$, $s=0.47 \times 0.19$; E=1.9-2.4; Q=2.1, sQ=0.12; n=30.

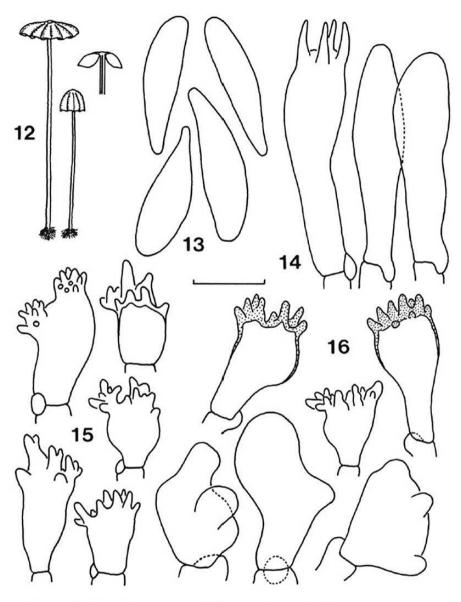
MARASMIUS PALUDIGENUS Desjardin sp. nov. Figs. 12-16.

Misapplied epithet: Marasmius glabellus Peck sensu Ellis, in de Thümen, Mycotheca Universalis Exsiccati Cent. 6, no. 505, 1876. Marasmius glabellus Peck sensu Ellis, in North American Fungi Exsiccati Ser. I, Cent. 10, no. 910, 1883.

Pileus 7-18 mm latus, convexus, sulcatus, subvelutinus, disco ochraceus, margine griseolo-aurantius vel alutaceus. Lamellae adnexae, remotae, latae, griseolo-aurantiae vel fusciochraceae. Stipes 20-65 mm longus, 0.5-1 mm crassus, teres, aequalis, glaber, non insititius, apice bubalinus, base brunneus, aetate atrans. Odor spermaticus. Basidiosporae 16-24 X 4.4-6 μm, clavatae, laeves, hyalinae, inamyloideae. Basidia tetraspora. Pleurocystidia nulla. Cheilocystidia elementis pileipellis similia. Pileipellis hymeniformis ex elementis latis, M. sicco similibus, etiam ex elementis laevibus, vesiculosis. Trama ex hyphis dextrinoideis, fibulatis. Ad folia dejecta in palustria. Holotypus: New Jersey, Salem Co., Camp Edge Boy Scout Camp, 18 Aug. 1987, R. E. Halling (no. 47622, TENN).

Basidiomata (Fig. 12) marcescent, reviving. Pileus 7-18 mm broad, obtusely conic or parabolic when young, expanding and becoming convex in age; disc rugulose, margin sulcate or plicate; surface dull, dry, opaque, subvelutinous; context thin, buff; color yellowish brown (5D5) overall when young, disc remaining so in age or fading slightly, margin fading to pale brownish orange (5C4-5) or greyish orange (5B3-4), eventually becoming tan or cream-colored (4A3). Lamellae adnexed or nearly free, remote [11-13 (rarely 16) reach the stipe], broad (2-4 mm), greyish orange (5B4-5) when young, soon becoming brownish orange (5C4-5), darkening in age to dark yellowish brown (5E-F5-6), neither forked nor intervenose; edges concolorous with the faces; lamellulae typically Stipe 20-65 X 0.5-1 mm, terete, equal, shiny, glabrous, hollow, arising from a small pad of yellowish mycelium; white to buff above when young, brown below (6F4-8), darkening overall in age. Odor of crushed pilei Taste not observed. spermatic.

Basidiospores (Fig. 13) 16-24 X 4.4-6 μ m [\bar{x} = 19.4 X 5.1 μ m, s = 0.45 X 0.15; E = 3.1-4.5; \bar{Q} = 3.8, s \bar{Q} = 0.13; TL90(90%) = 18.5-20.2 X 4.8-5.4 μ m, Q = 3.5-4; n = 30/9 specimens], clavate or fusiform-elliptical, sometimes



Figs. 12-16. Features of Marasmius paludigenus.
12. Basidiomata (X1) [Flynn 718]. 13. Basidiospores.
14. Basidium and basidioles. 15. Cheilocystidia.
16. Pileipellis elements. [Figs. 13-16: Halling,
18.viii.84, Holotype]. Scale bar = 10 μm.

curved in profile, hyaline, inamyloid; readily collapsing and reviving poorly. Basidia (Fig. 14) 25-38 X 7-8.8 µm, clavate, 4-spored. Basidioles (Fig. 14) clavate or ventricose. Pleurocystidia absent. Cheilocystidia (Fig. 15) abundant, 7.5-18(-25) X 4-8.8 μm, similar to the diverticulate pileipellis elements, hyaline. Pileipellis a hymeniform layer of versiform cells (Fig. 16), 6.5-25.5 X 4.5-12(-16) µm, irregularly cylindric, clavate, obclavate, pyriform or vesiculose, many lobed, inamyloid, with or entirely without apical diverticula; immature pilei composed mainly of diverticulate elements, basal portion of cells hyaline, thin-walled, diverticula 1-4.5 X 0.5-1.5 μm, hyaline or ochraceous, thin- or thickwalled; in mature pilei diverticulate elements abundant on the pileal disc, less frequent or rare elsewhere, pileus margin regions composed mainly of smooth, often lobed, non-diverticulate elements interspersed among tramal hyphae. Pileal and lamellar tramal hyphae interwoven, 3-9(-12) um diam, often inflated, branched, dextrinoid, hyaline to brownish yellow; pigment soluble in 3% KOH. Stipe cortical hyphae parallel, 2.5-6.5 µm diam, hyaline, dark ochraceous or brown, dextrinoid, walls -1 µm thick. Stipe medullary hyphae subparallel, 2.5-9 µm diam, hyaline or pale yellowish, weakly dextrinoid, thin-walled. Refractive oleiferous hyphae common. Caulocystidia absent. Clamp connections common throughout basidiomata.

HABIT, HABITAT AND DISTRIBUTION. Scattered on senescent leaves or among mosses in sandy and swampy areas with Quercus, Ilex and Pinus. Aug. - Oct. Locally abundant. DE, NJ, NY, VA.

MATERIAL EXAMINED. UNITED STATES. DELAWARE: no location data, 19.viii.84, Flynn, Vilgalys & Cotter, US 900515 (BPI). NEW JERSEY: Salem Co.: Camp Edge Boy Scout Camp, 18.viii.84, R. E. Halling s.n. (no. 47622, TENN - Holotype). Gloucester Co.: Newfield, Ellis s.n. (BPI); Newfield, Ellis 22.vii.1875 (BPI); Newfield, Ellis, viii.1875 in de Thümen, Myco. Univ. no. 505 (as Marasmius glabellus) (BPI, FH, presumably other distributions); Newfield, Ellis, viii.1882, in N. Amer. Fungi no. 910 (as M. glabellus) (BPI, FH, MICH, NY, NYS, PENN at PH, PH, presumably other distributions). NEW YORK: Suffolk Co.: Robert Moses State Park, 28.x.84, B. M. Thiers & R. E. Halling no. 3883 (no. 47623, TENN). VIRGINIA: Northampton Co.: swamp near Norfolk, 20.viii.84, T. Flynn no. 718 (no. 47624, TENN).

OBSERVATIONS. Marasmius paludigenus is characterized 1) yellowish brown or tan, sulcate pileus; 2) remote, broad, brownish orange or dark yellowish brown lamellae; 3) glabrous, brown, non-insititious stipe; and 4) growth in swampy environments. In addition, long spores (mean length 19.4 µm), absence of pleurocystidia and caulocystidia, and pileipellis morphology are distinctive. This species was collected by J. B. Ellis "among moss in swamps" in Newfield, New Jersey on several occasions between 1875 and 1882, although Ellis determined his specimens as Marasmius glabellus Peck. An Ellis collection was distributed by de Thümen as no. 505 in the Mycotheca Universalis Exsiccati (issued 1876). years later, Ellis distributed additional material (determined as M. glabellus) as no. 910 in his North American Fungi Exsiccati (issued 1883). All duplicates studied of the two exsiccata numbers mentioned above represent M. paludigenus. Marasmius glabellus is similar in stature, but differs in showing a darker pileus (i.e., usually retaining deep brownish orange or yellowish brown pigmentation in age and only rarely becoming pallid overall) and much paler lamellae which never develop dark yellowish brown tints as in M. paludigenus. Moreover, M. glabellus has numerous pleurocystidia, pileipelli composed entirely of Siccus-type diverticulate elements and smaller spores $[\bar{x} = 9 \text{ X 4.7 } \mu\text{m}, \text{ s} = 0.94 \text{ X 0.36}; \text{ E} = 1.6-2.2; \text{ Q} =$ 1.9, sQ = 0.13; n = 30. Holotype: Worcester & Croghan, Peck, July & August (NYS!)]. Another southeastern representative of sect. Sicci with sulcate pileus, distant broad lamellae and glabrous brown stipe is Marasmius similis Berk. & Curt. The latter differs from M. paludigenus in having a whitish pileus, pileipellis elements and cheilocystidia with densely nodulose diverticula, and in forming smaller spores $[\bar{x} = 12.3 \times 3.9]$ μm , s = 0.91 X 0.29; E = 2.8-3.6; Q = 3.2, sQ = 0.19; n = 30. Isotype: South Carolina, Society Hill, Curtis 1319 (FH!)1.

An interesting feature of pileipellis morphology in M. paludigenus is the abundance of non-diverticulate elements in mature pilei and their relative absence in immature pilei. Indeed, in some mature basidiomata it is difficult to locate broom-cell-type elements in the pileal margin regions, whereas the entire pileipellis of immature basidiomata is formed almost exclusively of broom-cell-type elements. One might be easily misled as to the sectional disposition of this taxon if only a single tangential section of the pileus were examined. Were a

hymeniform pileipellis of smooth cells present, this in combination with other basidiomata characters of M. paludigenus, would suggest placement in sect. Globulares Kühner. However, because of the abundant Siccus-type pileipellis elements present in young pilei and in the disc region of mature pilei, this species is accepted here in sect. Sicci.

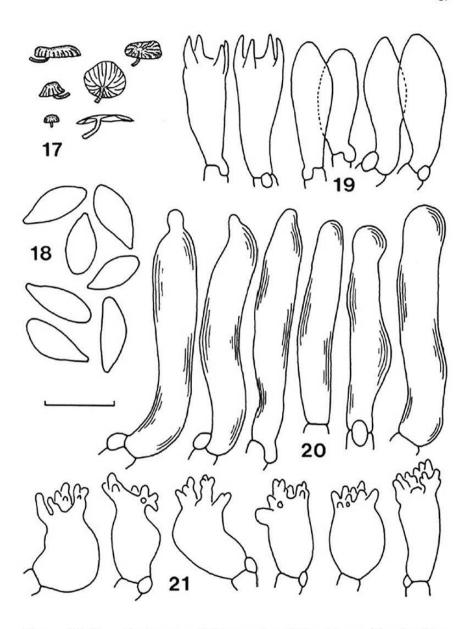
Marasmius paludigenus has many characteristics in common with M. decipiens Halling, Desjardin & Tish. example, both taxa are similar in basidiomata stature, pileus shape and coloration, lamellar width and spacing, stipe coloration, spore shape, hyphal tissue amyloidity and absence of pleurocystidia. And, although the cheilocystidia and pileipellis elements of these two species are similar in shape, diverticula are altogether lacking from these structures in M. decipiens, an important diagnostic criterion dictating placement of M. decipiens in sect. Globulares. Marasmius decipiens differs also in having paler lamellae, pubescent to strigose stipe base and longer spores [\bar{x} = 22.9 X 4.6 μm , $s = 0.65 \times 0.12$; E = 4-6; $\bar{Q} = 5$, $s\bar{Q} = 0.24$; TL90(90%) = $21.5-24.4 \times 4.3-4.9 \mu m$, Q = 4.5-5.5; n = 25/6 specimens. Holotype: Tish 1602-F (NY!)]. See Halling et al. (1985) for a description of M. decipiens.

MARASMIUS FALCATIPES Desjardin sp. nov. Figs. 17-23.

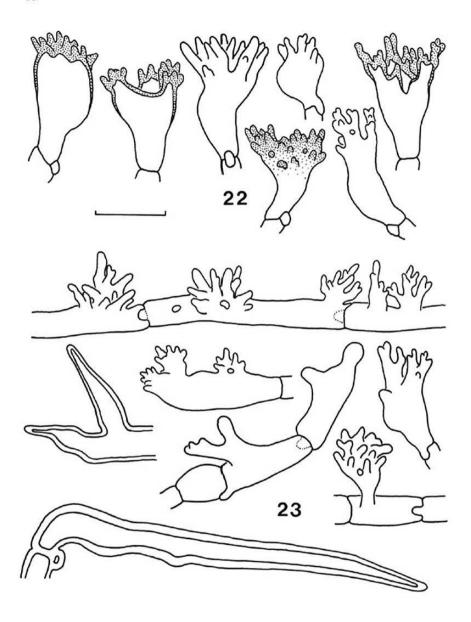
Pileus 1-7(-11) mm latus, e convexo plano-convexus, ruguloso-striatus, subvelutinus; primo bubalinus, griseolo-brunneus, brunneo-aurantius vel brunneus, in aetate pallidior. Lamellae adnatae, confertae vel subdistantes, angustae, pallidae. Stipes 1-2.5 mm longus, <0.2 mm crassus, eccentricus vel centralis, teres, aequalis, falcatus, pruinosus, non insititius, bubalinus. Odor et sapor nullus. Basidiosporae (7.5-)8-10.5(-12) X 3.5-5.2 µm, ellipsoideae vel amygdaliformes, laeves, hyalinae, inamyloideae. Basidia tetraspora. Pleurocystidia rara vel abunda, refractiva, cylindrica, obtusata. Cheilocystidia elementis pileipellis similia. Pileipellis hymeniformis ex elementis M. sicco similibus; diverticuli hyalini et ferruginei. Trama ex hyphis dextrinoideis, fibulatis. Caulocystidia diverticulata. In foliis et ramis emortuis dicotyledonum vel monocotyledonum. Holotypus: North Carolina, Macon Co., Highlands, Horsecove, 10 Aug. 1987, D. E. Desjardin no. 4415 (no. 47629, TENN).

Basidiomata (Fig. 17) marcescent, reviving. Pileus 1-7(-11) mm broad, campanulate or convex, expanding to plano-convex or plane, rarely umbonate, often undulate in age, rugulose-striate; surface dull, dry, opaque, subvelutinous; context thin, whitish; color exceedingly variable, when young buff, greyish cream (4C2), grey (4E2), pale brownish grey (5E2-3), brownish orange (5C4), dark yellowish brown (5F4) or brown (6E4-6), the more deeply pigmented pilei fading in age to light yellowish brown (5D-E4-5), greyish yellow (5D3), pale brownish orange (5C3) or yellowish grey (4B3), but drying darker. Lamellae adnate, close or subdistant (7-14 reach the stipe), narrow or moderately broad (-1.5 mm), rarely forked or intervenose near the margin, white, buff or pale yellowish white (4A2) at first, remaining so in age or becoming pale yellowish grey (4B3) or orange white (5A2), not marginate; lamellulae in 1-2 series. Stipe 1-2.5 X <0.2 mm, typically eccentric, but often central or rarely nearly lateral, terete, equal, curved or geniculate, pruinose overall, arising from a small, white mycelial pad, white or buff overall when young, remaining so in age or the base darkening to cream (4A3), pale yellowish grey (4B3) or pale brownish orange (5C3). Odor and taste not distinctive.

Basidiospores (Fig. 18) (7.5-)8-10.5(-12) X 3.5-5.2 $\mu m \ [\bar{x} = 9.4 \ X \ 3.9 \ \mu m, \ s = 0.45 \ X \ 0.19; \ E = 1.9-2.9; \ \bar{Q} =$ 2.4, $s\bar{Q} = 0.12$; TL90(90%) = 8.5-10.3 X 3.5-4.3 µm, Q = 2.2-2.7; n = 25/7 specimens], ellipsoid or amygdaliform, often with a slight suprahilar depression and abaxial bulge, with a prominent hilar appendix, hyaline, inamyloid. Basidia (Fig. 19) 16-22.5 X 5-6.5(-7.5) µm, clavate, 4-spored. Basidioles (Fig. 19) broadly clavate or ventricose-fusoid. Pleurocystidia (Fig. 20) rare to numerous, 30-45 X 4.8-8 µm, irregularly cylindric, obtuse, refractive, hyaline, inamyloid, arising from deep in the subhymenium and projecting up to 11 µm beyond basidioles; base often curved. Cheilocystidia (Fig. 21) numerous, 11- $17(-20) \times 4.8-8(-9) \mu m$, diverticulate, similar to pileipellis elements but typically hyaline overall, only rarely with pale ferruginous diverticula; lamellar edge entirely sterile or with scattered basidia, basidioles and rare pleurocystidia-type elements. Pileipellis a hymeniform layer of Siccus-type elements (Fig. 22), 8.5-16 X 4.5-8.5(-9.5) μm, cylindric, clavate or irregular in outline, often lobed, diverticulate; basal portion of cells hyaline, thin-walled, inamyloid; diverticula 1-7(-9)



Figs. 17-21. Features of Marasmius falcatipes [Desjardin 4415, Holotype]. 17. Basidiomata (x3). 18. Basidiospores. 19. Basidia and basidioles. 20. Pleurocystidia. 21. Cheilocystidia. Scale bar = 10 μ m.



Figs. 22-23. Features of **Marasmius falcatipes** [Desjardin 4415, Holotype]. 22. Pileipellis elements. 23. Elements of stipe vesture (thick-walled elements from stipe base). Scale bar = $10 \mu m$.

X 0.5-2 μm, irregularly cylindric or contorted, rarely branched, obtuse, hyaline to pale yellowish and thinwalled or ochraceous to ferruginous and thick-walled, pigmented areas weakly dextrinoid. Pileal and lamellar tramal hyphae interwoven, 2.5-8(-10) μm diam, inflated, non-gelatinous, hyaline, thin-walled, dextrinoid. Stipe cortical and medullary hyphae similar, parallel, 2.5-10 μm diam, hyaline or pale yellowish, strongly dextrinoid, walls -2 μm thick; hyphae from stipe base strongly sclerified. Stipe vesture (Fig. 23) of numerous diverticulate inflations projecting from the outermost layer of cortical hyphae, and with scattered elements similar to those of the pileipellis. Clamp connections common throughout basidiomata.

HABIT, HABITAT AND DISTRIBUTION. Scattered to gregarious on senescent leaves or stems of various hardwoods, herbaceous vines or grasses in mixed deciduous woodlands. July - Sept. Uncommon. NC, SC, TN, VA.

MATERIAL EXAMINED. UNITED STATES. NORTH CAROLINA: Buncombe Co.: Lake Powatah, near Asheville, 5.ix.87, DED no. 4472 (no. 47635, TENN). Haywood Co.: GSMNP, Cataloochee, 6.ix.87, DED no. 4485 (no. 47636, TENN); GSMNP, Cataloochee, 9.ix.87, DED no. 4490 (no. 47637, TENN). Macon Co.: Coweeta Hydrologic Lab, Ball Creek, 4.ix.86, DED no. 4134 (no. 47631, TENN); Coweeta Hydrologic Lab, Ball Creek, 13. viii. 87, DED no. 4456 (no. 47634, TENN); Highlands, Horsecove, 30.vii.87, DED no. 4413 (no. 47632, TENN); Highlands, Horsecove, 10. viii. 87, DED no. 4415 (no. 47629, TENN - Holotype). SOUTH CAROLINA: Oconee Co.: Ellicott Wilderness Area, Chattooga Picnic area, 12. viii. 87, DED no. 4448 (no. 47633, TENN). TENNESSEE: Blount Co.: GSMNP, Cades Cove, 17.ix.85, DED no. 3485 (no. 47630, TENN). VIRGINIA: no data, R. Vilgalys, US 900746 (BPI). Giles Co.: Jefferson Nat. Forest, 2.x.83, O. K. Miller 20804 (VPI). Montgomery Co.: Blacksburg, VPI, 14.ix.83, R. Vilgalys 83/195, US 900773 (BPI). Washington Co.: Little Tumbling Creek, 17.ix.83, R. Vilgalys 83/202, US 900121 (BPI).

OBSERVATIONS. Marasmius falcatipes exhibits substantial morphological and substrate variability. The stipe-pileus insertion ranges from central to nearly lateral, with the full range of variation exhibited within or between collections. Pileus coloration varies from buff, greyish yellow or brownish yellow to brownish orange, brown or grey. Basidiomata have been found growing on senescent leaves or stems of various deciduous

hardwoods or herbaceous vines (e.g., Rubus, Lonicera), as well as grass leaves. Moreover, there appears to be no correlation between degree of stipe eccentricity, pileus coloration and substrate preference.

Marasmius falcatipes belongs in sect. Sicci, subsect. Siccini Singer (1965) because of Siccus-type pileipellis elements, non-collariate lamellae, non-insititious stipe and dextrinoid tramal hyphae. Singer (1976) established two series within subsect. Siccini based on the presence of well-differentiated pleurocystidia (ser. Haematocephali) or their absence (ser. Leonini). Although M. falcatipes possesses distinctive pleurocystidia, it appears to be most phenetically similar to several taxa belonging to ser. Leonini, viz., M. armeniacus Gilliam (1975a) and M. pusio Berk. & Curt. (1853). Marasmius armeniacus [Holotype: Gilliam 932a (MICH!)] and M. pusio var. pusio [Isotype: Ravenel 816 (FH!)] both differ from M. falcatipes in longer stipes (at least two times longer than the width of the pileus) and having more polymorphic caulocystidia. In comparison, the stipe of M. falcatipes is usually shorter than the width of the pileus. Marasmius pusio var. quatopoensis (Dennis) Sing. essentially differs only in lacking pleurocystidia (fide Dennis, 1961).

If greater taxonomic emphasis is placed on the presence of a short, eccentric stipe, it could be argued that M. falcatipes belongs in sect. Neosessiles Singer This section was established to unify all taxa combining the following characters: 1) pleurotoid habit (i.e., stipe eccentric, lateral or absent); 2) noncollariate lamellae; 3) dextrinoid tramal tissue; and 4) hymeniform pileipellis of diverticulate elements. Subsequently, Singer (1965) emended the section to include both dextrinoid ("pseudoamyloid") tramal hyphae (subsect. Neosessilini) and inamyloid tramal hyphae (subsect. Spaniophyllini). If taxa currently placed in sect. Neosessiles are re-evaluated utilizing characters in common usage at sectional or subsectional levels, it appears that sect. Neosessiles is somewhat heterogeneous. It contains taxa with Siccus- or Rotalis-type pileipellis elements, insititious or non-insititious stipes, dextrinoid or inamyloid tramal tissue, and with or without pleurocystidia [see Singer (1976) for a thorough treatment of the neotropical species]. Examination of the holotype specimens of a number of species currently placed in sect. Neosessiles (Desjardin, unpublished data) indicates that this section includes discordant elements. For example, M. polycystis Singer (1976) exhibits all characters

diagnostic of sect. Sicci except for the presence of a short, eccentric stipe. Indeed, when compared with M. falcatipes, M. polycystis differs only in pleurocystidial In the latter, pleurocystidia are broadly morphology. ventricose and average 13.6 µm in width [n = 45 cystidia. Known only from the holotype: Singer B1499 (F!)], while in M. falcatipes, pleurocystidia are cylindrical with a mean width of 5.8 μ m [TL90(90%) = 4.9-6.7 μ m, n = 20/10 specimens). The extensive variability in stipe-pileus insertion exhibited by M. falcatipes indicates that stipe eccentricity may be of limited taxonomic value. These data suggest that M. polycystis is better placed in sect. Sicci, presumably closely allied with M. falcatipes. Since many species in sect. Neosessiles are known only from their type specimens, which in some cases consist of a single basidioma, it would be premature to dismantle or redefine the section until further material is available for comparative studies.

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A SYNOPSIS OF COLOMBIAN BOLETES

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Cryptogamic Herbarium The New York Botanical Garden Bronx. NY 10458-5126

RESUMEN

En el presente quince especies de Boletaceae son conocidas en el norte de los Andes en Colombia; ellos pertenecen a Austroboletus, Boletellus, Boletus, Gyrodon, Leccinum, Strobilomyces, y Tylopilus. Associaciones ectomycorrizicas con Quercus humboldtii y Alnus acuminata son asumidas en la mayoria de los casos. Por primera vez en la taxa se describen Boletus orquidianus, Leccinum andinum, y Tylopilus obscurus.

INTRODUCTION

Several weeks collecting during October-November 1986 and May 1987 in the Andean regions of Antioquia, Boyacá, Cauca, Cundinamarca, and Huila of Colombia resulted in the discovery of a number of interesting taxa (e.g., Halling & Ovrebo, 1987a,b). In particular, repeated trips to forests of Quercus humboldtii Bonpl. showed that members of the Boletaceae were fairly well represented. Also, in one area near Popayán, Alnus acuminata H.B.K. was found to support Gyrodon monticola Sing., originally described from Argentina (Singer & Digilio, 1958).

Recent reports on Boletaceae from South America include works by Horak (1977), Ovrebo (1983), Singer (1964, 1970, 1973), Singer & Digilio (1951, 1958, 1960), Singer et al. (1983), and Wolfe et al. (1988). Generally, these papers discuss boletes found in temperate/subantarctic Nothofagus forests, Amazonia, or other lowland tropical/subtropical regions of South America. Except for the report of Boletellus ananas (Curt.) Murr. and Boletus fuligineotomentosus Sing. from oak forests near Cali, Colombia (Singer, 1970, 1973), other Boletaceae (excluding Phylloporus) from that country have not been treated. Even though some taxa mentioned below also occur in the north temperate zone (North America, Europe, or Japan), I suspect these boletes are also native in Colombia [unlike Suillus luteus (Fr.) S.F. Gray and Boletus piperatus Fr. which are found associated with exotic Pinus spp.]. As mentioned previously (Singer, 1963, 1964; Singer & Morello, 1960), the oak forest mycota of Colombia remains essentially unsurveyed, thus this treatment of Colombian boletes must be considered a preliminary one.

Descriptions of Colombian boletes are given for those taxa that are newly described or of questionable identity, poorly known or thought to be true South American endemics. For species of *Gyrodon*, extralimital South American

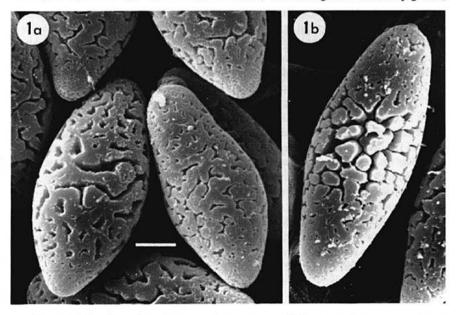
material has been compared. Color notations given as page, column, row (e.g., 6C6) are from Kornerup & Wanscher (1978). Other color names are general approximations.

- AUSTROBOLETUS SUBVIRENS (Hongo) C. B. Wolfe, Bibl. Mycol. 69: 125. 1979.

 FIG. 1
 - Porphyrellus subvirens Hongo, Acta Phytotax. Geobot. 18: 110. 1960.

Pileus 1.5 cm broad, convex, dry, with dull-green, granulose to crustose scales, sometimes fasciculated and then forming minute suberect or repent areolae. Flesh white, without odor or taste. Tubes porphyry pinkish, not changing when bruised. Stipe 3 cm long, 3-4 mm thick, ±equal, dry, white, green-subreticulate above, irregularly scaly below; scales sometimes coalescing and appearing alveolate-ridged (under a lens); interior white, unchanging.

Basidiospores smooth at first, with wall becoming minutely pitted, eventually dissected by meandering subreticulate channels that occasionally isolate irregular truncate warts or ridges, especially around middle, with walls up to 1.4 μ m thick, 14.7-18.2 × 6.3-8.8 μ m (mean Q=2.17), broadly subfusoid to elongate-amygdaliform, with a suprahilar depression, yellow brown in KOH, unreactive or dextrinoid in Melzer's. Basidia broadly clavate to subsaccate, hyaline, (3)4-sterigmate, 24-35 × 12-15 μ m. Hymenial cystidia absent. Tube trama divergent from a central stratum, with gelatinized lateral stratum; hyphae hyaline, 3.5-6.3 μ m broad. Pileus surface a trichodermium of long, cylindrical elements, sometimes fascicled, 5-10 μ m broad, smooth- and thin-walled, with dark green vacuolar pigment,



FIGS. 1 a,b. Scanning electron micrographs, basidiospores of Austroboletus subvirens (Halling 5955). Standard line = $2 \mu m$.

dissolving in KOH, irregularly coagulated in Melzer's and water mounts. Stipe surface lacking caulocystidia, with hyaline, narrow, subgelatinized hyphae, overlain with cylindrical elements forming reticulum, the latter morphologically similar to trichodermial elements of pileus. Clamp connections absent.

Material examined: DEPT. HUILA: near Parque Nacional Puracé, Finca de Ganaderia Merenberg, under Quercus humboldtii, 21 May 1987, Halling 5955 (NY).

The identity of this collection is tentative because only one, diminutive basidiocarp was found, and A. subvirens has been reported previously only from Japan and New Guinea. Despite the small size, other important characters such as the overall appearance of surface features, coloration, spore morphology and other microscopic features, correspond quite well to the protologue (Hongo, 1960), a later evaluation of the type specimen (Wolfe, 1979), and illustrations and comments on additional fresh material (Horak, 1980). However, more collections from Colombia are needed to assess the range of typical variation.

- 2. BOLETELLUS ANANAS (Curt.) Murr., Mycologia 1: 10. 1909.
 - ≡ Boletus ananas Curt., Amer. J. Sci. II 6: 251. 1848.

I have not seen specimens from Colombia, but information and a description of Colombian material can be found in Singer (1970) where one collection is cited: "VALLE. Rio Pance, 1800 m alt, 3 May 1968, Singer B6942 (F)." Also known to occur north to the southeastern United States and in southeast Asia.

- 3. BOLETELLUS RUSSELLII (Frost) Gilbert, Bolets. 107. 1931.
 - Boletus russellii Frost, Bull. Buffalo. Soc. Nat. Sci. 2: 104. 1874.

Only one immature basidiocarp was found in a 30 year-old, second-growth oak forest near Popayán. Despite the lack of spores, the long, coarsely lacerate-reticulate dull-reddish stipe with a viscid white base is an unmistakable field character. Detailed descriptions of material from the United States are available in Singer (1945) and Smith & Thiers (1970).

Material examined: DEPT. CAUCA: Municipio de Tunía, km 93 of Cali-Popayán road, Reserva Forestal "El Guayabo," 1800 m, under Quercus humboldtii, 19 May 1987, Halling 5270 (leg. G. Mueller) (NY).

- BOLETUS ATKINSONIANUS (Murr.) Sacc. & Trott., Syll. Fung. 21: 236. 1912. FIGS. 2-5
 - Ecriomyces atkinsonianus Murr., N. Amer. Flora 9: 144. 1910. TYPE: United States. North Carolina: Pink Bed Valley, Jul 1908, Murrill & House 64 (Holotype: NY!).

 10. **Type: NY!**

 10. **Type: United States.**

 11. **Type: United States.**

 12. **Type: United States.**

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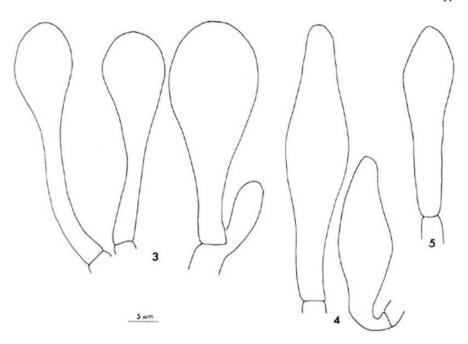
Pileus 2.5-8.5 cm broad, convex to plano-convex, viscid when wet, matted tomentose or areolate when dry; surface brown (7E8) to reddish brown (9E8) on disc and brownish orange (6C5) at margin when young, brownish orange (7C5) to light brown (7D5) to dull reddish (8C4-8C5) with age, uneven to shallowly pitted-rugulose or wrinkled in some; margin sterile and projecting about 1-1.5 mm when young, not so much with age; flesh 4-11 mm thick, white, unchanging, slightly reddish brown under pileus surface. Odor and taste mild. Tubes 5-17 mm long, unchanging when exposed, lemon yellow (2A8) to light yellow (3A5) when young,



Fig. 2. Habit of Boletus atkinsonianus. (Halling 5000) ×1/2.

more greenish yellow (3D7-3E7) with age; pores up to 1 per mm, light yellow (3A5) when young, mustard yellow to wax yellow (3B6-3B5) with age, unchanging when bruised. Stipe 7.5-12 cm long, 8-11 mm thick at apex, subclavate to broader below or sometimes ±equal, strict to somewhat curved, solid; surface subviscid to tacky when wet, glabrous, lacking reticulations, but some broad and obscure rugulose zones present or coarse alveolate ridges at apex when very young, streaked with reddish brown (8D6), with some yellowish to grayish orange (6B5) ridges near apex to half the length on white ground color, reddish brown (8D6) more abundant at apex when young, becoming whitish there with age, reddish brown (8D6) more abundant below with age, but with a white base throughout development; interior white, solid, unchanging.

Basidiospores olivaceous in fresh deposit, yellowish brown in KOH, occasionally some dextrinoid in Melzer's, smooth, thin-walled, subfusoid and inequilateral in profile to oblong ellipsoid, $11.9-16.8 \times 4.9-6.3 \mu m$ (mean Q=2.7). Hymenophore lemon yellow in water mounts, this color disappearing in KOH mounts, often with dextrinoid encrusting pigment in Melzer's when young. Basidia $24-32 \times 8-11 \mu m$, clavate, 4-sterigmate, hyaline. Pleurocystidia hyaline in KOH, hyaline or rarely pale orangish in Melzer's, fusoid, thin-walled, $35-53 \times 8-15 \mu m$. Cheilocystidia barely subfusoid to subclavate, hyaline in KOH, pale orangish in Melzer's, not as abundant as pleurocystidia, $30-40 \mu m$ long. Tube trama divergent from a central stratum, with gelatinized lateral strata, hyaline, $3.5-7 \mu m$ broad. Pileus trama



Figs. 3-5. Cystidia of Boletus atkinsonianus (Halling 5026). 3. Caulocystidia. 4. Pleurocystidia. 5. Cheilocystidium.

hyaline in KOH and Melzer's, interwoven, with hyphae 5-9 μ m broad. Pileus surface a tangled trichodermium in a gelatinous matrix, with elements subcylindrical, rarely inflated, often vermiform in general aspect, smooth, with vacuolar pigment, usually dissolving in KOH or yellow brown, coagulated and orangish in Melzer's, (2.8)3.5-8.4(10.5) μ m broad. Stipe surface composed of vertically oriented, parallel hyphae, becoming gelatinized with age, hyaline in KOH, encrusted with dextrinoid pigment and penicillate crystals in Melzer's, giving rise to caulocystidia, the latter often clustered, hyaline and smooth in KOH, sometimes with encrusting dextrinoid pigment, thin-walled, clavate to capitate clavate, generally gelatinizing with age, 24-50 × 7-14(18) μ m. Clamp connections absent.

Material examined: DEPT. ANTIQUIA: Municipio Santa Rosa de Osos, near Llanos de Cuivá, 6°45'N, 75°30'W, ±2500 m, under Quercus humboldtii, 10 Nov 1986, Halling 5000 (HUA, NY); 14 Nov 1986, Halling 5026 (HUA, NY); 25 Nov 1986, Halling 5057 (HUA, NY); road between San José de la Montaña and Llanos de Cuivá, 6°50'N, 75°35'W, ±2500 m, under Quercus humboldtii, 27 Nov 1986, Halling 5077 (HUA, NY).

Boletus atkinsonianus was originally described from North Carolina, USA, apparently based on Atkinson's (1901) concept of B. obsonium (Paul.) Fr., but seems not to have been described in detail since the description by Coker & Beers (1943). Diagnostic features include a viscid pileus and stipe with distinctive brown colors, projecting pileus margin, bright yellow hymenophore when young that, along with the flesh, is unchanging. Perhaps because of age and preservation, the

dextrinoid pigment in the stipe and young hymenophore of the type specimen is absent, but would seem to be a further distinction in fresher material. Most likely, B. atkinsonianus might be confused with B. viridiflavus Coker & Beers, but the latter is a smaller fungus with the pileus mottled a greenish yellow (Halling 3788, NY). A color illustration of B. viridiflavus (Weber & Smith, 1985) from the southeastern United States is reminiscent of the Colombian B. atkinsonianus. Guzmán-Dávalos et al. (1983) have reported the latter from Jalisco, México.

5. BOLETUS FULIGINEOTOMENTOSUS Singer, Beih. Sydowia 7: 101. 1973.

I have not seen specimens from Colombia, although I have collected near the paratype locality. Known only from Colombia, information and a description of B. fuligineotomentosus can be found in Singer (1973) where three collections are cited: "Typus a R. Singer (B 6958) in Columbia: Valle: Rio Pance, 1800 m alt., 3 V 1968 lectus et in F conservatus.-Paratypus: Singer B 6466, Cauca: via a Cali Popayán versus, km 100, 29 IV 1968.-Etiam B 6790, El Guayabo 29 IV 1968, omnes in F.-Boleto subsolitario affinis."

6. BOLETUS ORQUIDIANUS sp. nov.

FIGS. 6-9

Pileus viscidus, pileipelle hymeniformi; trama tuborum phylloporoideo; cystidia hymenii nulla; basidiosporae 10.5-13.3 × 4.2-5.6 µm, laeves, interdum dextrinoideae.

Pileus 2-2.5 cm broad, convex to plano-convex, reddish brown to brown (7F8-8E8), paler at the margin, moist to viscid, glabrous, not changing with NH₄OH. Flesh white, not bluing, with mild odor and taste. Tubes depressed around the



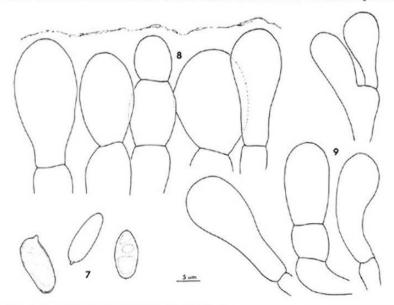
FIG. 6. Habit of Boletus orquidianus (Halling 4964, HOLOTYPE). ×2.

stipe, olive yellow to grayish yellow (3C6-3C5) not changing to blue when exposed, 5-7 mm long; pores up to 1 mm broad, concolorous, not changing to blue when bruised. Stipe 4-8 cm long, 4-5 mm broad at apex, ± equal to slightly larger at base; surface white at apex and base, streaked brownish (7E7) in mid-region, lubricous but not viscid, glabrous.

Basidiospores smooth, thin-walled, ellipsoid to subfusoid, golden yellow in KOH, a minority slightly dextrinoid in Melzer's, 10.5- 13.3×4.2 - $5.6 \mu m$. Basidia clavate, 4-sterigmate, hyaline, 28- 35×12 - $15 \mu m$. Hymenial cystidia absent. Tube trama slightly bilateral (Phylloporus-type), with hyphae hyaline, 2.8-8.4(14) μm broad. Pileus surface a hymeniform epithelium embedded in an obvious gelatinous matrix, with elements hyaline or golden yellow to yellow brown in KOH, hyaline or sometimes with dull orangish contents in Melzer's, broadly clavate to napiform or sphaeropedunculate, sometimes subisodiametric, appearing sphaerocyst-like in paradermal section, smooth and thin-walled, 17.5- 31.5×14 - $24.5 \mu m$. Pileus trama interwoven, hyaline in KOH, pale orange in Melzer's, with hyphae 4.2-9.8(14) μm broad. Stipe surface composed of parallel and vertically oriented hyphae, 2.8- $7 \mu m$ broad, giving rise to scattered clumps of caulocystidia that are clavate to subcylindric, 21- 35×10.5 - $14 \mu m$, rarely with an occasional dermatobasidium. Clamp connections absent.

TYPE: COLOMBIA. DEPT. ANTIOQUIA: Municipio Urrao, Parque Nacional Natural "Las Orquideas," sector Calles, 1300-1400 m, 30 Oct 1986, *Halling 4964* (HOLOTYPE: HUA; ISOTYPE: NY).

Boletus orquidianus is not associated with Fagaceae in Colombia, but rather with other hardwood trees in the submontane cloud forest. Boletus orquidianus



Figs. 7-9. Microscopic features of *Boletus orquidianus* (Halling 4964, HOLOTYPE).

7. Basidiospores. 8. Elements of pileus surface. 9. Caulocystidia.

keys to Xerocomus globuliger Sing. in Singer et al. (1983), which differs in a dry (not viscid) and granular to rivulose pileus surface, longer spores (13-17.5 μ m), and the presence of hymenial cystidia and pilocystidia. The viscid pileus and Phylloporustype trama would also suggest Pulveroboletus (sensu Singer), but the hymeniform pileus surface of B. orquidianus is like that found in Marasmius sect. Globulares but with a gelatinous matrix. Furthermore, none of the pileus surface types (cutis, ixocutis, trichodermium, or palisade) described for Pulveroboletus by Singer (1986) are applicable to B. orquidianus. Additionally, the spores of B. orquidianus are 2-5 μ m longer than the non-velate Pulveroboleti listed by Singer et al. (1983) and Pegler (1983).

7. BOLETUS PULVERULENTUS Opat., Arch. Naturgesch. 2: 27. 1836.

The dry, dark brown to nearly black pileus, yellow hymenophore and flesh that turn instantly to blue when bruised or exposed are key macroscopic features. Microscopically, the abundant hymenial cystidia with dextrinoid granular content are likewise distinctive. Known previously from the north temperate zone, the single Colombian collection of several basidiocarps agrees in all respects with material from eastern North America.

Material examined: DEPT. CUNDINAMARCA: near Pacho, Finca "La Ramada," under Quercus humboldtii, 11 May 1987, Halling 5251 (NY).

BOLETUS PSEUDORUBINELLUS Smith & Thiers, Boletes of Michigan. 300. 1970. FIG. 10

Pileus 2-6.5 cm broad, dry, convex to plano-convex, violet brown (10E5) at first, then english red to reddish brown (8D8-8D6), matted subtomentose to matted subvelutinous, barely with finely appressed squamules near the margin with dull ochraceous color showing through. Flesh up to 1.5 cm thick, near pinkish white (7A2) but ±paler with a faint tint of yellow, unchanging; odor and taste mild. Tubes near old rose (10D5) at first, near reddish brown (8D6) with age; pores concolorous, unchanging, ±1 per mm, adnate or depressed around the stipe. Stipe 5-7 cm long, 4-12 mm broad, equal or tapering downward, fibrous, curved or strict, fibrillose striate, near brick red (7D7), dry, with pinkish zone at apex, white or with some pale pinkish tones toward the base, with yellowish mycelium extending into substrate; interior yellowish, solid.

