MycoDigest: Bioluminescent Fungi

Brian A. Perry

Bioluminescence, the emission of visible light by living organisms, is known to occur in many distantly related phyla, including the fungi. Although written observations of this phenomenon in fungal species are reported to date as far back as Aristotle (384–322 BC) and Pliny the Elder (23–79 AD), and detailed studies have been conducted with many other organisms (i.e., insects, fish, dinoflagellates, bacteria), we know surprisingly little about the nature of the chemical reactions responsible for fungal bioluminescence, or even why this phenomenon occurs in fungal species.

Like all other organisms in which it occurs, bioluminescence in fungi is an oxygen-dependent reaction involving substrates generically termed luciferans, which are catalyzed by one or more of an assortment of unrelated enzymes referred to as luciferases. In fungi, both the luciferans and luciferases involved remain largely unidentified. During the luciferan-luciferase reaction, unstable chemical intermediates are produced. As these intermediates decompose, excess energy is released as light emission, causing the tissues in which this reaction occurs to glow or luminesce. Although the older literature reports some fungal species as producing white or blue light, all recent studies and observations indicate that bioluminescent fungi emit a greenish light with a maximum around 520–530 nm. For those of you who have observed such fungi, you know the light they emit is often quite faint, and typically requires very dark conditions to see. I recently locked myself in a darkened room with several cultures of a bioluminescent species of *Mycena*, and even in the presence of actively growing mycelium, it required several minutes for my vision to adapt to the dark before I could perceive the faint light these cultures produced. This, however, is certainly not always the case.

The basidiomes of *Poromycena manipularis* are reported to be visible from a distance of up to 40 meters, and other species have been reported to emit light that is bright enough to read by.

Bioluminescence has thus far been reported in approximately 50 species of fungi, all of which are white-spored basidiomycetes traditionally placed in the

Continued on page 2
THE PRESIDENT’S POST

This year’s Esteemed Volunteer List has been compiled and posted on our website, honoring those MSSF members who have significantly served the mission of the MSSF during the past season. The list is primarily comprised of Council members and Fungus Fair volunteer contributors, with a few other notable supporters included. This list also doubles as the invite list for our annual Volunteer Appreciation Day fete, scheduled for April. Please review the list at www.mssf.org to verify that your name has been included if you feel it should be, and kindly bring any perceived omissions to my attention for prompt correction.

According to the MSSF by-laws, I have appointed this year’s nominating committee. Carol Hellums, Ken Litchfield, and Curt Haney have agreed to handle this critical process. They are charged with the task of filling a proposed slate of officers for next year’s leadership, to be presented first to Council at the April meeting, then put before MSSF membership at the “annual” general meeting in May. Anyone wishing to volunteer to take a leadership role with our Society should feel free to contact one of the nominating committee members. As things now stand, positions will be opening for next year’s President, Vice President, Secretary, and two of the four Councilor positions. Also, we anticipate the need to replace George and Jane Collier as Membership Committee Co-Chairs and J.R. Blair as Fungus Fair Committee Chair. Thank you George, Jane, and J.R. for your superlative efforts on our behalf.

Members should always remember that the MSSF is nothing but the people who step forward to make it happen. If you are not clear on how you can participate in helping to make your Society ever more pertinent, worthwhile, and evolving, please feel free to contact me or any Council Officer or Committee Chair for suggestions and direction.

We, and that really means you, can always use more help.

-DC

The Education Committee would like to thank all those who have contributed educational materials. Please continue sending mushroom-related education aids to asun1@pacbell.net or pkoski04@yahoo.com. Educational materials will be posted on a forthcoming website.

MycoDigest Continued from page 1

family Tricholomataceae. Impressively, more than two thirds of these bioluminescent species are members of the diverse and widespread genus Mycena. Additional genera containing luminescent species include Armillaria, Omphalotus (including Lampteromyces and luminescent Pleurotus species), Gerronema, Panellus, and Dictyophanus (these latter two genera actually represent additional species of Mycena, but they have not yet been transferred to this genus). Luminescence, the intensity and location of which varies by species, typically occurs in the mycelium and/or basidiomes, or some portion thereof. In Mycena lamprospora, however, it is the mature spores rather than these tissues that have been observed to luminesce. In many instances it is the hyphae present in decaying plant tissues that luminesces, resulting in the appearance of luminescent wood or leaves.