Basidiospores smooth, thin-walled, pale olivaceous at first, but then bright greenish yellow in KOH, some becoming lightly dextrinoid in Melzer's, 9.1-12.6 × 4.2-4.9 μ m (mean Q=2.28), ellipsoid to subfusoid and inequilateral in profile. Basidia 4-sterigmate, clavate, hyaline, 19.6-31.5 × 8.4-10.5 μ m. Hymenial cystidia rare, narrowly fusoid ventricose, hyaline, 35-47 × 7-11 μ m, more abundant on the pores and then sometimes with amorphous pale brown content in KOH. Pileus surface a trichodermium of suberect, tangled, cylindrical cells, 5-9 μ m broad, soon collapsing and becoming repent; hyphae hyaline to pale ochraceous yellow from pigment dissolving in KOH, but pigment remaining in Melzer's and appearing granular-encrusting. Pileus tramal hyphae hyaline in KOH, somewhat collapsed and sometimes with a pale orangish tint in Melzer's, otherwise inamyloid, sometimes with scattered oleiferous elements. Caulocystidia often clustered, narrowly

fusoid ventricose, clavate, or sometimes spherical-saccate, thin-walled, $17.5-65 \times 7-18 \mu m$, without distinctive contents in KOH or Melzer's. Clamp connections absent.

Material examined: DEPT. CAUCA: Municipio de Tunía, km 93 of Cali-Popayán road, Reserva Forestal "El Guayabo," 1800 m, under Quercus humboldtii, 19 May 1987, Halling 5267 (NY).

In the original description of Smith & Thiers (1970), B. pseudorubinellus was described as occurring near spruce in northern Michigan. Despite the difference in supposed mycorrhizal hosts, Halling 5267 agrees in overall colors, spore morphology, yellowish reaction in KOH, lack of an acrid taste, and general lack of hymenial cystidia.

9. BOLETUS SUBTOMENTOSUS Fr., Syst. Mycol. 389, 1821.

■ Xerocomus subtomentosus (Fr.) Quél., Fl. Myc. 418. 1888.

The olive to yellow olive (4D6), dry, subtomentose pileus, yellow tubes that change to blue when cut and exposed, compound pores, yellowish stipe with some occasional coarse ribbing at the apex, and yellowish basal mycelium are useful field characters. Also, the pileus surface does not react with NH₄OH (blue to greenish). The descriptions of Smith & Thiers (1971) and Thiers (1975) fit the Colombian material well.

Material examined: DEPT. ANTIQUIA: Municipio Santa Rosa de Osos, road from San José de la Montaña to Llanos de Cuivá, 6°50'N, 75°35'W, ±2500 m, under Quercus humboldtii, 25 Nov 1986, Halling 5061 (HUA, NY).



Fig. 10. Habit of Boletus pseudorubinellus (Halling 5267). ×3/4.

- BOLETUS TRUNCATUS (Sing., Snell, & Dick) Pouzar, Ceská Mycol. 20: 2. 1966.
 - = Xerocomus truncatus Sing., Snell, & Dick in Snell, Singer & Dick, Mycologia 51:
 573, 1959.

Pileus 1.5-4 cm broad, convex to plano-convex, dry, velutinous to subtomentose, bronze brown (5E5). Flesh pale yellow to white (3A3-2A3), not changing to blue when exposed. Tubes pastel yellow to grayish yellow (2A4-2B5), compound, 5-9 mm long, with faint hint of changing to blue when exposed; pores concolorous. Stipe 3-4 cm long, 4-6 mm thick, ±equal, surface furfuraceous to pruinose-squamulose (red to pinkish) on yellow ground color above, pink at middle, pale brown below, eventually with a yellowish white (4A2) ground color.

Basidiospores truncated at the apex and then usually thicker-walled at the two apical angles and with markedly thinner wall between these angles, sometimes with faint but distinct longitudinal striae (with interference optics), yellowish brown in KOH, often fleeting amyloid and then some slowly and partially or completely dextrinoid in Melzer's, 11.2-15.4 × 4.9-5.6 µm (mean Q=2.5). Basidia 4-sterigmate, hyaline to pale yellowish in KOH and Melzer's, 24-42 × 9-12 μm. Hymenial cystidia not abundant but conspicuously projecting, fusoid to subventricose, hyaline in KOH and Melzer's, 35-68 × 9-12 μm. Tube trama of the Phylloporus-type, obscurely bilateral, hyaline in KOH and Melzer's, with hyphae 3.5-8.4 µm broad. Pileus surface a palisade trichodermium, with elements ochraceous in KOH, brown in Melzer's, generally encrusted, with individual hyphae barrel-shaped to isodiametric or nearly so, with apical cells subspherical to subcylindric, obtuse at the tips, (7)17-28 µm broad. Pileus trama hyaline, interwoven, with hyphae 7-17 µm broad. Stipe surface composed of vertically oriented hyphae giving rise to isolated fascicles of caulocystidia, the latter subclavate to clavate or rarely subcapitate, with yellow brown contents or rarely hyaline, in KOH, 24-42 × 7-11 μm, with occasional 2,4sterigmate caulobasidia intermixed. Clamp connections absent.

Material examined: DEPT. ANTIQUIA: Municipio Santa Rosa de Osos, road from San José de la Montaña to Llanos de Cuivá, 6° 50'N, 75°35'W, ±2500 m, under Quercus humboldtii, 25 Nov 1986, Halling 5059 (HUA, NY).

This is a tentative determination although the macroscopic features (very similar to *B. chrysenteron* Fr.) and truncate spores point toward *B. truncatus*. The presence of longitudinal striae are foreign to the protologue, current concepts and descriptions, but there appear to be other xerocomoid taxa in the United States which possess striate spores that may or may not be truncate.

11. GYRODON EXIGUUS Singer & Digilio, Lilloa 30: 154, 1960. FIG. 12

Pileus 1-3 cm, flabelliform to fan-shaped to infundibuliform, dry, matted fibrillose scaly, especially at margin, with brown, appressed fibrillose scales on yellowish (4A5-4B5-5B5) ground color. Flesh yellow, up to 2 mm thick, slowly bluing, with mild odor and taste. Hymenophore decurrent, boletinoid, with compound pores, definitely radial in orientation, yellowish (4A6), bluing at first when bruised or cut, then changing to brown. Stipe lateral or sometimes eccentric, up to 1.5 cm long, 8 mm thick at apex, yellow to pale orange (5A3) above, olive brown to watery brownish toward base, matted tomentose with a lens, arising from a dirty yellow-



Fig. 11. Scanning electron micrograph, basidiospores of *Boletus truncatus* (Halling 5059). Standard line = 1.4 μ m.

brown superficial mycelium, the latter sometimes forming rhizomorphic strands over the substrate.

Basidiospores olive brown in deposit, 7-9.8 × 4.9-6.3 μ m, (mean Q = 1.55), hyaline to pale yellow brown in KOH, fleeting amyloid at first, but then some dextrinoid or pale yellowish brown in Melzer's, smooth, ovoid to broadly ellipsoid, rarely short-subcylindric. Basidia clavate, 4-sterigmate, hyaline, 22-30 × 6.5-9 μ m. Hymenial cystidia rare to scattered and inconspicuous, hyaline, subclavate with a broad mucro, or subcylindric, sometimes with short apical ramifications, 15-25 × 4-9 μ m. Tube trama hyaline, bilateral, with hyphae 2.1-8.4 μ m broad. Pileus surface a tangled trichodermium with elements that form the fibrils possessing a red brown encrusting pigment in Melzer's, the pigment soluble in KOH, sometimes with homogeneous ochraceous contents, thin-walled, \pm cylindric to filamentous, 3.5-8 μ m broad. Pileus trama hyaline in KOH, hyaline to pale orange in Melzer's, with hyphae interwoven, thin-walled, smooth, 3.5-10.5 μ m broad. Stipe surface a collapsed trichodermium with hyphae resembling those of the pileus surface, arising from a hyaline trama with elements 4-15 μ m broad. Clamp connections present.

Material examined: COLOMBIA. DEPT. ANTIQUIA: Municipio Urrao, Parque Nacional Natural "Las Orquideas," sector Calles, 1300-1400 m, 28 Oct 1986, Halling 4942; 30 Oct 1986, Halling 4969 (both HUA, NY). ECUADOR. PROV. PASTAZA: 2 km N of Rio Pastaza-Rio Topo confluence, 15 April 1987, Halling 5168 (QCA, NY).

The dingy yellowish pileus with brown appressed fibrils, yellow hymenophore and flesh that become blue with handling and exposure, eccentric to lateral stipe, and small size (for a bolete) are diagnostic macroscopic features. In my experience, G. exiguus fruits on standing tree trunks or wet soil banks that are covered with rootlets, humus, etc. rather than on the forest floor. A mycorrhizal connection has not been demonstrated for G. exiguus as it has for the following species.

12. GYRODON MONTICOLA Sing. in Singer & Digilio, Lilloa 28: 256. 1957.

FIG. 13

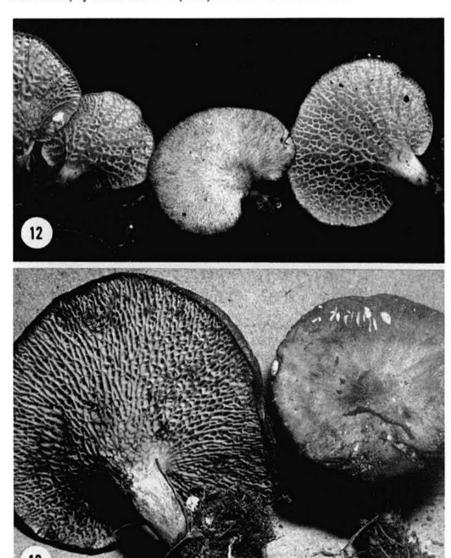
Pileus 3-11 cm broad, viscid in wet weather, otherwise dry, dark cinnamon brown, matted fibrillose, convex or rarely a with subacute low umbo, with incurved margin at first. Flesh whitish, bluing when exposed, up to 2 cm thick. Hymenophore boletinoid, decurrent, with compound pores, shallow, up to 2 mm long, yellow, bluing when bruised. Stipe 2-6 cm long, 5-14 mm thick, ± equal to subclavate or narrower downward, central to eccentric, curved or strict; surface dry, pinkish brown, more sordid toward the base, especially after handling, matted subtomentose to matted subfibrillose, arising from well-developed, dirty yellowish brown basal mycelium, developing scattered concolorous sclerotia, the latter hard but brittle, dull when fresh, wrinkled and shiny when dry, 1-2(3) mm broad, globose to subglobose.

Basidiospores olive brown in deposit, $5.6-7 \times 3.5-4.9 \mu m$ (mean Q=1.46), smooth, hyaline to pale yellow brown in KOH, some lightly dextrinoid in Melzer's, ovoid to short ellipsoid, sometimes inequilateral in profile. Basidia 31-42 x 7.5-9 μm, 4-sterigmate, clavate, hyaline or rarely with pale yellow brown pigment. Tube trama hyphae bilateral, hyaline, 3.5-9(13) µm broad. Hymenial cystidia most abundant at and near pores, generally hyaline, sometimes with amorphous yellow brown content, thin-walled, narrowly fusoid-ventricose with ampullaceous apex, 30-60 × 7.5-9 μm. Pileus surface a trichodermium of loosely interwoven hyphae, with elements generally cylindrical, but sometimes irregularly inflated or strangulated, occasionally branched, thin-walled, smooth and hyaline to ochraceous in KOH, pale orange brown and with red brown encrusting pigment in Melzer's, (2.1)3.5-7(9) µm broad. Pileus trama hyaline, with pale rosy purplish pigment leaching out in KOH mounts, hyaline to pale yellowish orange in Melzer's; hyphae 4-8 µm broad, smooth and thin-walled. Stipe surface barely differentiated from tramal hyphae, loosely interwoven, generally repent, hyaline or rarely with ochraceous content, smooth in KOH and Melzer's, 3.5-7 µm broad, subtended by tramal hyphae often inflated to 21 µm, leaching a pale rosy purplish pigment in KOH, with walls usually thickened to 1 μm. Clamp connections present.

Material examined: ARGENTINA. PROV. TUCUMAN: Dept. Tafi del Valle, ±5 km N of Tafi del Valle, under Alnus acuminata, 18 Mar 1988, Halling 5849 (NY). COLOMBIA. DEPT. HUILA: E of Parque Nacional Puracé, Finca de Ganadería Merenberg, under Alnus acuminata, 21 May 1987, Halling 5287 (NY).

Gyrodon monticola appears to be exclusively associated with Alnus acuminata in South America. In fact, Halling 5287 was found in nursery beds consisting solely of A. acuminata at Finca Merenberg. The Colombian material corresponds well with a collection (Halling 5849) from near the Argentine type locality. Gyrodon

monticola was also found by G. Mueller in Alnus forests of Ecuador (Napo Province, ±8-9 km east of Papallacta, along road to Baeza), but voucher material was not retained because of its advanced age. The sclerotia of G. monticola are nearly the same morphologically as those reported for G. merulioides (Schw.) Sing. (as Boletinellus) by Cotter & Miller (1985) but seem to differ in color.



Figs. 12-13. Habits of Gyrodon exiguus and G. monticola. 12. G. exiguus (Halling 4969) ×2. 13. G. monticola (Halling 5849) ×1.

13. LECCINUM ANDINUM sp. nov.

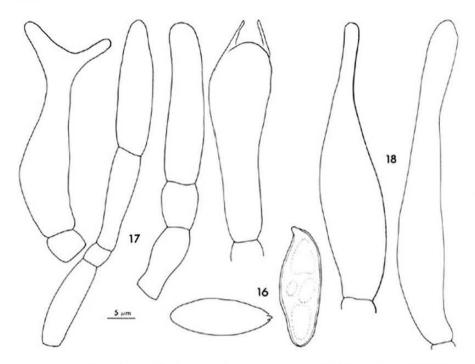
A speciebus aliis sectionis Luteoscabrorum, nocta semper cyanescens, coloribus uniformiter succineis vel brunneo-flavidis, pileipelle trichodermium cystidioideum revocanti, dermatobasidiis bisterigmatis, et cum Querco humboldtii consortione sua distinguenda.

Pileus (4)9-11.5 cm broad, convex to plane, dry, minutely subtomentose when voung, subviscid to tacky and glabrous with age, grayish yellow (4B4) at the margin, darker near brownish yellow (5C6) on the disc when young, brass yellow (4C7) at the margin with age and raw sienna (6D7) at the disc, honey yellow (5D6) to light orange (5A5) to cinnamon brown (6D6) to amber yellow (4B6) in splotches, or brownish yellow (5C6-5C7) to yellowish brown (5D8-6D7); margin often sterile and projecting. Flesh 7-20 mm thick, whitish to yellowish white to orange white (4A2-5A2), bluing slightly near the tubes when exposed, but not intensely, slightly reddish-brown under the pileus surface. Tubes 3-20 mm long, depressed around the stipe, light yellow (2A5-3A5-3A6) when young, olive yellow (3D6) with age, bluing when exposed, boletoid; pores up to 2-3 per mm, yellow to deep yellow (3A7-4A8) when young (slight brownish discoloration) apparently stuffed, bluing when bruised. Stipe 3-12 cm long, 1-2 cm thick at apex, ±equal to subequal to subclavate to slightly enlarged below, strict or curved, dry, densely scabrous when young, less so with age; ground color pale yellow (4A3) when young, gravish vellow (4B4) with age, white at the base; scabers vellow (2A5) when young, yellow ochre to brownish yellow to light brown (5D8-5C8-5C7-5C6) to brownish orange to light brown (6C7-6D7,6,5) with age; interior solid, yellow (2A5) when young and bluing near the apex, marbled brown and white at the base.

Basidiospores olive brown to umber brown in fresh deposit, 14.7-23.8 x 6.3-8 μ m (mean Q=2.88), smooth, subfusoid to ellipsoid, usually inequilateral with a suprahilar depression in profile, ochraceous in KOH, with dextrinoid walls in Melzer's. Basidia 31.5-40 x 12-15 µm, 4-sterigmate, clavate, hyaline. Hymenial cystidia moderately abundant, more common near pores, thin-walled, hyaline or rarely with homogeneous ochraceous content in apex, ventricose rostrate to lageniform or barely subfusoid to narrowly ampullaceous, 50-73 × 5-11 μm. Tube trama bilateral from a central strand that is sometimes tinged yellowish in KOH, otherwise hyaline, the lateral strata becoming subgelatinous, with elements 2-7 μm broad. Pileus surface a loosely interwoven trichodermium, with hyphae seemingly embedded in a hyaline matrix, yellow ochraceous in KOH, sometimes with ochraceous homogeneous contents, hyaline to pale ochraceous yellow in Melzer's, consisting of ± filamentous, branched, occasionally cylindric, suberect smoothwalled elements, with endcells 2.8-5.6 µm broad, sometimes cystidioid and then subcapitate to inflated or obtuse to slightly tapered, intercalary cells sometimes subisodiametric, arising from a layer of broader sphaerocyst-like hyaline hyphae, 12-30 × 10-21 μm broad. Pileus trama interwoven with hyaline hyphae, 3.5-10.5 μm broad. Stipe surface covered with isolated scabrosities, these sometimes fusedsubreticulate, composed of versiform caulocystidia, narrowly lageniform to ventricose rostrate, subcylindric or sometimes filamentous with short-branched apices, hyaline and thin-walled, often arising from subisodiametric cells, 30-78 x 3-12 µm; caulobasidia 2-sterigmate, broadly clavate, generally hyaline, intermixed with caulocystidia. Clamp connections absent.



Figs. 14-15. Habits of Leccinum andinum. 14. Halling 5001 \times 1/2. 15. Halling 5052 (HOLOTYPE) \times 1/2.



Figs. 16-18. Microscopic features of Leccinum andinum (Halling 5052, HOLOTYPE).

16. Basidiospores. 17. Elements of stipe surface. 18. Hymenial cystidia.

TYPE: COLOMBIA. DEPT. ANTIOQUIA: Municipio Santa Rosa de Osos, near Llanos de Cuivá, 6°45'N, 75°30'W, ±2500 m elev, under *Quercus humboldtii*, 25 Nov 1986, *Halling 5052* (HOLOTYPE: HUA; ISOTYPE: NY).

Additional material examined: DEPT. ANTIQUIA: Municipio Santa Rosa de Osos, near Llanos de Cuivá, 6°45'N, 75°30'W, ±2500 m elev, under Quercus humboldtii, 10 Nov 1986, Halling 5001 (HUA, NY); 14 Nov 1986, Halling 5027 (HUA, NY); Municipio San José de la Montaña, ±13 km S of San José de la Montaña along road to Labores, ±2500 m, under Quercus humboldtii, 26 Nov 1986, Halling 5064 (F, HUA, NY).

Macroscopically this Leccinum approaches Boletus morrisii Pk. with regard to overall color schemes, but differs in bluing reactions (reddening in the latter), white basal mycelium (yellow in B. morrisii), and the pores are yellowish or rarely brownish in L. andinum (reddish in B. morrisii). Furthermore, L. andinum has larger spores (12-15.4 \times 3.4-4.3 μ m in B. morrisii [TENN 26054, 42113]), and the erect trichodermium composed of encrusted, broad, compact elements of B. morrisii contrasts markedly with the narrow diameter hyphae of the loosely interwoven trichodermium in L. andinum. The association with Quercus, the yellowish context, and yellow hymenophore clearly indicate section Luteoscabra, but consistent bluing reactions have not been reported in that section before. Other taxa of Luteoscabra that sometimes are cyanescent include L. subglabripes (Pk.) Sing. and

its variants (Singer, pers. com.), but that species is differently colored on the pileus and stipe, has smaller spores, and the hyphae of the pileus surface form a hymeniform epithelium.

14. STROBILOMYCES CONFUSUS Singer, Farlowia 2: 108. 1945. FIG. 19

A few immature basidiocarps with an intact veil were found along with one basidiocarp that was over-mature. The spores from the latter are unmistakable and possess the "sparassoid" type of ornamentation characteristic for *S. confusus*. The dry, suberect, black squamules on the pileus, the gray and soon blackening hymenophore, reddening flesh on exposure, and woolly stipe surface further distinguish the species. Excellent descriptions are available in Singer (1945) and Smith & Thiers (1970).

Material examined: DEPT. HUILA: E of Parque Nacional Puracé, Finca de Ganaderia Merenberg, under Quercus humboldtii, 21 May 1987, Halling 5280 (NY).



Fig. 19. Scanning electron micrograph, basidiospores of Strobilomyces confusus (Halling 5280). Standard line = $2 \mu m$.

15. TYLOPILUS OBSCURUS sp. nov.

FIGS, 20-23

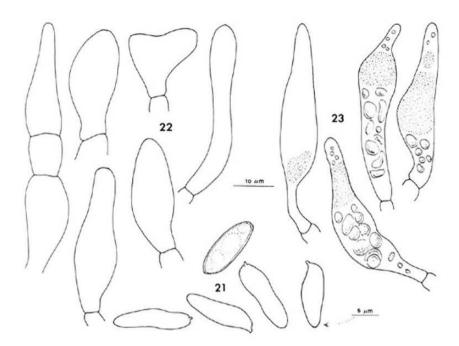
Pileus usque 13 cm latus, brunneus vel griseobrunneus vel atrogriseus, tomentosus vel subvelutinus, atrogriseus quum dessicatus. Contextus pallidus, immutabilis. Tubuli pallidi tum subroseocinnamomei, immutabiles; pori brunneo-umbrini vel ochraceobubalini tactu cinnamomei. Stipes ±totus conspicue alveolatoreticulatus, pagina subroseocinnamomei; reticulum pileo concolor ad apicem pallidum aetate subcanescens compositum. Sporae 10.5-15.4(20) × 4.2-5.6 µm. Cystidia pigmentifera parietibus tenuibus.

Pileus 4-13 cm broad, convex then plane, dry, tomentose to subvelutinous to matted tomentose to matted velutinous, brown to dark brown to grayish brown to dark gray (7E-F5,4,3); margin slightly incurved to decurved, fertile, uplifted and irregular with age. Flesh near grayish orange (5B3) or whitish, unchanging, 1.5-2 cm thick, odor and taste mild. Tubes up to 12 mm long, subdecurrent or depressed, orange white (5A2) when young, near light pinkish cinnamon (6C5) at maturity, not changing when exposed or bruised; pores 1-2 per mm, cocoa brown to burnt umber to teak brown (6E-F6,5) when young, ochraceous buff (5B4) with maturity, near cinnamon (6D7) when bruised. Stipe 8.5-15 cm long, 1.3-4 cm thick, subclavate to ±equal, solid within and marbled white plus brown or black; surface near light pinkish cinnamon (6C5), alveolate-reticulate nearly to the base; reticulum concolorous with cap surface, concolorous with hymenophore above, grayish and compound with age.

Basidiospores tinted flesh-pinkish in a light deposit, subfusoid and inequilateral to ellipsoid or subcylindric, sometimes constricted or bent near the middle, smooth and thin-walled, ochraceous in KOH, usually pale ochraceous or a few dextrinoid in Melzer's, $10.5-15.4(20) \times 4.2-5.6 \mu m$ (mean Q=2.71). Basidia clavate, 4-sterigmate, hyaline, $24-35 \times 9-12 \mu m$. Hymenial cystidia conspicuous, thin-walled, with granular, homogeneous, or coagulated and refractive orange brown content in Melzer's and uniform yellow brown or coagulated content in KOH, or more rarely hyaline and these more often near the pores, lageniform to fusoid ventricose to ventricose rostrate to subclavate rostrate, $42-63 \times 8.5-12 \mu m$. Tube trama bilateral; hyphae diverging from a pale ochraceous central stratum, $3.5-10.5 \mu m$ broad, with



Fig. 20. Habit of Tylopilus obscurus (HOLOTYPE) ×3/4.



Figs. 21-23. Microscopic features of Tylopilus obscurus (HOLOTYPE). 21. Basidiospores. 22. Elements of pileus surface. 23. Hymenial cystidia.

the lateral stratum becoming gelatinized. *Pileus surface* a palisade trichodermium, becoming more tangled and less erect with age, not encrusted but hyaline or with brown to olive brown vacuolar pigment, with elements cylindric to broadly clavate, subfusoid to cystidiiform or rarely subisodiametric, $11-45 \times 5-15~\mu m$, with obtuse apices. *Pileus trama* hyaline, interwoven, $3.5-10.5~\mu m$ broad. *Stipe surface* formed of long-cylindric, thin-walled, usually hyaline hyphae, $3.5-10.5~\mu m$ broad, that occur between the ridges of the reticulum, the latter composed of clavate to subfusoid, lageniform *caulocystidia* with contents similar to those of the hymenium. *Clamp connections* absent.

TYPE: COLOMBIA. DEPT. ANTIOQUIA: Municipio Guarne, Centro Experimental Piedras Blancas, ±14 km E of Medellín, 2350 m, Cupressus, Eucalyptus, Pinus, and Quercus nearby, 11 Nov 1986, Halling 5008 (HOLOTYPE: HUA, ISOTYPE: NY).

Tylopilus obscurus is not close to any of the neotropical Tylopili discussed by Singer et al. (1983). However, there are a few somber-colored Tylopili with reticulated stipes known from the Old World that are similar (viz. T. niger (Heinemann & Goossens) C. B. Wolfe, T. nigerrimus (Heim) Hongo & Endo and T. nigropurpureus (Corner) Hongo). They differ from T. obscurus in important features: all have flesh that changes color when exposed, and some have shorter spores (T. nigropurpureus, T. niger), thick-walled cheilocystidia (T. niger), or olivaceous pig-

mentation (*T. nigerrimus*). An undescribed species from the eastern United States has black to gray tubes and pores, and tubes and flesh that change colors with exposure (Wolfe & Halling, *in ed.*).

Exotic plantings of *Pinus patula*, *Eucalyptus*, and *Cupressus*, along with stands of native *Q. humboldtii*, were located within 50 m of the collecting site. Although not unquestionably associated with *Quercus*, *T. obscurus* was growing in an area once recently forested by *Q. humboldtii* and may be associated with the oak roots. Clearly this is circumstantial evidence for an association with oak, and deserves further investigation.

ACKNOWLEDGEMENTS

I am grateful to Gregory Mueller, Betty Strack, Clark Ovrebo, and Barbara Thiers for providing bolete collections while in Colombia. Also, the support from National Science Foundation grant #BSR-860024 made this study possible. The generosity, patience, and help of the staff and students, particularly Lucía Atehortua, Linda Albert de Escobar, Ricardo Callejas, Beatriz Echeverry and Patricia Velasquez in Medellín, Margarita Pulido in Popayán, and Gunther Buch at Finca Merenberg are likewise very much appreciated. The assistance of the curators, staff, and students at QCA and LIL enabled access to collecting sites. Esperanza Franco kindly assisted with the Spanish summary, and Donald and Susan Black provided graphic and technical expertise. Ron Petersen arranged for a loan of specimens from TENN. In addition, I thank Tim Baroni, Ernst Both, Egon Horak, and Rolf Singer for many helpful discussions on bolete identities. Naturally, I shall always be indebted to Harry Thiers for sharing his excitement about boletes and giving me the chance to wonder about them too.

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January 20, 1989

CLADONIA THIERSII: A NEW LICHEN FROM CALIFORNIA

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SUMMARY

Cladonia thiersii is described from northern California. It is compared to C. subsubulata Nyl. and C. squamosa (Scop.) Hoffm. var. subsquamosa (Nyl. ex Leight.) Vain. The identity of a long-disputed specimen from California labeled C. santensis in the Tuckerman collections in FH is clarified.

Cladonia sect. Perviae (Fr.) Matt.

Cladonia thiersii sp. nov. Fig. 1

Type: USA. California: Marin Co., Point Reyes National Seashore, Kehoe Beach, on humus, E facing, 50 m, 1988, Hammer 2286 (Holotype: SFSU; Isotype FH); contains thamnolic acid.

Thallus primarius squamulosus, persistens, crassus, subcoralloides, partim infossus, ramosus infra substratum, ad 12 mm longus et 5 mm latus. Podetia fragilia, pulvinos densos formans, cinereo-virescentia, ad 30 mm alta et 4.5 mm lata, subcylindrica, parce dichotome ramosa, axillis perforatis vel clausis et sufflatis, cortex crassus vel rugulosus, verruculosus, squamulosus. Hymenia fusca; conidiomata gelatinum hyalinam continentia. Acidum thamnolicum continens.

Primary thallus squamulose; primary squamules persistent, thick, forming extensive mats over surface of substratum, barely distinguishable from one another, deeply established in substratum, 4-12 mm long, 1-5 mm wide, irregularly dichotomously branched below surface of substratum, deeply laciniate, subcoralloid to irregularly lobate above; edges

¹Present address: Farlow Herbarium, Harvard University, Cambridge, MA 02138.

sinuate, to 0.3 mm thick, accessory lobules occasionally present; upper surface glaucescent green, sometimes with bluish tinge, subpruinose; ventral surface white, smooth to subfibrillose, upturned, esorediate or with granular soredia beneath upturned lobes. Podetia from upper surface of primary squamules, 4-30 mm tall, to 4.5 mm wide, subcylindrical, sometimes appearing inflated, forming scyphus-like openings at apices, sparingly to moderately branched; branches arising laterally or from margins of apical formations; cortex continuous to subcontinuous, sometimes disappearing, usually becoming quite thick above basal portions and appearing chinky-areolate to rugose to verruculose above; areoles or verruculae becoming elevated and appearing as closely appressed squamules, or enlarging and imbricating, or becoming upturned, in some podetia becoming abundant, breaking up and appearing as corticated granules; apices enlarging, often abundantly covered with peltate squamules, gradually opening, exposing smooth, whitish to chestnut brown interiors of podetia; closed apices enlarging and appearing inflated. Apothecia brown, borne in clusters around margins of apical openings, to 0.9 mm in diam; ascospores 8/ascus, hyaline, non-septate, oblong-ellipsoid, 6-16 × 3-6 μm; pycnidia brown, borne on margins; conidia hyaline, non-septate, straight to arcuate, 0.5-2 × 4-8.8 μm.

Anatomy: Primary squamules 200-300 μ m thick; cortex 35-60 μ m thick, of tightly interwoven to adglutinated hyphal cells 7-10 μ m in diam; algal layer 40-90 μ m thick; medulla of densely packed, irregularly arranged, subcylindrical, sparingly branched hyphal cells 3-4.5 μ m thick. Podetial wall 340-450 μ m thick; outer layer of closely agglutinated cells, 40-60 μ m thick; exterior medullary layer 250-300 μ m thick; internal cartilaginous tissue 50-90 μ m thick. Hymenium 20-44 μ m thick; subhymenium 28-48 μ m thick; asci 25-28 μ m thick, clavate; paraphyses subcylindrical unbranched, 2-3 septate, 28-39 \times 2-3 μ m.

Spot test reactions: K+ bright yellow, persistent; KC+ yellow; P+ deep yellow to orange.

Chemical constituents: Thamnolic acid with accessory substances F and G.

Specimens examined: CALIFORNIA. Marin Co.: Hammer 2286 (TYPE), Hammer 2302, 2395, 2407, 2411; Mendocino Co.: Hammer 1522 (all SFSU); San Francisco Co.: Bolander 30 (FH).

Cladonia thiersii is an intermediate species between C. subsubulata (=C. carassensis Vain.) and C. squamosa var. subsquamosa. TLC analyses demonstrate identical chemical constituents for this lichen and for the above named species. Cladonia thiersii is distinct on the basis of its morphology. Its podetia lack the wide lateral openings that are common in C. subsubulata. The axils of C. thiersii may be open or closed, whereas they are always open in C. subsubulata. The primary thallus of C. thiersii is persistent, the squamules thick and deeply established in the substratum, unlike C. subsubulata or C. squamosa var. subsquamosa, whose squamules lack these characters. The podetia of C. thiersii become inflated when there is no apical opening, a characteristic I have

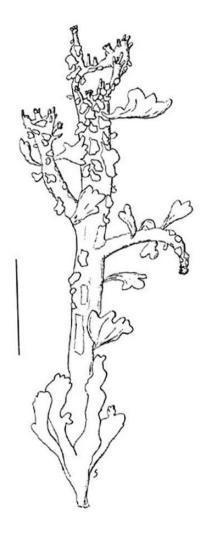


Fig. 1 <u>Cladonia thiersii</u> Hammer sp. nov. Scale bar =5mm

not observed in other members of sect. *Perviae*. Many podetia are densely squamulose, approaching *C. squamosa* var. *subsquamosa*. In *C. thiersii*, this state is often accompanied by a thick cortex, whereas in *C. squamosa* var. *subsquamosa*, densely squamulose podetia are usually decorticated.

This lichen has a long and confused history in California. A specimen collected by Bolander in 1863 from Mission Dolores (Bolander 30, FH) matches the type specimen of C. thiersii. Bolander sent his specimen to Tuckerman who called it C. santensis. The determination of this and several other specimens as C. santensis was considered by Nylander (Tuckerman, 1872) and later by Vainio (1887). Robbins (1927) summarized the controversy over Tuckerman's treatment of C. santensis and stated, "Tuckerman conceded to C. santensis a wide latitude." Robbins cited seven distinct species included in Tuckerman's concept of C. santensis, and determined Bolander 30 to be "a young state of C. crispata." This latter specimen, however, contains thamnolic rather than squamatic acid, which is found in C. crispata. Cladonia thiersii bears a superficial resemblance to C. crispata but differs in its chemistry and morphology.

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STUDIES IN AGARICUS IV: NEW SPECIES FROM COLORADO

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Abstract

The history of <u>Agaricus</u> study in Colorado is reviewed. Two new species of <u>Agaricus</u> from the Rocky Mountains of Colorado are described. They are: <u>Agaricus amicosus</u>, section <u>Spissicaules</u>, and <u>Agaricus cuniculicola</u>, section <u>Arvenses</u>.

The recorded study of <u>Agaricus</u> in Colorado began shortly before the close of the nineteenth century, when E. Bethel sent some dried mushrooms which had been collected near the town of Craig to the New York State Botanist, C. H. Peck. This material formed the basis of <u>A. tabularis</u> Pk. (Peck, 1898). Peck (1905) subsequently renamed the Colorado fungus <u>A. praerimosus</u> Pk., addressing the conflict of priority posed by the earlier <u>A. tabularis</u> Pers. within the framework of the just-codified "rules of botanical nomenclature."

E. B. Sterling, a New Jersey resident (and namesake of the 1902 species A. sterlingii Pk.) visited Denver in 1903, collected mushrooms in and around the city, and sent his dried specimens to Peck. Based on this material, Peck (1904) published four new species of Agaricus, which are given here with their later synonyms (Peck, 1905), if any: A. solidipes Pk., A. rutilescens Pk., A. sphaerosporus Pk. (= A. pilosporus Pk.), and A. cothurnatus Pk. (= A. chlamydopus Pk.).

All five of these species were based on material collected in the plains to the east and west of the Rocky Mountains. With the exception of A. praerimosus, the "fairy rings" of which were studied extensively by Shantz and Piemeisel (1917), their natural history and their phenotypic variation in the field are undocumented. Today they are but very poorly known.

Kauffman (1923) discussed two species of <u>Agaricus</u> (as <u>Psalliota</u>) found in the high Rockies. One was determined as <u>A. semotus</u> Fr., whereas the other formed the basis of a revision of <u>A. rutilescens</u> Pk. Smith (1940) reassessed Kauffman's treatment of <u>A. rutilescens</u>. Both of these reports are pertinent to <u>A. amicosus</u> (described below), and will be discussed in that context.

No published reports on <u>Agaricus</u> of Colorado (other than type studies) have appeared since Kauffman's paper. There has been, however, a substantial amount of field research on the agarics of the Rockies, conducted by professional and amateur mycologists over the last several decades. Both A. H. Smith and H. D. Thiers, in particular, have spent portions of numerous "seasons" in this region, and both have related their impressions of the striking elements of the Rocky Mountain <u>Agaricus</u> mycota to me. My own observations from portions of three seasons spent in these mountains confirm and extend those of my recent predecessors.

Materials, methods, and conventions: Formulae for most of the reagents mentioned below are given in Kerrigan (1985). Some new reagent formulations are:

Syringaldazine: 10 mg in 10 ml of 95% ethanol (a saturated solution)
Ethanol: 95%, aqueous

Color terms in single quotes are from Kornerup and Wanscher (1978). Other details of microscopy and terminology are given in Kerrigan (1985). Vouchers are deposited at SFSU or UCSB.

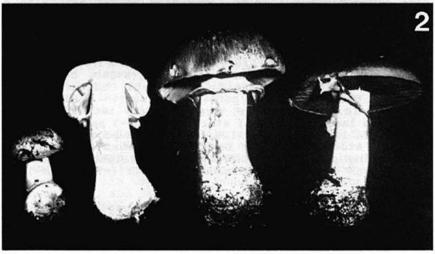
Agaricus amicosus Kerrigan, sp. nov.

Figs. 1, 2.

Pileus 7-18 cm latus, maturitate late convexus, fibrilloso-squamosus, albidus, fibrillis appressis, initio pallide fulvus, aetate rufobrunneis praeditus; contextus ex albo rufescens; odor mitis, dulcis. Stipes 6-12 cm longus, apice 1.1-2.5 (-3.2) cm et basi 3.0-4.5 cm latus, clavatus vel modice bulbosus, e farcto cavus; contextus albus modice rubescens; superficies alba, tactu rufula vel flavida; velum pendens, album, margine bruneolum; sporae (5.0-5.4-) 6.0-6.7 (-7.2-8.0) x (4.4-) 4.8-5.3 (-6.2) $\mu \rm m$; basidia 26.5-30.5 x 9-10.5 $\mu \rm m$, tetraspora; cheilocystidia 13.5-20 x 6.5-11.5 $\mu \rm m$. Holotypus: R. W. Kerrigan 1258, Robber's Roost C.G., Grand Co., Colorado. 21 August 1983. SFSU; Isotypus NY.

PILEUS 7-18 cm broad, at first hemispherical or semicolumnar to semi-cuboidal, becoming broadly to very broadly convex, the disc sometimes truncate or slightly depressed;





Figs. 1-2. Agaricus amicosus. Basidiocarps, x 1/3. 1. RWK 1258 (Holotype). 2. RWK 1259.

surface dry, variably fibrillose-squamose, the squamae ca. 5 mm long by 2-20 mm broad, usually appressed, somewhat concentrically arranged, or the squamae obscure and the surface essentially fibrillose, colored pale buff ('6B3') when young and protected to medium deep brown ('6C5'-'6D5'-'6D6'-'6E7'-'7E7') in age, background white, becoming pink to reddish brown when incised or bruised; context white, becoming light reddish to slightly vinaceous ('9B5'-'10C6') when exposed, especially above stipe and below disc, moderately firm, 7-22 mm thick, odor fruity/spicy.

LAMELLAE free, close (ca. 13 per cm at 1 cm from stipe), to 9 (-13) mm broad, when young pallid pinkish, becoming deep dingy pinkish with a slightly paler margin, then bruising rose color, later becoming drab brown, ultimately dark blackish brown.

STIPE 6-12 cm long x 1.1-2.5 (-3.2) cm above, 3.0-4.5 cm at base, clavate or essentially equal above a moderate to indistinct bulb; interior white, lustrous, becoming rather uniformly medium red ('9B5'-'9B6'-'10C6'-'10C7') when sectioned longitudinally, stuffed-hollow, the cavity to 6 mm broad; surface glabrous, with fine striations, white, becoming bright reddish orange ('9D7'-'8C7') or sometimes bright orangish yellow ('5A7') below, when bruised; basal 1-2.5 cm rooted in litter layer.

VEILS forming a moderately thin, pendant, subapical (to supramedian) white annulus with a thick (to ca. 3 mm), grooved, often brownish (like pileus surface) UV margin, also often forming a white, appressed volval boot with an appressed or slightly flaring brownish margin, or rarely a series of brown-tipped rings or only an obscure velar remnant above the base.

SPORES (5.0-5.4-) 6.0-6.7 (-7.2-8.0) x (4.4-) 4.8-5.3 (-6.2) μm , mean size = 6.29 x 5.02 μm (N=340, C=12), dark brown, broadly ellipsoid to ellipsoid, hilar appendix slightly prominent, germ pore not evident. BASIDIA 26.5-30.5 x 9-10.5 μm , clavate, predominately tetrasporic, absent from lamellar margin; sterigmata 2.5-3 μm long. CHEILOCYSTIDIA 13.5-30 x 6.5-11.5 μm , clavate to cylindro-clavate, or stocking-shaped, becoming brownish in age, then rehydrating poorly. PILEIPELLIS of straight, subparallel cylindrical elements of dimensions 33-43 (-78) x (4-) 8-9 μm .

CHEMICAL REACTIONS: KOH yellow or not on pileus surface, faintly to moderately strongly yellow on basal stipe context, slightly yellowish to negative elsewhere; Aniline x HNO3 ("Schäffer reaction") red to orange (1/1 tests); ETOH orange on pileus surface (hence o-tolidine, syringaldazine, 1-napthol and 2,4-D orange in the absence of other color changes); o-tolidine blue (or orange; see ETOH) on pileus surface, blue on stipe base surface, violet elsewhere; 1-napthol bright pink to pinkish-orange everywhere (or with some purplish streaks in lower stipe context), to red on pileus surface (except disc sometimes purple); syringaldazine orange (see ETOH). [Note: the extracellular laccase isozyme phenotype of isolate RWK 1438 is given in Kerrigan and Ross (in press).]

Gregarious, often in rings or arcs, in deep litter under <u>Picea</u> and <u>Abies</u>, at elevations of 8500 to 10,000 feet, in the Rocky Mountains of Colorado. August. Routinely encountered.

Material studied: COLORADO. Boulder Co.: R. W. Kerrigan 1438. Grand Co.: RWK 1257, 1258, 1259, 1263, 1269, 1273, 1275, 1277, 1302, 1430, 1433, 1435, 1436, 1446. San Miguel Co.: RWK 1448, 1452. Misc.: RWK 1447.

Observations: In my experience, A. amicosus is the most frequently observed Agaricus in the high-elevation conifer forests of Colorado. Not only is it fairly common, but also the robust habit and red-staining context and surfaces of this brown-capped mushroom are distinctive. The impressions related by A. H. Smith and H. D. Thiers confirm that this striking species is quite familiar to those who study this habitat during the August rainy season. Judging from conversations with several collectors, it appears that A. amicosus has often been taken for A. haemorrhoidarius Schulz. in Kalchbr. One difference between these two species is the much narrower spore of A. haemorrhoidarius: 3-3.5 µm according to Cappelli (1984). Another way to distinguish A. amicosus from A. haemorrhoidarius is by chemical spot-tests on the pileus surface. The KOH (yellow), ETOH (orange), and positive Schäffer's reaction of A. amicosus are not shared by A. haemorrhoidarius, and suggest affinities with section Spissicaules (Heinem.) Kerrigan. The occasional tendency of the stipe cuticle to turn bright yellow-orange (e.g. RWK 1448) rather than bright red also appears to support this relationship. While perplexing to the uninitiated, this rather singular trait may ultimately shed light on the chemistry of these color reactions in the genus as a whole.

Agaricus amicosus is quite similar to the European A. lanipes (Möll.) Möll., another member of section Spissicaules. Agaricus amicosus differs from A. lanipes in habitat (high-elevation spruce-fir forests vs. lower-elevation oak forests), in chemistry (Schäffer's reaction positive vs. negative), and in spore size. The spores of A. lanipes are given by Möller (1950) as 5.5-6.5 x 3.75-4 μm , and by Cappelli (1984) as 5.5-6.5 x 3.5-4.5 μm . The spores of A. amicosus are slightly longer and substantially broader; the lowest mean spore width value recorded for A. amicosus (collection RWK 1302), with a 95% confidence interval of $\pm 0.10~\mu\text{m}$, is 0.37 μm larger than the most extreme spore width recorded by Cappelli, and is 0.87 μm broader than the broadest spores noted by Möller. Taking the mean spore size of A. lanipes, from Cappelli's data, as 6 x 4 μm , that species has a mean spore volume of 50.3 μm^3 (calculating the volume of the spore as $(4/3)\pi(\text{L/2})(\text{W/2})^2$). Agaricus amicosus, with a mean observed spore size of 6.29 x 5.02 μm , has a mean spore volume of 83.0 μm^3 , 65% greater than that of A. lanipes. I suggest that the difference in spore size between the two species is most indicative of a long evolutionary divergence that warrants recognition of A. amicosus at the species level.

Kauffman's (1923) emended description of \underline{A} . <u>rutilescens</u> is also evocative of \underline{A} . <u>amicosus</u>. Kauffman described a frequently-encountered, large, brownish-capped, rufescent

mushroom under spruce and fir at both sites he studied (Leal, in Grand Co., and Tolland, in Gilpin Co.). The points of discrepancy in his description, relative to $\underline{\mathtt{A}}.$ amicosus as I have observed it, are a solid stipe [Kauffman's emphasis], a thin, narrow annulus, and spores which were reported as 5-6 x 4-4.5 $\mu\mathrm{m}.$ Smith later corrected Kauffman's spore measurements on the material to 5-6.5 x 4-5.5 $\mu\mathrm{m}$, in good agreement with my own observations (ironically, Kauffman regarded Peck's spore measurements as being in error). The features of the annulus undoubtedly can be influenced by weather and environment, and in any event were described subjectively. Smith (1940) determined that Kauffman's material probably belonged to more than one species, since one collection had spores measuring 7-9 x 5-6 $\mu\mathrm{m}$ (I have also found such a large-spored collection, RWK 1449, among material of my own which was initially determined as $\underline{\mathrm{A}}.$ amicosus). Smith recommended adherence to the type concept of $\underline{\mathrm{A}}.$ rutilescens. I have examined neither the type of $\underline{\mathrm{A}}.$ rutilescens nor Kauffman's material, and prefer to follow Smith's advice. It seems likely that Kauffman may have had $\underline{\mathrm{A}}.$ amicosus in hand, as least in part, when he redescribed $\underline{\mathrm{A}}.$ rutilescens.

The epithet <u>amicosus</u>, while suggestive of the gregarious habit of this mushroom, was actually chosen to celebrate the many friendships which are a hallmark of Harry Thiers' career.

Agaricus cuniculicola Kerrigan, sp. nov.

Fig. 3.

Pileus 5-11 cm latus, ex acute convexo planus, appresso-fibrillosus vel fibrilloso-squamulosus, pallide coloratus, fibrillis initio brunneis demum fuscis praeditus; contextus albus, interdum aurantio-flavescens; odor amygdalinus; stipes 6-14 cm longus, apice 0.8-1.5 cm et basi 2-3 cm latus, bulbosus vel abrupte bulbosus, e farcto cavus; vela pendentia, interdum recurvo-pendentia, margine et pagina inferiore aurantia vel bubalina; sporae (5.0-5.4-) 6.2-6.9 (-7.6-8.0) x (4.2-) 4.6-5.6 (-6.2) μ m; basidia (17.5-) 22.5-27.5 x 8-11 μ m, tetraspora; cheilocystidia 7-30.5 x 6.5-18.5 μ m. Holotypus: R. W. Kerrigan 1271, Willow Creek Pass summit, Grand Co., Colorado. 22 August 1983. SFSU; Isotypus NY.

PILEUS 5-11 cm broad at maturity, less than half the diameter of the stipe in primordia, acutely convex when young, ultimately becoming semi-plane with a slightly depressed or slightly umbonate disc; surface dry, innately appressed-fibrillose, becoming appressed-fibrillose or minutely fibrillose-squamulose (except the disc remaining entire), the squamules ca. 1-3 mm long x 1-2 mm broad, these hyphae initially medium brown (about '6C4'-'6C6'-'7C5'-'7D6') or paler, becoming darker in age (to about '7E8' or darker) on a whitish (to yellowish in age) back-



Fig. 3. Agaricus cuniculicola RWK 1271 (Holotype). Basidiocarps, x 1/3. Note three basidiocarps that formed in small tunnels, with pilei just protruding above substrate surface.

ground; context white, unchanging when young, becoming orangish in older material when exposed, 6-10 mm thick, odor of almonds.

LAMELLAE free, close (ca. 16 per cm at 1 cm from stipe), 6-12 mm broad, initially pallid, then greyish-drab and faintly marginate or not, color unchanging when bruised, finally dark blackish brown.

STIPE 6-14 cm long x 0.8-1.5 cm broad above, 2-3 cm broad at base, bulbous to abruptly bulbous; interior white, unchanging in young material, or becoming orangish in older material, when exposed, lustrous, fibrous, stuffed-hollow to hollow, the cavity 3-4 mm broad; exterior white, lustrous, becoming yellowish when bruised, finely striate above, covered below with numerous scattered, small, white, floccose velar squamules, these deciduous in age, lower surface lustrous, finely fibrous-striate; basal bulb covered with coniferous litter.

VEILS forming a thin, pendant to pendant-recurved, sub-apical, white (or later orangish-yellow) annulus, with a finely striate upper surface and a scurfy, sometimes buff colored lower (UV) surface, the margin slightly thicker, somewhat eroded, orangish-buff; the UV also leaving scattered scurfy squamules over most of the lower stipe.

SPORES (5.0-5.4-) 6.2-6.9 (-7.6-8.0) x (4.2-) 4.6-5.6 (-6.2) μm , mean size 6.58 x 5.05 μm (N=150, C=5), dark brown, broadly ellipsoid to ellipsoid (with many hyaline subglobose immature spores often also present), hylar appendix not prominent, germ pore not evident. BASIDIA (17.5-) 22.5-27.5 x 8-11 μm , clavate to cylindro-clavate, predominately tetrasporic, extending to edge of lamellar margin; sterigmata 3.5-4 μm long. CHEILOCYSTIDIA 7-30.5 x 6.5-18.5 μm , globose, ovoid, ellipsoid, or various, catenulate, abundant but restricted to the center of the lamellar margin. PILEIPELLIS of parallel to subparallel hyphae composed of straight, cylindrical elements of dimensions (15-) 33-47 (-56) x 6.5-9.5 μm .

CHEMICAL REACTIONS: KOH yellow; o-tolidine blue everywhere; 1-napthol purple at base of stipe and on cuticles (slowly so on context near base of stipe), pink elsewhere.

Gregarious to scattered in litter of <u>Picea</u> and/or <u>Abies</u>, particularly in deep piles of decaying cone scales that result from the feeding activities of squirrels; the primordia sometimes form several cm beneath the surface, on the walls of short tunnels apparently excavated by small mammals; from ca. 8500-10,000 feet in the Rocky Mountains of Colorado. August. Fairly frequently encountered.

Material studied: COLORADO. Boulder Co.: R. W. Kerrigan 1439. Grand Co.: RWK 1271, 1272, 1278, 1279, 1301, 1431, 1432, 1445. San Miguel Co.: RWK 1453.

Observations: Agaricus cuniculicola, when slender, most closely resembles A. smithii Kerrigan (= A. perrarus sensu A. H. Smith, 1940) of the coastal Pacific Northwest, differing macroscopically only in having a brownish cuticular pigment when immature, rather than the tawny orangish pigment of A. smithii. The overall aspect of these two species, including a narrowly convex pileus when young, a bulbous stipe base, and frequently a pendant-recurved annulus, suggest a close relationship between them. Other, more robust collections which resemble pale specimens of A. augustus Fr., or brownish forms of A. perobscurus Kerrigan, may also belong to A. cuniculicola. Such material that I have obtained has unfortunately been too immature for microscopic analysis. If these variants are all conspecific, then A. cuniculicola has a fairly wide range of aspects. This makes field identification problematic, particularly since members of Agaricus section Arvenses Konrad & Maublanc are well represented in the high Rockies.

Microscopically, the spores of A. <u>cuniculicola</u> are shorter than those of A. <u>smithii</u>. Mean values for spore length from eleven collections of A. <u>smithii</u> ranged from 8.3 μ m down to 7.5 μ m, whereas mean spore lengths for collections of A. <u>cuniculicola</u> ranged from 6.3 to 6.8 μ m. The mean spore width of A. <u>cuniculicola</u> varied more between collections than did mean spore length, ranging from 4.6 to 5.6 μ m. The difference in mean spore volumes (116.3 μ m for A. <u>smithii</u> vs. 89.2 μ m for A. <u>cuniculicola</u>) is about 30% of the mean spore volume of A. <u>cuniculicola</u>.

The pink color formed by 1-napthol when placed on some of those areas of the context which turn blue with o-tolidine has not been recorded previously in other species; a blue tolidine reaction usually correlates with a purple napthol reaction. This unusual combination of reactions may have to do with the biochemistry of the orangish hue that develops in older context when exposed.

Although not restricted to tunneled piles of conescales, in my experience \underline{A} . <u>cuniculicola</u> fruits most abundantly there. Its association with this "naturally-manufactured" feature of the high coniferous forests of the Rockies is striking enough to have been noted by other collectors, among them H. D. Thiers (pers. comm.). This association is reflected in the species epithet.

ACKNOWLEDGMENTS

I would like to express my gratitude to those who interested me with their tales of the Colorado mountain species of <u>Agaricus</u> (including my mentor and his mentor), and to those who guided my way in the field, offered shelter and company, and made it financially feasible to work in their state. Marilyn Shaw, Linnea Gillman, Duane H. Mitchel, and many other members of the Colorado Mycological Society, Emmanuel Salzman and Fungophile, Inc., deserve special mention. I thank David Farr for checking the priority of the proposed names, Robert Patterson for the covert loan of material housed at SFSU, and Roy Halling and Wayne Ferren for their comments on the manuscript. I am particularly grateful to Ellen Thiers for rendering the taxonomic diagnoses into Latin.

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A NEW, LIGNICOLOUS SPECIES OF ENTOLOMA (Entolomataceae, Agaricales) FROM CALIFORNIA.

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SUMMARY

A new species of *Entoloma* (sensu stricto), *E. lignicola*, that grows on conifer wood is described from northern California.

INTRODUCTION

In November of 1986, at least 200 basidiomes of a species of *Entoloma* (sensu stricto) were found growing on a conifer log in northern California. A collection of nearly 50 basidiomes in all stages of development was made. Because of the following set of features, this species was considered distinct and unusual: woody substrate, consistently convex, tan pileus with a margin extending beyond the lamellae, close, narrow lamellae, curved, slender stipe, obscurely angled, isodiametric, small basidiospores, and a narrow cutis as the pileipellis. A careful review of the pertinent literature resulted in the conclusion that this species had not been previously described.

Therefore, it is with pleasure that I dedicate this species, *Entoloma lignicola*, to Harry D. Thiers.

Entoloma lignicola Largent, sp. nov.

Pileus 20-45 (-55) mm latus, convexus vel lato-convexus, glaber, tannus, haud hygrophanous, margine decurvato, integro, non-striato. Lamellae adnatae, albae, angustatae, confertae. Stipes 3-5 (-6) mm crassus, 25-60 mm longus, glaber, subalbus. Odor et sapor farinceus. Sporae 5.1-6.1 x 4.1-5.1 μ m, isodiametricae, obscuroangulatae. Hymenial cystidia desunt. Pileipellis cutiformis, cellulis terminalibus cylindro-clavaticis. Stipitipellis cutiformis; caulocystidia desunt. Pigmentum in vacuolis hypharum. Fibulae in hyphis pileipellis, pileal trama, lamellar trama, stipitipellis, stipe trama, et basi basidiorum adsunt. Basidiocarpi dispersi vel gregarii ad lignum in sylvis sub Lithocarpum, Arbutum, et Pseudotsuga . Holotypus (DLL 8747) in HSU conservatus.

Pileus: 20-45 (-55) mm in diameter, 10-20 mm in height, consistently broadly convex and without an umbo, glabrous, dull, dry, with an incurved to decurved, non-translucent-striate margin that consistently extends beyond the lamellae by 1-3.5 mm, not hygrophanous, colored at first an off-white to a pale buff (6,A-B,3 to 6,B,3), soon becoming and remaining a uniform tan (6,C-D,5); pileal flesh concolorous with the surface, 1.5-2.5 mm thick. Lamellae: adnexed to adnate at first becoming typically adnate, narrow to somewhat moderately broad (3-7 mm high, 10-30 mm long), typically close to rarely subdistant, colored white at first, with a smooth margin concolorous with the surface. Stipe: 3-5 mm thick at the apex, 3-6 mm thick

at the base, 25-60 mm long, most often equal but at times tapered towards the apex, usually entirely glabrous but at times with a slight pruinose apex, decidedly curved towards the light and away from the ground, thus negatively geotrophic and positively phototrophic, colored an off-white, obscurely longitudinally striate, with a sparse to moderate, whitish basal tomentum. Odor and taste: farinaceous, especially when the flesh of the pileus is crushed.

Spores 5.1-6.1 x 4.1-5.1 μm, average length 5.44 μm, average width 4.85 μm, Q (average length/width) 1.12, length/width 1.0-1.33, length minus width 0-1.5 μm. isodiametric, multiangular with the angles typically obscure, even in outline and with no protrusions or outgrowths. Basidia clavate, 25.4-33.5 x 6.1-8.1 μm, length/ width 3.3-5.0, 4-spored. Hymenial cystidia absent. Subhymenium in cross section a tightly interwoven layer, up to 24.6 µm wide, composed of small, slender hyphae, 3.7-4.9 µm wide. Lamellar trama in cross section composed of subparallel hyphae, 71.4-172.4 x 12.3-17.3 \(\mu\)m. Pileal trama in radial section composed of interwoven hyphae above the stipe and hyphae parallel to the pileal surface above the lamellae; hyphae 36.9 -135.5 x 7.4-29.6 µm, with the broader hyphae more abundant beneath the pileipellis. Pileipellis in radial section a cutis, 2-6 hyphae thick, with the hyphae more slender than, and thus differentiated from, the underlying hyphae of the pileal trama, composed of slightly entangled hyphae over the stipe and parallel hyphae elsewhere; terminal cells cylindro-clavate to somewhat broadly clavate, 24.6-69.0 x 6.2-9.9 μm, length/width 3.3-11.2. Stipitipellis composed of a very narrow layer of loosely interwoven hyphae overlying a layer of parallel hyphae; caulocystidia absent. Pigmentation apparently vacuolar, distinctly not incrusting or membranal. Lactifers quite rare, more common in the trama of the stipe and the lamellae than in the pileus trama. Clamp connections extremely rare on the hyphae of the pileipellis, moderately abundant on the tramal hyphae of the pileus and stipe, abundant on the tramal hyphae of the lamellae and at the base of the basidium, rare on the hyphae of the stipitipellis.

Distribution and Habitat: Rare, collected only once; scattered to gregarious on a slightly decomposed conifer log in a Tanbark Oak (*Lithocarpus densiflorus* (Hook. & Arn.)Rehd.), Douglas fir (*Pseudotsuga menziesii* (Mirbel)Franco), Madrone (*Arbutus menziesii* Pursh.) forest; Humboldt County, California; mid-November.

Material Studied: CALIFORNIA: Humboldt Co.: DLL 8747 (HOLOTYPE: HSU; 16 November 1986, 5.0 miles east from the junction of Big Hill Road and State Highway 96)

An unsuccessful attempt at identifying this species was made utilizing the following pertinent literature: Horak (1973, 1978, 1980), Kühner & Romagnesi (1953), Noordeloos (1981, 1987), and Romagnesi & Gilles (1979).

On the basis of its small basidiomes, convex, tan pileus, narrow, adnate lamellae, rather slender stipe, farinaceous odor, small, obscurely angular, isodiametric basidiospores, cutis as the pileipellis, and lignicolous habit, *Entoloma lignicola* appears to be a unique species.

Because of its non-hygrophanous, non striate, glabrous pileus, it appears related to Entoloma niphoides Romagn. ex. Noordel., E. eulividum Noordel., E. sinuatum (Bull.:Fr)Kumm., and E. prunuloides (Fr.:Fr.)Quél. However, all of these species have much larger spores, a humicolous habit, a pileus that is up to 100-125mm broad, and a Tricholoma-like stature.

Because of its basidiome colors, convex pileus with thin flesh, and farinaceous odor, Entoloma lignicola appears also to be related to E. rhodopolium and E. speculum (Fr.:Fr.)Kummer. However these species are distinct because of their hygrophanous pileus with a striate margin, humicolous habit, and larger basidiospores that are distinctly angular.

On the basis of its small, obscurely angular basidiospores, Entoloma lignicola

could be placed in *Entoloma* section *Turfosa* (Romagn.)Noordel. However, all species in this section possess a hygrophanous pileus with a striate margin, grow in the humus, and possess basidiomes that are much darker in color.

Colors from Kornerup and Wanscher (1978) are quoted by page (first number), horizontal row (letter), and vertical column (last number).

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NOTES ON THE GENUS PROTUBERA (PHALLALES)

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ABSTRACT

The genus <u>Protubera</u> includes species of Phallales that are essentially gasteromycetous. Basidiomata are composed of a thin peridium enclosing a gelatinous matrix. Fertile glebal plates or chambers extend inward from the peridial layer and eventually fill all or part of the interior. There are seven described species of <u>Protubera</u>: <u>P. africana</u>, <u>P. borealis</u>, <u>P. brunnea</u>, <u>P. clathroidea</u>, <u>P. jamaicensis</u>, <u>P. maracuja</u> (the type species), and <u>P. nipponica</u>. An eighth species, <u>P. sabulonensis</u> is described as new to accommodate collections from primary sand dunes on Sable Island, Nova Scotia, Canada. All of the species are briefly characterized, including notes on type and other collections, illustrated in part and differentiated by a dichotomous key.

INTRODUCTION

In 1890 Alfred Möller, while collecting fungi near Blumenau, Santa Catarina, Brazil, encountered a gasteromycetous form that closely resembled an unexpanded "egg" of one of the Phallales. This fungus was common in the region and fruited abundantly throughout the year. He was able to study it closely throughout its development and determined that it remained in the closed gasteromycetous form right through to its final dissolution. After his return to Germany he determined this fungus to represent a new genus of Phallales and described it as Protubera maracuja Möller (Möller, 1895). In that paper developmental stages and mature basidiomata were well illustrated, and these were later reproduced by Fischer (1900). Since then this fungus has been collected a number of times and reported from various parts of the world; Furtado & Dring (1967) accumulated and presented most of these records, although they accepted as correctly identified only material from southern Brazil.

As described by Möller, basidiomata of \underline{P} . maracuja first appear as brown, spherical to elongated structures. They are attached to the soil by stout rhizomorphs and consist of a compact peridial layer surrounding a gelatinous center. During maturation, hyphal plates or lobes grow into the central gelatinized tissue from the

peridium and give rise to internal labyrinthine cavities lined with basidia. Cross sections of mature basidiomata reveal a number of radially arranged fertile lobes connected by narrow strands to the inner surface of the peridium and extending halfway or more into the center.

Lloyd (1920) received additional material of P. maracuja from Rev. Rick in Brazil, who stated that it is not rare, but added nothing to Möller's description. In the same paper Lloyd reported on a species collected in Stellenbosch, South Africa by Miss A. V. Duthie and described it as a new species, P. africana Lloyd. This species was said to differ from P. maracuja in having a single glebal mass filling the center of the basidiomata rather than radiating plates. The glebal mass was described as "compact and minutely porous to the eye" and similar to that of Rhizopogon species.

A third species, \underline{P} . borealis Imai was proposed by Imai (1936) to accommodate a collection from soil in Cryptomeria iaponica (L.) D. Don. forests near Sapporo, Hokkaido, Japan. \underline{P} . borealis was reported to be similar to \underline{P} . maracuja and to differ from it in having slightly larger spores and a nearly white peridium.

Kobayasi (1938) described the new species \underline{P} . $\underline{nipponica}$ Y. Kob. for a collection from soil in the woods near Kunitati, Honshu, Japan, said to be similar to \underline{P} . $\underline{maracuja}$ and \underline{P} . $\underline{borealis}$ but differing in having a hollow center caused by the disintegration of the gelatinous matrix. The glebal plates were described as greatly elongated and extending nearly to the center of the basidiomata.

Imai & Kawamura (1958) obtained material of P. maracuja from Dr. Rick in Brazil and compared it directly with the two Japanese species. Based on the nature of the peridial and glebal tissues these authors proposed two new genera for the Japanese species; Protuberella for P. borealis and Kobayasia for P. nipponica. Interpretation of this paper is rather difficult, but the following key may reflect Imai & Kawamura's views:

- Peridium composed of three distinct layers <u>Protubera maracuja</u>
- 1. Peridium composed of two layers 2
 - Basidiomata hollow at the center Kobayasia nipponica
 - Basidiomata gelatinous at the center <u>Protuberella borealis</u>

A fifth species of <u>Protubera</u>, <u>P. clathroidea</u> Dring, was proposed by Dring (1964) for a form collected in sandy places in Togo and also one reported as <u>P. maracuja</u> from Pakistan by Ahmad (1952). In <u>P. clathroidea</u> the glebal plates appear to be united into a single mass. This species was reported to be similar to <u>P. africana</u> Lloyd and

to have similarly broad basidiospores. Unlike \underline{P} . $\underline{africana}$, \underline{P} . $\underline{clathroidea}$ has basidiomata with a sterile gelatinous center.

Two further species, P. brunnea (Zeller) Zeller and P. jamaicensis (Murrill) Zeller must be included in this discussion. Protubera jamaicensis was originally described as the type species of Protophallus Murrill (Murrill, 1910). Protophallus was apparently described without knowledge of Protubera and was maintained as distinct from it by Zeller (1939) and Imai & Kawamura (1958) apparently on the basis of a simple rather than branched columella (central gelatinous area). Zeller (1948) later rejected the distinction and transferred the two species of Protophallus to Protubera, a decision accepted by Dring (1964). Protubera jamaicensis and P. brunnea were not originally compared with species of Protubera and are thus not easily distinguished from them on the basis of their diagnoses. Protubera jamaicensis was reported to be characterized by a viscid peridium and P. brunnea by broadly ellipsoidal basidiospores (5-6 X 2.5-3 µm).

During October, 1982, I spent three weeks studying fungi on Sable Island, Nova Scotia. This island is a narrow bar of sand about 200 km east of the Nova Scotia mainland that supports a surprisingly varied vegetation. The foredunes on the north side of the island are relatively unstable and support a vegetation dominated by Ammophila breviligulata Fern. (Graminae) and Lathyrus maritimus (L.) Bigel. (Leguminosae). This habitat was generally rather poor for fungi, but I nevertheless found abundant basidiomata of a species of Protubera. Although descriptions were available for all of the described species of Protubera it quickly became apparent that species concepts were confused or not well defined and that identification of my unknown specimen was nearly impossible. Because of this, it became necessary to examine representative material of some of the species similar to the Nova Scotia collections and to arrive at a more satisfactory concept of existing species. The following notes are based on these examinations. Colors designated in upper case are according to the Methuen Handbook of Colour (Kornerup & Wanscher, 1978).

THE SPECIES OF PROTUBERA

PROTUBERA AFRICANA Lloyd, Mycological Notes 64: 987. 1920.

Figs. 1-3.

BASIDIOMATA (Fig. 1) more or less spherical, smooth, pale brown; in cross section revealing four separate tissues, 1) a thin brown peridium, 2) a soft gelatinous layer about 3 mm thick, 3) a thin internal membrane surrounding 4) a central glebal mass. RHIZOMORPHS stout, extending into the soil. ODOR not specified.

OUTER PERIDIAL LAYER compact, 52-96 μm thick, brownish, composed of tightly interwoven non-gelatinized hyphae, never enclosing druse-like crystalline masses. GELATINOUS AREAS 600-700 um thick, composed of interwoven, septate, gelatinous hyphae, containing numerous oleiferous hyphae, sometimes containing a tissue similar to the peridium that is oriented parallel to the peridium. GLEBAL MASS filling the center of the basidiomata, reticulate-poroid as in species of Rhizopogon, bearing basidial hymenia within the chambers, connected to the peridium by narrow bands of tissue. BASIDIA (Fig. 2) 8-spored, short-sterigmate, 21-33 X 4.2-7.2 μ m. BASIDIOSPORES (Fig. 3) ellipsoidal, smooth, with a conspicuous basal apiculus, greenish olive in mass, 4.6-6.2 (mean = 5.1 \pm 0.44) X 2.0-2.8 (m = 2.4 \pm 0.17) μ m, with mean D/d = 2.09 \pm 0.19).

MATERIAL EXAMINED: SOUTH AFRICA: Stellenbosch, Papagaaisberg, in damp clayey soil, <u>Duthie</u> 233 (Lloyd 22143), 20.VI.1919, HOLOTYPE (BPI); possibly same locality as holotype, <u>Duthie</u> 243 (Lloyd 22144) (BPI).

The macroscopic part of the description is based on that of Lloyd (1920) who presumably had a description from Miss Duthie, the collector. The holotype packet also contains a colored drawing of fresh material, redrawn in Fig. 1. This drawing indicates that there are strands connecting the peridium to the gleba as in other species, although Murrill states that no such structures are present. I was unable to observe these in the herbarium specimens, but the parallel layer that resembled to me a second embedded peridium may in fact have been one of these connections. This is the only species of Protubera where the glebal masses appear to be combined into a single central unit. As Lloyd pointed out, the resemblance of the gleba to that of Rhizopogon species is striking.

PROTUBERA BOREALIS (Imai) Imai & Kawamura, Sci. Rep. Yokohama Nat. Univ. Sect. II, 7:4. 1958.

Protuberella borealis Imai, Bot. Mag., Tokyo 50:223.

1936.

Figs. 4-6.

BASIDIOMATA (Fig. 4) arising from a rhizomorph, uneven to wrinkled or clearly sulcate, grayish white to pale sordid, 20-50 mm in diameter; in cross section there appear to be four tissues, 1) a thin pale compact peridium, 2) a rigid, gelatinous peridium-like layer 1-3 mm thick, 3) a thin gelatinous "filling", and 4) centripetally arranged glebal plates extending inward from the peridium. RHIZOMORPHS white, gelatinous within, branched. ODOR not recorded.

PERIDIUM compact, 230-360 um thick, pale, composed of interwoven, occasionally clamped hyphae with globose to oblong or cylindrical cells 8-20 um in diameter, without crystalline masses. GELATINOUS AREAS composed of

interwoven gelatinous hyphae up to 9 um in diameter, rather firm near the peridium and glebal masses and highly gelatinous and watery elsewhere, sometimes containing capitate hyphae 12-18 um in diameter. GLEBAL MASSES radiating inward from the peridium, short and often cerebriform. BASIDIA (Fig. 5) clavate to irregularly cylindrical, 8-spored, clamped at base, 14-20 X 2.8-4.9 μm . BASIDIOSPORES (Fig. 6) ellipsoidal, smooth, with a broad basal apiculus, Grayish yellow to Olive brown (4CD3) in mass in rehydrated material, 3.8-4.7 (mean = 4.2 \pm .020) X 1.6-2.1 (mean = 1.8 \pm 0.13) μm , with mean D/d = 2.36 \pm 0.205.

MATERIAL EXAMINED: JAPAN: Tottori Pref., Tottori-City, Kokoge, gregarious in stand of <u>Quercus myrsinaefolia</u> Blume in woods dominated by <u>Pinus densiflora</u> Siebold & Zaccarini, <u>Nagasawa</u>, 16.VII.1980 (TMI-6948) (TRTC).

The material examined here seems close enough to the original description of <u>P. borealis</u> to cause little doubt as to its identity. The holotype was collected in forests of <u>Cryptomeria japonica</u> (L.) D. Don. near Sapporo, Ishikari Prov., Hokkaido, Japan. The one point of disagreement is in spore size: that given by Imai (1936) was 3.75-4.5 X 2-2.5 μm which is broader than the spores of the Tottori material. The species is distinguished from other <u>Protubera</u> species by its combination of short glebal masses, soft or almost watery gelatinous material and relatively narrow basidiospores.

PROTUBERA BRUNNEA (Zeller) Zeller, Mycologia 40: 644. 1948.

= <u>Protophallus brunneus</u> Zeller, Mycologia 31: 28. 1939.

BASIDIOMATA arising from a rhizomorph, spherical, smooth but somewhat felty, white, becoming sordid, reticulate with a few lines, 15-35 mm in diameter; in cross section there appear to be four separate tissues, 1) a thin tough peridium, 2) a rigid gelatinous peridium-like layer 2-4 mm thick, 3) a thin gelatinous "filling, and 4) centripetally arranged glebal plates extending inward from the peridium. RHIZOMORPHS white, apparently unbranched, with a peridium-like cartilaginous sheath and a gelatinous center, extending nearly into the center of the basidiomata. ODOR not specified.

PERIDIUM compact, about 175-250 µm thick, composed of interwoven and anastomosing non-gelatinous hyphae, with crystalline masses not reported. GELATINOUS AREAS composed of interwoven anastomosing, highly gelatinous hyphae. GLEBAL MASSES arising as ingrowths of the peridium, less gelatinous than the surrounding tissues, extending nearly to the center of the basidiomata, giving rise to a regular hymenium of basidia internally. BASIDIA elongate-clavate, 4-6-spored. BASIDIOSPORES broadly ellipsoidal, smooth, brown in mass, 5-6 X 2.5-3 $\mu \mathrm{m}$.

MATERIAL EXAMINED: none. The above description has been taken from that of Zeller (1939) and transformed into the standard format of this paper.

Protubera brunnea appears to be distinctive in having the rhizomorph extending well into the center of the basidioma and in having large broad basidiospores. The type (now at FH) was collected by Roland Thaxter in a park, Buenos Aires, Argentina in February and March 1906. The type locality is not so distant from that of P. maracuja that it does not force comparison with it. However, the two diagnostic features mentioned above, as well as the white, filamentous peridium of P. brunnea, seem to distinguish them.

PROTUBERA CLATHROIDEA Dring, Mycol. Pap. CMI, 98:3. 1964.

Figs. 7-8.

BASIDIOMATA (Fig. 7) arising from a rhizoid, ovoid to subglobose, smooth, covered with an incomplete network of shallow grooves, dirty white, 15 X 15-30 X 60 mm; in cross section there appear to be five separate tissues, 1) a thin white membranous peridium, 2) a rigid gelatinous peridiumlike layer, 3) a thin white membranous layer enclosing the gleba, 4) fused glebal masses attached to the peridium by centripetally extended "sutures" and 5) a central gelatinous "filling". RHIZOMORPHS white, occasionally branched. ODOR when ripe of ethyl acetate (apples).

BASIDIOSPORES (Fig. 8) ellipsoidal to ovoid, smooth, hyaline, with a broad sterigmatal scar, (3.5) 4-6 (-7) X (3-) 3.5-4.5 (-5) μm .

MATERIAL EXAMINED: none. Description adapted from that of Dring (1964).

It is difficult to compare P. clathroidea with other described species of Protubera because of the lack of microscopic detail reported in its original diagnosis. The holotype was collected in sandy places in Togo. As noted above, the species also seems to occur in Pakistan. Aside from the habitat it is distinguished by its confluent peridial masses surrounding a central sterile gelatinous zone (called a columella by Dring) and by its broad basidiospores.

PROTUBERA JAMAICENSIS (Murrill) Zeller, Mycologia 40:644.

Protophallus jamaicensis Murrill, Mycologia 2:25. 1910

Figs. 9-11.

BASIDIOMATA (Fig. 9) arising from a rhizomorph, spherical, smooth, viscid, avellaneous, becoming white at

maturity, 20-40 mm in diameter; in cross section there appear to be three separate tissues, 1) a thin white compact peridium, 2) a gelatinous inner layer that forms a peridium-like tissue 1-1.5 mm thick and extends inward to the center, and 3) centripetally arranged glebal plates extending inward from the peridium almost to the center. RHIZOMORPHS arising from the substrate, white, unbranched, extending to the center of the basidiomata. ODOR lacking.

PERIDIUM compact, 200-280 μm thick, composed of rather densely interwoven hyaline hyphae in a gelatinous matrix. GELATINOUS AREAS composed of interwoven gelatinous hyphae. GLEBAL MASSES arising as ingrowths of the peridium, filamentous, extending nearly to the center of the basidioma, olivaceous to deep brown, giving rise to a tortuous hymenium of basidia internally. BASIDIA (Fig. 10) 8-spored, clavate to subcylindrical. BASIDIOSPORES (Fig. 11) ellipsoidal, smooth, with a broad basal apiculus, brown in mass, 3.1-4.4 (mean = 3.6 \pm 0.25) X 1.3-1.9 (mean = 1.6 \pm 0.11) μm , with mean D/d = 2.26 \pm 0.223.

MATERIAL EXAMINED: JAMAICA: near Cinchona, in shaded soil rich in humus on the bank of the Clyde River, Murrill, 7.I.1909. HOLOTYPE (NY); "same general locality" as the holotype (Coker & Couch, 1928), on very rotten wood, Coker, 1900 (NY).

The above description was based upon the reports of Murrill (1910), Coker & Couch (1928) and Zeller (1939) and augmented by my own examination of the holotype and Coker's material from the same locality. A colored illustration made by a Miss Taylor, who was studying at Cinchona at the time, is contained in the holotype packet and was also used. A second illustration, now torn in two, illustrates a cross sectional view of a basidioma (redrawn in Fig. 9) and of one glebal mass. It is not clear whether this was done by Miss Taylor or Dr. Murrill. The herbarium material at the New York Botanical Garden is not in good condition: the holotype seems to be nothing more than shell-like peridial fragments devoid of gleba or spores and the Coker material is half of a basidioma dried down from liquid preservative. There is a permanent microscope slide mount of P. jamaicensis at NY that is not clearly from either of the two localities. Like the Coker collection, however, it came originally from the herbarium of S. M. Zeller and may be part of the material that Coker had collected and later sent to him. On the other hand, a note in the holotype packet states that part of the collection had been preserved in liquid and it may be that this is what Zeller had used for his slide. This slide is the only material on which 8-spored basidia can be seen clearly.

The elongated glebal plates and basidiospore dimensions suggest that it is close to \underline{P} . $\underline{nipponica}$: in fact, it is difficult to discover characters useful in separating the two species. The only feature that may serve this purpose is the peridium, which is described as

viscid in <u>P. jamaicensis</u>. Coker & Couch (1928), however, make no mention of this character at all. Another feature that may prove diagnostic is the extension of the rhizomorph of <u>P. jamaicensis</u> well into the center of the basidioma in the manner of a columella: this does not seem to occur in <u>P. nipponica</u>.

PROTUBERA MARACUJA Möller in Schimper, Bot. Mittheil. aus den Tropen 7: 10. 1895.

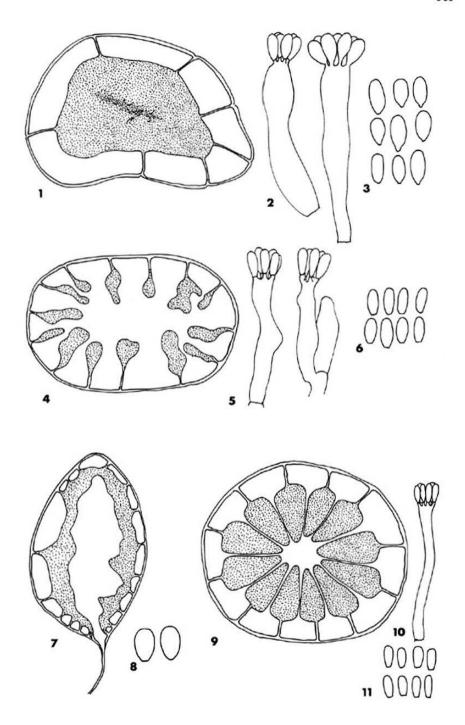
Figs. 12-15.

BASIDIOMATA (Fig. 12) arising from a rhizomorph, smooth, pale leather brown when young, becoming wrinkled and darker at maturity, up to 50 mm in diameter; in cross section there appear to be four separate tissues, 1) a thin brown compact peridium, 2) a rigid gelatinous peridium-like layer 2-3 mm thick, 3) a thin gelatinous "filling" and 4) centripetally arranged glebal plates growing inward from the peridium. RHIZOMORPHS extending into the humus, nearly white to pale reddish below, up to 3 mm in diameter, becoming branched and extending out into a network up to 1 meter long. ODOR of ripe passion fruit when mature.

OUTER PERIDIAL LAYER (Fig. 13) compact, 175-225 µm thick, appearing to be pseudoparenchymatous in cross section, orange-brown, with cells ca. 10-60 µm in diameter, with inner cells apparently enclosing large druse-like masses of irregular colorless crystals (Fig. 14). GELATINOUS AREAS composed of septate, interwoven, rather contorted and apparently clampless hyphae 1.8-3.7 µm in diameter, with hyphae less gelatinized in the area adjacent to the peridium and the glebal masses. GLEBAL MASSES arising as ingrowths from the peridial layer, filamentous, less gelatinized than the surrounding tissues, extending one-third to two-thirds of the way to the center, giving rise to a regular hymenium of basidia internally. BASIDIA 8-spored, short-sterigmate. BASIDIOSPORES (Fig. 15) ellipsoidal, smooth, with a broad basal apiculus, Brown (7E6-8) in mass, 2.9-3.8 (mean = 3.3 ± 0.20) X 1.4-2.0 (mean = 1.70 ± 0.13) µm, with mean D/d = 1.95 ± 0.174.

MATERIAL EXAMINED: BRAZIL, Santa Catarina, Blumenau,

Figs. 1-3. Protubera africana. Fig. 1. Basidioma, redrawn from colored illustration in holotype packet. Fig. 2. Basidia. Fig. 3. Basidiospores. Figs. 4-6. Protubera borealis. Fig. 4. Basidioma, redrawn from Kobayasi (1938). Fig. 5. Basidia. Fig. 6. Basidiospores. Figs. 7-8. Protubera clathroidea. Fig. 7. Basidioma, redrawn from Dring (1964). Fig. 8. Basidiospores, redrawn from Dring (1964). Figs. 9-11. Protubera jamaicensis. Fig. 9. Basidioma, redrawn from illustration in holotype packet. Fig. 10. Basidium, probably collapsed. Fig. 11. Basidiospores. The basidiomata are X 1; the remainder X 1500.



in soil in woods, Möller, 1890. HOLOTYPE (B). ADDITIONAL MATERIAL EXAMINED BUT NOT INCLUDED IN THE ABOVE DESCRIPTION: BRAZIL: São Paulo: São Paulo, Reserva Biológica, Parque Estadual das Fontes do Ipiranga, Sales & Vital, 8.V.1961 (SP 62010); Milanez & Altimari, 27.V.1961 (SP 62033); Zago & Furtado, 23.XII.1960 (SP 62107); Guidicci, 7.VII.1965 (SP 83551); Serra da Cantareira, Picada das Jaboticabeiras, Zampieri, 13.I.1966 (SP 91082); Serra da Cantareira, Serviço Florestal do Estado, Hernandes, 13.I.1966 (SP 91083); Serra da Cantareira, Johnston, 13.I.1966 (SP 91084); Ubatuba, Estaçao Experimental do Instituto agronomico de Campinas, Hernandes, II.1966; Paranapiacaba, Estaçao Biológica do alto da Serra, Hernandes, II.1966; São Paulo, Reserva Biológica, Parque Estadual das Fontes do Ipiranga, Skvortzov, 14.VI.1967. All of the above are at the Instituto de Botanica, São Paulo (SP).

The above description may be somewhat narrow as it includes only Möller's and my observations on the type. Furtado and Dring (1967), however, presented a description of this species based on a number of additional collections from Brazil. In that paper Furtado and Dring stated that their material confirmed "in every respect" the description of Möller. However, Möller described his material as having brown basidiomata while those of Furtado and Dring were white or grayish. Since both authors seem to have observed numerous specimens it is unlikely that differences in age account for this variation. Möller's original material came from temperate forests in Santa Catarina while that of Furtado and Dring was from tropical rain forests further north; perhaps humidity or habitat has some effect on color. I have examined 10 of the specimens cited by Furtado and Dring (1967) and find that there is also a difference in spore size from the holotype. In P. maracuja the spores never exceeded 3.8 µm long while those of the Furtado and Dring material averaged 4.1 µm and could be as long as 5.1 um. Spore diameters of the two groups were approximately the same and thus the D/d ratios were 1.7-2.4 in the holotype and 1.9-2.8 in the Furtado and Dring collections. The report of 4-spored basidia in their material by Furtado and Dring seems to be in error; I found only basidia with 8 spores.

The most striking feature of P. maracuja is the presence of numerous masses of crystals in the inner peridial cells (Fig. 14). These are very large and easily seen with lower power microscope objectives. I have not observed these in any other species and believe that they may be diagnostic. In this respect it is interesting that all of the Furtado and Dring specimens examined also contained these crystals. Möller (1895) supposed these to be calcium oxalate but did not offer evidence other than to mention that they dissolved in HCl. The supposedly pseudoparenchymatous peridium in P. maracuja may also be diagnostic. All of the material of this species that I examined, including the "controversial" collections, had

this feature. It is very difficult to revive this tissue and it is quite possible that it is not truly pseudoparenchymatous. However, that is the way it appears in herbarium specimens and it is quite unlike the clearly hyphal peridia of other species.

PROTUBERA NIPPONICA Y. Kobayasi in Nakai & Honda, Novae Fl. Japan. 2:25. 1938.

<u>Kobayasia nipponica</u> (Kobayasi) Imai & Kawamura, Sci. Rep. Yokohama Nat. Univ., Sect. II, 7:5. 1958.

Figs. 16-18.

BASIDIOMATA (Fig. 16) arising from a rhizomorph, spherical to somewhat irregular in shape, somewhat wrinkled or cracked above, sulcate toward the base, white, 25-50 mm in diameter; in cross section there appear to be three separate tissues, 1) a thin compact peridium, 2) a rigid gelatinous peridium-like layer 1.0-1.5 mm thick, 3) centripetally arranged glebal plates extending inward from the peridium; the center is hollow. RHIZOMORPHS white, simple or branched. ODOR not reported.

PERIDIUM compact, 150-235 µm thick, composed of interwoven and occasionally clamped hyphae. GELATINOUS AREAS composed of loosely interwoven gelatinous hyphae 2-5 µm in diameter, very firm and rubbery near the peridium and the glebal plates and softer to almost watery elsewhere. GLEBAL MASSES arising as ingrowths of the peridium, filamentous, densely packed, extending nearly to the center of the basidiomata, giving rise to a regular hymenium of basidia internally. BASIDIA (Fig. 17) 8-spored, shortsterigmate, irregularly clavate to cylindrical or ventricose, clamped at base, 22-41 X 1.7-5.0 µm. Basidiospores (Fig. 18) narrowly ellipsoidal, smooth, with a broad basal apiculus, Olive to Olive brown (3-4EF4) in mass, 3.5-4.8 (mean = 4.0 \pm 0.24) X 1.5-2.3 (mean = 1.8 \pm 0.16) µm, with mean D/d = 2.23 \pm 0.211.

MATERIAL EXAMINED: JAPAN: Tottori Pref., Tottori-City, Kokoge, In woods of <u>Pinus densiflora</u>, <u>Nagasawa</u>, 21.IX.1976 (TMI-4250); Shimane Pref., Ochi-gun, Mizuho-cho, in forest of <u>Pinus densiflora</u>, <u>Maeda</u>, 9.X.1980 (TMI-6925).

The holotype was collected on the ground in unspecified woods in Kunitati (a western suburb of Tokyo), Honshu, Japan (Kobayasi, 1938). Additional collections were described by Imai & Kawamura (1958) from Kubokawa-City, Kochi Pref., Shikoku and Shingi, Omi Prov. (in Shiga Pref.), Honshu, Japan. It has been very well illustrated by Kobayasi (1938), Imai & Kawamura (1958) and Imazeki & Hongo (1965).

As discussed above, the most difficult species to distinguish from \underline{P} . $\underline{nipponica}$ is \underline{P} . $\underline{jamaicensis}$. The only other species of the genus reported from Japan is \underline{P} . $\underline{borealis}$, which has shorter glebal plates. Kobayasi also

distinguished the two species on the basis of the hollow center of \underline{P} . $\underline{nipponica}$ basidiomata and the fact that the glebal chambers of \underline{P} . $\underline{nipponica}$ are green in liquid preservative while those of \underline{P} . $\underline{borealis}$ are leather brown.

PROTUBERA SABULONENSIS Malloch, sp. nov.

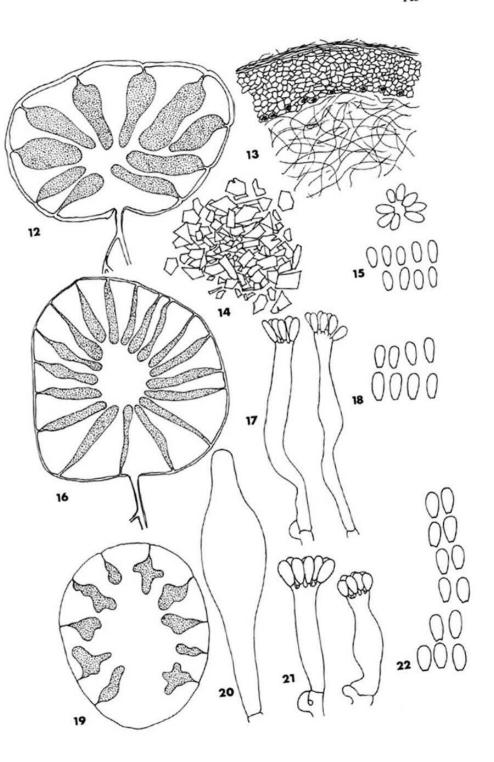
Figs. 19-24.

Basidiomata ad obovoidea irregulariter tuberoidea, ad levis araeolata, ad basem frequenter sulcata, alba, 21-64 X 10-55 mm. Peridium 16-65 µm crassum, luteobrunneum, a hyphae intertextis compositum. Trama gelatinosa, firma, a hyphae gelatinosae intertextae composita. Gleba ad peridium in laminae irregularae centripetaliter radiata, 3-15 X 1-5 mm. Basidia octospora, ad subclavata cylindracea, 16-25 X 3.9-5.0 µm. Basidiosporae leniter obovoideae, laevae, ad basim truncatae, flavobrunneae, 3.8-5.0 X 1.0-2.6 µm.

HOLOTYPUS: CANADA: Nova Scotia, Sable Island, 600 m NW of West Light, in loci aranosi a Ammophila breviligulata associata, Malloch 30.9.82/4, 30 September 1982. In herbarium cryptogamicum University of Toronto conservata.

19, 23-24) arising BASIDIOMATA (Figs. from rhizomorph, obovoid to somewhat irregular in shape, smooth to finely cracked above, often coarsely sulcate below or grooved when in contact with grass culms, dry, rubbery in texture, initially white, with surface easily discoloring when touched to reveal colors near Grayish yellow to Olive brown (4CF4) to Yellow brown (5E5), with some tints of Brownish orange (7C4) in age, 21-64 mm high, 10-55 mm broad; in cross section there appear to be three separate tissues, 1) a compact white peridium, 2) a firm gelatinous tissue filling the bulk of the basidioma, and 3) centripetally arranged glebal plates extending in from the peridium. RHIZOMORPHS white, usually branched, with peridium and gelatinous matrices continuous with those of the basidiomata, not extending into the interior of the basidiomata, extending into the substrate. ODOR of

Figs. 12-15. Protubera maracuja. Fig. 12. Basidioma, redrawn from Möller (1895). Fig. 13. Cross section of peridium showing outer hyphal layer, "pseudoparenchymatous" layer and inner gelatinous matrix; note crystalline inclusions in the inner cells of the "pseudoparenchyma". Fig. 14. Crystalline inclusion from peridial cells. Fig. 15. Basidiospores, with upper group of 8 as attached to basidium. Figs. 16-18. Protubera nipponica. Fig. 16. Basidioma, redrawn from Kobayasi (1938). Fig. 17. Basidia. Fig. 18. Basidiospores. Figs. 19-22. Protubera sabulonensis. Fig. 19. Basidioma. Fig. 20. Cystidium-like element from gelatinous matrix. Fig. 21. Basidia. Fig. 22. Basidiospores. The basidiomata are X 1, Fig. 13 is X 75 and the remainder X 1500.



overripe bananas when old.

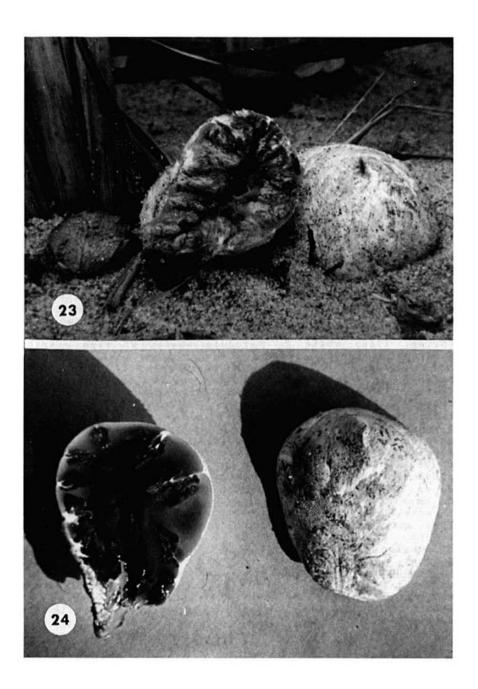
PERIDIUM 16-65 μm thick, yellowish brown, composed of parallel to somewhat interwoven, apparently clampless hyphae 1.7-6.0 um in diameter, never enclosing crystalline masses. GELATINOUS AREAS hard and rather agar-like, nearly colorless to Yellowish grey (4B2) or Olive brown (4DE4) depending upon the stage of glebal maturity, composed of hyphae that are interwoven, very loosely arranged, clampless to occasionally clamped, hyaline, and 1.3-9.0 μm in diameter, often containing oleiferous hyphae that are sometimes swollen at the ends to form cystidium-like elements (Fig. 20). GLEBAL MASSES arising from "plates" of nearly parallel and hardly gelatinous hyphae similar to those of the peridium that extend inwardly at right angles to the surface, cerebriform, composed of labyrinthine cavities lined with basidia, rather irregular in size and shape but approximately 3-15 X 1-5 mm. BASIDIA (Fig. 21) 8-spored, borne in a parallel hymenium, ventricose to subclavate, clamped at base, with short sterigmata, 16-25 X 3.9-5.0 μm. BASIDIOSPORES (Fig. 22) narrowly obovoid, smooth, truncate at the broad sterigmatal scar, inamyloid, Grayish yellow (4BC3) to Yellowish brown (5EF6) in mass when fresh, 3.8-5.0 (mean - 4.4 ± 0.22) X 1.9 - 2.6 (mean - 2.3 ± 0.14) μm, with mean D/d = 1.94 ± 0.149.

MATERIAL EXAMINED: CANADA: Nova Scotia, Sable Island, 600 m NW of West Light (UTM Grid no. 21TTU567686), scattered to gregarious in sand in dense marram community on side of sand dune in association with Ammophila breviligulata Fern., Lathyrus maritimus (L.) Bigel., and Solidago semprevirens L., Malloch 30.9.82/4, 30.IX.1982, HOLOTYPE (TRTC); 2.5 km E of West Light (UTM Grid no. 21TTU599687), in sand in small dune depression in dense marram community, Malloch 1.10.82/4, 1.X.1982 (TRTC).

 $\underline{P}.$ sabulonensis is unique among species of $\underline{Protubera}$ in having a peridium less than 70 μm thick, a very dense and agar-like gelatinous matrix, quite broad basidiospores (mean D/d < 2.0) and habitat on oceanic sand dunes. It should not be confused easily with any other species.

The habitat of <u>P</u>. <u>sabulonensis</u> is unlike that of other species, with the possible exception of <u>P</u>. <u>clathroidea</u>. Both localities were behind the crests of large barrier sand dunes densely covered with <u>Ammophila</u> <u>breviligulata</u> ("Dense Marram Community" of Freedman, Catling & Lucas, 1982). Although well covered with grasses, these sites are all very dry and have no soil other than sand. All of the basidiomata were tightly adpressed to the base of the <u>Ammophila</u> culms and were deeply grooved along the area of

Figs. 23-24. <u>Protubera sabulonensis</u>. Fig. 23. Basidiomata in sand beside culms of <u>Ammophila</u> <u>breviligulata</u>. Fig. 24. Basidiomata. Both X 1.25



contact. The rhizomorphs extended into the sand and appeared to be attached to dead and rotting culms and rhizomes. Of all species of <u>Protubera</u>, <u>P. sabulonensis</u> appears to be the most densely and uniformly gelatinous. It is likely that this extremely gelatinous nature of the basidiomata protects them against drying in the very xeric sites they occupy.

Most other species of <u>Protubera</u> occur in humus in forests; however, there is no indication that they are ectomycorrhizal. I know of no confirmed records of ectomycorrhiza formation by members of the Phallales. In addition, the occurrence of species of <u>Protubera</u> is frequently in association with trees known to form only vesicular-arbuscular mycorrhizae, such as <u>Cryptomeria japonica</u>. The roots of <u>Ammophila breviligulata</u> in the communities where <u>P. sabulonensis</u> occurred were only weakly mycorrhizal, and this appeared to be brought about by the usual aseptate VAM fungi.

The relationship of species of Protubera to the Phallales has not been disputed since the first species was described. In spite of this little has been said about odors. Most species of <u>Protubera</u> have been described as odorless. It is significant, though, that this is not entirely so: old basidiomata of \underline{P} sabulonensis smell of overripe bananas, those of \underline{P} . clathroidea smell of apples (Dring, 1964) while P. maracuja smells of ripe passion The fruity odor of P. maracuja was striking enough to Möller that he used it as the basis of his specific epithet; ie. maracujá, the local Brazilian name for passion fruit. It seems possible that these species attract and reported that insects attacked older basidiomata of \underline{P} . clathroidea and it is likely that this happens in other species but has passed unnoticed. The fact that some species have been reported as odorless may only be because the collectors smelled young basidiomata; if the fungus is attracting dispersers with these odors it will not likely do so before the spores are fully mature. It is tempting to consider <u>Protubera</u> species as dispersed by frugivorous insects while species of other Phallales attract feeders on less attractive substances. It is interesting in this regard, however, that Pilát & Usák (1958), in their discussion of Phallus impudicus L. ex Pers., state that Mutinus caninus (Huds.) Fr. has the same odor as P. impudicus and that while it is strong and offensive in the latter, M. caninus has been said by some mushroom collectors to have the odor of fruit. This suggests, at least, that the same substances may play a part in the odors of all Phallales.

KEY TO THE SPECIES OF PROTUBERA

There is much yet to be learned about the taxonomy of Protubera. Most collections have not been adequately studied in the fresh state and we thus lack information

about elongation of glebal plates and changes in the gelatinous consistency of tramal tissues. Some of the species outlined above may be based on isolated stages in development and may be synonymous with one another. In spite of this uncertainty it is possible to make some decisions about taxonomic relationships among the species and to identify, cautiously, an unknown specimen. The following key is a step in this direction.

| 1. | Peridium appearing | to be pseudoparenchymatous |
|-------|------------------------|------------------------------|
| | | often enclosing druse-like |
| | crystalline masses | in the innermost parts |
| | | P. maracuja |
| 1. | | learly composed of inter- |
| | | nts, not enclosing large |
| | | 2 |
| | , | |
| | 2. Glebal masses | apparently confluent, not |
| | | centripetally arranged |
| | ingrowths of | the peridium 3 |
| | | distinct and extending |
| | | he peridium as individual |
| | | ses 4 |
| | Process or mass | |
| 3. | Glebal mass hollow | ; basidiospores broader than |
| 7. 7. | | P. clathroidea |
| 3. | | reticulate or poroid, |
| | | Rhizopogon species; basid- |
| | | than 3µm . P. africana |
| | respectes marrower. | onen spin E. Gerronia |
| | 4. Basidiospores | 5-6 X 2.5-3.0 μm |
| | | P. brunnea |
| | 4. Basidiospores | smaller 5 |
| | | |
| 5. | Glebal masses elong | gated and extending nearly |
| | to the center of the | he basidiomata; gelatinous |
| | tissues soft to was | tery, sometimes absent at |
| | the center | |
| 5. | | ly extending more than |
| | | center of the basidiomata; |
| | | firm and present at the |
| | | turity 7 |
| | TIMES OF THE SECOND | |
| | 6. Surface slight | tly viscid; rhizomorph |
| | | l into the basidioma |
| | | P. jamaicensis |
| | | rhizomorph not extending |
| | | dioma P. nipponica |
| | Theo the basis | oroma i. mappointed |
| 7. | Peridium > 200 um | thick; gelatinous tissues |
| | | and agar-like; mean |
| | | h/width ratio > 2.0 |
| | - addition por a rouge | P. borealis |
| 7. | Peridium < 100 um | thick; gelatinous tissues |
| | hard and agar-14ke | ; mean basidiospore |
| | mare and agar. TIVE | , mean vastatospore |

length/width ratio < 2.0 P. sabulonensis

ACKNOWLEDGEMENTS

I thank Dr. E. Nagasawa for sending me representative material of the two Japanese specimens and accompanying me to the collection locality of one of them and Dr. T. Sawa for translating some Japanese texts and clarifying for me the citations of Japanese localities. I am grateful to Dr. A. R. Lock of the Canadian Wildlife Service for arranging my visit to Sable Island and to Mr. R. B. Taylor for his generous help before, during and after that visit. help of the curators of the New York Botanical Garden, the National Mycological Herbarium at Beltsville, Maryland, the Botanischer Garten und Botanisches Museum, Berlin-Dahlem and the Instituto de Botanica at Sao Paulo is gratefully This work was supported by an Operating acknowledged. Grant from the Natural Sciences and Engineering Research Council of Canada.

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NOTES ON CLAVARIADELPHUS. III. NEW AND NOTEWORTHY SPECIES FROM NORTH AMERICA 1

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SUMMARY

Clavariadelphus americanus is proposed as an autonomous taxon based on Clavariadelphus pistillaris var. americanus. It is redescribed and a neotype specimen designated. Four new species from North America, C. caespitosus, C. flavidus, C. occidentalis, and C. pallido-incarnatus are described and illustrated.

Although Clavariadelphus Donk (1933) has been treated in several publications (Corner, 1950, 1970; Wells & Kempton, 1968; Smith, 1971; Petersen, 1972; Petersen et al., 1974), delimitation of infrageneric taxa in North America has proven difficult in many cases. considerable part of the problem is the result of poor documentation of subtle variations in basidiocarp color, size, shape, growth habit, and micromorphological structures. Additionally, there has been a tendency for systematists to categorize collections of Clavariadelphus into three widely, often misapplied, epithets, C. ligula (Schaeff.: Fr.) Donk, C. pistillaris (L.: Fr.) Donk, and C. truncatus (Quel.) Donk. Lack of type specimens for certain taxa, including the three listed above, has further compounded the confusion surrounding the taxonomic and nomenclatural limits of infrageneric taxa in North America.

¹This work represents a portion of a dissertation submitted to the Graduate School of The University of Tennessee, Knoxville, in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

During an examination of material collected by the author, and dried specimens from cooperating herbaria, some new taxa were recognized and are described herein. Additionally, <u>C. americanus</u>, recognized as an autonomous taxon based on <u>C. pistillaris</u> var. <u>americanus</u> Corner, is redescribed and a neotype specimen designated.

Microscopic features are described from sections revived in 95% ethanol and water, then mounted in 3% KOH, Melzer's reagent or cotton blue. Measurements were made in 3% KOH. Colors terms followed by alphanumeric designations are from Kornerup and Wanscher (1978), those from Ridgway (1912) are bracketed by quotation marks. Recipes for macrochemicals may be found in Marr and Stuntz (1973), Marr (1979), and Singer (1986), and abbreviations are as follows: KOH = 3% potassium hydroxide; FeCl₃ = 10% ferric chloride; EtOH = 95% ethanol; Melzer's = Melzer's reagent; PCR = p-cresol; PYR = pyrogallol; SYR = syringaldazine; TYR = 1-tyrosine; GUA = guaiac tincture; PHN = phenol; NH4OH = 10% ammonium hydroxide; NAP = 1-naphthol; ANO = aniline oil.

Abbreviations used in citation of basidiospore size are as follows: L = mean length; W = mean width; E = length/width ratio; E = mean of E. Herbarium acronyms are from Holmgren et al. (1981) except for the following individuals who lent specimens from their private herbaria: Wm. Bridge Cooke -- Herbarium of Wm. Bridge Cooke (= WBC); P. E. Kempton -- Wells and Kempton Herbarium (= WK); Clark L. Ovrebo -- Herbarium of Clark L. Ovrebo (= CLO).

Clavariadelphus americanus (Corner) Methven, stat. nov. Figs. 1,3-5

- = Clavariadelphus pistillaris var. americanus Corner. 1950. Ann. Bot. Mem. 1: 692.
- = <u>Clavaria pistillaris</u> var. <u>americana</u> (Corner) Leathers. 1955. The genus <u>Clavaria Fries</u> in Michigan. Ph.D. dissertation (ined.), <u>University</u> of Michigan, Ann Arbor. 344 pp.

NEOTYPE (des. mihi.): TENN: United States, Massachusetts, Berkshire Co., White Oaks Road, vicinity of Williamstown, 16 Aug 1986, legit A. S. Methven No. 4724 (TENN 47403).

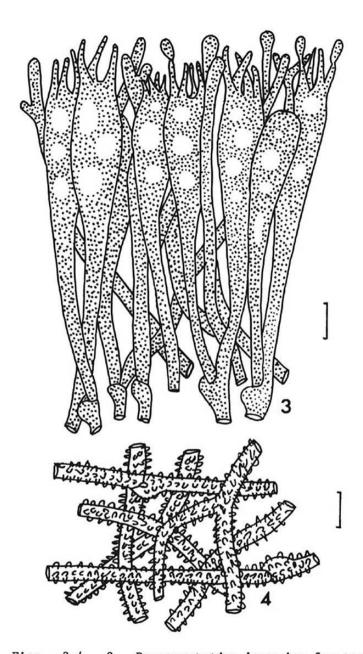


Figs. 1-2. 1. Basidiocarps of <u>Clavariadelphus</u> americanus (Methven 4715). x 1/2. 2. Basidiocarps of <u>Clavariadelphus</u> caespitosus (TENN 34744). x 3/4.

BASIDIOCARP 3-15 cm high, inserted 1-4 cm in the substrate, 3-12 mm diam basally, up to 30 mm diam apically, simple, initially subcylindric to narrowly clavate, enlarged upward in age, then clavate to broadly clavate; mycelial hyphae interwoven or aggregated into rhizomorphic strands up to 1 mm diam, off-white to pallid; base terete, smooth, pruinose, white or pallid where covered, otherwise yellowish white (4A2) to orange white (5A2), "light ochraceous-buff," "pale ochraceous-buff," "pale pinkish buff"; hymenium initially smooth, longitudinally rugose to rugulose in age, initially pale orange (5A3-2) to greyish orange (5B4-3), "light ochraceous-buff," "pale ochraceous-buff," "cartridge buff," "light buff," "pinkish buff," then brownish orange (6C6-4), "cinnamon-rufous," "cinnamon buff," "cinnamon, "orange-cinnamon," finally light brown (7D6-4) to brown (7E6-4), "mikado brown," "verona brown," "fawn color," "army brown": apex obtuse to broadly rounded, smooth, more or less concolorous with the hymenium; surface staining slowly, irregularly brown (6E6-4, 7E6-4) to dark brown (7F6-4), "verona brown," "mikado brown," "mar's brown," "russet" where cut or bruised, staining more conspicuously downward; flesh initially solid, becoming soft and spongy upward as the apex enlarges, white to pallid, on exposure staining slowly, irregularly brown (6E6-4, 7E6-4) to dark brown (7F6-4), "verona brown," "russet," "mar's brown," "mikado brown". ODOR AND TASTE not distinctive.

MACROCHEMICAL REACTIONS: FeCl₃, FeCl₃ + EtOH, ANO, PYR, PHN, GUA, PCR, SYR = positive; KOH, NH₄OH, TYR = negative.

MYCELIAL HYPHAE 2.5-5 µm diam, branched, clamped, uninflated; walls thin or irregularly thickened to 1 µm, hyaline in KOH, refractive under phase contrast, smooth, echinate or echinulate; projections up to 1 µm high, hyaline, insoluble in KOH, refractive under phase contrast, acyanophilous; clamps uninflated or inflated (-8 µm), sometimes medallion or ampulliform; hyphal contents amorphous, hyaline in KOH. TRAMAL HYPHAE 4-12 µm diam, more or less parallel to longitudinally interwoven basally, more loosely interwoven upward, radially interwoven beneath the subhymenium, uninflated, inflated (-16 µm) or broadly undulate, branched, clamped; walls thin or irregularly thickened to 1 µm diam, hyaline in KOH, refractive under phase contrast, smooth; clamps uninflated or inflated (-16 µm), sometimes medallion or



Figs. 3-4. 3. Representative hymenium for taxa of Clavariadelphus: basidia and leptocystidia.

4. Representative mycelial hyphae for taxa of subg. Clavariadelphus sect. Clavariadelphus. Scale bars = 10 µm.

ampulliform; hyphal contents amorphous, hyaline in KOH. GLOEOPLEROUS HYPHAE 2.5-5 µm diam, arising from generative hyphae at clamp connections, scattered throughout the trama, more abundant downward, uninflated, inflated (-8 µm) or strangulated, branched, clamped; walls thin, hyaline in KOH, smooth; clamps uninflated or inflated (-8 µm), sometimes medallion or ampulliform; hyphal contents amorphous, subopalescent, yellow in KOH, refractive under phase contrast, cyanophilous. SUBHYMENIUM rudimentary; hyphae 2.5-5 um diam, interwoven, branched, clamped, uninflated; walls thin, hyaline in KOH, smooth; clamps uninflated; hyphal contents amorphous, hyaline in KOH. HYMENIUM thickening, extending from near the base of the basidiocarp over the apex, composed of basidia and leptocystidia: LEPTOCYSTIDIA 55-80 x 2.5-5.5 um, scattered among and scarcely projecting beyond the basidia, cylindric, subcylindric or strangulated, inflated apically at maturity, then narrowly clavate, at times apically or subapically branched, clamped; walls thin, hyaline in KOH, smooth; clamps uninflated; hyphal contents amorphous, pale yellow in KOH, acyanophilous: BASIDIA 60-110 x 8-12.5 µm, narrowly clavate to clavate, inflated apically at maturity, then broadly clavate, clamped; walls thin or irregularly thickened, hyaline in KOH, smooth: clamps uninflated; basidial contents multiguttulate and refringent to aguttulate and amorphous, pale yellow in KOH; sterigmata (2) -4, 7-9.5 µm long, broadest basally, narrowed to an obtuse apex, incurved. BASIDIOSPORES white in deposit, $8-12 \times 4.5-6.5 \mu m$ (L = $9.6 \mu m$; W = $5.2 \mu m$; E = 1.6-2.1; E = 1.8); broadly ovate to amygdaliform; walls thin, hyaline in KOH, smooth; contents multiguttulate and refringent to aguttulate and amorphous, pale yellow in KOH; acyanophilous, inamyloid; hilar appendage oblique with an obtuse apex.

HABIT, HABITAT, AND DISTRIBUTION: Scattered to gregarious, less commonly in caespitose clusters; terrestrial; duff; mixed coniferous-deciduous forests in association with Quercus and Pinus, eastern North America: Illinois, Maine, Massachusetts, Michigan, Minnesota, New York, North Carolina, Nova Scotia, Ohio, Ontario, Pennsylvania, Tennessee, Vermont, and Wisconsin.

SPECIMENS EXAMINED: CANADA. NOVA SCOTIA. Kings Co.: Kentville Research Station Ravine, 4 Aug 1973, Harrison No. 12137 (ut <u>Clavariadelphus pistillaris</u>) (MICH). Colchester Co.: Upper Brookside, 27 Aug 1931,

Smith No. 1417 (ut Clavaria pistillaris); Folleigh Lake, 29 Aug 1931, Wehmeyer No. 1417a, (ut Clavaria pistillaris). ONTARIO. Haliburton Co.: Wren Lake, 20 Sep 1984, Methven No. 3248 (TENN). Nipissing Co.: Algonquin Provincial Park, 21 Sept 1984, Methven Nos. 3256, 3257 (TENN). UNITED STATES. ILLINOIS. Jackson Co.: Lake Murpheysboro State Park, 7 Nov 1984, Methven No. 3587 (TENN). MAINE. Aroostook Co.: Near Madawaska Lake, 18 Aug 1956, Bigelow No. 4095 (ut Clavariadelphus pistillaris) (MICH). Hancock Co.: Acadia National Park, Mt. Desert Island, 1935, Morse s. n. (ut Clavariadelphus pistillaris) (TENN 31518). MASSACHUSETTS. Berkshire Co.: Oblong Road, vicinity North Adams, 15 Aug 1986, Methven No. 4715 (TENN); White Oaks Road, vicinity Williamstown, 16 Aug 1986, Methven No. 4724 (TENN 47403) [NEOTYPE]. MICHIGAN. Emmet Co.: Pellston Hills, 25 Aug 1956, Thiers No. 4394 (ut Clavariadelphus pistillaris) (MICH). Gratiot Co.: Ithaca, 15 Sep 1961, Potter No. 13146 (MICH). Jackson Co.: Clear Lake, 13 Aug 1960, Shaffer No. 2604 (ut Clavariadelphus pistillaris) (MICH). Marquette Co.: Canyon Lake Bay, 4 Sep 1970, Harrison No. 9614 (ut Clavariadelphus pistillaris) (MICH). Oakland Co.: Road, 12 Aug 1937, Smith No. 7012 (ut Clavaria pistillaris) (MICH; NCU); Haven Hill, Highland Recreation Area, 20 Sep 1972, Weber No. 3723 (ut Clavariadelphus pistillaris) (MICH); New Hudson, 26 Aug 1937, Smith No. 7302 (ut Clavaria pistillaris) (MICH; NCU); Haven Hill, 16 Sep 1961, Smith No. 64300 (ut Clavariadelphus pistillaris) (MICH); Horner Hill, 25 Sep 1975, Smith No. 86661 (ut Clavariadelphus pistillaris var. americanus) (MICH). Ostego Co.: Vanderbilt, Pigeon River, Red Bridge, 10 Aug 1969, Smith No. 77794 (ut Clavariadelphus pistillaris) (MICH). Presque Isle Co.: Little Presque Isle Point, 28 Aug 1978, Ovrebo No. 634 (CLO). Washtenaw Co.: Ann Arbor, Horner Woods, 1 Aug 1973, Smith No. 84324 (ut Clavariadelphus pistillaris) (MICH); South of Highland Lake, 2 Oct 1970, Weber No. 3768 (ut Clavariadelphus pistillaris) (MICH); Waterloo, Bush Road Trail, 2 Aug 1973, Nimke No. 401 (ut Clavariadelphus pistillaris) (MICH). MINNESOTA. Rice Co.: Wheeling Township, Nerstrand Woods State Park, 24 Jul 1962, Weaver No. 7-24-62-N-1 (ut Clavariadelphus pistillaris f. americanus) (MICH; TENN 33669). NEW YORK. Washington Co.: Vaughns, 11 Aug 1915, Burnham No. 68 (ut <u>Clavaria</u> <u>pistillaris</u>) (NCU); Vaughns, 2 Sep 1917, Burnham No. 139 (ut Clavaria pistillaris) (NCU). NORTH CAROLINA. Macon Co.: Highlands, 10 Sep 1971, Harrison No. 11093 (ut

Clavariadelphus pistillaris) (MICH); Horse Cove, Jul 1964, No. 31411 (ut Clavariadelphus pistillaris) (TENN); Cliffside Lake, 2 Sep 1986, Desjardin No. 4101 (TENN): Highlands, 30 Aug 1932, No. 9599 (ut Clavaria pistillaris) (NCU). Orange Co.: Vicinity of Ginghaul Castle, 22 Oct 1947, No. 14321 (ut Clavaria pistillaris) (NCU); Chapel Hill, Battle's Branch, near Indian Springs, 21 Oct 1915, No. 1913 (ut Clavaria unicolor) (NCU); Chapel Hill, Battle Park, 20-23 Sep 1945, No. 13933 (ut Clavaria unicolor) (NCU); Chapel Hill, Battle Park, 24 Sep 1945, No. 13920 (ut Clavaria pistillaris var. unicolor) (NCU); Chapel Hill, Battle Park, 26 Sep 1945, No. 13950 (ut Clavaria pistillaris var. unicolor) (NCU); Chapel Hill, Meeting of Waters, 26 Sep 1945, No. 13951 (ut Clavaria pistillaris var. unicolor) (NCU); Chapel Hill, Meeting of Waters, 28 Sep 1945, No. 13960, (ut Clavaria pistillaris var. unicolor) (NCU); Chapel Hill, Meeting of Waters, 3 Oct 1945, No. 13995 (ut Clavaria pistillaris var. unicolor) (NCU); Chapel Hill, Mason Farm, 25 Oct 1946, No. 14068 (ut Clavaria pistillaris) (NCU); Chapel Hill, New Hope Creek Farm, 24 Oct 1947, No. 14324 (ut Clavaria pistillaris) (NCU). Swain Co.: Almond, 21 Sep 1971, Harrison Nos. 11233, 11234, 11235 (ut Clavariadelphus pistillaris) (MICH). Transylvania Co.: Pisgah National Forest, White Pines Campground, 13 Sep 1966, No. 32337 (ut Clavariadelphus pistillaris) (TENN). OHIO. Hamilton Co.: Miami-Whitewater Forest Park, Timberlakes Area, 2 Oct 1965, Cooke No. 36192 (ut Clavariadelphus pistillaris) (WBC: TENN 32445). Pike Co.: Pike Lake State Park, 23 Sep 1973, Cooke No. 48742 (WBC; TENN 47398). PENNSYLVANIA. Chester Co.: West Chester, Sep-Oct, 1887, North American Flora, Second Series No. 1922b (ut Craterellus pistillaris) (PAD). TENNESSEE. Blount Co.: Nales Creek, 26 Sep 1959, No. 22939 (ut Clavaria pistillaris) (TENN). Knox Co.: Ball Camp Pike, 6 Oct 1934, No. 6542 (ut Clavaria pistillaris) (TENN); Ball Camp Pike, 9 Oct 1934, No. 6543 (ut Clavaria pistillaris) (TENN). VERMONT. Windham Co.: Grafton State Forest, 30 Aug 1961, Shaffer No. 3510 (ut Clavariadelphus pistillaris) (MICH). WISCONSIN. Dane Co.: Blue Mounds, Aug 1903, No. 162 (ut Clavaria pistillaris) (NCU).

Corner (1950) described <u>C</u>. <u>pistillaris</u> var. <u>americanus</u> from frondose wood in eastern North America. Although Corner (1950) published a Latin diagnosis for var. <u>americanus</u> he did not designate a type specimen having examined no North American specimens at the time.

Instead, Corner based his variety on previous literature reports of <u>C</u>. <u>pistillaris</u> in North America, noting that it differed "in colour, form, and small spores from the European species."

In an attempt to bring order to the taxa similar to C. pistillaris in North America, Wells and Kempton (1968) proposed C. cokeri based on "Coker's excellent notes, the good spore deposit, Miss Eaton's fine illustration (Coker, 1932 [sic], P1. 23)" and Coker's specimen (No. R 27, NCU). Wells and Kempton (1968) did not include Corner's var. americanus in their preliminary study of Clavariadelphus in North America, concluding that var. americanus was "based on literature" and because "we have seen no specimens which could be referred to it." Corner (1970), in a critical rebuttal, noted that Wells and Kempton dismissed "Coker's contribution and discarded the idea of var. americanus because it was based on literature and because they had seen no specimens which could be referred to it." Corner (1970) went on to say that var. americanus was based "not on literature (? belles lettres) but on the scientific researches of Harper, Coker, and Wehmeyer by direct citation and of Burt and Doty by reference in my Table XXI (Monogr. p. 282)." In Corner's own words then, his protologue (Corner, 1950) for var. americanus was taken from literature and in no part from specimens he had examined. After examining the collections for which Corner (1950) cited spore measurements in Table XXI, I found them to be representative of several discrete taxa. Coker's specimen from Connecticut (No. R 27, NCU) is the holotype of C. cokeri Wells and Kempton, Wehmeyer's collections (Smith 1417, Wehmeyer 1417a, MICH) are C. americanus, Doty's specimens are C. occidentalis, two of Coker's collections cited from New York (Burnham 68, 71, NCU) are C. americanus and C. truncatus, respectively, and Coker's collections from North Carolina are <u>C. americanus</u> (Nos. 1913, 3793, NCU) and <u>C. unicolor</u> (No. 4770, NCU). It is little wonder, then, that Wells and Kempton were confused by Corner's concept of var. americanus.

Following an examination of specimens labeled as C. pistillaris from eastern North America I believe one element of Corner's conglomerate taxon is more accurately recognized as autonomous. In order to provide maximum taxonomic data, one of my collections has been selected as a neotype for this taxon. Although the basidiocarps of C. americanus are similar in coloration to those of C. pistillaris, they are generally not as robust, the flesh

has a sweet or nondistinctive taste, the basidiospores are smaller (10.5-14 x 6-7.5 μm for C. pistillaris), and it grows in mixed deciduous-coniferous forests in association with Pinus and Quercus.

In eastern North America, C. americanus is most likely to be confused with C. cokeri and C. flavidus. Clavariadelphus cokeri is distinct in its caespitose to fasciculate growth habit in hemlock forests, pinkish buff to rose pink basidiocarps, which are at times branched apically, and longer, narrower basidiospores (L = 10.3 μ m; W = 4.4 μ m). Clavariadelphus flavidus occurs in mixed coniferous-deciduous forests, produces bright yellow to lemon yellow basidiocarps, flesh without a distinctive taste, and the smallest basidiospores in subg. Clavariadelphus (7-10.5 x 4.5-5.5 μ m).

In cases where the apex of the basidiocarp has been damaged during development, and becomes more or less truncate or turbinate as a result, C. americanus might be confused with C. unicolor (Rav. apud Berk.) Corner, which is found in similar habitats. Clavariadelphus unicolor is distinct, however, by its violet-brown to lavender-brown basidiocarps which become truncate early in development, often appearing cantharelloid or craterelloid at maturity, and longer, narrower basidiospores (L = 10.3 µm; W = 5.0 µm). As long as several basidiocarps at different stages of development are available, there is little problem in segregating these two taxa.

Clavariadelphus caespitosus Methven, sp. nov. Figs. 2, 6

Receptaculum ad 15 cm altum, apice 5-15 mm latum, simplex, fusiforme vel clavatum; apex subacutus, laevis vel rugosus; hymenium laeve vel rugosum, juventute cinnamomeum, maturitate ferrugineum vel castaneum; caro spongiosa, albida, brunnescens; odor et sapor nullus; sporae 8-11.5 x 4.5-6.5 μ m (L = 9.8 μ m; W = 5.6 μ m; E = 1.7-1.9; E = 1.8); late ovatae vel amygdaliformes, laeves, albae; hyphae monomiticae, intertextae, fibulatae. Gregaria vel cespitosa ad terram in sylvis coniferis Americae borealis occidentalis.

HOLOTYPUS: TENN: United States, Idaho, Bonner Co., Upper Priest River, 21 Sep 1968, legit A. H. Smith s. n. (TENN 33983).

BASIDIOCARP 3-15 cm high, 3-15 (20) mm diam apically, simple, intially subcylindric, enlarged upward in age, then fusiform to clavate; base terete, pruinose, orange white (5A2, 6A2), "pale ochraceous salmon," "buff-pink," "seashell pink"; hymenium initially smooth, longitudinally rugose to rugulose in age, initially greyish red (7B3-2) to dull red (8C3-2), "cinnamon buff," "cinnamon," "japan rose," "vinaceous-buff," "light vinaceous-fawn," finally reddish brown (8D5-4), "mikado brown," "cacao brown," "fawn-color," "vinaceous-russet"; apex subacute to narrowly obtuse, remaining more or less pointed throughout development, smooth, concolorous with the hymenium; surface staining slowly, irregularly brown (6E6-4, 7E6-4) to dark brown (7F6-4), "verona brown," "mikado brown," "russet," "mar's brown" where cut or bruised, staining more conspicuously downward; flesh initially solid, becoming soft and spongy upward as the apex enlarges, white to pallid, on exposure staining slowly, irregularly brown (6E6-4, 7E6-4) to dark brown (7F6-4), "verona brown," "mikado brown," "russet," "mar's brown". ODOR not distinctive. TASTE not distinctive or slightly bitter.

MACROCHEMICAL REACTIONS: FeCl₃, FeCl₃ + EtOH, NAP, ANO, PYR, PHN, GUA = positive; KOH = yellow to golden yellow; NH4OH = negative.

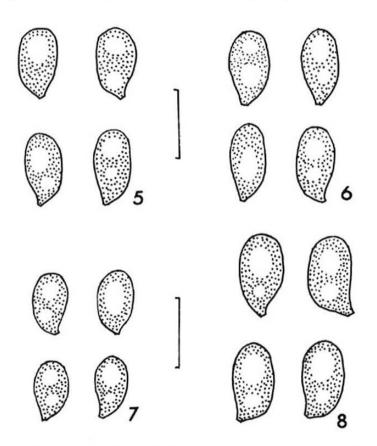
MYCELIAL HYPHAE 2.5-4 µm diam, branched, clamped, uninflated; walls thin or irregularly thickened to 1 µm, hyaline in KOH, refractive under phase contrast, smooth, echinate or echinulate; projections up to 1 µm high, hyaline, insoluble in KOH, refractive under phase contrast, acyanophilous; clamps uninflated or inflated (-12 µm), sometimes medallion or ampulliform; hyphal contents amorphous, hyaline in KOH. TRAMAL HYPHAE 3-12 µm diam, more or less parallel to longitudinally interwoven basally, more loosely interwoven upward, radially interwoven beneath the subhymenium, uninflated, inflated (-16 µm) or broadly undulate, branched, clamped; walls thin or irregularly thickened to 1 µm, hyaline in KOH, refractive under phase contrast, smooth; clamps uninflated or inflated (-16 µm), sometimes medallion or ampulliform; hyphal contents amorphous, hyaline in KOH. GLOEOPLEROUS HYPHAE 2.5-6.5 µm diam, arising from generative hyphae at clamp connections, scattered throughout the trama, more abundant downward, uninflated, inflated (-9.5 μm) or strangulated, branched, clamped; walls thin, hyaline in KOH, smooth; clamps uninflated or inflated (-12 μm),

sometimes medallion or ampulliform; hyphal contents subopalescent, yellow in KOH, refractive under phase contrast, cyanophilous. SUBHYMENIUM rudimentary; hyphae 2.5-5 µm diam, interwoven, branched, clamped, uninflated; walls thin, hyaline in KOH, smooth; clamps uninflated; hyphal contents amorphous, hyaline in KOH. thickening, extending from near the base of the basidiocarp over the apex, composed of basidia and leptocystidia: LEPTOCYSTIDIA 65-125 x 2.5-5 µm, scattered among and scarcely projecting beyond the basidia, cylindric, subcylindric or strangulated, inflated apically at maturity, then narrowly clavate, at times apically or subapically branched, clamped; walls thin, hyaline in KOH, smooth; clamps uninflated; contents amorphous, pale yellow in KOH, acyanophilous: BASIDIA 70-125 x 8-13.5 um, narrowly clavate to clavate, inflated apically at maturity, then broadly clavate, clamped; walls thin or irregularly thickened, hyaline in KOH, smooth; clamps uninflated; basidial contents multiguttulate and refringent to aguttulate and amorphous, pale yellow in KOH; sterigmata (2) -4, 7-11 µm long, broadest basally, narrowed to an obtuse apex, incurved. BASIDIOSPORES white in deposit, 8-11.5 x 4.5-6.5 μ m (L = 9.8 μ m; W = 5.6 μ m; E = 1.7-1.9; E = 1.8); broadly ovate to amygdaliform; walls thin, hyaline in KOH, smooth; contents multiguttulate and refringent to aguttulate and amorphous, pale yellow in KOH; acyanophilous, inamyloid; hilar appendage oblique with an obtuse apex.

HABIT, HABITAT, AND DISTRIBUTION: Gregarious, densely gregarious or caespitosus clusters; terrestrial; duff; coniferous or mixed coniferous-deciduous forests; California, Idaho, Oregon, and Washington.

SPECIMENS EXAMINED: UNITED STATES. CALIFORNIA. Del Norte Co.: Jedediah Smith Redwoods National Park, 11 Sep 1967, No. 33193 (ut Clavariadelphus pistillaris) (TENN). Humboldt Co.: Fickel Hill, 14 Sep 1984, Saylor No. 2184 (SFSU). Mendocino Co.: Jackson State Forest, 23 Nov 1985, Methven No. 4396 (TENN). Yuba Co.: Bullard's Bar Recreation Area, Schoolhouse Campground, 15 Dec 1983, Methven No. 2681 (TENN). IDAHO. Bonner Co.: Upper Priest River, 4 Oct 1970, No. 34685 (TENN); Priest Lake, 2 Oct 1966, No. 31954 (TENN); Priest Lake, 28 Sep 1968, Smith No. 76695 (MICH); Priest River, 19 Sep 1968, No. 33937 (TENN); Upper Priest River, 21 Sep 1968, Smith s. n. (TENN 33983) [HOLOTYPE]; Priest Lake, 29 Sep 1968, Smith

No. 76727 (MICH); Upper Priest River, 19 Sep 1968, Smith No. 76548 (MICH); Upper Priest River, 25 Sep 1968, Smith No. 76667 (MICH; TENN 47399). Kootenai Co.: Couer d'Alene, 7 Oct 1970, Nos. 34724, 34644 (TENN); Couer d'Alene National Forest, Deception Creek Experimental Forest, 22 Sep 1969, Smith no. 70662 (ut Clavariadelphus ligulus) (MICH). OREGON. Clackamas Co.: Mt Hood National Forest, 20 Oct 1984, Methven Nos. 3519, 3520 (TENN). WASHINGTON. Pierce Co.: Mt Rainier National Park, 15 Oct 1984, Methven No. 3540 (TENN).



Figs. 5-8. 5. Basidiospores of Clavariadelphus
americanus (TENN 47403, Neotype). 6. Basidiospores of
Clavariadelphus caespitosus (TENN 33983, Holotype).

7. Basidiospores of Clavariadelphus flavidus (TENN 47401,
Holotype). 8. Basidiospores of Clavariadelphus
occidentalis (TENN 47402, Holotype). Scale bars = 10 µm.

Clavariadelphus caespitosus is one of several taxa within sect. Clavariadelphus passing under the name C. pistillaris sensu lato. Clavariadelphus caespitosus is, however, quite distinct from that taxon by its slender, narrowly clavate, greyish red to dull red basidiocarps with subacute apices, caespitose growth habit in coniferous or mixed coniferous-deciduous forests, and smaller basidiospores (10.5-14 x 6-7.5 µm for C. pistillaris). In western North America C. caespitosus might be confused with C. subfastigiatus or C. fasciculatus Methven and Guzman. Clavariadelphus subfastigiatus differs in its pallid flesh-color to light cinnamon basidiocarps with obtuse apices, forest green staining reaction with KOH, scattered to gregarious growth habit in coniferous forests, and smaller basidiospores (8-10.5 x 5-6 µm). Clavariadelphus fasciculatus, known at this writing only from central Mexico, is distinct by the strongly fasciculate growth habit of its basidiocarps, larger basidiospores (11-14 x 5-7 µm), and acerose- to acicular-shaped crystals encrusting the walls of the mycelial hyphae.

Clavariadelphus flavidus Methven, sp. nov.

Fig. 7

Receptaculum 10-15 cm altum, apice 10-12 mm latum, simplex, cylindricum vel anguste clavatum; apex subacutus vel obtusus, laevis; hymenium laeve vel rugosum, laete aureum vel flavidum; caro spongiosa, albida, brunnescens; odor nullus, sapor amarus; sporae 7-10.5 x 4.5-5.5 μ m (L = 8.4 μ m; W = 5.0 μ m; E = 1.4-2.0; E = 1.7); late ovatae vel amygdaliformes, laeves, albae; hyphae monomiticae, intertextae, fibulatae. Sparsa ad terram in sylvis frondosis-coniferis Americae borealis orientalis.

HOLOTYPUS: TENN: United States, Massachusetts, Berkshire Co., Williamstown Reservoir, 14 Aug 1986, legit A. S. Methven No. 4714 (TENN 47401).

BASIDIOCARP 10-15 cm high, 10-12 mm diam apically, simple, cylindric to narrowly clavate; mycelial hyphae interwoven or aggregated into rhizomorphic strands up to 1 mm diam, white to pallid; base terete, smooth, pruinose, off-white to pale cream; hymenium intially smooth, longitudinally rugulose in age, yellow (3A7-6) to yellowish orange (4A7-5), "apricot yellow," "light orange yellow," "light cadmium," "primuline yellow"; apex

subacute to obtuse, smooth, concolorous with the hymenium; surface staining slowly, irregularly brown (6E5-4, 7E5-4) to dark brown (7F5-4), "rood's brown," "vandyke brown," "army brown," "natal brown," "bone brown" where cut or bruised, staining more conspicuously downward; flesh initially solid, becoming soft and spongy upward as the apex enlarges, white to pallid, on exposure staining slowly, irregularly brown (6E5-4, 7E5-4) to dark brown (7F5-4), "rood's brown," "vandyke brown," "army brown," "natal brown," "bone brown". ODOR not distinctive. TASTE bitter.

MACROCHEMICAL REACTIONS: FeC1₃, FeC1₃ + EtOH, PCR, PHN, PYR, ANO, GUA, SYR = positive; KOH, NH4OH, NAP, TYR = negative.

MYCELIAL HYPHAE 2.5-5 um diam, branched, clamped, uninflated; walls thin or irregularly thickened to 1 um, hyaline in KOH, refractive under phase contrast, smooth, echinate or echinulate; projections up to 0.5 µm high, hyaline, insoluble in KOH, acyanophilous; clamps uninflated or inflated (-12 um), sometimes medallion or ampulliform; hyphal contents amorphous, hyaline in KOH. TRAMAL HYPHAE 3-9.5 jum diam, more or less parallel to longitudinally interwoven basally, more loosely interwoven upward, radially interwoven beneath the subhymenium, uninflated, inflated (-12 um) or broadly undulate, branched, clamped; walls thin or irregularly thickened to 1 um, hyaline in KOH, refractive under phase contrast, smooth; clamps uninflated or inflated (-16 µm), sometimes medallion or ampulliform; hyphal contents amorphous, hyaline in KOH. GLOEOPLEROUS HYPHAE 3-5 um diam, arising from generative hyphae at clamp connections, scattered throughout the trama, more abundant downward, uninflated, inflated (-9.5 µm) or strangulated, branched, clamped; walls thin, hyaline in KOH, smooth; clamps uninflated or inflated (-8 µm), sometimes medallion or ampulliform; hyphal contents subopalescent, yellow in KOH, refractive under phase contrast, cyanophilous. SUBHYMENIUM rudimentary; hyphae 2.5-5 µm diam, interwoven, branched, clamped, uninflated; walls thin, hyaline in KOH, smooth; clamps uninflated; hyphal contents amorphous, hyaline in HYMENIUM thickening, extending from near the base of the basidiocarp over the apex, composed of basidia and leptocystidia: LEPTOCYSTIDIA 50-80 x 2.5-4 µm, scattered among and scarcely projecting beyond the basidia, cylindric, subcylindric or strangulated, inflated apically

at maturity, then narrowly clavate, at times apically or subapically branched, clamped; walls thin, hyaline in KOH, smooth; clamps uninflated; hyphal contents amorphous, pale yellow in KOH, acyanophilous: BASIDIA 80-105 x 8-11 µm, narrowly clavate to clavate, inflated apically at maturity, then broadly clavate, clamped; walls thin or irregularly thickened, hyaline in KOH, smooth; clamps uninflated; basidial contents multiguttulate and refringent to aguttulate and amorphous, pale yellow in KOH; sterigmata (1,2,3) -4, 8-11 µm long, broadest basally, narrowed to obtuse apex, incurved. BASIDIOSPORES white in deposit, 7-10.5 x 4.5-5.5 μ m (L_m = 8.4 μ m; $W_{\perp} = 5.0 \, \mu \text{m}$; E = 1.4-2.0; $E_{\perp} = 1.7$); broadly ovate to amygdaliform; walls thin, hyaline in KOH; contents multiguttulate and refringent to aguttulate and amorphous, pale yellow in KOH; acyanophilous, inamyloid; hilar appendage oblique with an obtuse apex.

HABIT, HABITAT, AND DISTRIBUTION: Solitary or scattered; terrestrial; duff; mixed deciduous-coniferous forests under Larix, Picea, Betula, Populus, Tilia, and Pinus; Massachusetts.

SPECIMENS EXAMINED: UNITED STATES. MASSACHUSETTS. Berkshire Co.: Williamstown Reservoir, 14 Aug 1986, Methven No. 4714 (TENN 47401) [HOLOTYPE].

The hymenium extending from near the base of the basidiocarp over the apex, mycelial hyphae in which the walls are echinate or echinulate, and the broadly ovate to amygdaliform basidiospores with an Em < 2.0 indicate that C. flavidus is best placed in subg. Clavariadelphus sect. Clavariadelphus. In North America there are several taxa within sect. Clavariadelphus with which C. flavidus might be confused, including C. occidentalis, C. pistillaris, and C. americanus. Although Clavariadelphus americanus shares similar habitats with C. flavidus in mixed coniferous-deciduous forests in eastern North America, its larger, more robust, pale ochraceous basidiocarps which darken to cinnamon brown in age, and longer, broader basidiospores (L = $9.6 \mu m$; W = $5.2 \mu m$) are distinctive. Clavariadelphus pistillaris differs in its more robust, clavate, pale ochraceous basidiocarps which darken to cinnamon brown or fawn brown in age, larger basidiospores (10.5-14 x 6-7.5 µm), and habitat in deciduous forests in association with Fagus. Clavariadelphus occidentalis, which, as far as is known, is restricted to western North

America, exhibits more robust, pale yellow basidiocarps which darken to greyish orange in age, larger basidiospores (9-13.5 x 5.5-7 μm), and mild tasting flesh.

Among the European taxa included in sect.

Clavariadelphus, C. flavo-immaturus Petersen and C.

xanthocephalus Rahm & Schild are similiar to, yet distinct from, C. flavidus. Clavariadelphus flavo-immaturus features more robust, clavate basidiocarps, larger basidiospores (11-13.5 x 5.5-7 µm), and an orange staining reaction with KOH. Clavariadelphus xanthocephalus exhibits larger, more robust, turbinate or capitate basidiocarps, larger basidiospores (9.5-12 x 4.5-6 µm), and is not reactive with KOH.

In the field, <u>C</u>. <u>flavidus</u> might also be confused with <u>C</u>. <u>ligula</u> and <u>C</u>. <u>sachalinensis</u> (Imai) Corner, both of whose basidiocarps are infrequently bright yellow in color. These taxa can readily be segregated microscopically, however, by basidiospore size and shape. The basidiospores of <u>C</u>. <u>flavidus</u> are broadly ovate to amygdaliform in profile, with an Em <2.0, while those of <u>C</u>. <u>ligula</u> and <u>C</u>. <u>sachalinensis</u> are narrowly ellipsoid to boletoid in profile with an Em >3.0.

Clavariadelphus occidentalis Methven, sp. nov.

Figs. 8, 12

Receptaculum 10-20 cm altum, apice 10-30 mm latum, simplex, clavatum; apex obtusus, laevis dein rugosus; hymenium laeve dein rugosum, luteolum vel ochraceum; caro spongiosa, albida, brunnescens; odor et sapor nullus; sporae 9.5-13 x 5.5-7 µm (L = 11.1 µm; W = 6.3 µm; E = 1.4-2.0; E = 1.7); late ovatae vel amygdaliformes, laeves, albae; hyphae monomiticae, intertextae, fibulatae. Sparsa vel gregaria ad terram in sylvis frondosis-coniferis Americae borealis occidentalis.

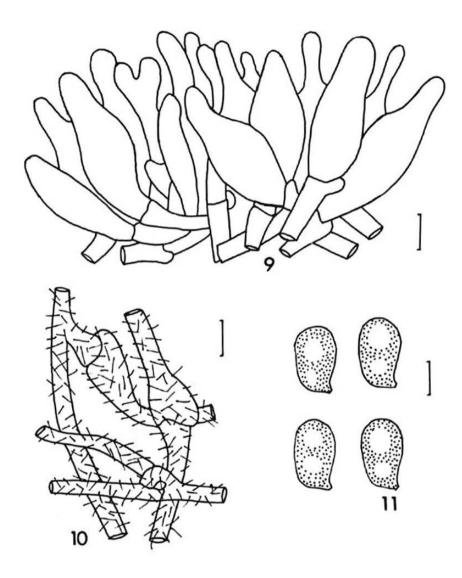
HOLOTYPUS: TENN: United States, California, Yuba Co., Bullard's Bar Recreation Area, Schoolhouse Campground, 4 Jan 1987, legit A. S. Methven No. 5068 (TENN 47402).

BASIDIOCARP 5-20 cm high, 5-12 mm diam basally, 10-30 mm diam apically, simple, initially subcylindric to subfusiform, enlarged upward in age, then clavate to broadly clavate, finally irregularly, laterally compressed; mycelial hyphae interwoven or aggregated into

rhizomorphic strands up to 1 mm diam, white to pallid; base terete, smooth, pruinose, white to pallid where covered, otherwise vellowish white (3A2) to pale vellow (4A3). "ivory yellow," "cartridge buff," "light buff," "pale ochraceous-buff"; hymenium initially smooth, longitudinally rugose to rugulose in age, initially light yellow (4A5-4) to orange white (5A2), "light buff," "pale ochraceous-buff," "pale ochraceous-salmon," "warm buff," "chamois," "light ochraceous-buff," "cream buff," finally light orange (5A4-3) to greyish orange (5B4-3, 6B4-3), "capucine buff," "pale yellow-orange," "cinnamon-buff, "pinkish cinnamon"; apex initially subacute, then obtuse or broadly rounded, smooth, concolorous with the hymenium; surface staining slowly, irregularly brown (6E6-4, 7E6-4) to dark brown (7F6-4), "verona brown," "mikado brown," "russet," "mar's brown" where cut or bruised, staining more conspicuously downward; flesh initially solid, becoming soft and spongy upward as the apex enlarges, white to pallid, on exposure staining slowly, irregularly brown (6E6-4, 7E6-4) to dark brown (7F6-4), "verona brown," "mikado brown," "russet," "mar's brown". ODOR AND TASTE not distinctive.

MACROCHEMICAL REACTIONS: FeCl₃, FeCl₃ + EtOH, ANO, PHN, PYR, PCR, GUA, SYR = positive; KOH, NH4OH, NAP, TYR = negative.

MYCELIAL HYPHAE 2.5-4 µm diam, branched, clamped, uninflated; walls thin or irregularly thickened to 1 µm, hyaline in KOH, refractive under phase contrast, smooth, echinate or echinulate; projections up to 1 um high, hyaline, insoluble in KOH, refractive under phase contrast, acyanophilous; clamps uninflated or inflated (-9.5 µm), sometimes medallion or ampulliform; hyphal contents amorphous, hyaline in KOH. TRAMAL HYPHAE 4-12 µm diam, more or less parallel to longitudinally interwoven basally, more loosely interwoven upward, radially interwoven beneath the subhymenium, uninflated, inflated (-13.5 µm) or broadly undulate, branched, clamped; walls thin or irregularly thickened to 1 µm, hyaline in KOH, refractive under phase contrast, smooth; clamps uninflated or inflated (-16 µm), sometimes medallion or ampulliform; hyphal contents amorphous, hyaline in KOH. GLOEOPLEROUS HYPHAE 2.5-5 µm diam, arising from generative hyphae at clamp connections, scattered throughout the trama, more abundant downward, uninflated, inflated (-8 µm) or strangulated, branched, clamped; walls thin, hyaline in



Figs. 9-11. Micromorphological characters of Clavariadelphus pallido-incarnatus (TENN 47404, Holotype).

9. Apical pellis. 10. Mycelial hyphae.

11. Basidiospores. Scale bars = 10 µm for apical pellis and mycelial hyphae; 5 µm for basidiospores.

KOH, smooth; clamps uninflated or inflated (-12 µm), sometimes medallion or ampulliform; hyphal contents subopalescent, yellow in KOH, refractive under phase contrast, cyanophilous. SUBHYMENIUM rudimentary: hyphae 2.5-5 µm diam, interwoven, branched, clamped, uninflated; walls thin, hyaline in KOH, smooth; clamps uninflated; hyphal contents amorphous, hyaline in KOH. thickening, extending from near the base of the basidiocarp over the apex, composed of basidia and leptocystidia: LEPTOCYSTIDIA 55-85 x 2.5-5 µm, scattered among and scarcely projecting beyond the basidia, cylindric, subcylindric or strangulated, inflated apically at maturity, then narrowly clavate, at times apically or subapically branched, clamped; walls thin, hyaline in KOH, smooth; clamps uninflated; hyphal contents amorphous, pale yellow in KOH, acyanophilous: BASIDIA 70-125 x 9.5-14 µm, narrowly clavate to clavate, inflated apically at maturity, then broadly clavate, clamped; walls thin or irregularly thickened, hyaline in KOH, smooth; clamps uninflated; basidial contents multiguttulate and refringent to aguttulate and amorphous, pale yellow in KOH; sterigmata (2) -4, 8-12 µm long, broadest basally, narrowed to an obtuse apex, incurved. BASIDIOSPORES white in deposit, 9.5-13 x 5.5-7 μ m (L = 11.1 μ m; W = 6.3 μ m; E = 1.4-2.0; E = 1.7); broadly ovate to amygdaliform; walls thin, hyaline in KOH, smooth; contents multiguttulate and refringent to aguttulate and amorphous, pale yellow in KOH; acyanophilous, inamyloid; hilar appendage oblique with an obtuse apex.

HABIT, HABITAT, AND DISTRIBUTION: Scattered to gregarious, infrequently in caespitose clusters; terrestrial; duff; coniferous or mixed coniferous-deciduous forests: Alaska, Arizona, California, Idaho.

SPECIMENS EXAMINED: UNITED STATES. ALASKA.

Gustavus, Rink River, Johnson Homestead, 6 Sep 1981, Cooke No. 59896 (WBC; TENN 47397); Fairbanks, Harding Lake Campground, 26 Aug 1965, Wells and Kempton Nos.

8/26/65-14, 8/26/65-15 (ut Clavariadelphus pistillaris)
(WK 1984, 1985); Fairbanks, Livingood Road, 15 Aug 1964, Wells and Kempton No. 8/15/64-10 (ut Clavariadelphus pistillaris)
(MICH); Glacier Bay National Monument, Water Pumping Station, 6 Sep 1979, Cooke No. 57176 (WBC; TENN 44854); Glacier Bay National Monument, Bartlett Cove, 3 Sep 1979, Cooke No. 57002 (WBC; TENN 44855); Glacier Bay National Monument, Water Pumping Station, 7 Sep 1979,

Cooke No. 57231 (WBC; TENN 44852). ARIZONA. Graham Co.: Coronado National Forest, 29 Aug 1958, Lowe No. 9425 (TENN CALIFORNIA. Humboldt Co.: Willow Creek, no date, Largent No. 8158 (HSC). Marin Co.: Samuel P. Taylor State Park, 26 Dec 1985, Methven No. 4409 (TENN); Alpine Lake, 8 Dec 1984, Thiers No. 48393 (ut Clavariadelphus pistillaris) (SFSU). San Mateo Co.: Francisco Watershed, 12 Jan 1986, Saylor No. 3041 (SFSU). Santa Barbara Co.: 17 Feb 1940, Rea No. 370 (ut Clavaria pistillaris) (MICH). Trinity Co.: Brizard Ranch, east of Salyer, Denning Road, 6 Dec 1982, Lanphere No. 12/6/62 (ut Clavariadelphus pistillaris) (MICH). Tuolumne Co.: 120, Moccasin Creek Recreation Area, 27 Jan 1979, Thiers No. 39368 (ut Clavariadelphus pistillaris) (SFSU). Yuba Co.: Bullard's Bar Recreation Area, Schoolhouse Campground, 15 Dec 1983, Methven No. 2682 (TENN); Bullard's Bar Recreation Area, Schoolhouse Campground, 4 Jan 1987, Methven No. 5068 (TENN 47402) [HOLOTYPE]; Bullard's Bar Recreation Area, Schoolhouse Campground, 4 Jan 1987, Methyen No. 5069 (TENN). IDAHO. Bonner Co.: Priest Lake, 29 Sep 1984, Methven Nos. 3320, 3323 (TENN); Nordman, Granite Creek, 12 Oct 1956, Smith No. 54506 (ut Clavariadelphus pistillaris) (MICH); Upper Priest River, 21 Sep 1968, Smith No. 76553 (ut Clavariadelphus pistillaris) (MICH); Priest Lake, Binarch Creek, 22 Sep 1968, Smith No. 76574 (MICH); Priest Lake, 29 Sep 1968, Smith No. 76770 (ut Clavariadelphus pistillaris) (MICH); Priest Lake, Binarch Creek, 8 Oct 1968, Smith No. 77019 (MICH); Priest River, 21 Sep 1966, No. 32771 (ut Clavariadelphus pistillaris) (TENN); Priest River, 6 Oct 1966, No. 32241 (ut Clavariadelphus pistillaris) (TENN); Priest River, 21 Sep 1968, No. 33997 (TENN); Priest River, 22 Sep 1968, No. 34017 (TENN); Priest Lake, 24 Sep 1968, No. 34041 (TENN); Priest Lake, 23 Sep 1968, No. 34076 (ut Clavariadelphus pistillaris) (TENN); Priest River, 1 Oct 1968, No. 34261 (ut Clavariadelphus pistillaris) (TENN); Priest River, 7 Oct 1968, No. 34340 (TENN); Priest River 3 Oct 1968, No. 34708 (TENN). Kootenai Co.: Couer d'Alene, 30 Sep 1966, No. 32206 (ut Clavariadelphus pistillaris) (TENN); Couer d'Alene, 7 Oct 1970, No. 34737 (ut Clavariadelphus pistillaris) (TENN). Shoshone Co.: Devil's Elbow, Couer d'Alene River, 24 Oct 1972, Smith No. 83190 (ut Clavariadelphus pistillaris).

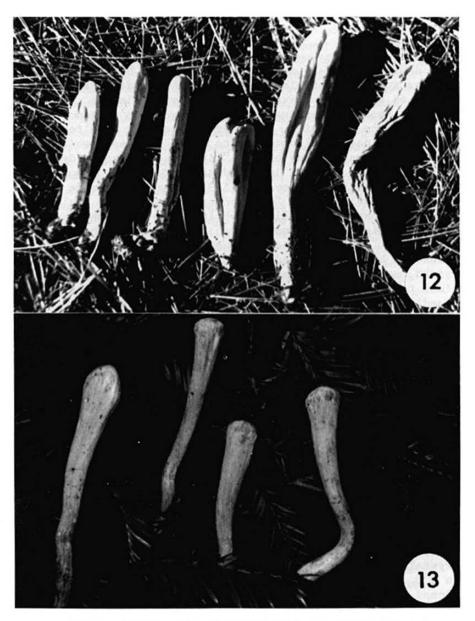
<u>Clavariadelphus occidentalis</u> is one of several taxa in sect. <u>Clavariadelphus</u> passing under the name <u>C</u>. pistillaris sensu lato. Clavariadelphus occidentalis

differs from the latter by its light yellow basidiocarps which darken to greyish orange in age, habitat in coniferous or mixed coniferous-deciduous forests, and smaller basidiospores (10.5-14 x 6-7.5 µm for C. pistillaris). Other taxa within sect. Clavariadelphus with which C. occidentalis might be confused include C. subfastigiatus, C. caespitosus, and C. fasciculatus. Clavariadelphus subfastigiatus is distinct from C. occidentalis in its pallid flesh-color to light cinnamon basidiocarps, forest green staining reaction with KOH, and smaller basidiospores (8-10.5 x 5-6 µm). Clavariadelphus caespitosus differs from C. occidentalis by its slender, narrowly clavate, greyish red to dull red basidiocarps with subacute apices, caespitose growth habit, and smaller basidiospores (8-11 x 4.5-6.5 µm). Clavariadelphus fasciculatus, known at this writing only from Mexico, is unique in its strongly fasciculate growth habit, pinkish orange basidiocarps, larger basidiospores (11-14 x 5-7 um), and acerose- to acicular-shaped crystals encrusting the walls of the mycelial hyphae.

Small, immature basidiocarps of <u>C</u>. <u>occidentalis</u> might also be confused in the field with <u>C</u>. <u>ligula</u> and <u>C</u>. <u>sachalinensis</u>. These taxa can readily be segregated microscopically, however, by size and shape of basidiospores. Basidiospores of <u>C</u>. <u>occidentalis</u> are broadly ovate to amygdaliform in profile with an Em < 2.0, while those of <u>C</u>. <u>ligula</u> and <u>C</u>. <u>sachalinensis</u> are narrowly ellipsoid to boletoid in profile with an Em > 3.0.

Clavariadelphus pallido-incarnatus Methven, sp. nov. Figs. 9-11, 13

Receptaculum 7-15 cm altum, apice 10-15 mm latum, simplex, clavatum vel turbinatum; apex obtusus dein truncatus, rugosus, sterilis; hymenium laeve dein rugosum, pallido-incarnatum, in KOH luteum; caro spongiosa, albida, brunnescens; odor nullus, sapor dulcis; sporae 9-11.5 x 6-7 µm (L = 10.3 µm; W = 6.3 µm; E = 1.4-1.8; E = 1.6); late ovatae vel amygdallformes, laeves, albae; hyphae monomiticae, intertextae, fibulatae. Sparsa vel gregaria ad terram sub Sequoia sempervirenti, Picea sitchensi, et Alno spp. in America boreali occidentali.



Figs. 12-13. 12. Basidiocarps of Clavariadelphus occidentalis (Methven 5067). x 1/2. 13. Basidiocarps of Clavariadelphus pallido-incarnatus (TENN 47404, Holotype). x 3/4.

HOLOTYPUS: TENN: United States, California, Humboldt Co., Prairie Creek Redwoods State Park, Davidson Road, 15 Oct 1986, legit A. S. Methven No. 5003 (TENN 47404).

BASIDIOCARP 7-15 cm high, 5-10 mm diam basally, 10-15 mm diam apically, simple, initially subcylindric, enlarged upward in age, then clavate to narrowly turbinate; mycelial hyphae interwoven or aggregated into rhizomorphic strands up to 1 mm diam, off-white to pallid; base terete, smooth, pruinose, yellowish white (4A2) to orange white (5A2), "pale ochraceous-buff," "light buff," "cartridge buff"; hymenium smooth, longitudinally rugose to rugulose in age, initially pale orange (5A3) to greyish orange (5B3), "seashell pink," "pale ochraceous-salmon," "pale pinkish cinnamon," finally flesh (6B3) to brownish orange (6C4-3), "light ochraceous-salmon," "light pinkish cinnamon," "light vinaceous-cinnamon"; apex initially obtuse to broadly rounded, more or less truncate in age, smooth, more or less concolorous with the hymenium; disc plane to depressed, not perforate or excavate; margin broadly rounded; surface staining slowly, irregularly brown (6D6-5, 6E7-6), "ochraceous-tawny," "buckthorn brown," "sayal brown," "tawny-olive" where cut or bruised, staining more conspicuously downward; flesh initially solid, becoming soft and spongy upward as the apex enlarges, white to pallid, on exposure staining slowly, irregularly brown (6E6-5, 7E6-5), "russet," "snuff brown," "rood's brown". ODOR not distinctive. TASTE slightly sweet.

MACROCHEMICAL REACTIONS: NAP, PYR, GUA, FeCl₃, FeCl₃ + EtOH, PCR, PHN, ANO, SYR = positive; KOH = yellow; NH4OH, TYR = negative.

MYCELIAL HYPHAE 2.5-4 µm diam, branched, clamped, uninflated; walls thin or irregularly thickened to 1 µm, hyaline in KOH, refractive under phase contrast, walls smooth, encrusted with acicular- to acerose-shaped crystals; crystals up to 8 x 1 µm diam, hyaline, insoluble in KOH, refractive under phase contrast, acyanophilous; clamps uninflated or inflated (-9.5 µm), sometimes medallion or ampulliform; hyphal contents amorphous, hyaline in KOH. TRAMAL HYPHAE 4-14.5 µm diam, more or less parallel to longitudinally interwoven basally, more loosely interwoven upward, radially interwoven beneath the subhymenium, uninflated, inflated (-19.5 µm) or broadly

undulate, branched, clamped; walls thin or irregularly thickened to 1 µm, hyaline in KOH, refractive under phase contrast, smooth; clamps uninflated or inflated (-19.5 um), sometimes medallion or ampulliform; hyphal contents amorphous, hvaline in KOH. GLOEOPLEROUS HYPHAE 5-9.5 um diam, arising from generative hyphae at clamp connections, scattered throughout the trama, more abundant downward, uninflated or inflated (-12 µm), branched, clamped; walls thin, hyaline in KOH, smooth; clamps uninflated or inflated (-12 µm), sometimes medallion or ampulliform; hyphal contents subopalescent, vellow in KOH, refractive under phase contrast, cyanophilous. SUBHYMENIUM rudimentary; hyphae 2.5-5 µm diam, interwoven, branched, clamped, uninflated; walls thin, hyaline in KOH, smooth; clamps uninflated; hyphal contents amorphous, hyaline in HYMENIUM thickening, limited to the sides of the basidiocarp, composed of basidia and leptocystidia: LEPTOCYSTIDIA 60-85 x 2.5-6 µm, scattered among and scarcely projecting beyond the basidia, cylindric, subcylindric or strangulated, inflated apically at maturity, then narrowly clavate, at times apically or subapically branched, clamped; walls thin, hyaline in KOH, smooth; clamps uninflated; hyphal contents amorphous pale yellow in KOH, acyanophilous: BASIDIA 65-90 x 6-9.5 µm, narrowly clavate to clavate, inflated apically at maturity, then broadly clavate, clamped; walls thin, hyaline in KOH, smooth; clamps uninflated; basidial contents multiguttulate and refringent to aguttulate and amorphous, pale yellow in KOH; sterigmata (2) -4, 6-9.5 µm long, broadest basally, narrowed to an obtuse apex, incurved. APEX sterile: apical pellis a palisade of scattered basidia and sterile elements: STERILE ELEMENTS 20-40 x 5-10 µm, fusoid-ventricose to ventricose, clamped; walls thin, hyaline in KOH, smooth; clamps uninflated; contents amorphous, hyaline in KOH, smooth: described above. BASIDIOSPORES white in deposit, 9-11.5 x 5.5-6-7 μ m (L_m = 10.3 μ m; W_m = 6.3 μ m; E = 1.4-1.8; E_m = 1.6); broadly ovate to amygdaliform; walls thin, hyaline in KOH, smooth; contents multiguttulate and refringent to aguttulate and amorphous, pale yellow in KOH; acyanophilous, inamyloid; hilar appendage oblique with an obtuse apex.

HABIT, HABITAT, AND DISTRIBUTION: Scattered to gregarious; terrestrial; duff; under Sequoia sempervirens (Lamb.) Endl., Picea sitchensis (Bong.) Carr, and Alnus spp.; California.

SPECIMENS EXAMINED: UNITED STATES. CALIFORNIA. Humboldt Co.: Prairie Creek Redwoods State Park, Davidson Road, 15 Oct 1986, Methven No. 5003 (TENN 47404) [HOLOTYPE]; Prairie Creek Redwoods State Park, Rugg Grove, 8 Nov 1986, Saylor No. 3732 (SFSU).

The sterile, truncate basidiocarp apex, acicular- to acerose-shaped crystals encrusting the mycelial hyphae, and broadly ovate basidiospores place this taxon in subg. Clavariadelphus sect. Cantharellopsis, quite near C. truncatus. The pale coloration of the basidiocarps, lack of reactivity with KOH, and habitat in coastal coniferous forests of Sequoia sempervirens and Picea sitchensis distinguish C. pallido-incarnatus from C. truncatus.

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KEY TO THE SPECIES OF INOCYBE IN CALIFORNIA

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SUMMARY

A key to the species of Inocybe found in California is presented, based on a recent systematic study of the genus in southern California. The occurrence of nearly 60 indicated for the species is augmenting the 16 nominal species previously reported in the literature. Several species with type localities in California or the west coast of the U.S. were re-collected and determined for the first time since their original description. Distinct Inocybe floras appear in northern and southern California, associated with different forests, mixed conifer vs. live oak, respectively. Less than a quarter of the total species occur in both regions. checklist is provided of nominal Inocybe species of California, based on published reports and herbaria records at SFSU and LAM.

The genus Inocybe has been poorly studied in most of North America, some conspicuous exceptions being areas near New York (Peck, 1872-1910), Michigan (Kauffman, 1920, 1924, 1925; A.H. Smith, 1939; Stuntz, 1954), Washington (Stuntz, 1940, 1965; A.H. Smith & Stuntz, 1950), Florida (Murrill, 1941, 1944, 1945), and Nova Scotia, Canada (Grund & Stuntz, 1968-1984). A recent systematic study of Inocybe in southern California (Nishida, 1987, and ms. in prep. for Contributions in Science, Natural History Museum of Los Angeles County) revealed that the genus is surprisingly well-represented in semi-arid southern California, in relatively moist, coastal woods of live oak (Quercus agrifolia). At least 26 smooth-spored species and 5 nodulose-spored species are reported from southern California. Voucher specimens are deposited in herbarium LAM (Natural History Museum of Los Angeles County, California). It is worth noting that most of these nodulose species occur in inland, montane conifer woods of

Pinus ponderosa, P. jeffreyi, and Abies concolor.

My study of the herbarium specimens at San Francisco State University (SFSU) indicates a northern California Inocybe flora of at least 26 smooth-spored species and 13 nodulose-spored species. Many of the Inocybe collections had been annotated by Daniel Stuntz in 1971, but many other collections had not been determined, nor examined microscopically and none had been reviewed in light of recent taxonomic revisions of the genus. Nearly 60 species of Inocybe are presently reported from California, in contrast to 16 nominal species previously reported in the literature (Earle, 1904; Peck, 1909; Kauffman, 1924; Murrill, 1916; A.H. Smith, 1939, 1941; Smith & Stuntz, 1950; Grund & Stuntz, 1970).

Based on collections in the herbarium at SFSU there is a contrasting <u>Inocybe</u> flora in northern This abundant collection represents the California. mycological activities of Harry D. Thiers and his students over many years in the mixed conifer and conifer-hardwood (Pseudotuga menziesii, Abies grandis, Picea sitchensis, Quercus chrysolepis, Q. kelloggii) forests of northern California. Although the two regions (northern and southern California) appear to have the same number of species of Inocybe, a closer examination shows that there are two distinct floras, with some overlapping of species. In general, nodulose species are more to be found associated with conifers. The northern California collection, mostly of the mixed conifer region, has 13 nodulose spored species, compared to 5 in southern California, where most of my collecting has been in the live oak woods. Nearly half (48%) of the total species occur only in northern California; less than a third (30%) occur only in southern California. Less than a quarter (23%) of the species are found in both regions. Among these latter are species of wide distribution in the world $(\underline{I}. \underline{fraudans}, \underline{I}. \underline{geophylla}, \underline{I}. \underline{leptocystis}, \underline{I}. \underline{rimosa}, \underline{I}. \underline{mixtilis}, \underline{and} \underline{I}. \underline{variabillima}).$

California is an area of great floristic, topographic, and climatic diversity. Sampling of the live oak woods of the southern coast and the pine and fir woods of the northern coast has yielded nearly 60 species of Inocybe. Large areas, potentially rich in Inocybe species, remain unstudied, especially the stands of Quercus kelloggii, and Q. chrysolepis on the lower slopes of the Sierra Nevada range, and of Q. douglasii surrounding the central valley, as well as much of the conifer forest extending along the Sierra Nevadas.

Recent taxonomic studies by Thomas W. Kuyper, including a revision of European smooth-spored species (1986), have provided useful information on some particularly difficult "species complexes," as well as updating nomenclature. My own recent systematic study of the southern California Inocybe has resulted in species of some taxonomic revision. Both these works should be consulted for complete descriptions and synonymy of species, as well as Nishida (1988) for new species, reported in this key to species of Inocybe in California.

Key to Subgenera, Sections, and Subsections of Inocybe *

- - - Pileus squamulose to squarrulose; context often reddening; basidia slender; odor often distinct...
- - - 5. Caulocystidia present over entire length of stipe (occasionally scarce in lower 1/3, or difficult to find or interpret) as thin- or thick-walled metuloids or thin-walled clavate, cylindrical cells of various sizes, or combination of these; cortina absent in young stageSubsect. Holoconiatae

^{*} The infrageneric classification follows Kuyper (1986). I concur that this is a phylogenetically valid grouping of smooth-spored and nodulose-spored species.

- 6. Caulocystidia over entire length (including lower 1/3); cortina absent in young stage.....
 Subsect. Marginatae

Key to Species of Subgenus Mallocybe

Pleurocystidia absent; cheilocystidia thin-walled, no crystals at apex; spores always smooth; cheilocystidia originating from hymenophoral trama; basidia often with necropigment.

Key to Species of Subgenus Inosperma

Pleurocystidia absent; cheilocystidia originating as modified hymenial elements; basidia without necropigment.

- - 2. All parts of basidioma, including context, changing to vinaceous, pinkish red, or vinaceous brown; distinctive odor lacking; spores 10-12.5(-15) x 6-7(-7.5) µm.....

 I. adaequata
 - - Stipe with blue-violet, gray-blue tints......
 Spores (sub)reniform, > 6 µm broad.....

- 5. Spores elliptical, < 6 µm broad; stipe gen. pale yellow, occ. violet......I. quietiodor
 4. Stipe white, pale yellow, becoming more yellow.....
- 6. Pileus often pallid overall at first, due to heavy covering of white velipellis (particularly in southern California husky, inodorous forms), in time becoming rimose and also yellow, yellow-brown to fulvous; odor absent, spermatic, or of fresh corn; spores 10-13 x 6-7 µm, (sub)reniform.......
- 6. Pileus with conspicuous central white patch of velipellis, drying entire, rarely, in squamules; umbo very obtuse or absent; stipe wax colored, smooth, equal or swollen, never emarginate-bulbous; spores 9-10 x 5-5.5 µm, ellisoid, fewer subreniform; odor lacking or faintly rancid-mealy.....<u>I. brunnescens</u>

Key to Species of Subgenus <u>Inocybe</u>, Section <u>Inocybium</u> Spores smooth (ovate, ellipsoid, subamygdaliform, subreniform; pleurocystidia present.

Key to Species of Subsection <u>Holoconiatae</u>
Caulocystidia found along entire length of stipe.

- Entire basidioma reddening with age and/or on bruising, pure white at first; stipe base bulbous, sub-emarginate; odor spermatic; spores (10-)11-12.5(-15) x 6-7.5 µm, subamygdaliform to sublimoniform, apex subconical......
- - 3. Without distinct odor of bitter almond..........5

- - 6. Pileus often bicolorous, bright, tawny brown to redbrown on disc and ochraceous to honey in margin; stipe salmon-incarnate, context incarnate or pinkish orange; pileus and stipe often with tawny to orange fibrils; pleurocystidia extremely abundant, with very thick walls (4.5-5 µm); spores 9-11 x 5.5-6 µm
- 5. Pileus not brightly colored, definitely brown......7
 7. Pileus tending to become squarrose-scaly around disc, without obvious velipellis, ochraceous brown to fulvous; stipe distinctly reddish brown, sometimes becoming purplish; pleurocystidia bright yellow in KOH, thick-walled; odor spermatic, rarely, faintly spicy or of almond.......
- 7. Pileus smooth, uniformly brown......8
- 8. Pileus ochraceous brown, chestnut-brown, sometimes greyish on disc from velipellis; stipe reddish brown to orange ochraceous, with marginate bulb; pleurocystidia thin-walled, hyaline; spores rather small (7.5-9.5 x 4.5-5.5 µm), mostly ellipsoid.....
- 2. Stipe white, pallid, or variously colored, sometimes distinctly darkening, but nowhere incarnate......9
 - 9. Spores generally >11 µm long (10-12 [-16] µm), ellipsoid to subamygdaliform; robust habit; pileus buff, tan, dull ochraceous to ochraceous brown, paler in center from thick velipellis; husky stipe (30-80 mm long), with subbulbous to emarginate bulbous base, often with grey-green stains; pleurocystidia variable, often subcapitate; thin-walled clavate caulocystidia sometimes present at base.
 - sometimes present at base.....<u>I. bakeri</u>
 9. Spores generally <11 µm long......10
 10. Pileus light (cream, isabella brown, buff, tan, dull ochraceous, ochraceous brown); stipe not distinctly darkening.....11
 - 11. Pileus bright, yellow to golden with fulvous disc when fresh, becoming entirely orange brown when dry; velipellis absent; stipe pale yellow; pleurocystidia fusiform with very thick (4 µm), pale to moderately yellow wall; spores amygdaliform to sublimoniform 10-11 x 5.5-6 µm.......
 - 11. Pileus pallid, not bright; stipe long, pallid...12
 12. Habit robust (pil. 10-60 mm); pileus cream to isabelline, ochraceous, fibrillose-scaly at

- 12. Habit regular (pil. 38 mm); pileus white to buff silky-smooth; context light brown under pellis; acrid taste; spores 9-10 x 5-5.5 µm, elliptical to subreniform; pleurocystidia short, very rare, clavate to subfusiform, with extremely thick walls (4-5.5 µm), hyaline.....
- 10. Pileus definitely brown, sometimes appearing bicolorous; stipe darkening in lower half; odor of
 Pelargonium or of Amanita phalloides, or else

Key to Species of Subsection Acroconiatae

Caulocystidia found only in upper 1/3 to 1/2 of stipe.

buff to tan, never silky-fibrillose; odor lacking.....
I. insinuata

1. Basidioma colored from the first (ochre, yellow-brown, fulvous, reddish brown, umbrinous, etc.)......6 6. Basidioma having a distinct sweet, aromatic, or fruity 7. Pileal disc, and/or some part of the stipe with green (greyish green to dull olive-green), pileus often scaly; context whitish, not reddening; strong odor of "Peruvian balsam" or cinnamaldehyde..... 7. Pileus smooth, color pale ochraceous, pale fulvous, or mixture of yellow, red, dark russet, umbrinous, vinaceous brown; context pallid, reddening upon exposure; stipe becoming brick red then vinaceous; strong odor, variously described as methyl cinnamate, "Peruvian balsam," or "matsutake".....<u>I</u>. <u>fraudans</u> 6. Basidioma lacking a distinct aromatic, sweet odor, or else with a spermatic odor.....8 8. Violet or lilac shades in some or all parts: pileus, lamellae, stipe.....9 9. Pileus small, 10-35 mm, ochraceous brown, smooth, in age becoming diffracted-scaly in margin; lamellae briefly violaceous; stipe equal to subbulbous, often violaceous in lower portion; pleurocystidia fusoidventricose, hyaline; spores subamygdaliform, 9. Pileus large, 15-50 mm, dark brown, umbrinous to reddish brown, with violaceous tinges from underlying context, distinctly scaly to tomentose-squamulose; stipe equal with brown fibrillose punctae, streaks, or squamules, especially toward base; pleurocystidia slenderly fusiform, with thick, bright yellow walls; spores amygdaliform with subconical to papillate apex 8.5-10 x 5-5.5 µm......I. phaeocomis var. major 8. Violet or lilac shades absent and pileus pallid, 10. Pileal colors pallid, ochraceous, to ochraceous brown or brightly colored, not definitely brown..ll 11. Spores = or > 11 µm (10.5-13 x 5.5-6.0 µm) subamygdaliform; pleurocystidia broad, utriform to fusoid, thick walled, hyaline; pileus 25-55 mm, pale ochraceous to ochraceous brown, smooth, often with dirt or litter adhering; stipe white, husky (50-80 x 5-15 mm) with bulbous to emarginate base; differentiated caulocystidioid hairs sometimes found on base of -5.0 µm, subamygdaliform; pileus isabella, greyish ochraceous to ochraceous brown; odor spermatic and farinaceous.....<u>I</u>. <u>subochracea</u> 12. Pleurocystidia short (40-60 µm), fusiform to utriform, with pale to bright yellow wall; spores 8.3-9 x 4.5-5.5 µm, subamygdaliform; pileus yellow, pale cream to ochraceous yellow 10. Pileus definitely brown; basidiocarp rarely with

| violaceous colors |
|---|
| 13. Basidioma with striking lamellar colors (bright |
| orange to ochraceous tawny); also pileus orange to |
| cinnamon at first, becoming cinnamon to "Sayal |
| brown," context orange-cinnamon; stipe with heavy |
| covering of cinnamon colored fibrils, context and |
| surface cinnamon, becoming brownish, spores sub- |
| surface Cinnamon, becoming brownish, spores sub- |
| amygdaliform; pleurocystidia fusoid-ventricose |
| <u>I</u> . <u>cinnamomea</u> |
| 13. Basidioma without striking lamellar color, but |
| stipe may be incarnate (with pinkish, pinkish |
| brown, reddish orange, reddish brown) or not14 |
| 14. Stipe incarnate |
| 15. Pleurocystidia uniquely thin-walled, without a |
| double membrane, clavate to utriform with wavy margin, apex obtuse or subcapitate; spores |
| margin, apex obtuse or subcapitate; spores |
| subamygdaliform, 8-9 x 5-6 µm; pileus red-brown, |
| subamygdaliform, 8-9 x 5-6 µm; pileus red-brown, "bay," sometimes fading to "tawny," at center or |
| margin; odor faint, raphanoid to farinaceous |
| <u>I</u> . <u>leptocystis</u> |
| Pleurocystidia definitely thick-walled16 |
| 16. Spores generally >11 um |
| 17. Spores elongate to slightly angular, 11-14 x |
| 4.5-5.5 µm; pileus coarsely fibrillose, |
| tomentose, squamulose to squarrose; stipe |
| buff at apex, sometimes with pinkish tinge; |
| brownish toward base, fibrillose I. lacera |
| 17. Spores never angular, but broad, 11.5-13.5 x |
| 6-7 µm; pileus orange-brown to cinnamon - |
| brown with conspicuous and persistent white |
| patch of velipellis in center; smooth to |
| slightly diffracted scaly on disc; stipe |
| light brown with reddish to orange tinges, |
| with submarginate bulbous base |
| with submarginate bulbous base |
| 16 Common (1) hemileuca |
| 16. Spores <11 µm18 |
| 18. Pileus with disc distinctly darker than |
| margin (disc umber to fuscous, sometimes |
| ochraceous brown, outer whitish to cream); |
| ochraceous brown, outer whitish to cream); surface smooth to appressed-scaly to diffracted scaly; stipe densely fibrillose, |
| reddish brown context and surface coule |
| reddish brown context and surface, caulo- |
| cystidia at apex very rare; spores |
| 9-10 x 5-5.5 µm; pleurocystidia subcylin- |
| drical to subfusiform, walls moderately |
| thick (1.5-2 µm) <u>I. phaeodisca</u> |
| 18. Pileus unicolorous, dark brown, rufous to |
| umbrinous, margin sometimes tawny olive; |
| pleurocystidia ventricose, very thick-walled |
| (3.5 µm); spores 10 x 5-5.5 µm, subamyg- |
| daliform; odor spermatic |
| <u>I</u> . <u>subdestricta</u> |
| 14. Stipe not incarnate; pileus pale brown, ochraceous |
| brown, fibrillose-squamulose especially over disc, |
| often recurvately squamulose-squarrose; stipe |
| white, becoming pale ochraceous or pale brownish; |
| spores 8.5-9.5 x 5-6 µm, subamygdaliform; pleuro- |

Key to Subgenus Inocybe, Section Inocybe

Spores angular, angular-nodulose, or obtusely to definitely nodulose to stellate in outline; pleurocystidia usually present.

Key to Species of Subsection Marginatae

Caulocystidia along entire stipe; stipe pruinose overall; cortina lacking or attached to base of stipe which is frequently bulbous.

- Basidioma reddening and with pleasant, aromatic, fruity or sweet odor; pileus fulvous to yellowish brown; spores 7-9 x 5-6.5 µm, bluntly nodulose; pleurocystidia fusoid ventricose, thick walled.......
 bresadolae
- - 3. Pileus red-brown, cinnamon-brown, glabrous; stipe with marginate bulb, color gradually darkening; spores 9-11 x 5.5-8 µm, with 8-10 large, prominent nodules; pleurocystidia broadly ventricose to subglobose.....
 - 2. Stipe not becoming incarnate......4
 4. Basidioma entirely white, remaining pallid......5
 - 5. Pileus 25-50 mm smooth, greasy to subviscid at first, in time pale ochre-yellow; stipe base not distinctly bulbous; spores 8-10 x 5-6 µm, ellipsoid-oblong with 7-9 coarse nodules; pleurocystidia fusoid ventricose, thick walled (2.5-3 µm); strong odor of Cortinarius purpurascens
 - purpurascens

 Pileus 15-30 mm, dry, fibrillose, becoming obscurely scaly, white becoming dingy to ochraceous; stipe base bulbous to submarginate; spores 7-10 x 5-6 µm, polygonal, 4-9 nodules, or merely angular; pleurocystidia distinctly thick walled (4-5.5 µm), short (30-55 µm), fusoid to clavate.....
 - 4. Basidioma not white, but variously colored..........6
 6. Stipe noticeably darkening or blackening...........7
 7. Pileus 20-35 mm, straw-yellow to brownish yellow,
 - often paler in margin or disc from velipellis, moist

- - 8. Pileus ochraceous brown to cinnamon-ochre, covered with greyish to grey-brown veil, smooth or greyish brown, scaly, 45-65 mm, umbonate, subviscid, dirt often adhering; stipe pallid, becoming yellowish brown; spores very large, 9-13 (-15) um, scarcely nodulose, polygonal; pleurocystidia ventricose to clavate, thick walled (3 µm)I. decipiens

Key to Species of Subsection Cortinatae

Caulocystidia lacking on base of stipe; stipe not pruinose all over; cortina present in young specimens; stipe base bulbous or not.

- - Pileus brown, tomentose-scaly, to squarrulose-scaly...3
 Pleurocystidia lacking; only thin-walled subglobose cheilocystidia; pileus dry, disc densely covered with minute squarrose scales, margin smooth, walnut-brown to umber; stipe floccose fibrillose to tomentose, concolorous; spores 10-12 x 8-9 µm ellipsoid, with 12-20 prominent subconical nodules; in damp woods. on
 - 2. Pileus not strongly squarrulose-scaly; ochraceous, fulvous brown, reddish brown, fibrillose to finely appressed-fibrillose scaly; stipe pallid to tan, glabrous; spores 9-11.5 x 5.5-6.5 µm, oblong, notable by their extreme variability, from merely angular to angular-nodulose, to nodulose, but with low

Checklist of Species of Inocybe in California

This is a checklist of nominal <u>Inocybe</u> species which either have appeared in the literature as occurring in California, or are associated with collections in the herbarium, SFSU. Some names, therefore, are synonyms or have been misapplied. Recent taxonomic studies of European inocybes by Kuyper (1986) and southern California inocybes by Nishida (1987, in prep.) should be consulted for discussions of species and complete synonymies. The columns to the right provide a quick reference to reports of <u>Inocybe</u> species in California. Headings are: (R), reports in literature; (N), collection from northern California in herbarium SFSU, only those studied and annotated by D.E. Stuntz and/or Nishida; (S), collection of southern California in LAM determined by Nishida; (P), associated plants: "Q" = <u>Quercus</u>, "C" = conifer. In columns, "T" indicates type collection made in California, "X" = present, "0" = absent.

| | Smooth-spored Species | R | N | S | P |
|----|------------------------------|---|---|---|---|
| ı. | adaequata (Britz.) Sacc. | 0 | х | х | Q |
| ī. | agardhii (Lund) Orton | 0 | x | 0 | C |
| ī. | agglutinata Peck = I. whitei | 0 | x | 0 | C |
| ī. | amblyspora Kuhn. | 0 | 0 | x | Q |
| ī. | anomala Murr. | T | 0 | 0 | C |
| ī. | auricoma (Batsch) J. Lange | 0 | x | 0 | C |

| I. bakeri Peck | T | 0 | x | Q |
|--|-------|----|---|--------|
| I. brunnescens Earle | T | х | x | õ |
| non I. brunnescens Atk. | _ | | | ~ |
| I. bulbosa Peck | T | 0 | х | Q |
| $\frac{\underline{\underline{\underline{I}} \cdot \underline{\underline{balbosa}}}}{(probably = \underline{\underline{I}} \cdot \underline{\underline{bakeri}})}$ | - | • | ^ | × |
| (probably = 1. <u>bakerl</u>) | • | | ^ | • |
| I. calamistrata (Fr.) Quel. I. cincinnatula Kühn. | 0 | X | 0 | C |
| 1. cincinnatula Kunn. | 0 | X | 0 | Q,C |
| = <u>I. phaeocomis</u> var. <u>major</u> | | | | |
| I. cinnamomea A.H. Smith I. corydalina Quel. | T | 0 | 0 | C |
| I. corydalina Quel. | 0 | x | 0 | Q |
| I. dulcamara (Alb. et Schw.: Fr.) Kumm. | 0 | X | x | ŝ |
| I. fastigiata (Fr.) Quel. = I. rimosa | x | X | x | Q |
| <u>I. fastigiata</u> (Fr.) Quel. = <u>I. rimosa</u> <u>I. fastigiella</u> Atk. | o | x | x | |
| T flooryless (Perk) Com | ŏ | x | ô | Q,C |
| I. flocculosa (Berk.) Sacc. | | | 7 | C |
| I. fraudans (Britz.) Sacc. | 0 | X | x | Q,C |
| I. fuscodisca (Pk.) Massee | x | X | 0 | Q,C |
| I. geophylla (Fr.:Fr.) Kummer | x | X | x | Q,C |
| I. geophylla var. lilacina (Pk.)Gill. | 0 | X | 0 | C |
| 1. geophylla f. perplexa Kauff. | 0 | X | 0 | C |
| = I. whitei | | | | |
| I. godeyi Gill. | 0 | 0 | x | 0 |
| I. hirsuta var. maxima | x | x | 0 | Q C |
| = I. calamistrata | ** | ** | • | • |
| T hirtolla Proc | 0 | 0 | v | 0 |
| I. hirtella Bres. | | | X | Q |
| I. insinuata Kauff. | T | х | X | Q,C |
| I. jurana sensu auct. = I. adaequata | 0 | X | Х | Q,C |
| 1. Kaulimanii Smith | x | x | 0 | C |
| I. lacera (Fr.:Fr.) Kumm. | 0 | X | 0 | C |
| I. laetior Stz. | 0 | 0 | X | ? |
| I. leiocephala Stz. | 0 | X | 0 | Q,C |
| I. leptocystis Atk. | 0 | x | x | Q |
| I. lilacina (Pk.) Kauff. | x | x | 0 | ĉ |
| = I. geophylla var. lilacina | | | • | |
| I. muricellata Bres. | 0 | 0 | х | 0 |
| T alempiana (2 H Cmith) | o | x | Ô | Q C |
| I. olympiana (A.H. Smith) | | ^ | U | C |
| phaeocomis var. major (S. Petersen) Kuy | | | | _ |
| and the second s | 0 | X | 0 | C |
| I. phaeodisca Kuhn. | 0 | X | 0 | Q |
| I. phaeoleuca Kuhn. | 0 | 0 | X | Q |
| I. pudica Kühn. = I. whitei | 0 | X | 0 | Q,C |
| I. pusio P. Karst. | 0 | 0 | x | Ĉ. |
| I puriodora concu auct = I fraudanc | x | x | x | 0 |
| I. pyriodora sensu auct. = I. fraudans I. quietiodor M. Bon | ô | Ô | x | Q C |
| I. quietiodor M. Bon | | | | ~ |
| I. retipes Atk. | 0 | X | 0 | C |
| I. rimosa (Bull.:Fr.) Kumm. | 0 | X | x | Q,C |
| I. serotina Peck | X | 0 | 0 | |
| (report is based upon a misapplied r | name) | | | |
| <u>I. sororia</u> Kauff. = <u>I. rimosa</u> <u>I. splendens</u> Heim | 0 | X | 0 | Q,C |
| I. splendens Heim | 0 | 0 | X | Q |
| I. subbrunnea Kuhn. = I. leiocephala | 0 | X | 0 | ĉ |
| I. subdestricta Kauff. | ŏ | x | x | Q,C |
| I. subochracea (Pk.) Pk. | ŏ | x | Ô | Ĉ, |
| I. vaccina Kühn. | ŏ | x | ŏ | c |
| T winocictinitata Crad C Cta | ő | | | ~ |
| I. vinosistipitata Grnd & Stz. | | 0 | X | Q |
| I. whitei (B. & Br.) Sacc. | 0 | X | X | Q,C |
| FHN #2487 | 0 | 0 | x | Q |
| FHN #3976 | 0 | 0 | X | Q |

| FHN #498 | 0 | x | х | C |
|--|------------------|-------------|--------------------------------------|----------------------|
| Nodulose-spored Species | R | N | s | P |
| <pre>I. acystidiosa Kauff. =</pre> | T | 0 | 0 | С |
| | 0 | х | 0 | Q,C |
| I. albodisca Peck I. bresadolae Mass. I. californica Kauff. I. chelanensis Stz. | Ö | x | 0 | č |
| I. californica Kauff. | | | 0 | c c c,c |
| I. chelanensis Stz. | T 0 0 | 0 X X | 0 0 X 0 | C |
| I. decipiens Bres. | 0 | X | x | Q,C |
| I. decipientoides Peck | 0 | X | 0 | C |
| = I. variabillima | | | | |
| I. fallax Peck | 0 | X | 0 | C |
| I. lanuginosa (Fr.) Kummer | 0 | X | 0 | C A C |
| I. leptophylla Atk. | 0 | X | 0 | A |
| I. longicystis Atk. | 0 | X | 0 | C |
| I. mixtilis (Britz.) Sacc. | 0 | X | х | Q,C |
| I. nigrescens Atk. | 0 | X | 0 | C |
| I. oblectabilis Britz. | 0 0 0 0 | х 0 | x | C |
| I. olida Maire | 0 | 0 | X | 0,c c c o,c |
| I. petiginosa (Fr.) Gill. | 0 | X | 0 | č |
| I. umbratica Quel. | 0 | x | 0 | C |
| I. variabillima Speg. | 0 0 0 0 | X X | 0 0 X 0 X 0 0 X | c c q,c |
| I. leptophylla Atk. I. longicystis Atk. I. mixtilis (Britz.) Sacc. I. nigrescens Atk. I. oblectabilis Britz. I. olida Maire I. petiginosa (Fr.) Gill. I. umbratica Quel. I. variabillima Speg. I. xanthomelas Bours. & Kühn. | 0 | X | 0 | ĉ. |

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FOLIICOLOUS FUNGI 8: CAPNODIUM IN CALIFORNIA*

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One species of Capnodium occurs in California, which is redescribed with darkly pigmented and transverse to muriform septate ascospores. Capnodium dematum (V. M. Miller & Bonar) Reynolds nov. comb. is culturally found, as predicted in the literature, to have Phaeoxyphiella fisheri Batista in Batista & Ciferri as its anamorph. Other California fungi identified, misdescribed, and misidentified as Capnodium are annotated.

The systematic stability of the genus Capnodium sensu lato is representative of other ascomycete genera in which the sexual state has been historically presumed to be associated with one or more conidium-producing states. The first concept of the genus followed the spore morphology system of P. A. Saccardo and attributed darkly pigmented, muriform ascospores to the teleomorph and usually hyaline, unicellular or dark muriform pycnidial characters to deuteromycetes presumed as the anamorphs. Taxonomy of the California fungi called Capnodium is a microcosm of mycological progress from a Saccardian view of taxa delimitation based on character categorization to one of the "whole fungus" based on predictable patterns of biologically linked teleomorphs and anamorphs.

^{*} The previous paper in this series was published in Mycotaxon 27:377-403.

Attention was first drawn to California capnodiaceous fungi in the San Francisco Bay area by Cooke and Harkness (1881, 1884) in their series on California fungi. J. B. Ellis and B. M. Everhart (1893-1899) included W. C. Blasdale, A. J. McClatchie and W. H. Harkness collections from the area in their exsiccati series, Fungi Columbiani. Miller and Bonar (1941) described new species and misidentified several collections from similar material from the same area. Batista and Ciferri (1963a, 1963b) incorporated these and other specimens in their monographic revision of the genus and its supposed anamorphs. Records of sooty molds have been made in other areas of California (Farlow, 1876; Millspaugh and Nuttall, 1923; Reynolds, 1987).

CALIFORNIA CAPNODIUM

- 1. Capnodium dematum (V. M. Miller & Bonar)
 Reynolds nov. comb. Miller and Bonar
 1941:411.
 - =Phaeosaccardinula dematum V. M. Miller & Bonar. Miller and Bonar 1941:411-412.
 - =Capnodium baccharidis Batista & Ciferri.
 Batista and Ciferri 1963a:90-92.
 - =<u>Leptocapnodium</u> <u>krameri</u> Batista & Ciferri. Batista and Ciferri, 1963a:123-125. Pro parte, Reynolds, 1971a:151-152.

Type: USA, California, San Mateo County, Moss Beach, H. E. Parks 2139, 17 April 1924, on Baccharis pilularis, UC617322.

ASCOSPORES 5-6 celled, usually forming longitudinal septa in one or more cells at perpendicular to oblique angles to the cross septa; fusiform to elliptical in shape; the mature ascospore is usually larger at one end than the other because of by a smaller septal diameter at or near the median lengthoften giving the effect of a constricted spore; range in length is 25 to 40µ; the forward cell of the two celled immature ascospore formed by the initial transverse septum enlarges more than the lower cell; pigmentation begins to be visible at this stage, as well as a distinct echinulation formed on the outer wall surface; the two-celled

ascospore measures 25 µ in length and 8 the widest cell; ascospore size may remain constant or increase up to 40 µ in length and 12 µ across the wider cell as the number of septa increase; additional cross septa form in each of the two cells; the ascospore may remain transversely septate, or characteristic longitudinal septa will develop in one or more of the ascospore cells. ASCUS eight-spored, with thickened wall at apex and lateral areas; apical chamber with distinct masse apicale; in ascospore dispersal the inner wall layer extends well beyond outer wall layer in the bitunicate fashion; fasciculate, maturing sequentially, obtuse, ventricose; measuring 10-25 µ at widest diameter, 65-100 µ in length. HYMENIUM basal, asci serially maturing; aparaphysate. ASCOCARP WALL multilayered, comprised of textura angularis tissue, the cells larger and lighter pigmented in the wider median area; outer layer externally aparaphysate, with deep brown melanoid wall pigment; inner wall layers producing elongate periphysoids projecting into centrum cavity that seem to be the source of a hygroscopic gelatinous matrix filling the ascus chamber. ASCOCARP 100-150 μ , ostiolate, becoming collabent at times, occurring singly or amassed in groups of up to 15; subtended by a sterile tissue stalk of almost imperceptible length to one cm in length.

ANAMORPH

Phaeoxyphiella <u>fisheri</u> Batista in Batista & Ciferri. Batista and Ciferri 1963b:148-149.

- =Phaeoxyphiella morototoni Batista & Ciferri in Batista & Ciferri. Batista and Ciferri 1963b:149-150.
- =Phaeoxyphiella walteri Batista, Nascimento & Ciferri in Batista and Ciferri. Batista and Ciferri 1963b:152-153.
- [=Hendersoniella sp. described by Fisher 1933:187-188.]

CONIDIOSPORES formed in basal hymenial layer; linearly dispersed in dry catenate extrusion, with the acuminate straight to slightly curved and rounded pigmentless apex of one roughened conidium loosely adhering to the truncate base of

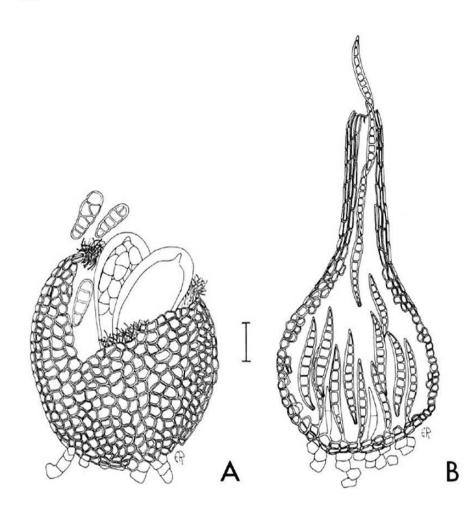


FIGURE 1. Diagramatic representations of the teleomorphic and anamorphic fruitbodies of Capnodium dematum (V. M. Miller & Bonar) Reynolds. A. Ascoma: Two asci extend among periphysoids from the apex of the broken ascocarp wall. Ascospores are shown as two-celled initials, and with transeptate to muriform Conidioma: septation. в. The pycnidium is shown as a longtudinal section. The basal conidiogenous cells produce conidia which become loosely attached, end on end, as they move through and beyond the pycnidial neck. Bar=20 µ .

the darkly pigmented conidium in line above it; length $40-75\mu$; $4-8\mu$ width at widest diameter; with 8 to 15 cross septa. CONIDIOGENOUS CELLS unicellular, hyaline, phialidic, solitary to multiconidiogenic, integrated into wall of conidiomata. PYCNIDIUM (conidium producing) with melanoid pigment in one or two outer layers of wall, comprised of textura globulosa tissue in the lower wall surrounding the conidiogenous centrum changing to textura prismatica tissue from the base of the neck onward to the ostiole; the innermost wall cells lining the conidiogenous centrum are hyaline; neck with central canal for spore dispersal $15-25\mu$ in width, extending $45-80\mu$ in length; lower area containing conidiogenous centrum $40-60\mu$ in diameter and $65-85\mu$ in height to base of neck.

Pure culture isolates were made from single and multiple conidia of P. fisheri, and ascospores of C. dematum on half-strength YMA agar (2g yeast, 5g malt extract, 2g glucose [or 4g sucrose], 15g agar, 1000ml distilled water) and Nitrogen Base Medium (10ml of a concentrate made from 5g KCl, 5g MgSO4.7H2O, 0.1g FeSO4.7H2O added to 1g K2HPO4, 3g NaNO3, 20g sucrose, 15g agar, 1000ml distilled water).

Germinating spores were observed in material collected from nature, as well as on the surface of the agar plates. On 2% plain agar, the hyphae from a germinating conidium were observed to grow downward through the agar with few hyphae developing near the agar surface.

The colonies on YMA agar grew to a diameter of one cm in 14 days. The three-dimensional mycelium remained tightly formed into a pulvinate mass, with no perceptible individual hyphae extending into the agar at any measurable distance. The mycelial mass was transferred to nitrogen base medium without agar and maintained on a shake table at approximately 850 revolutions/minute resulted in no discernable increase in mycelial mass nor change in colony morpholgy after two weeks.

Ascomata and conidiomata development was initiated through the cell division of a hyphal cell or from a cell of an ascospore or a conidium

The type specimen of Phaeosaccardinula dematia, H. E. Parks 2139, was also cited as the type of Naetrocymbe scoriadea Batista & Ciferri, and mentioned as an additional specimen of Leptocapnodium kramerii Batista & Ciferri by Batista and Ciferri (1963a) (with the collector misprinted as H. E. Parker).

Hughes (1976) predicted three Coelomycete taxa as the anamorphic component of Capnodium species, i.e. Fumagospora, Phaeoxyphiella and Scolecoxyphium. The proposed pleomorphy was based on concomitant occurrence in nature and the work of Fisher (1933, 1939) and Fraser (1934, 1935a, 1935b). Representatives of these asexual taxa occur in association with naturally occurring C. dematum. The conidial state later described as Phaeoxyphiella fisheri was suggested as the anamorph of C. dematum (Miller and Bonar, 1941), and has been culturally confirmed here. Fisher (1933), working with Australian species, failed to demonstrate pleomorphy between Phaeoxyphiella fisheri (as Hendersoniella sp.) and any ascosporic state; her spore-derived pure culture proof for the link between Capnodium salicinum Montagne and its anamorph in the same study is unquestionable.

The handwritten label on P. A. Saccardo specimen 2507, from Upper Yarra, Australia (LAM 202028), lists the names C. pelliculosum and C. ellisii Saccardo under C. walteri Saccardo. A coelomycete fitting the description of P. fisheri is present in the collection. I believe that the Saccardo species is based on heterogeneous material. The genus Capnodium is defined as having muriform ascospores (Reynolds, 1978). C. dematum produces ascospores with variable septation from transverse to muriform septation. Often the entire spore complement of an ascus will have only the transversely septate ascospores.

The other Capnodium species that has been suggested as having Phaeoxyphiella fisheri as its anamorph, C. walteri (Hughes, 1976), was described as having only transverse septate ascospores. Acceptance of this species into Capnodium as Hughes advocated (1976) raises a major question. A species with transverse to muriformseptate ascospores is acceptable into Capnodium as it now To admit C. walteri as Fraser (1935b) described the species with only transversely septate ascospores requires an emendation of the genus. Or, the Phaeoxyphiella link must be accepted as a character uniting the variable spore septation pattern. Fraser (1935b) emended the Saccardo description of C. walteri without indicating that the type was reexamined; material from the type locality was mentioned. None of the cited Fraser material that I examined had ascocarps of Capnodium; only Phaeoxyphiella fruitbodies were present. Obviously ascocarps were seen by her in some specimens that were the basis of the emendation. No designation was made in the list of examined specimens cited to indicate whether there was merely a presumption of pleomorphy and the presence of the supposed anamorphic state was taken as evidence of a Capnodium species.

The proof of pleomorphy accepted by Fraser (1935a, 1935b) was indirect, based on cultural characters of the hyphae, such as measurement of the diameter of the colonies. (In some cases only comparative hyphal morphology was used as pleomorphic proof rather than the unquestionable demonstration via production of reproductive structures from single spore isolates.) Fraser's approach to the demonstration of pleomorphy is also evident in her description (Fraser, 1935a) of a variety of C. salicinum based on supposed differences in pycnidial characters, including the septation of the Fisher (1933) had earlier culturally conidium. demonstrated a varability in the number of conidial septa in the anamorph of Capnodium salicinum from an "abnormal" single septum to conidia with "increased septation in a muriform conidium." Based on study of the California and Australian material of C. dematum I consider the pleomorphic link of <u>Capnodium</u> species with an anamorphic state other than <u>Phaeoxyphiella</u> to be tenuous until further data are available.

CALIFORNIA FUNGI MISDESCRIBED AS CAPNODIUM

1. Capnodium spongiosum Barr

-Capnophaeum spongiosum (Barr) Batista & Ciferri. Batista and Ciferri 1963a:108

-Morfea alaskensis (Saccardo & Scalia)

Batista & Ciferri. Batista and Ciferri 1963a:142

-Limacinia alaskensis Saccardo & Scalia

Emended Barr. Barr 1955:501

The concept of Capnodium used by Barr (1955) was "species of sooty molds with muriform spores." The genus Capnodium sensu stricto of Hughes (1976) was characterized by sessile or shortly stalked ostiolate ascocarps without appendages; the ascospores were defined as transverseto muriform septate. Barr characterized the ascocarps of <u>C</u>. <u>spongiosum</u> as being appendaged and sessile, but occurring in or on a mycelial mat comprised of loosely tangled hyphae. Barr observed no longitudinal septa in the ascospores of the California material, although recent collections (LAM300844, LAM300845) demonstrate the variable septation of the ascospore in the California population of this species. The association of anamorphic states predicted for this species have yet to be validated (Barr, 1955; Hughes, 1974, 1976).

The Morfea alaskensis concept of Batista and Ciferri (1963a) was based on California material cited by Barr (1955) in her description of Capnodium spongiosum. The type material of Limacinia alaskensis, the supposed basionym of M. alaskensis, contains only immature ascocarps. Hughes (1974) provisionally included M. alaskensis as a synonym of Euantennaria rhododendri (Woronochin) Hughes.

Our collections of <u>Capnodium spongiosum</u> (LAM300846) are mixed with deuteromycete species in <u>Antennariella</u> and <u>Antennatula</u>. The logic of the <u>Hughes's (1976)</u> hyphal morphology system that redefines the capnodiaceous sooty molds would

place Barr's California <u>C. spongiosum</u> in either one of two families. The pycnidium would indicate the ascomycete genus <u>Antennulariella</u> (allowing for muriform ascospores) of the Antennulariellaceae; the blastospore suggests the genus <u>Euantennaria</u> of the Euantennariaceae. Similar discrepancies can be noted (Hughes, 1968, 1972, 1976) for another California sooty mold, <u>Strigopodia batistae</u> Hughes, which has conidia attributed to it from his Euantennariaceae (<u>Antennatula</u>) and from his Metacapnodiaceae [=Capnodiaceae sensu Reynolds, 1985] (Capnophialophora) .

2. Capnodium rhamni Cooke & Harkness.

The original description of this species by Cook and Harkness (1884) makes this name an anamorphic one. The emended description by Batista and Ciferri (1963a) adds a teleomorph in such a way that the the holomorphn becomes a nomen confusum.

Cooke and Harkness (1884) described the conidia as uniseptate, darkly pigmented, 18-20 x 9 and associated with a sexual state. No asci were described in their material (Harkness #2482).

In Batista and Ciferri (1963a), the <u>C. rhamni</u> type was not declared as having been seen.

Instead, California material (URM2380=IMUR5249 ex BPI) and another California collection (URM2807 =IMUR5669 ex UC) collected by H. E. Parks from Marin county were examined instead.

In their discussion of the URM2380 specimen under Capnodium rhamni Batista and Ciferri (1963a) mentioned that the material came to them from Herbarium BPI labeled as Capnodium rhamni on Rhamnus californicus; they found "only one species of Phaeoxyphiella and another one of Asbolisia." Batista and Ciferri's (1963b) description of Phaeoxyphiella fisheri Batista, Ciferri & Nascimento cites a Herbarium BPI collection with similar data as its type; no IMUR number was given. The specimen was collected "on leaves of Rhamnus, March 1931. Collected near Mirabel mine, Lake Co. Associated

with Asbolisia ampullula Speg. In the same material we were not able to find Capnodium rhamni Cooke and Hark. as determined by H. E. and S. T. Parks. Miller and Bonar (1941) cite a specimen under their discussion of C. rhamni collected, "near Middletown, Lake Co., March, 1931, H. E. Parks 3581." Mirabell Mine is located four miles south of Middletown in Lake County, California (Yates and Hilpert, 1946).

Clearly, the material collected by H. E. Parks from Lake County was used for two species descriptions. The redescription of Capnodium rhamni, was based on a portion which was kept in Herbarium URM as IMUR 5249 (Batista and Ciferri, 1963a). The description of Phaeoxyphiella fisheri (Batista and Ciferri, 19963b) was based on the portion of the material returned to Herbarium BPI.

My examination of URM2380 (= IMUR 5249) revealed P. fisheri, Asbolisia sp., and sporulating Hormonema ?prunorum (Dennis & Buhagiar)
Hermanides-Nijhof. Specimen URM2807 was cited by Batista and Ciferri (1963a) as a gift from Lee Bonar. The data given were "on Rhamnus purshiana D. C., from Marin Co. California U.S.A., ex Herb. Univ. California, Leg. H. E. Parks, Febr. 19, 1931." The fungus present in the collection is Vertixore atronitidum V. M. Miller & Bonar.

Batista and Ciferri (1963a) redescribed <u>C. rhamni</u> "based on this very poor material." The apparent reference is to the two specimens cited as IMUR5249 and IMUR566N. The asci were said to be commonly "early evanescent", but were described anyway. I believe that the Batista and Ciferri redescription of <u>C. rhamni</u> is based on characters from unrelated species present in the collections they examined.

3. Capnodium heteromeles Cooke & Harkness.

This species is a nomen confusum. The description of the spores was tentative (Cooke and Harkness, 1884), made from "free sporidia and hence uncertain." The morphology of the spores was proposed as triseptate, muriform, darkly

pigmented, 18 x 8 µ. The material in the type specimen, now located in Herbarium BPI rather than Herbarium CAS as stated in Miller and Bonar (1941), does not provide additional information about C. heteromeles. Batista and Ciferri (1963a) cited the binomial under "Excluded species of Capnodium" saying that "The spores are not surely recognizable."

Two concepts are outstanding for the California material. The W. C. Blasdale collections, LAM 200614, 200643, 200648, 202012 (= Ellis and Everhart, Fungi Columbiana 114 and North American Fungi 2918), made at the time that W. H. Harkness obtained his California material (LAM 200847), and a few years earlier than M. A. Howe collected material (LAM 200613) have the fruitbodies of the "Capnodium citri" pycnidium. Chaetasbolisia californiana Batista, Ciferri & Nascimento was described from Fungi Columbiana 114 (UC151179) (Batista and Ciferri, 1963b). The interpretation by V. M. Miller and L. Bonar, fifty years later, is supportive of the type description in septation, pigmentation and size of the supposed conidium, LAM 202010, 202068 (Ex California Fungi 603, H. E. Parks collection 3621) Phaeochaetia arbutifoliae Batista, Ciferri & Nascimento was described from California Fungi 603 (Ex UC756704) (Batista and Ciferri, 1962). Reynolds (1982) considered P. arbutifoliae and the California species, Vertixore atronitidum Miller & Bonar to be conspecific. The description of the latter species (Miller and Bonar, 1941) cited the H. E. Parks collection 3621 and C. heteromeles was mentioned as associated with it. Recent collections from the Berkeley area (LAM 300843, 300844, 300845) have conidiomata of these species.

Other taxa have been described from the type material of <u>C. heteromeles</u>. Cooke and Harkness (1884) described <u>Meliolopsis heteromeles</u> Cooke & Harkness and Batista and Ciferri (1963a) found <u>Naetrocymbe stevensonii</u> Batista & Ciferri on the Harkness collection of <u>Heteromeles</u> leaves. Reynolds (1971b) transferred both <u>M. heteromeles</u> and <u>N. stevensonii</u> to <u>Limacinula</u> as synonyms of <u>L. anomala</u> (Cooke & Harkness) Reynolds.

MISIDENTIFIED CALIFORNIA CAPNODIUM

1. Several collections labeled as <u>Capnodium</u> <u>salicinum</u> are mentioned in the literature. The <u>California "Capnodium"</u> ascospores in specimens associated with these reports that have been reexamined are too large for <u>C. salicinum</u> fide the Reynolds's (1978) restudy of the type. They are Capnodium dematum.

Batista and Ciferri (1963a) did not state that they examined the Montagne type of C. salicinum for their monograph of the Capnodiaceae; rather they cited a material from Contra Costa County collected in 1931 by Lee Bonar. This collection is one of Capnodium dematum, UC966391, that A. C. Batista (unpublished data from herbarium label) also listed as having Capnodium salicinum, Phaeoxyphiella morototoni, Fumagospora gaultheriae Batista & Vital, as well as Morfea hendrickxii (Hansford) Batista in the same collection. Collections from California were distributed as Capnodium salicinum Montagne in several exsiccati, including those of W. C. Blasdale in Ellis and Everhart's as Fungi Columbiani #112 and North America Fungi #2917, and that of H. E. Parks as California Fungi #257. Miller and Bonar (1941) cite a questioned C. salicinum determination on #112 as a specimen of Phaeosaccardinula dematum. Batista and Ciferri (1963a) cite the 2917 from P. A. Saccardo's herbarium as the type of Capnodium baccharidis.

Miller and Bonar (1941) refer a California collection to <u>Pleosphaeria</u> <u>salicina</u> (Mont.) Arnaud (Arnaud, 1911). They confusingly described a setose, globose fruitbody and a glabrous <u>Capnodium</u> -like fruitbody "as described by Arnaud" from collections found on the bark of <u>Baccharis pilularis</u> DC. subspecies <u>consanguinea</u> (DC.) Wolf from Marin and Santa Clara Counties.

Batista and Ciferri (1963b) cited a specimen of Fumagospora gaultheriae Batista, Vital & Ciferri associated with Capnodium salicinum from California on Baccharis pilularis, UC756704; this same collection (= LAM200744) serves as the

type specimen of <u>Phaeochaetia</u> <u>arbutifoliae</u> Batista, Ciferri & Nascimento (Batista and Ciferri, 1962).

- 2. Several taxa have been described with darkly pigmented, muriform conidia. Most likely these fungi are related to the species cluster of Fumagospora capnodioides Arnaud, F. cistophila Batista & Ciferri and F. gaultheriae (Arnaud, 1911; Batista and Ciferri, 1963b).
- a. Capnodium elongatum Berkeley & Desmazieres

A California specimen named <u>C. elongatum</u>, collection by Marshall A. Howe, 6 June (error for January, according to L. Bonar [unpublished data]) 1894, was cited under <u>Fumagospora gaultheriae</u> in Batista and Ciferri (1963b). Miller and Bonar (1941) mention a W. C. Blasdale specimen of C. elongatum from Berkeley.

b. Capnodium caespitosum Ellis & Everhart

This species was described from A. J. McClatchie collection 748, July 1894, Pasadena California. The pycnidia were described as subulate-cylindrical, collected into hemispherical clusters, subtended by sparse moniliform hyphae. The conidia were described as muriform, dark-brown, 12-20 x 7-10 μ . I have not seen the type specimen.

c. Capnodium araucariae Thümen

Thümen (1879) gave no description of the fruitbody and detailed the dark muriform spores without indicating their origin. Saccardo (1882) listed this species under "asci ignoti."

This species was reported from Berkeley by Miller and Bonar (1941) as ?Polychaetella araucariae (Thümen) Spegazzini. They note the paucity of details in accounts of the species and the absence of authentic determined material for use in the determination. The larger spores they utilized were "seen out of the perithecia;" smaller spores were observed in the ascocarps.

3. "Capnodium citri complex."

Several species in the sooty mold family Asbolisiaceae of Batista and Ciferri (1963b) have been referred to since the turn of the century in plant pathological literature as <u>Capnodium citri</u> (Farlow, 1876). This group of deuteromycetes, characterized by unicellular, hyaline conidia produced in pycnidia, are species in <u>Leptoxyphium</u>, <u>Podoxyphium</u>, and <u>Polychaeton</u> (unpublished data).

a. Capnodium citri Berkeley & Desmazières.

This name was used by Farlow (1876) for a California deuteromycete found on citrus and olive from San Diego and Santa Barbara. Batista and Ciferri (1963b) reinterpreted collections from Berkeley (W. C. Blasdale on citrus, March 1893) and Los Angeles (D. Coquillett on citrus, August 1889) as Podoxyphium yuccae Batista, Nascimento & Ciferri.

b. Capnodium coffeae Patouillard

Miller and Bonar (1941) uncertainly described under this name pycnidia under this name with hyaline conidia from Inverness Ridge in Marin County.

c. Capnodium footii Berkeley & Desmazières

Miller and Bonar (1941), citing a specimen (uncertain determination) from Berkeley, noted that they had only a pycnidiaceous sooty mold with hyaline, unicellular conidia. This is the same taxon that Batista and Ciferri cited from Moss (erroneously listed as Moon [L. Bonar, unpublished data]) Beach as Scolecoxyphium (Microxyphium) americanum Batista. I. Tavares (personal communication) noted a discrepancy between the conidial size reported for the species by Miller and Bonar (1941), 4-5 x 2-2.5µ, and Batista and Ciferri (1963a) for the generic description, 3-4.5 x 1-1.5µ.

d. Capnodium tuba Cooke & Harkness.

Cooke and Harkness (1884) did not see asci in their specimen #2395 from Palo Alto. ascocarps were described as cylindrical and the questioned conidia were characterized as oval, nonseptate, and hyaline. Batista and Ciferri (1963a) transferred the Cooke and Harkness species to Morfea without seeing the type. based the concept of their new combination on a another Herbarium BPI collection by J. P. Thom. According to them, "It is possible that this material, collected in the same state and on the same genus of the host plant, would be referable to Capnodium tuba, agreeing with the description of Cooke and Harkness of Capnodium tuba for perithecia , since the ascospores were not described."

Miller and Bonar (1941) cite specimens of <u>C</u>. <u>tuba</u> from Sausalito and Ross in Marin County, and from Wildcat Canyon in Contra Costa County consisting only of pycnidia.

SPECIMENS EXAMINED

The specimen data are listed, if known, in the following order: country; state and county, or comparable political division of a country; specific locality; collector and field number; date of collection; most original label determination (det.) and latest redetermination (redet.); associated plant; and curation history are given. The acronyms are those listed in the 1981, Edition 7, of the Index Herbariorum. All specimens examined in the course of this study are listed, whether referable to the species discussed or not.

Portions of a borrowed foliicolous fungal collection are many times retained by an investigator and added to an associated herbarium. This standard practice has, in my experience, resulted in multiple names for the same fungus, especially in the work of A. C. Batista and R. Ciferri. Knowing the collector of the specimen and the curation history as well are

often a valuable aid in the interpretation of a species, especially where the material is scanty or no longer in good condition. Therefore, the herbaria where the specimen at hand has been curated as part of a larger portion are listed as part of the specimen data when these data are known.

AUSTRALIA. New South Wales: Ullaula, L. R. Fraser, April 1934, det. Capnodium walteri, on Casuarina glauca, LAM2009918 (Ex BPI, ex K), LAM200977 (Ex IMI26088). Victoria: Upper Y Upper Yarra, Walter, det. <u>Capnodium walteri</u> and <u>Capnodium pelliculosum and Capnodium ellisii</u>, on Bursaria spinosa LAM200791 (Ex PAD2507, ex herbarium of P. A. Saccardo). Wyong, L. R. Fraser B101, 9 January 1935, det. Capnodium walteri, LAM200750 (Ex DAR12717=DAOM110692). National Park: L. R. Fraser A93, June 1933, det. Capnodium walteri, on Dodonsea sp., LAM200752 (Ex DAR14686). FRANCE. Eure-et-Loir. Dreux, Gallet and Feulleaubus 571, September 1883, det. Capnodium footi and Fumago fagi, LAM201523 (Ex ILL, ex C. Roumeguere Fungi Selecti Gallici Exsiccati 3096). ITALY. Palermo: V. Beltrami, October 1883, det. Capnodium araucariae, LAM200662 (Ex ILL, ex Rabenhorst Fungi Selecti Gallici 3051). Parma: Passerini, 1875, det. Capnodium australe, redet. Fumagospora gaultheriae, on Alnus glutinosa, LAM201241 (Ex URM4806=IMUR10905, ex P. A. Saccardo herbarium, ex Thümen Mycotheca Universalis 1350), LAM201242 (Ex URM4808 =IMUR10907, ex Thümen Herbarium Mycologicum Oeconomicum 433). Verona: 1876, det. Fumagospora gaultheriae, on Alnus glutinosa, LAM201232 (Ex URM4518=IMUR10616, ex P. A. Saccardo herbarium). PORTUGAL. Coimbra: A. F. Möller, August 1878, det. Capnodium araucariae, LAM201495 (Ex ILL, ex de Thümen, Mycotheca Universalis 1737). A. F. Möller, det. Capnodium araucariae, LAM201529 (Ex ILL, ex C. Roumeguere Fungi Selecti Gallici Exsiccati 5037). USA. California: Alameda County, Sunol, W. H. Harkness 2425, April 1881, det. Meliopsis heteromeles and Capnodium heteromeles, on Heteromeles, LAM200847 (Ex BPI, ex CAS1961). Alameda County, Berkeley, M. A. Howe, 15 June 1892, det. Capnodium heteromeles, on Heteromeles arbutifolia, LAM200613 (Ex

ILL6642, ex California Fungi). Alameda County, Berkeley, W. C. Blasdale, March 1893, det. Capnodium heteromeles, LAM200643 (Ex ILL, ex Ellis and Everhart, North American Fungi 2918) LAM200648 (Ex ILL, ex Ellis and Everhart Fungi Columbiani), LAM 202012 (Ex FLASf1870). Alameda County, Berkeley, University of California campus, Robert Ornduff, 5 February 1988, det. Capnodium dematum, on Baccharus pilulans LAM300844. Alameda County, Berkeley, University of California campus, Don R. Reynolds, November 1987, det. Capnodium dematum, on Baccharus pilulans LAM300843. Alameda County, Berkeley, University of California campus, Don R. Reynolds, 30 March 1988, det. Capnodium dematum, on Baccharus pilulans LAM300845. Contra Costa County, Mt. Diablo, W. H. Harkness 2482, May 1881?, det. Capnodium rhamni, LAM200874 (Ex URM2380=IMUR5249, ex BPI, ex CAS). Contra Costa County, north end of Wildcat Canyon, Lee Bonar, 21 April 1931, det. Phaeosaccardinula dematia, on Baccharus pilulans, LAM201029 (Ex UC966391, ex California Fungi 796), LAM205515 (Ex ILL,). Tilden Regional Park, Ron Rossa, 1969, det. Phaeosaccardinula dematia, on Baccharus pilulans, LAM205443 (Ex IMI142282). Del Norte County, South Fork of the Smith River, Rock Creek Lodge, W. B. Cooke and V. G. Cooke 25536, 16 August 1949, det. Capnodium spongiosum, on Chamaecyparis lawsoniana, UC915700 (Ex Mycobiota of North America 400). Del Norte County, Smith River Lodge, H. E. Parks 5174, September 1934, det. Capnodium tuba "conidial stage", on Umbellaria californica, LAM201226 (Ex URM2806=IMUR5668, ex UC, ex Fungi of California). Del Norte County, Smith River, H. E. Parks 5936, May 1937, det. Arthroboytrum spongiosum, redet. Capnodium spongiosum, redet. Capnophaeum spongiosum, on Libocedrus decurrens, LAM205509 (Ex UC692997), LAM205504 (Ex UC681382, ex California Fungi 418). Del Norte County, Smith River, Lee Bonar, 13 July 1933, det. Arthrobotryum spongiosum, redet. Limacinia multiseptata, on Libocedrus decurrens, LAM205507 (Ex UC960424). Marin County, H. E. Parks, 19 February 1931, det. Capnodium rhamni, LAM200875 (EX URM2807=IMUR5669, EX UC). Marin County, Inverness, H. E Parks, det. Capnodium salicinum plus Chaetasbolisia, redet.

Phaeosaccardinula dematia, on Baccharis pilularis, LAM201031 (Ex UC4394878, ex California Fungi 257). Marin County, Mt. Tamalpais, H. E. Parks 3065, det. Aithalomyces rhododendri, on Arctostaphlys sensitiva, LAM200583 (Ex ILL, ex UC21436). Marin County, Mt. Tamalpais, Fire Trail, H. E. Parks, 21 March 1926, det. Aithalomyces rhododendri, redet. Limacinia multiseptatum, redet. Ophiocapnocoma multiseptatum, on Manzanita, UC276037 (misprinted in Batista and Ciferri, 1963a as UC275037). Marin County. Marin County, Mt. Tamalpais, H. E. Parks 3406, April 1929, Aithaloderma rhododendri, on Arctostaphylos sensitiva, LAM200888 (EX UC371934). Marin County, Mt. Tamalpais, Vera Mentzer, March 1933, det. Aithalomyces rhododendri, redet. Limacinia multiseptata, on Arctostaphylos sensitiva, LAM205503 (Ex UC498813, ex California Fungi 301). Marin County, Mt. Tamalpais, Mill Valley, southside, Cascade Trail, W. B. Cooke 16789, 23 August 1942, det. Aithalomyces rhododendri, on Arctostaphylos sensitiva, LAM205508 (Ex UC681322). Marin County, east of Point Reyes lighthouse, Lee Bonar, 14 July 1939, det. Phaeosaccardinula dematia, on Baccharus pilulans, LAM201030 (Ex UC620826), LAM200620 (Ex ILL31390). San Mateo County, Moss Beach, H. E. Parks 2139, 17 April 1924, det. Phaeosaccardinula dematia, on Baccharis pilularis, LAM200885 (EX UC617322), LAM200622 (EX ILL31509), LAM200504 (EX URM9128 =IMUR13161, ex BPI). Sierra County, Sierra City, Don R. Reynolds, 9 April 1988, det. Capnodium spongiosum, on Libocedrus decurrens, LAM300846. Sonoma County, 2 miles east of Camp Meeker, M. A. Nobs and A. R. Kruckeberg, 28 September 1947, det. Arthrobotryum spongiosum, on Cupressus sargentii, LAM200483 (Ex UC960406). Sonoma County, between Knights and Alexander Valley, H. E. Parks 3622, 20 May 1931, det. Capnodium heteromeles , redet. Phaeosaccardinula anomala, on Photenia arbutifolia , LAM200550 (Ex URM12490=IMUR5276), LAM200615 (Ex ILL6644), LAM200744 (Ex UC75f6704, ex California fungi 603), LAM201512 (Ex FLASf41882). Washington: H. E. Bailey,, March 1935, Mt. Ranier National Park, Adelaide Lake, det. Phaeosaccardinula dematia, on Abies amabilis, LAM200481 (Ex UC620741).

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A NEW SPECIES OF GYMNOPILUS FROM NORTHERN CALIFORNIA

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This highly distinctive species of <u>Gymnopilus</u>, growing on fallen pine logs, was collected in <u>Wunderlich</u> Park in San Mateo County, California. The description which follows is taken from a thesis submitted to San Francisco State University in partial fulfillment of the Master of Arts degree in Biology (Seidl 1987).

The colors cited in the following description are from Kornerup and Wanscher (1978).

Gymnopilus thiersii Seidl, sp. nov. Fig. 1.

Pileus (1-2-)3-15 cm latus, primo convexus, deinde planus, postremo subdepressus, siccus, fibrillosus vel squamulosus discum versus, margine appendiculatus, initio omnino purpureo-brunneus, dein subflavidus et squamis subaurantio-brunneis vel rubello-brunneis tectus; vestigia veli partialis brunneolo-aurantia. Lamellae luteae vel subaurantio-brunneae, adnatae vel annexae, confertae. Stipes 3-10 cm longus x 0.7-3.2 cm crassus, aequalis vel attenuatus sursum, solidus, subfibrillosus, dilute aurantiacus, supra annulum vulgo purpureus; apex dense pruinosus, pruina e vinaceo albescens. Annulus apicalis, submembranaceus. Sporae 6-7.8 x 4.2-4.8(-5) um, ellipsoideae, asperae, in cumulo aurantiaco-brunneae. Cheilocystidia lecythiformia, hyalina.

Basidiocarpía solitaria vel gregaria, ad lignum arborum coniferarum. Holotypus: Wunderlich Park, San Mateo County, California, 13 March 1987, leg. M. T. Seidl 2291 (SFSU).

Pileus (1.2-)3-15 cm broad, convex expanding to plane or slightly depressed on disc, irregular in age, purple brown to reddish brown (8E7), margin inrolled, appendiculate with mandarin orange (6B8) to brownish orange (6C8) veil remnants, even, sometimes slightly hygrophanous,

¹Present address: University Herbarium, University of California, Berkeley, California 94720



Fig. 1. Gymnopilus thiersii, holotype. Basidiomes ca. X .5.

always fibrillose; surface dry, fibrillose, becoming scaly towards the disc, scales becoming erect, rimose-areolate in mature specimens, light orange (5A4, 5A5) to reddish brown (8E7), background pale yellow (3A3) or pastel yellow (3A4), developing vinaceous tints or, rarely becoming watersoaked where injured; context up to 2 cm thick on disc, white to pallid becoming purplish red (14A8) to deep Magenta (14E8) above lamellae and yellowish above stipe. Taste slight to very acrid.

Lamellae adnate to adnexed, some with a decurrent tooth, crowded, edges becoming eroded in age, pale yellow (3A3), butter yellow (4A5), maize (4A6), sunflower (4A7), or deep yellow (4A8), becoming orange (6A8), dark orange or light brown (6D6) in age, bruising orange brown to brown where handled.

Stipe 3-10 cm long, apex 0.7-3.2 cm thick, equal or tapering upward, some flattened due to growth habit, attachment central to slightly eccentric, solid, surface streaked-fibrillose, pale orange (6A3) to greyish orange (6B3) background, purple (15C8) to dark purple (14F8) above annulus, sometimes with slight vinaceous tints below annulus, whitish tomentum at base, staining brownish orange (6C8) where handled, apex densely pruinose, pruina dark purple at first, becoming white when mature; annulus apical, submembranous, may appear densely fibrillose, usually persistent; context white becoming yellowish in center and vinaceous at margins.

Spores 6-7.8 x 4.2-4.8 um, ellipsoid, roughened, nondextrinoid, without germ pore, brown to rusty brown in Melzer's reagent; orange brown or reddish golden (6B8, 6C7, 6C8, 6D7) in mass. Basidia 27-40(-43.5) x 6-10 um, clavate, hyaline, guttulate, (two)four-sterigmate. Pleurocystidia lacking. Cheilocystidia lecythiform, hyaline, capitate or non-capitate, thin-walled, 34-38 x (3-4.5 at head) 8-13 um. Caulocystidia present. Lamellar trama of subparallel and slightly interwoven hyphae, rusty brown oleiferous hyphae apparent when mounted in 3% KOH. Hymenium orange brown, subhymenium light orange.

Cuticle of light brown, repent, cylindric to slightly inflated, thin-walled hyphae, 7.5-15 um in diam, with encrusting pigments and fascicles of hyphae; clavate encrusted pileocystidia present; pileus context of interwoven, cylindric to filamentous hyphae, slightly darker than cuticle with scattered orange brown oleiferous hyphae, 3-5.5 um in diam. Clamp connections present.

Habit, habitat and distribution. Solitary to gregarious. On fallen Pinus radiata D. Don. (Monterey pine), erumpent between scales of outer bark. January to April. California.

Material examined. California: M. T. Seidl 2291 (HOLOTYPE: SFSU), M. T. Seidl 2305 (ISOTYPE: SFSU), Wunderlich Park, San Mateo County, California.

The burgundy, vinaceous or purplish tones present on the young unexpanded pileus and stipe make this species quite distinct. Singer (1986) refers to the following species with lilac or violet tones: G. janthinosarx (Sing.)Sing., G. calobasis, Pyrrhoglossum lilacipes Sing., and P. lilacinum Horak. Gymnopilus janthinosarx is from coniferous trees in Central Asia, has a lilacviolet context and a slightly viscid pileus (Singer 1949). Gymnopilus calobasis is an unpublished species from Amazonia, and no data are available concerning its characteristics. The two species of Pyrrhoglossum are characterized by an eccentric or lateral stipe, and are readily distinguished from <u>G. thiersii</u>. <u>Gymnopilus luteofolius</u> (Pk.) Singer has a <u>similarly colored pileus</u>, <u>but the contextual colors are different and the spores are dextrinoid</u> (Hesler 1969). A related species, <u>G. viridans</u> Murr., has nondextrinoid spores and lacks pleurocystidia, plus many other differences such as an umbonate pileus and in the colors of the basidiome. Flammula purpurata Cke. et Mass. (now a Gymnopilus), described from Australia (Cleland 1976), appears to be the most closely related species, however, the basidiome is much smaller, may possess greenish tones on the pileus, lacks purple or vinaceous tones above the annulus, the spores are oblique and not ellipsoid, and cystidia are lacking.

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THE LICHENS OF SERPENTINE ROCKS AND SOILS IN CALIFORNIA

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SUMMARY

Seventy-six species of lichens in 33 genera were collected from serpentine rocks and soils at five locations in central California. This number was approximately double that of the genera and species reported for serpentine areas in Bosnia, Yugoslavia. None of the serpentine-endemic lichens reported for Bosnia were found in California; however, the prominent species on serpentine rocks were similar for both areas. Fourteen percent of the lichens found on California serpentine were cyanophilic, and 11 percent were endolithic; 12 percent of the lichens collected on the highmagnesium serpentine were identified by various authorities as calcareous species.

INTRODUCTION

The unusual floras of serpentine soils have been of interest to botanists around the world for hundreds of years. The paucity of species, dwarfism, xeromorphism, and endemism of these floras have been attributed to various chemical and physical factors (Brooks, 1987) including the following:

- · low levels of plant nutrient in the soils:
- excesses of magnesium over calcium;
- high concentrations of phytotoxic chromium, nickel and cobalt; and
- the well-drained character of the shallow soils.

It has also been suggested that the growth of endemic plants on serpentine soils is related to the freedom from competition provided by the substrate rather than to specific nutritional requirements. The general consensus at present is that no single factor is responsible for the serpentine vegetation but that a combination of edaphic and biotic factors results in the unusual serpentine floras (Brooks, 1987).

The serpentine areas in the central coastal ranges of California have been studied by scientists of many disciplines (Whittaker, 1954, 1960; Barbour & Major, 1977; Kruckeberg, 1984a, 1984b, 1984c). Their reports contain examples of serpentine-endemic vascular plants, disjunct populations, and ecotypic variations; however, virtually no mention is made of the lichen or moss floras and their relationship to the serpentine substrate. The only field study to describe the lichen flora of serpentine substrates was performed by Ritter-Studnicka and Klement (1968) in the Republic of Bosnia in Yugoslavia. purpose of this study was to increase our knowledge of lichen floras on serpentine substrates by collecting, identifying, and comparing the lichens from five serpentine sites in California; in addition, comparisons were made between the lichen floras on serpentine substrates in Bosnia and in California

METHODS

Five areas of serpentine substrate were located on the geological maps of California with the assistance of staff at the California Division of Mines and Geology (Fig. 1). The study sites chosen: (1) include serpentine exposures distributed over the central portion of the state, (2) represent typical serpentine conditions, (3) have published analyses of the soil and rock substrates, and (4) have vascular plant species characteristic of and/or endemic to serpentine.

To ensure a complete sampling of the lichen flora, the author and a fellow botanist made at least two collection trips to each site (except for the Monkey Rock site which was visited only once by three botanists). The descriptive features of the study areas are given in Table 1; additional site information is found in Sigal (1975).

Lichens were identified using the most suitable keys and descriptions available for California's saxicolous lichen flora, which has been largely neglected except by Hasse (1913) and Herre (1910). In places where these sources were incomplete, it was necessary to use the more general works of Fink (1935), Howard (1950), Nearing (1947), and Duncan (1959). Saxicolous species were also studied by Wetmore (1968) and Brodo (1968). Although these latter manuscripts describe floras of eastern sections of the United States, they were helpful in some determinations.

Specimens in question were compared with known specimens in the herbaria at San Francisco State University and the University of California at Berkeley. Synonymy was a recurring problem, as were recent changes in nomenclature. The problem of comparing serpentine lichens in Bosnia with those in California was best expressed by Herre (1910): "Perhaps no more important work could be done than the careful overhauling of the synonymy of American lichens by someone who has access to the published exsiccata of Europe and America as well as the literature of the subject."

Collections that were particularly difficult to identify and that were not represented by specimens in the local herbaria were mailed to specialists for

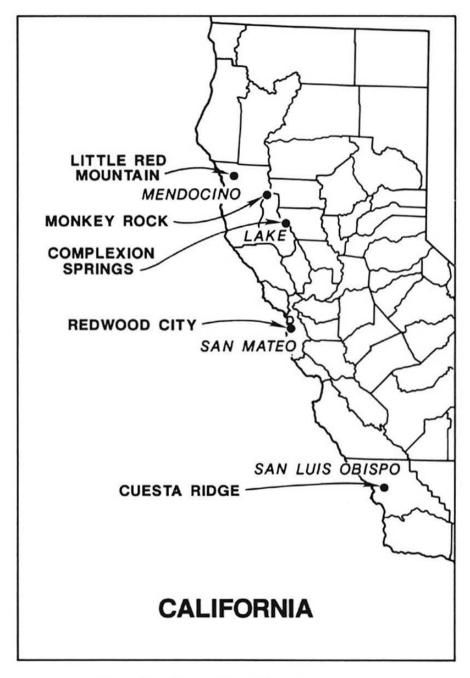


Fig. 1. Map of collection sites.

Table 1. Descriptive features of the study areas.

| Site | Elevation | Temperature extremes (1963-1972)* | Annual precipitation (normal)* | Representative vascular plant species |
|--|-----------|---|--|--|
| Little Red Mountain, Mendocino County Legget Quadrangle R.5 E T.23 N | 762 m | -7.8 to 37.7°C | 180 cm C | Pinus attenuata Lemmon Cupressus sargentii Jeps. Onychium densum Brack. Libocedrus decurrens Torr. |
| Complexion Springs, Lake County Clearlake Oaks Quadrangle R.6 W T.15 N | 610 m | -6.6 to 40.6°C | 58 cm <u>C</u> G | Cupressus sarqentii . macnabiana A. Murr. Auercus durata Jeps. Garrya conqdoni Eastw. Arctostaphylos viscida Parry |
| Cuesta Ridge, San Luis Obispo County San Luis Obispo Quadrangle R.36 W T.29 S | 610-762 m | -2.2 to 37.7°C | 102 cm <u>F</u> | Cupressus sarqentii Pinus coulteri D. Don Onychium densum Monardella palmeri Gray Chorizanthe breweri Wats. |
| Redwood City, San Mateo County Woodside Quadrangle R.4 W T.11 S | 183 m | -2.2 to 37.7°C | 51 cm <u>I</u> <u>M</u> <u>F</u> | Quercus <u>durata</u> .ewisia <u>redivia</u> Pursh <u>Mimulus douglasii</u> Gray <u>Pritillaria liliacea</u> Lindl. <u>Muilla maritima</u> Wats. |
| Monkey Rock, Hull Mountain, Mendocino County Hull Mountain Quadrangle R.10 W T.20 N | 1,890 m | No information | 140 cm <u>I</u> | Pinus jeffreyi Grev. & Balf Libocedrus decurrens Quercus garryana Dougl. var. breweri Jeps. |

^{*}U.S. Weather Bureau, 1963-1972.

confirmation or identification. Dr. John W. Thomson assisted with Verrucaria, Physcia, Dermatocarpon, and Aspicilia. A specimen and chromatogram of Xanthoparmelia cumberlandia (Gyeln.) Hale was sent to Dr. Mason E. Hale, Jr., for confirmation. A single collection of an unknown "Bacidia" from Complexion Springs was sent to Dr. Brian J. Coppins. He identified it as Ramonia gyalectiformis (Zahlbr.) Vězda and mailed the collection to Dr. Vězda for his comments. Dr. Coppins stated that as far as he knew, the species was known only from its type locality at Palm Springs (Hasse 1913).

Loans of material, particularly <u>Lecidea</u>, were made from Dr. Hannes Hertel, Dr. Chris Davidson, Dr. Howard Crum, Dr. John Thomas, and Dr. Isabelle Tavares. Species of the genus <u>Aspicilia</u> were a problem, and Dr. William Weber was consulted regarding this perplexing group. Collections were deposited at San Francisco State University. Nomenclature in this report follows that of Egan (1987).

RESULTS AND DISCUSSION

Seventy-six species of lichens in 33 genera were collected from the five serpentine sites (Table 2). Compared to the study by Ritter-Studnicka and Klement (1968), which reported 39 species of lichens in 16 genera on serpentine in Bosnia, this study indicates the richness of the lichen flora of California serpentine.

For several reasons, the largest number of different lichens (42 species) was collected at Complexion Springs. This site had very large areas of weathered and unweathered serpentine as well as a constantly running stream that created yet another ecological niche. Although Little Red Mountain also had a constant water supply, fewer species (31) were collected at this site. The substrate was a fairly

homogeneous dunite type of serpentine, and this characteristic probably explains the more limited number of species.

Both Redwood City and Cuesta Ridge lacked stream water, but the Redwood City site with 24 species consistently had more in common with Complexion Springs than with Cuesta Ridge (24 species). Species at Redwood City were similar to those at Complexion Springs, probably because the blue-green type of serpentine was common to both of these sites, whereas Cuesta Ridge consisted largely of outcroppings of a weathered, brownish peridotite type of serpentine.

Cuesta Ridge had 11 species that were found only at this southernmost site. Since neither climate nor substrate were substantial variables, one must consider other factors to explain the variation. Observers of the vascular plant flora indicate that the area of San Luis Obispo is unique for its number of endemic species. The flora of the Santa Lucia Mountains (Cuesta Ridge) contains many vascular plant species that have widely or markedly distinctive distributions due to isolation from connecting ranges. It appears that topography may influence also the lichen flora at Cuesta Ridge. the species found only at this site, Thelidium is considered a southern California lichen, and Peltula omphaliza is a distinctly southwestern species. Lecanora argopholis and three species of Caloplaca were unique to the southern collection site. particular, Caloplaca bolanderi, with its outstanding iridescent red apothecia, was commonly present. The other species at Cuesta Ridge were also found at Complexion Springs and Little Red Mountain.

There were 15 species of lichens collected at Monkey Rock, eight of which were not found elsewhere. These eight were lichen species expected at higher altitudes.

Table 2. Lichen genera and species (according to Egan 1987).

| | Taxon | Complexion Springs | Cuesta Ridge | Little Red Mountain | Redwood City | Monk ey Rock |
|-----|-------------------------------------|-----------------------|-----------------|------------------------|-----------------|-----------------|
| 1. | Acarospora fuscata (Nyl.) Arnold | х | х | x | | х |
| 2. | Acarospora schleicheri (Ach.) Massa | | | | | |
| 3. | Aspicilia caesiocinerea | | | | | |
| | (Nyl. ex Malbr.) Arnold" | X | X | X | X | X |
| 4. | Aspicilia cinerea (L.) Korber | x | | | | X |
| 5. | Buellia badia (Fr.) Massal. | x | | | | |
| 6. | Buellia punctata (Hoffm.) Massal. | | | | x | |
| 7. | Buellia spuria (Schaerer) Anzi | X | | X | | |
| 8. | Buellia stellulata (Taylor) Mudd | | | | | X |
| 9. | Buellia vilis Th. Fr. | X | | X | | |
| 10. | Caloplaca bolanderi (Tuck.) Magnuss | on | X | X | | |
| 11. | Caloplaca laeta Magnusson | | | | | X |
| 12. | Caloplaca squamosa (B. de Lesd.) | | | | | |
| | Zahlbr. | X | X | X | X | |
| 13. | Caloplaca sp., Unknown #1 | | x | | | |
| 14. | Caloplaca sp., Unknown #2 | x | | | | |
| 15. | Candelaria concolor (Dickson) | | | | | |
| | B. Stein | | x | | | |
| 16. | Candelariella vitellina (Hoffm.) | | | | | |
| | Mull. Arg. | x | x | x | x | X |
| 17. | Catapyrenium cinereum (Pers.) Körbe | r* X | | x | x | |
| 18. | Catapyrenium lachneum (Ach.) R. San | t" | | | x | |
| 19. | Catillaria lenticularis (Ach.) Th. | Fr. X | | | | |
| 20. | Cladonia coniocraea auct. (fide Aht | i) X | x | x | | |
| 21. | Cladonia pyxidata (L.) Hoffm. | x | | x | X | |
| 22. | Dermatocarpon miniatum (L.) Mann_va | r. | | | | |
| | complicatum (Light.) T. Fries | | | | | X |
| 23. | Dimelaena radiata (Tuck.) Hale & Cu | lb. | | X | | |

Table 2. Lichen genera and species - Cont.

| | Taxon | Complexion Springs | Cuesta Ridge | Little Red Mountain | Redwood City | Monk ey Rock |
|----------|---|-----------------------|-----------------|------------------------|-----------------|-----------------|
| 24. | Diploschistes scruposus (Schreber) Norman | | | | х | |
| 25. | Diplotomma alboatrum (Hoffm.) Flotos | a . | | | x | |
| 26. | Euopsis pulvinata (Schaerer) Nyl. | | | x | | |
| 27. | Flavopunctelia flaventior (Stirton) | | | 1.75 | | |
| THE WALL | Hale | | x | | | |
| 28. | Lecanora argopholis (Ach.) Ach. | | x | | | |
| 29. | Lecanora polytropa (Hoffm.) Rabenh. | x | X | | | |
| 30. | Lecanora pulicaris (Pers.) Ach. | x | | | | |
| 31. | Lecanora rupicola (L.) Zahlbr. | | | | | X |
| 32. | Lecanora scotopholis (Tuck.) Timdal | x | | | | |
| 33. | Lecanora sp. | | | X | | |
| 34. | Lecidea atrobrunnea (Ramond in | | | | | |
| | Lam. & DC.) Schaerer | x | | | | |
| 35. | Lecidea fuscoatra (L.) Ach. | | | x | | X |
| 36. | Lecidea tessellata Flörke | X | | x | x | |
| 37. | Lecidea sp. | x | | X | | X |
| 38. | Lecidella carpathica Körber | x | x | x | x | |
| 39. | Lecidella stigmatea (Ach.) Hertel | | | | | |
| | & Leuck. | x | x | x | | |
| 40. | Leptochidium albociliatum (Desmaz.) | | | | | |
| | M. Choisy | X | | X | x | |
| 41. | Leptogium californicum Tuck. | X | | X | x | |
| 42. | Leptogium corniculatum (Hoffm.) Mini | ks X | | | | |
| 43. | Leptogium sp. | | | x | | |
| 44. | Pannaria leucophaea (Vahl) P. Jørg. | | | x | | |
| 45. | Parmeliella cyanolepra (Tuck.) Herre | Э | | x | x | |
| 46. | Peltula bolanderi (Tuck.) Wetm. | | | X | x | |

Table 2. Lichen genera and species - Cont.

| | Taxon | omplexion Springs | Cuesta Ridge | Little Red Mountain | Redwood City | Monk ey Rock |
|------------|--|----------------------|-----------------|------------------------|-----------------|-----------------|
| 47. | Peltula omphaliza (Nyl. in Eckf.) We | t.m. | х | | | |
| 48. | Physcia adscendens (Fr.) H. Olivier | | X | | | |
| 49. | Physcia stellaris (L.) Nyl. | | 185 | | | Х |
| 50. | Physconia grisea (Lam.) Poelt f. isidiigera (Zahlbr.) Thomson comb. nov. | x | | | | - |
| 51. | Physconia distorta (With.) Laundon | X | x | | x | |
| 52. | Placynthium nigrum (Huds.) Gray | | | x | | |
| 53. | Psora globifera (Ach.) Massal. | x | | x | x | |
| 54. | Psorula rufonigra (Tuck.) G. Schneider | | | х | | |
| 55. | Pyrenopsis phaeococca Tuck. | x | | x | x | |
| 56. | Ramonia gyalectiformis (Zahlbr.) Vez | da X | | | | |
| 57. | Rhizocarpon bolanderi (Tuck.) Herre | x | x | | x | |
| 58. 59. | Rhizocarpon geographicum (L.) DC. Rhizocarpon grande (Florke ex Flotow |) | | | | Х |
| | Arnold | | x | | | |
| 60. | Rhizocarpon viridiatrum (Wulfen) Kor | ber X | 150 | | | |
| 61. | Rhizoplaca chrysoleuca (Sm.) Zopf. | | | | | X |
| 62. | Rhizoplaca melanophthalma (DC. in La DC.) Ramond | m. & | | | | x |
| 63. | Rinodina tephraspis (Tuck.) Herre | x | x | | | |
| 64. | Tephromela atra (Huds.) Hafellner | | | | x | |
| 65. | Thelidium sp. * | | X | | | |
| 66. | Toninia aromatica (Turner ex Sm.) Ma | ssal. X | | x | | |
| 67. | Toninia squalida (Schleicher ex Ach.) Massal. | | | | х | |

Table 2. Lichen genera and species - Cont.

| | Taxon | Complexion Springs | Cuesta Ridge | Little Red Mountain | Redwood City | Monk ey Rock |
|-----|---|-----------------------|-----------------|------------------------|-----------------|-----------------|
| 68. | Umbilicaria krascheninnikovii (Savicz) Zahlbr. | | | | | х |
| 69. | Umbilicaria phaea Tuck. | X | | | | X |
| 70. | Verrucaria aethiobola Wahlenb. in A | ch. X | | | | |
| 71. | Verrucaria margacea (Walhenb. in Ac | h.) | | | | |
| | Wahlenb. | X | | | | |
| 72. | Verrucaria muralis Ach. | X | | | | |
| 73. | Verrucaria nigrescens Pers. | X | | x | | |
| 74. | Verrucaria viridula (Schrader) Ach. | X | | x | | |
| 75. | Xanthoparmelia cumberlandia (Gyelni | k) | | | | |
| | Hale | X | x | | | |
| 76. | Xanthoria sp. | | X | | | |

^{*}Species considered to be calciphilous by various authors.

Of particular interest were the well-developed colonies of <u>Rhizocarpon geographicum</u>. Kruckeberg (1971) discusses <u>R. geographicum</u> in relation to serpentine: "Little is known yet about the edaphic preferences of bryophytes and lichens in the Pacific Northwest. One most striking case is the near absence on serpentine of the crustose lichen <u>R. geographicum</u>. It is plentiful on circumjacent nonserpentine rocks." In California I found <u>R. geographicum</u> on serpentine only at high-elevation sites.

There was another yellow Rhizocarpon on the serpentine at mid-elevation sites that at first was mistaken for a depauperate R. geographicum but was identified as R. viridiatrum on closer inspection. It was listed only for the Complexion Springs site, but I have also found thriving colonies at other serpentine sites, particularly the Elwell Ranch property at Cedar Mountain, Alameda County, California, and at Goodyear's Bar, Sierra County, California. Hasse (1913) cited a collection of R. viridiatrum on "trap" rock, and Herre (1910) noted a collection on sandstone, adding that R. viridiatrum was "a distinct species, very rare with us." It is possible that R. viridiatrum is a serpentine species since it is not commonly found elsewhere. collections were made of another lichen that, according to Herre (1910), is abundant on serpentine. Rinodina tephraspis was found at Complexion Springs and at Cuesta Ridge on the brownish, weathered peridotite.

When the identifications were completed, some general floristic patterns were detected. Whether these patterns are related to the chemical or physical factors of serpentine substrates has not been determined because the source of nutrients and elements and the effects of substrate on saxicolous lichen species are largely unknown. Nevertheless, 14 percent of the lichens found at the serpentine

sites were cyanolichens compared to an estimated 8 percent of lichens worldwide (Hitch and Stewart. 1973). Galun et al. (1982) suggest that cyanophilous lichens adapt well to extreme physical conditions; they may also be tolerant of extreme chemical conditions. Endolithic lichens represent 11 percent of the species found on the various types of serpentine rock. Apothecia on the rock surfaces were the only clues to the presence of these lichens. At Monkey Rock, there were many welldeveloped apothecia of an unknown species of Lecidea on the slick, blue-green type of serpentine. Several species of Caloplaca were commonly endolithic, including: C. bolanderi, C. laeta, and C. "festiva" (identification uncertain). Lecanora polytropa was also present, recognizable by its light-brown, solitary apothecia scattered over the flat surfaces of the rocks as well as grouped in the crevices. There were several species of Verrucaria. their presence evident only by the partially innate perithecia, V. margacea and V. aethiobola in particular. Although these species were noted by Fink (1935) as having thalli that "sometimes disappear," the serpentine substrate appears to intensify the endolithic characteristic of the lichens for unknown reasons. A study by Wilson et al. (1981) on the weathering of serpentine by Lecanora atra suggested that lichens can sequester harmful ions in an amorphous silica gel that is formed from the oxalic acid secreted by the mycobiont and thus can tolerate high concentrations of phytotoxic elements. It is not known if the same strategy applies to endolithic lichen species on serpentine.

Twelve percent of the lichens collected on the high-magnesium serpentine were identified by various authorities as calcareous species. An outstanding example, the soil lichen <u>Catapyrenium cinereum</u>, was very abundant and obvious in the spring when mats of

the squamulose thallus were still green and turgid from the rains. During the summer, the lichen was harder to find, because the thallus dried brown and blended with the soil. According to Dr. John W. Thomson, C. cinereum is distinctly a calciphilous lichen, yet, predictably, it is found on the soil in serpentine areas. Ritter-Studnicka and Klement (1968) briefly mention "vague soil genera which also settle on chalk." They included in this group Dermatocarpon miniatum, Candelariella vitellina, Physica caesia (Hoffm.) Fürnr., and Placodium saxicolum (Poll.) Kbr. [syn: Lecanora muralis (Schreber) Rabenh.]. The species of Dermatocarpon and Candelariella listed above were found at the California study sites but not necessarily on soil. Physcia caesia was found on serpentine but not at the study sites; L. muralis was not found.

Hannes Hertel's monograph on <u>Lecidea</u> (1967), in which he describes calciphilous species in the Alps, mentions two species of <u>Lecidea</u> that were commonly found on the California serpentine: <u>Lecidea</u> <u>carpathica</u> (syn: <u>Lecidella carpathica</u>) and <u>Lecidea stigmatea</u> (syn: <u>Lecidella stigmatea</u>). <u>Lecidella carpathica</u> was also found in Bosnia, but <u>L. stigmatea</u> was not mentioned by Ritter-Studniĉka and Klement (1968).

When the lichens collected at each site were compared, a group of species was found occupying the serpentine rock at most of the sites. (These lichens presumably had similar gross ecological requirements.) They comprise the "lichen association" of the selected serpentine sites in California. Included in the group are Aspicilia caesiocinerea, Lecidella carpathica, Rhizocarpon bolanderi, Caloplaca squamosa, Candelariella vitellina, and Acarospora fuscata. Ritter-Studniĉka and Klement (1968) concluded that most of the lichens found on serpentine in Bosnia were members of the Aspicilictum ochraceae, a primary association. According to them, the lichens of this initial association occurred on slightly weathered

serpentine along a watercourse, above the high-water mark. In abundantly settled lichen colonies on serpentine, they found that <u>Aspicilia caesiocinerea</u> and <u>Candelariella vitellina</u> were the most conspicuous species of the association. The same species were also among the dominant members of the lichen association on the California serpentine--an interesting parallel to report.

Ritter-Studnicka and Klement consider the following four lichens to be found only on serpentine: Rhizocarpon sphaericum (Schaer.) Mig., Aspicilia polychroma (Anzi) Nyl. var. ochraea Anzi, Aspicilia serpentinicola (Suza) Ras., and Aspicilia crusii Klem. Specimens of A. serpentinicola were borrowed from Dr. Hannes Hertel in Munich because this species was not found on the sites studied in California. At the time of this study, the other two species of Aspicilia were considered European because they were not listed in Hale's checklist of North American lichens (1970); however, A. polychroma is listed in Egan's 1987 checklist. Rhizocarpon spahaericum (Schaer.) Mig. is synonymous with R. effiguratum (Anzi) Th. Fr., which is not considered to be serpentinicolous (W. Weber, personal communication). R. sphaericum has a bright yellow to whitish-yellow thallus and so differs markedly from the brown thallus of R. bolanderi, which is the Rhizocarpon found so commonly on the California serpentine. Because R. sphaericum has uniseptate spores and R. viridiatrum (also a yellow thallus) has multiseptate spores, these lichens are not likely to be confused. None of the European serpentine-endemic lichens were found at the study sites in California.

According to Ritter-Studniĉka and Klement (1968), the community changes as the serpentine weathers. They found that the <u>Aspicilictum ochraceae</u> association gave way to the more widely spread association of <u>Aspicilictum cinereae</u>, which is common throughout middle and southern Europe and

generally occurs on silicate rocks. The Aspicilictum cinereae association differs from the Aspicilictum ochraceae in the absence of Aspicilia polychroma var. ochracea and A. serpentinicola. "silica-genera" found on the serpentine in Bosnia, which were considered part of the Aspicilictum cinereae association, were remarkably similar to those found in California. The species common to both continents included Lecidea carpatica Körb ... (syn: Lecidella carpathica), Rhizocarpon geographicum, R. viridiatrum, and Aspicilia cinerea. In Europe the association of Aspicilictum cinereae is succeeded by that of Parmelietum molliusculae. I found no evidence on the sites studied of such a foliose association becoming the climax vegetation. The most common foliose lichen found at the study areas was Xanthoparmelia cumberlandia, generally considered a pioneer species.

Discussion of the lichen flora of California serpentine is not complete until taxonomic uncertainties with the prominent Aspicilia cf. caesiocinerea Nyl. are described. The lichen is characterized by a variable rimose-areolate thallus with sunken apothecia and K-, C-, and I- thallus reactions; the exciple and hymenium of the apothecia have a wine-red I+ reaction. Multiple samples sent to two taxonomists were identified as \underline{A} . caesiocinerea by one and \underline{A} . cf. calcarea by the other. Comparison with the type specimen was not possible, but acceptance of the \underline{A} . caesiocinerea determination further enhances the similarity between the lichen species found on serpentine in Bosnia and California.

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LEPIOTA SENSU LATO IN CALIFORNIA. III. SPECIES WITH A HYMENIFORM PILEIPELLIS.

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SUMMARY

Four species of Lepiota, each with a hymeniform pileipellis, are noted from California. Three are described and illustrated—Lepiota cristata (Bolt.: Fr.) Kummer, L. neophana Morgan, and L. thiersii. Lepiota thiersii has ovoid spores and agrees with the original diagnosis of L. castaneidisca Murrill. Because Murrill's species is actually a synonym of L. cristata, L. thiersii is described as new.

To my knowledge, the California mushroom flora has only four medium- to small-sized species of Lepiota S. F. Gray sensu lato that exhibit a hymeniform pileipellis. In addition to pileipellis anatomy and basidiome size, they share small spores (length = 8 µm or less) with walls inamyloid and weakly to not dextrinoid and an initially smooth, nonfibrillose pileipellis that in some species diffracts into more or less concentrically arranged scales. One species, Lepiota luteophylla Sundberg, was described previously (Sundberg 1971) and has since been reported from Michigan (Smith, Smith, and Weber 1979). The others are described below. With the exception of Lepiota cristata (Bolt.: Fr.) Kummer, these species are poorly known; one is described as new. All would be placed in section Cristatae Kühner following Singer (1975), but because of diversity in spore features, some workers (e.g., Bon 1981) align them in different sections.

In the descriptions below, colors in quotation marks are from Ridgway (1912). Herbarium abbreviations are according

to Holmgren and Keuken (1974).

LEPIOTA CRISTATA (Bolt.: Fr.) Kummer. Der Führer in die Pilzkunde. p. 137. 1871. Figs. 1-2, 10-12.

PILEUS 1-7 cm broad, almost conic at first, then convex to broadly convex, finally plano-convex in age; slightly to distinctly umbonate on expansion; margin at first incurved, appendiculate, and exceeding the lamellae, then decurved, plane to uplifted in age, entire, becoming rimose; surface dry; pileipellis continuous and glabrous at first, remaining so on the disc, becoming somewhat concentrically diffracted and appressed-scaly exposing the radially fibrillose flesh toward the margin, infrequently splitting radially, scales close to widely spaced, often evanescent near the margin; disc dark reddish brown ("carob brown", "chocolate", "chestnut", "bay", "walnut brown", or "burnt umber") to reddish brown ("cameo brown" to "warm sepia" to "verona brown"), sometimes as light as "russet" to pale "tawny" to "ochraceous-tawny", paler toward the margin, scales grading from concolorous near the disc to brownish pink ("fawn color" to "avellaneous") to "buff-pink" or sometimes "light vinaceous-cinnamon" to "light pinkish cinnamon" to "pinkish buff" toward the margin; exposed flesh white to "pale ochraceous-buff".

FLESH 1-3 mm thick at the disc, solid, fragile, white and unchanging. Taste farinaceous (disagreeable), rarely indistinct. Odor sweet and cinnamon-like to farinaceous, rarely mild.

LAMELLAE free, approximate; white, becoming "cartridge buff", "pale pinkish buff" to pale "warm buff"; close to subdistant; thin and fragile; somewhat ventricose; up to 4.5 mm broad; margins smooth, concolorous. Lamellulae in one to three tiers.

STIPE 3-12 cm long, 2-6 mm broad at the apex, equal to subbulbous; surface dry, almost glabrous at first, then innately fibrillose to appressed fibrillose, fibrils becoming loose in age; white to "pale pinkish buff" to "light pinkish cinnamon", often tinged "vinaceous" near the base, becoming "pale vinaceous" to "light russet vinaceous" to "snuff brown" to "sayal brown", at times almost gray when handled or in age, base clothed with white, rhizomorphic hairs; stuffed, becoming hollow; pith fibrils white, cortex white at first, toward the base becoming "vinaceous-fawn" to "vinaceous-brown".

ANNULUS occasionally persistent, submembranous, and



Figs. 1-2. Lepiota cristata. 1. Sundberg 474. X 1. 2. Sundberg XI-30-86-C-1. X 4/5.

flaring, more frequently collapsed against the stipe or remaining only as scattered patches of evanescent, tomentose to submembranous material, most often vanishing entirely; median to superior and white to "pale pinkish buff" when present.

SPORES pale "cream" in mass, 6.3-7.9 X 3-4.7 µm; bulletor wedge-shaped and spurred opposite the hilar appendix, tapered toward the rounded apex, inequilateral, smooth, wall slightly thickened, apical pore absent, most uniguttulate, hyaline in KOH, inamyloid, not dextrinoid, pale to dark yellow in Melzer's reagent. BASIDIA 24-33 X 5-10 µm, clavate, 4-sterigmate, hyaline in KOH and Melzer's reagent. PLEUROCYSTIDIA lacking. CHEILOCYSTIDIA abundant, 22-45 X 10-14 µm; clavate to sphaeropedunculate, bases often long, narrow, and with flexous walls, smooth, hyaline in KOH and Melzer's reagent. LAMELLAR TRAMA parallel, hyaline in KOH and Melzer's reagent. PILEAL TRAMA interwoven, hyaline in KOH and Melzer's reagent. PILEIPELLIS a hymeniform layer of elongate-clavate to pyriform elements, surface covered with a thin amorphous layer; elements 34-74 X 9-16 µm, some rostrate or branched, dull rusty brown in mass and hyaline to pale brown when viewed singly in KOH and Melzer's reagent. Subcuticular layer interwoven, hyphae hyaline to rusty brown in KOH. CLAMP CONNECTIONS present.

HABIT AND HABITAT: Solitary to scattered in humus under conifers, hardwoods, and mixed woods. November to March.

COLLECTIONS EXAMINED: Alameda Co.: Thiers 7292 (SFSU). Butte Co.: Kowalski 960 (SFSU). Contra Costa Co.: Sundberg II-7-81-1 (SIU). Marin Co.: Sundberg 1732, 1777, 4068 (all SIU); Thiers 7326, 8517 (both SFSU). Mendocino Co.: Thiers 8187, 8500 (both SFSU). Monterey Co.: Thiers 11811 (SFSU). San Francisco Co.: Sundberg 1004; Thiers 8581 (both SFSU). San Mateo Co.: Sundberg 474, 1116 (both SFSU). Santa Barbara Co.: Sundberg I-7-83-5 (SIU). Santa Cruz Co.: Sundberg 1017 (SFSU). Solano Co.: Sundberg 1557 (SIU). Sonoma Co.: Sundberg XI-8-86-B-3 (SIU). Trinity Co.: Sundberg 1144 (SIU).

DISCUSSION: Lepiota cristata is widely distributed in California. It differs from other species in section Cristatae included here by formation of spurred spores—spores that are bullet—or wedge—shaped (more or less truncate) and spurred at the base opposite the hilar appendix. Because of this feature, some workers (e.g., Bon 1981) put L. cristata in section Stenosporae (Lange) Kuhner.

LEPIOTA THIERSII Sundberg, sp. nov.

Figs. 3, 5-6.

Pileus 0.8-4 cm latus, convexus demum plano-convexus, siccus, glaber, ad marginum demum squamosus, cinnamomeo-brunneus, ad marginum pallide cinnamomeus vel subroso-bubalinus. Caro albus. Lamellae liberae, confertae, fere albus. Stipes 3-6 cm longus, 2.5-5 mm latus, glaber vel obscure fibrillosus, albus, basi cinnamonmeus vel pallide brunneus. Annulus evanescens. Sporae 4.7-6.3 X 3-3.9 µm, ovoideae vel breve ellipsoideae, non dextrinoideae vel amyloideae. Cheilocystidia nulla. Cuticula paliformis. Typus: United States, California, San Mateo County, San Francisco Water Department Property, February 10, 1970, Sundberg II-19-87-A-2 (Holotypus: SIU; Isotypus: SFSU).

PILEUS 0.8-4 cm broad, convex when young, then broadly convex, finally plane, often with a slight to broad, convex to flat umbo; margin incurved, appendiculate, and exceeding the lamellae at first, then decurved and entire, becoming plane, eroded to lacerate in age, appendiculate material thin, cottony to submembranous, fugacious; surface dry; pileipellis continuous and glabrous throughout at first, sometimes remaining so, usually becoming more or less concentrically diffracted and appressed-scaly exposing the radially fibrillose flesh toward the margin; scales elon-



Fig. 3. Lepiota thiersii. Sundberg II-18-87-A-2. X 2/3.

gated along the pileus circumference near the disc, irregular in outline, smaller and more equal-sided toward the margin; flesh fibrillose and radially arranged between the scales; disc brown ("verona brown") to "cinnamon brown" to "clay color" to "cinnamon" to "pinkish cinnamon", rarely "warm buff" to "light buff", unbroken surface and scales grading from concolorous to "pale pinkish buff" near the margin, exposed flesh white to "pale pinkish buff".

FLESH 1-5 mm thick at the disc (at stipe edge), solid, white and unchanging. Taste disagreeable, farinaceous, rarely mild. Odor sweet-farinaceous to farinaceous, rarely indistinct.

LAMELLAE free, close to the stipe, infrequently forking and anastomosing near the stipe; white to off-white (pale "cream buff" to "pale pinkish buff"); close; thin and fragile; up to 5 mm broad, margin even, smooth, concolorous. Lamellulae in one to three tiers, free ends abruptly tapered but not truncate.

STIPE 3-6 cm long, 2.5-5 mm broad at the apex, equal; surface dry, innately fibrillose, white at first, becoming tinged "cinnamon-buff" to "cinnamon" to dark cinnamon-brown ("sayal brown" to "mikado brown") to pale brown toward the base in age or on handling, covered at the base by a white tomentum; stuffed, becoming hollow, pith fibrils white, cortex concolorous with the surface.

ANNULUS when present superior, submembranous, appressed to slightly flaring, very fragile, off-white, usually evanescent on most specimens, often leaving only a fibrillose zone or adhering to the pileus margin.

SPORES white (prints thin), 4.7-6.3 X 3.1-3.9 µm; ovoid to short ellipsoid, slightly inequilateral, smooth, apiculate, thin-walled, apical pore absent, uni- to biguttulate, hyaline in KOH, inamyloid, not dextrinoid, pale yellow in Melzer's reagent. BASIDIA 21-29 X 5-8 µm, clavate, 4-sterigmate, hyaline in KOH, hyaline to pale pinkish in Melzer's reagent. PLEUROCYSTIDIA lacking. LAMELLAR TRAMA subparallel to parallel, hyaline in KOH, hyaline to pale pinkish in Melzer's reagent; subhymenium cellular, concolorous. PILE-AL TRAMA interwoven, hvaline in KOH, hvaline to pale pink (more reddish in mass) in Melzer's reagent. PILEIPELLIS an irregular and tightly arranged palisade of more or less clavate elements (often appearing somewhat cellular in thicker sections), surface covered with an amorphous material; elements 27-49(-90) X 9-20 µm, clavate, sometimes irregularly shaped, rarely branched, bases at times long and narrow, walls unevenly thickened, hyaline to pale yellowish brown in mass, and hyaline or with a yellowish brown content when viewed singly in KOH, more intense yellowish brown in Melzer's reagent; some subcuticular elements encrusted. CLAMP CONNECTIONS present at the base of the pileipellis elements and in the trama.

A pale yellow pigment, soluble in water but not alcohol, diffuses from the tissue during rehydration for sectioning.

HABIT AND HABITAT: Scattered to gregarious in humus under Cupressus macrocarpa. November through April.

COLLECTIONS EXAMINED: San Mateo Co.: Sundberg II-18-87-A-2 (Holotype, SIU; Isotype, SFSU); Sundberg 1125 (SFSU), 1842, 4153, 4192, II-20-87-6, II-20-87-8, II-20-87-9, II-20-87-11 (all SIU); Thiers 11934, 18832 23195, 24775, 24813, 33070 (all SFSU).

DISCUSSION: The specific epithet honors, with deepest gratitude, Dr. Harry D. Thiers who first collected the species and who introduced me to mycology.

This species agrees with the original description of Lepiota castaneidisca Murrill (1912). However, Murrill (1914) subsequently listed L. castaneidisca as synonomous with L. cristata. Type studies of L. castaneidisca by H. Smith (1966) and myself both confirm Murrill's conclusion. Therefore, this species is described here as new.

Lepiota thiersii is morphologically similiar to and usually exhibits the odor of L. cristata, but differs from it by usually lacking the reddish component in the pileus disc color and always having ovate rather than spurred spores. The formation of scales by the pileipellis on pileus expansion and a lighter colored stipe as well as the lack of both orange in the pileus color and grayish pileal trama



Fig. 4. Lepiota neophana. Sundberg II-20-87-A-1. X 1.

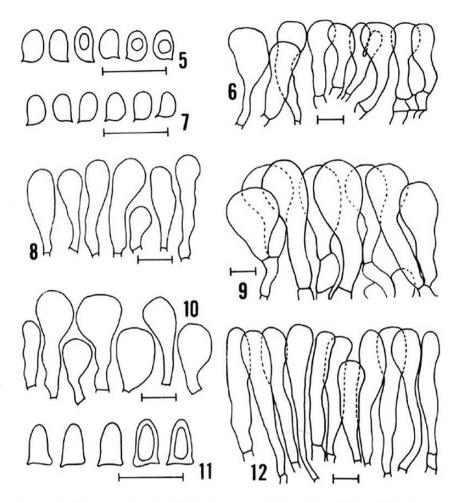
distinguish L. thiersii from L. cristatoides Einhellinger. In Bon's (1981) system, L. thiersii would belong in section Lilaceae Bon.

LEPIOTA NEOPHANA Morgan. J. Mycol. 12: 248. 1906. Figs. 4, 7-9.

PILEUS 1.8-3.7 cm broad, broadly convex to plane, often with a low broad umbo; margin appendiculate, exceeding the lamellae and incurved at first, becoming decurved to plane, entire to rimose, frequently undulating; surface moist to dry; pileipellis continuous, glabrous, and sometimes minutely rugulose on the disc, becoming more or less concentrically diffracted and appressed-scaly exposing the flesh toward the margin; scales irregular in outline, elongated along the pileus circumference near the disc and more uniformly equal-sided toward the margin; disc blackish brown to very dark brown ("fuscous" to "mummy brown" to "mars brown"), scales concolorous but most lacking black tinges to somewhat paler ("clove brown"), exposed flesh white at first, becoming very pale grayish olive ("olive-buff" to "pale olive-buff").

FLESH 1-3 mm thick at the disc (at stipe edge), solid, fragile, white, tinged "pale pinkish buff" under the disc, unchanging. Taste mild. Odor slightly pungent.

LAMELLAE free, approximate at first, but receding early, separated from the stipe by a collar-like band; white near the stipe, off-white ("cartridge buff") to "light buff" to "warm buff" elsewhere, unchanging; close to subdistant; thin and fragile; margins even, minutely fimbriate when



Figs. 5-12. Anatomical features of Lepiota thiersii, L. neophana, and L. cristata. 5-6. L. thiersii. 5. Basidiospores. 6. Elements of pileipellis. 7-9. L. neophana. 7. Basidiospores. 8. Cheilocystidia. 9. Elements of pileipellis. 10-12. L. cristata. 10. Cheilocystidia. 11. Basidiospore. 12. Elements of the pileipellis. Scale lines = 10 µm.

viewed with a hand lens, concolorous. Lamellulae in one to two tiers; free ends abruptly tapered but not truncate, sometimes anastomosing with longer lamellae.

STIPE 2.5-7.5 cm long, 2.5-6 mm broad at apex, equal; surface dry; glabrous to silky appressed fibrillose above,

fibrillose to obscurely fibrillose scaly toward the base; white, becoming "pale pinkish buff" to "pale pinkish cinnamon", sometimes developing "cinnamon" to "orange-cinnamon" or brownish pink ("avellaneous", "vinaceous-fawn", or "fawn color") streaks and areas toward the base in age, "vinaceous" when bruised; clothed at the base with numerous, white to "pale cinnamon-pink to "light vinaceous-cinnamon" mycelial hairs that sheath it where buried in humus; stuffed becoming hollow, pith fibrils white, cortex white, "pale cinnamon-pink" to "light vinaceous-cinnamon" near the base.

ANNULUS lacking or if present forming only a fibrillose to appressed zone near the stipe apex, concolorous with the pileus surface.

SPORES "pale cream" in mass, 4.7-6.3 X 2.7-3.2 µm, ovoid to short ellipsoid, inequilateral, smooth, apiculate, thinwalled, apical pore lacking, most uniquttulate, hyaline in KOH, inamyloid, not dextrinoid, pale yellow in Melzer's reagent. BASIDIA 21-29(-34) X 5-7 µm, clavate, 4-sterigmate, hyaline in KOH and Melzer's reagent. CHEILOCYSTIDIA 19-48 X 6-11(-14) μm, abundant; clavate to elongate-clavate, some ventricose, infrequently rostrate, base narrow and elongate in most; walls thin, often flexuous; hyaline in KOH and Melzer's reagent. PLEUROCYSTIDIA absent. LAMELLAR TRAMA parallel to subparallel, hyaline in KOH, hyaline to pale pink in Melzer's reagent; subhymenium obscure, elements small, concolorous with trama. PILEAL TRAMA interwoven, hyaline in KOH, hyaline to pale pink in Melzer's reagent; oleiferous hyphae infrequently present. PILEIPELLIS a palisade of clavate to pyriform, rarely catenulate elements, surface covered with a hyaline amorphous material; elements 25-75(-87) X (11-)14-25 µm, rarely rostrate, some distorted and with flexuous walls, bases often narrow and elongate, walls thickened, pale yellow to pale yellowish brown in KOH and yellowish brown to dark reddish brown in Melzer's reagent, pigment in the walls. CLAMP CONNECTIONS present in the subcuticular layer, pileal trama, and lamellar trama.

HABIT AND HABITAT: Solitary to scattered in humus under Cupressus macrocarpa. December through April.

COLLECTIONS EXAMINED: Butte Co.: Kowalski 1281 (SFSU). San Mateo Co.: Sundberg 1093, 1126 (both SFSU), 1835, II-18-87-A1, II-20-87-1 (all SIU).

DISCUSSION: Known also from Ohio (Morgan 1906) and Michigan (Smith 1954), *L. neophana* is apparently widely distributed but is very infrequently reported. The dark color of the pileus readily distinguishes this species from others noted in this paper.

In Bon's (1981) treatment, L. neophana would belong in

section Lilaceae.

ACKNOWLEDGMENTS

I wish to thank Dr. Harry D. Thiers of San Francisco State University for his friendship and guidance, for allowing use of specimens and photographs in his care, and for making my personal field observations possible through his collecting permit granted by the San Francisco Water Department. I also thank Dr. Barbara Thiers of the New York Botanical Garden for providing some needed literature and Dr. Mary Palm of the National Fungus Collections for her critical and valuable comments. The help of Dr. Charles Speck of Southern Illinois University in preparing the Latin diagnosis is appreciated. Funding provided for some of my field work by the American Philosophical Society Grant No. 1388--Johnson Fund is gratefully acknowledged.

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MYCOTAXON

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EXAMINATION OF STILBOTHAMNIUM TOGOENSE FOR ASPERGILLUS FLAVUS GROUP MYCOTOXINS.

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SUMMARY

Stilbothamnium togoense (=Aspergillus togoensis), a taxon considered by some to be related to the Aspergillus flavus group near A. tamarii, produced sclerotia when cultured on autoclaved oatmeal, but no A. flavus group mycotoxins (e.g. aflatoxins, sterigmatocystin, cyclopiazonic acid, kojic acid, dihydroxyaflavinine and aflatrem) were detected in extracts of the sclerotia or fermented meal. When cultured on autoclaved rice, S. togoense produced substantial quantities of sterigmatocystin which is believed to be an intermediate in the biosynthesis of aflatoxin. The data supports linking A. togoense to the A. flavus group because sterigmatocystin is not produced by species in the A. ochraceus group with which A. togoense also shares outstanding characteristics.

Stilbothamnium cogoense Henn. [=Aspergillus togoensis (Henn.) Samson and Seifert] occurs in equatorial rainforests where it colonizes the seeds of fruit rotting on the forest floor. The fungus produces large synnemata (6-8 cm tall) with yellow to greenish or brownish, radiate conidial heads and is considered by Roquebert and Nicot (1985) to be related to the A. flavus group sensu Raper

and Fennell (1965) near Aspergillus tamarii Kita. Roquebert and Nicot noted that the formation of a septum in the lower part of the phialide of S. togoense makes it different not only from A. tamari but from all other aspergilli as well. Samson and Seifert (1985) reduced Stilbothamnium to synonymy with Aspergillus retaining the species of Stilbothamnium in a separate subgenus. [i.e. Aspergillus subgenus Stilbothamnium (Henn.) Samson and Seifert]. They reasoned that there are numerous synnematous species in Penicillium, thus the production of such structures in connection with the Aspergillus anamorph should not serve to exclude those taxa from Aspergillus. The suggestion that A. togoense may be an ancestral form of the A. flavus group (Samson and Seifert, 1935) prompted us to investigate whether S. togoense produces any of the known mycotoxins (e.g. aflatoxin, aflatrem, dihydroxyaflavinine, kojic acid, cyclopiazonic acid, sterigmatocystin, and other aflatoxin-like metabolites) associated with different members of the A. flavus group [e.g. A. flavus var. flavus Link: Fr., A. flavus var. parasiticus (Speare) Kurtzman et al; A. nomius Kurtzman et al; and A. tamarii] (Dorner, 1983; Dorner et al., 1984; Kurtzman et al., 1987; Wicklow and Cole, 1982; Wicklow and Shotwell, 1983).

We examined two sclerotium producing strains of S. togoense: NRRL 13,551 (=LCP 67.3456; CBS 205.75) isolated by M.F. Roquebert from a seed of Landolphia sp. (Apocyanaceae) collected by R. Heim in 1967, near La Maboke, Central African Republic; and NRRL 13,550 (=LCP 64.1910) isolated by J. Nicot from undetermined seeds collected by R. Heim in 1964, near La Maboke, Central African Republic. Previous work has shown that substantial quantities of A. flavus group mycotoxins can be extracted from A. flavus sclerotia (Wicklow and Cole, 1982; Wicklow and Shotwell, 1983; Wicklow et al. 1988). Gram quantities of sclerotia were consistently produced by either strain when inoculated onto moistened, steam sterilized oatmeal or oat seed (D.T. Wicklow and C.E. McAlpin, unpublished). Samples of air-dried sclerotia (3 g) produced on oatmeal by both NRRL 13,550 and NRRL 13,551 were separately extracted and analyzed for A. flavus group mycotoxins (see above) according to the method described by Wicklow and Cole These mycotoxins were not detected in the (1982).sclerotia or in methanol extracts of the fermented oats.

Strain NRRL 13,550 was inoculated onto steam-sterilized rice (30% moisture content) and incubated at 25 C for 6 weeks. No sclerotia were produced by the fungus on rice. However, approximately 600 ug of sterigmatocystin was produced per gram of rice, determined by thin-layer chromatography as described by Vesonder and Horn (1985). Sterigmatocystin was isolated from the methanol extract of the rice and crystallized from ethyl acetate as pale yellow

needles melting at 245 C. Conclusive identification was by comparisons of melting point, infrared (IR) and mass spectrum with that of a standard. No cyclopiazonic acid or aflatoxins were detected in methanol extracts of the fermented rice. Sterigmatocystins are produced by several species of Aspergillus, including some with the teleomorph state Emericella, the dematiaceous hyphomycete Bipolaris (=Dreschlera), and certain species of the ascomycete Chaetomium (Hamasaki and Hatsuda, 1977; Rabie et al., 1977; Udagawa et al. 1979). Sterigmatocystin has been proposed as an intermediate in aflatoxin biosynthesis and 14C-labeled sterigmatocystin is converted by Aspergillus parasiticus into aflatoxin Bl (Hsieh et al., 1973). At the same time, sterigmatocystin is not known to be produced by any species assigned to the Aspergillus ochraceus group (Cole and Cox, 1981) with which S. togoense also shares outstanding characteristics (Christensen, 1982). These analyses provide additional evidence linking S. togoense to the A. flavus group (Samson and Seifert, 1985).

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We take great pleasure in celebrating the pre-eminent mycological career of Professor Harry D. Thiers on his 70th birthday.

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THE OCCURRENCE OF VESICULAR-ARBUSCULAR MYCORRHIZAE IN BURNED AREAS OF THE SNAKE RIVER BIRDS OF PREY AREA, IDAHO.

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SUMMARY

Soils from 1981, 1983, and 1985 burn sites and an unburned site within the Snake River Birds of Prey Area were collected. All sites were vegetated primarily with Artemisia tridentata Nutt. var. wyomingensis (Beetle and Young) Walsh (big sage) which commonly forms vesicular-arbuscular mycorrhizae (VAM) for its healthy growth. These soils were investigated using pot culturing methods to determine if they contained active VAM fungal propagules. The results from pot cultures inoculated with the 1981 and 1983 soils showed that fungal propagules were present and actively infected 100% of the roots. With the 1985 burn soils, infection was much lower; only 50% of the roots from the pot cultures became infected.

Wildfires have beome an increasingly common occurrence within the Snake River Birds of Prey Area. Over the past ten years, 37% (90,000 acres) of the sagebrush-dominated rangeland has burned; and 80% (72,000 acres) of this burned in the past five years. Artemisia tridentata Nutt. var. wyomingensis (Beetle and Young) Walsh (big sage) is the dominant variety of sagebrush present. After a burn, the previously sagebrush-dominated area is revegetated by big sage and invading non-native grasses,

particularly cheat grass (Bromus tectorum L.). After each fire more big sage is replaced by cheat grass, and eventually the area may be completely overrun by cheat grass. Cheat grass burns very quickly and therefore is hard to control. Repeated fires within these cheat grass-dominated regions result in a ripple effect. The fire burns the cheat grass and a zone of previously undisturbed big sage surrounding it. With each consecutive fire, these areas increase in size and more big sage is lost (Winward, 1985).

The big sage community supports high densities of black-tailed jack rabbits (Lepus californicus Gray). Jack rabbits are the main prey of golden eagles (Aquila chrysaetos L.), and research has shown a strong relationship between eagle productivity and jack rabbit abundance (U.S. Dep. Interior, 1979). The severe decline in jack rabbit numbers in recent years is thought to have been facilitated by the extensive loss of big sage habitat. There are concerns that the large loss of big sage may continue to maintain low jack rabbit numbers and resulting golden eagle numbers.

A positive solution to the problem is to revegetate these areas with the big sage soon after a burn, before the non-native grasses take a stronghold. The purpose of this study was to determine if VAM fungi, which are essential for the healthy growth of \underline{A} . $\underline{tridentata}$ var. $\underline{wyomingensis}$ are present and remain active in soils after experiencing a recent burn.

MATERIALS AND METHODS

Soil samples, taken to depths of 15 cm, were collected from the rhizosphere of Artemesia tridentata var. wyomingensis at four different sites. The first collection site was from an unburned control area vegetated primarily with big sage. The remaining three sites were vegetated primarily with the big sage before experiencing a burn in 1981, 1983, or 1985. Three plots from each site were randomly selected.

Soil samples were used as inoculum for pot cultures the day after collection. For each plot, two pot cultures were inoculated, resulting in six pot cultures per site. An equal amount of inoculum soil was mixed with 500 g of sterilized, sandy garden soil. One control from each plot, in which the inoculum soil was sterilized as well, was prepared. All were then planted with surface sterilized seeds of sudan grass (Sorghum vulgare Pers var. sudanese Hitchc.). Pot cultures were watered, and received sixteen hours of light, daily.

The sudan grass was harvested three months after planting the seeds. Roots were removed with approximately 50 g of soil. This soil was washed from the roots using a strong stream of distilled water, and collected for wet sieving, following the sucrose centrifugation procedure in Daniels & Skipper, 1982.

Following the procedure of Phillips and Hayman (1970), sudan grass roots fixed in FAA were cleared and stained with trypan blue. The roots were then examined for mycorrhizal propagules.

RESULTS AND DISCUSSION

Table 1. shows the incidence of VAM infection within sudan grass roots. The results from pot cultures inoculated with the 1981 and 1983 soils show that fungal propagules were present and actively infected 100% of the roots. With the 1985 burn soils, infection was much lower. Only 50% of the sudan grass roots from the pot cultures became infected.

VAM spores were found within the filtrate of all soil samples, including controls, pointing toward possible contamination. However, only one of the twelve control soils had infected sudan grass roots (Table 1.), suggesting that sterilization of the soils inactivated, but did not disrupt or destroy spores. The VAM spore occurring most frequently in all soil filtrates was identified as the asexual chlamydospore of Glomus microcarpus Tul. & Tul. The spore is smooth, globose hyaline to light yellow, and approximately 50 um in diameter. It is attached singly to a hyphal extension. A large spore with a suspensor-like bulb attached to its base was found. This spore fit the description of the azygospores of the genus Gigaspora Gerdemann & Trappe.

| Table 1. | | | | | | | |
|---------------|----|-------|-------|-------|------|-----|-----------|
| VAM infection | of | sudan | grass | roots | from | pot | cultures. |

| Soil | | 1981 | 1983 | 1985 |
|-----------|----------|------|------------------|------|
| Plots | Unburned | Burn | Burn | Burn |
| la | + | + | + | _ |
| 1b | * | * | + | - |
| 2a | + | + | + | + |
| 2Ъ | * | + | + | + |
| 3a | + | + | + | - |
| 3ъ | + | + | * | _ |
| Control 1 | - | + | _ | - |
| Control 2 | = | - | s - - | _ |
| Control 3 | - | - | 19 — 5 | _ |

* = no plant

Also investigated was the incidence of VAM infection within recently burned A. tridentata var. wyomingensis roots from two of the 1985 sites. One site experienced fire of low intensity, while the other a fire of higher intensity. 67% of roots from the low intensity burn were infected, while only 18% of roots from the higher intensity burn were infected.

The preceding data suggest that VAM fungi are affected more adversely by a high intensity burn and that they recover from a burn within at most two years. However, after two years have passed, these areas are often highly invaded by cheat grass which does not normally form mycorrhizae. Therefore, areas experiencing a low intensity burn in which the mycorrhizae are not significantly reduced, should be revegetated that same year before cheat grass invasion. In high intensity burn areas in which mycorrhizae are significantly reduced, revegetation programs should begin one to two years after the fire, giving the mycorrhizal propagules time to increase in numbers. In this case, steps would have to be taken to eradicate the cheat grass before reseeding.

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COMPATIBILITY AND FRUITING STUDIES OF AN ALBINO FORM OF AURICULARIA CORNEA

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SUMMARY

Compatibility and fruiting studies were carried out with an Auricularia collection with white basidiocarps. Aside from the basidiocarp color, this collection was morphologically referable to Auricularia cornea. Mating studies determined this stock to be bifactorial and compatible with normally pigmented stocks of A. cornea. Fruiting studies demonstrated that the white basidiocarp characteristic is inherent rather than an environmentally induced feature. Interstock crosses between pigmented and white strains produced hybrid basidiocarps with normal pigmentation. Only pigmented basidiocarps were observed from intrastock crosses of compatible strains derived from hybrid basidiocarps. Based on mating and fruiting studies, it is concluded that the white basidiocarp collection is an albino form of A. cornea. Since only pigmented basidiocarps were observed in crosses between pigmented and white strains, a single gene, composed of a pair of dominant and recessive alleles, is thought to control pigmentation and albinism in basidiocarp color respectively. However, a Mendelian 3:1 ratio was not observed, and white basidiocarps were not recovered in self crosses of isolates derived from hybrid basidiocarps. The absence of white basidiocarps is thought to be due to the low number of compatible crosses utilized in this study.

INTRODUCTION

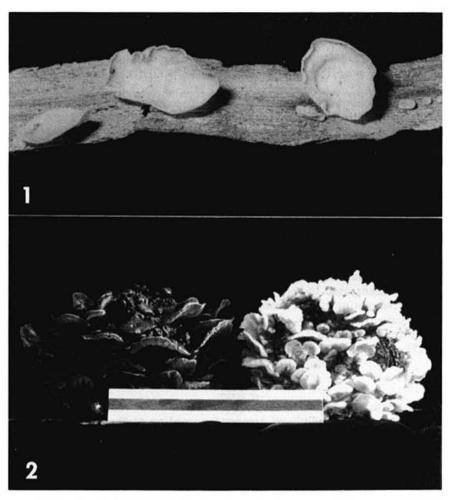
The first white species of Auricularia Bull.: Merat was described in 1872, as A. albicans Berk. (in Lloyd, 1925). There have since been two more white species of Auricularia described, A. leucochroma by

Kobayasi (1942), and A. eburnea by Li and Liu (1985). Auricularia albicans and A. leucochroma are presently recognized by Kobayasi (1981) as albino forms of A. auricula-judae (Bull.:Fr.) Schroet. and A. polytricha (Mont.) Sacc., respectively.

Incompatibility studies have only been carried out in four species of Auricularia: A. auricula-judae, A. polytricha, A. delicata (Fr.) P. Henn., and A. fuscosuccinea (Mont.) Farl. These studies have been reviewed by Wong and Wells (1987).

Other than in cultivation of Auricularia polytricha, there have been few fruiting studies carried out in this genus (Cheng and Tu, 1978; Quimio, 1982). Cheng and Tu (1979) described, macroscopically, basidiocarp development of A. polytricha grown in a sawdust and rice bran medium. Quimio (1982) studies the effects of aeration, light, and substrate supplementation on basidiocarp development. Hung (1983) described, macroscopically, basidiocarp development of A. polytricha, A. fuscosuccinea, and A. mesenterica. Mating and fruiting studies by Wong and Wells (1987) determined that the morphological differences between A. cornea, A. polytricha, and A. tenuis sensu Lowy (1951, 1952) and Kobayasi (1981), were environmentally induced, rather than inherent characteristics. Thus, the three species, in the sense of these authors are synonymous, and will, hereafter, be referred to as A. cornea, since it is the earliest species name validly published (Lowy, 1952).

A specimen of Auricularia (GJW 820) with white basidiocarps, morphologically referable to A. cornea [=A. polytricha f. leucochroma (Kobayasi) Kobayasi] (Fig.1), was collected in Hawaii, on the island of Oahu, along the Manoa Falls Trail. Based on the morphology, in cross section, A. leucochroma basidiocarps, Kobayasi (1981) reduced this species to a form of A. cornea under the name A. polytricha f. leucochroma. However, this has not been substantiated with genetic evidence. In order to determine if GJW 820 is referable to A. cornea, intrastock and interstock mating and fruiting studies were carried out. The criterion of compatibility between interstock crosses has been demonstrated as a useful tool in defining species in a number of studies (Boidin, 1986; Boidin and Languetin, 1984a,b; Capellano, 1985). However, partially sterile hybrids have been observed in interspecific crosses between Typhula idahoensis Rembsberg and T. ishikariensis Imai (Christen and Bruehl, 1979; Bruehl and Machtmes, 1980). Fruiting studies of this collection would also determine if the white basidiocarp condition is an inherent, or an environmentally induced condition. Auricularia cornea is defined here as having a medullated basidiocarp with abhymenial hairs approximately 200-600 mm in length. Lowy (1951, 1952) and Kobayasi (1981) also used the width and morphology of the medulla in defining species, but these characteristics have been demonstrated to vary according to environmental conditions and to intergrade in presently recognized species of Auricularia (Wong and Wells, 1987; Wong, unpubl.).



Figs. 1-2. Auricularia basidiocarps. 1. White basidiocarps of GJW 820. 1/2X. 2. Basidiocarps of GJW 820 (1 x 2) on right and basidiocarps of GJW 669 (9 x 11) on left. 1/3X.

MATERIALS AND METHODS

The method utilized for single spore isolation has previously been discussed (Wong and Wells, 1987). Mating strains derived from normally pigmented basidiocarps of A. cornea, GJW 802-18 (A₁₇B₁₁), GJW 802-16 (A₈B₁₃), GJW 669-9 (A₅B₃) and GJW 669-11 (A₆B₅), were isolated and identified by Wong and Wells (1987). Isolates were maintained on malt-yeast-soytone agar (MYP; Bandoni et al., 1975). Inocula and matings were made on 3% malt agar (MA; Wong and Wells, 1987). Crosses were

made by cutting out 7 mm diameter plugs with a cork borer from the margins of inocula, and placing the inocula approximately 8 mm apart. After about 21-30 days, a small piece of agar was taken where the inocula have grown together, mounted in 3% KOH, and examined under phase optics.

The method used for fruiting has previously been described by Wong and Wells (1987). The substrate was made up of 6 parts sugar cane bagasse and 1 part Old Fashioned Quaker Oats. The sugar cane bagasse-rolled oats medium was thoroughly mixed with an equal volume of tap water, and excess water squeezed out, before placing the mixture in a 1000 ml beaker. The beaker was covered with a 23.5 cm² sheet of aluminum foil placed on top of a paper towel of equal area and held in place with a rubber band. The beaker was then autoclaved at 121°C for 90 min, followed by a 12 h cooling period. Following inoculation of the medium, the beaker was placed in the dark at 25°C until the mycelium had grown throughout the substrate. The substrate was then removed from the beaker and placed in a greenhouse with diffused lighting and an automatic misting system to keep the mycelium moist.

Specimens used in this study have been deposited at BISH, and representative mating strains from each stock have been stored at ATCC.

Hymenium colors, in brackets, of GJW 669, GJW 802 and basidiocarps formed from fruiting studies were cited from Ridgway (1912).

RESULTS

Intrastock crosses determined that GJW 820 was bifactorial. The results are summarized, and arranged according to their mating strains in Table I. The reactions are the same as those previously observed for A. cornea (Wong and Wells, 1987). Three types of reactions were observed in the contact zones where the monokaryons grew together:

A]B]: Clamp connections at most septa.
A]B=: False clamps at most septa.
A=B], or A=B=: Simple septa throughout.

Clamp connections were observed only in the contact zones. Nuclear migration apparently did not occur.

Compatible crosses of GJW 820 produced only white basidiocarps, while GJW 669 (9 x 11) and GJW 802 (16 x 18), under the same conditions, produced only pigmented basidiocarps (Fig. 2). Crosses between pigmented strains of A. cornea and GJW 820, GJW 820-1 x GJW 669-11 and GJW 820-1 x GJW 802-18, were compatible, and produced fertile, pigmented basidiocarps. Twelve single spore isolates were obtained from each hybrid basidiocarp, and crossed in all possible combinations in order to identify compatible crosses. Only pigmented basidiocarps were produced in the latter compatible crosses.

Table I
Pairing Reactions of GJW 820

| | 1 | 6 | 2 | 4 | 5 | 7 | 8 | 10 | 11 | 12 | 3 | 9 |
|----|---|---|---|---|---|---|---|----|----|----|---|---|
| 1 | - | _ | + | + | + | + | + | + | + | + | F | F |
| 6 | | - | F | F | F | F | F | F | F | F | + | + |
| 2 | | | - | - | - | - | - | - | - | - | - | - |
| 4 | | | | - | - | - | _ | - | - | - | - | - |
| 5 | | | | | - | | - | - | - | - | - | - |
| 7 | | | | | | - | - | - | - | - | - | - |
| 8 | | | | | | | - | - | - | - | - | - |
| 10 | | | | | | | | - | - | - | - | - |
| 11 | | | | | | | | | - | - | - | - |
| 12 | | | | | | | | | | - | - | - |
| 3 | | | | | | | | | | | - | _ |
| 9 | | | | | | | | | | | | - |

Symbols:

1. -: Contact zone with simple septa.

Pairing reactions

- 2. F: Contact zone with false clamps at most septa.
- 3. +: Contact zone with clamp connections at most septa.

Table II

Pairing reactions

| | - | | | | | | | | | | | | | | | | | | | | | | | | |
|----|---|---|----|----|-----|---------|---|-----|----|-----|---|----|----|---|---|----|----|-----|---------|---|----|----|-----|----|---|
| | | G | JW | 82 | 0-1 | of X | | 3JW | 66 | 9-1 | 1 | | | | G | JW | 82 | 0-1 | of X | G | JW | 80 | 2-1 | 8 | |
| | _ | | | | | | | | | | | _ | | - | | | | | | | | | | | _ |
| | 1 | 7 | 3 | 8 | 12 | 4 | 9 | 10 | 2 | 5 | 6 | 11 | | 1 | 2 | 4 | 5 | 9 | 10 11 | | 7 | 3 | 8 | 12 | 6 |
| 1 | _ | _ | _ | - | _ | + | + | + | F | F | F | F | 1 | - | - | - | _ | - | - | _ | - | F | F | F | + |
| 7 | | - | - | - | 02 | * | * | + | F | F | F | F | 2 | | - | _ | _ | - | - | _ | - | F | F | F | + |
| 3 | | | - | _ | - | + | + | + | F | F | F | F | 4 | | | - | - | - | - | - | - | F | F | F | + |
| 8 | | | | - | - | F | F | F | * | + | + | + | 5 | | | | - | - | - | - | - | F | F | F | + |
| 12 | | | | | - | F | F | F | + | + | + | + | 9 | | | | | - | - | - | - | F | F | F | + |
| 4 | | | | | | _ | - | - | _ | _ | _ | _ | 10 | | | | | | - | _ | - | F | F | F | + |
| 9 | | | | | | | - | - | _ | _ | _ | - | 11 | | | | | | | - | - | F | F | F | + |
| 10 | | | | | | | | - | - | - | - | - | 7 | | | | | | | | - | + | + | + | F |
| 2 | | | | | | | | | - | - | - | - | 3 | | | | | | | | | - | - | - | - |
| 5 | | | | | | | | | | _ | - | _ | 8 | | | | | | | | | | - | _ | - |
| 6 | | | | | | | | | | | - | - | 12 | | | | | | | | | | | - | |
| 11 | | | | | | | | | | | | - | 6 | | | | | | | | | | | | - |

^{*} Denotes compatible crosses not producing basidiocarps.

Three compatible crosses did not produce basidiocarps in GJW 820-1 x GJW 669-11. The dikaryons of these crosses were slow growing and unable to infiltrate the bagasse-rolled oats substrate. The results of the interstock mating and fruiting studies are summarized in Table II.

The pigmented, field basidiocarps from Wong and Wells (1987) showed the most variability. GJW 669 was dark brown [Dark Livid Brown to Warm Blackish Brownl, to brownish black [Dusky Brown to Blackish Brown (1)] when dry, and reddish brown [Mahogany Red to Chestnut] to brown [Auburn] when wet. GJW 802 was light brown [Cacao Brown to Walnut Brown] to brown [Hay's Brown to Seal Brown] when dry, and orange brown [Sayal Brown to Snuff Brown] to reddish brown [Vinaceous-Brown, or Sorghum Brown to Dark Vinaceous-Brown] when wet. Basidiocarps produced under greenhouse conditions were uniform with respect to color. The following crosses: GJW 669 (9 x 11), GJW 802 (16 x 18), GJW (820-1 x 669-11), GJW (820-1 x 802-18), GJW (820-1 x 669-11) self crosses, and GJW (820-1 x 802-18) self crosses, produced basidiocarps in the same color range. basidiocarps were brown black [Dusky Brown to Blackish Brown (1)] to dark grayish black [Dusky Purplish Gray, or Dusky Neutral Gray] to black [Black] when dry, and dark reddish brown [Liver Brown, or Chocolate to brown [Carob Brown, Burnt Umber, or Vandyke Brown] when wet.

DISCUSSION

The compatibility of interstock crosses between GJW 820 and pigmented stocks of A. cornea demonstrated that GJW 820 is referable to A. cornea. Hybrid basidiocarps, i.e., basidiocarps derived from GJW 820-1 x GJW 669-11, produced morphologically normal basidiocarps with abundant basidiospores, and do not represent partially sterile hybrids as those observed in interspecific crosses between Typhula idahoensis and T. ishikariensis (Christen and Bruehl, 1979; Bruehl and Machtmes, 1980).

The characteristic of the white basidiocarp is inherent as demonstrated by intrastock crosses of GJW 820 (Fig. 2). Under the same environmental conditions, intrastock crosses of GJW 669 and GJW 802 produced only pigmented basidiocarps (Fig. 2). Thus, genetically, it has been verified that white basidiocarp variants that are morphologically referable to A. cornea are albino forms of this species as Kobayasi (1981) suggested.

Hybrid basidiocarps produced in this study were pigmented and uniform in color. This suggests that pigmentation is controlled by a single gene in which there is a dominant-recessive relationship in the pigmented and albino phenotypes. However, only pigmented basidiocarps were observed in compatible crosses in Table II, but because of the small number of compatible crosses fruited, a 3:1 Mendelian ratio of pigmented to albino basidiocarps should not be expected.

The occurrence of the A. cornea albino form in Hawaii is rare. In the five years that I have collected in Hawaii, GJW 820 has been the only albino collection of A. cornea observed. The albino form also appears to be rare elsewhere, since Lowy (1951, 1952) did not record the occurrence of albinism in his treatment of Auricularia. Kobayasi (1981) recorded albino forms of A. cornea, as well as several other Auricularia species, but did not comment on the frequency of their occurrence in nature.

The verification of GJW 820, as an albino form of A. cornea places another synonym under this species name. However, this has been done in concept only. Because a type probably does not exist for A. cornea, a neotype must be designated before A. cornea, A. polytricha, A. tenuis, and the albino form for this species can be reduced to synonymy.

ACKNOWLEDGEMENTS

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TYPE SPECIMENS OF AGARICS, BOLETES AND GASTEROMYCETES IN THE SAN FRANCISCO STATE UNIVERSITY HERBARIUM (SFSU)

BARBARA M. THIERS and ROY E. HALLING

Cryptogamic Herbarium New York Botanical Garden Bronx, NY 10458-5126

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- A. fuscovelatus Kerrigan, Mycotaxon 22: 424. 1985. CALIFORNIA. San Francisco Co.: San Francisco, under Cupressus macrocarpus, SW corner of Sunset Ave. & Lawton St., 8 Nov 1977, Kerrigan 791.
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