Here in California, Armillaria mellea, Omphalotus olivascens, and Panellus stipticus occur regularly and are likely your best bet for locally observing luminescence. While many species of Mycena are present in California, it is primarily the tropical members of the genus that are luminescent. Studies by Bermudes and colleagues have demonstrated that M. haematopus (a locally abundant temperate species) does emit low levels of light, but this is not detectable by the human eye and was determined with the use of a photometer. The mycelium of several additional temperate Mycena species (e.g. M. epipterygia, M. galopus, M. maculata, M. pura, and M. sanquinolenta) have also been reported to luminesce in European collections, but this condition has not yet been confirmed for North American material. The basidiomes of both O. olivascens and P. stipticus are luminescent, while for A. mellea it is only the mycelium (and rhizomorphs) that emits light. Due to the high levels of light pollution present in most regions, not to mention the moon, it is often necessary to relocate specimens of these species to darker locales in order to observe their luminescence. David Arora recommends locking yourself in a dark closet with fresh specimens, as well as a grilled cheese sandwich to help combat the boredom while allowing your eyes to adjust to the dark!

Our current understanding of the evolutionary relationships of the fungi, based on the phylogenetic analyses of the Assembling the Fungal Tree of Life collaboration, suggest that bioluminescence within the basidiomycetes has evolved independently in at least three distinct lineages. Within the Mycena lineage (i.e. Mycenaceae) which contains the majority of these luminescent species (and likely well over 500 species in total), it remains to be seen whether luminescence evolved a single time early in the evolutionary history of this group and was then subsequently lost by numerous species, or whether it evolved numerous times independently as it appears to have done in the basidiomycetes as a whole.
First Annual Marin Mushroom Mania: A Splendid Success!

Terri Beausejour

The first ever “Marin Mushroom Mania” at the Marin Art and Garden Center began at 9 am, January 26, with four Marin forays: Pt. Reyes, Roy’s Redwoods, Indian Tree OSP, and Fairfax Cascades OSP. Although weather conditions had recently transitioned from bitter cold and dry to rainy just the day before, the foray participants arrived with plentiful baskets, boxes, and bags containing a surprisingly wide variety of species. Fred Stevens, Peter Werner, J.R. Blair, David Campbell, and Terry Sullivan were our key taxonomists for the Friday ID sessions, and thanks so much to them for providing this essential component! Master Gardener, Sandy Waks, was our display coordinator and what a beautiful job she and her crew of volunteers did in presenting the species on the display tables. Fortunately, within the beautiful 11 acres of forest and gardens of the Marin Art and Garden Center property, there was plenty of habitat in which to collect duff, logs, fruiting branches, pine cones, and other accoutrements to make the displays look really spectacular. Indoor setup consisted of preparing for the speakers, placing and testing chairs and projectors, setting up MSSF book and t-shirt sales and membership tables, and preparation for “the gate” to collect the $10 entrance fee for the programs. Special thanks to Ron Pastorino for setting up early and helping to organize the placement of the MSSF tables. Taylor Lockwood and Medea Minnich were also on hand early to setup their wonderful “Treasures.” And we were privileged that the California Lichen Society participated by setting up a lovely display and some microscopes—thanks very much to Kathy Faircloth for their collaboration.

After a very long Friday consisting of forays, setup, and identification, Jane Wardzinska whooshed in just as it began to get darker and darker (and colder) and provided a hearty, spicy, and very tasty array of Indian curries accompanied by perfectly steamed basmati rice, wine, beer, and carrot cake and chocolates for dessert. Yum! I have it on good authority that Jane was up until the wee hours the night before, shopping and prepping, to ensure our volunteers were well cared for after a long day, culminating in a damp, cold, but rewarding night! Warmed by libations, full bellies, and new friendships, we were all well prepared for the Saturday event!

The weather Saturday could not have been more lovely. A cool morning melted into a warm, misty, spring-like condition. The fungal displays had rested well under their cozy netting, which allowed the fungi to sleep comfortably in a humid environment with sufficient ability to breathe and prepare for many hundreds of inquisitive, curious, and studying eyeballs to be gazing upon them for hours to come…not to mention the occasional fondling thereof.…

Saturday was packed with presentations on a variety of topics including fungal taxonomy, ecology, toxicology, culinary, biology, cultivation, and various observations and commentary related to the tactile, sensory, spiritual, and emotional manifestations one might experience when encountering fungi. For example, one hasn’t quite lived until one has experienced our own Ken Litchfield extolling the virtues of the “stinky whiffle ball.” Heartfelt thanks are also given to J.R. Blair, and Master Gardener and longtime MSSF member Sandra Massen for their intellectually stimulating and enlightening slide presentations, and to Master Gardener and MSSF member Sandy Waks, and reknowned Chef Sunita Dutt for their delectible culinary presentations and taste sensations. Suffice it to say, the audiences were highly attentive, duly entertained, and very appreciative of the experiences of these presentations.

But wait, there’s more! In order that everyone in attendance had the opportunity to take something very special home with them—as a memoir, perhaps, or even something to learn and grow with in the weeks and months to come—there were a wide variety of fresh wild and cultivated mushrooms, mushroom cultivation kits, educational books, DVDs, t-shirts, posters, photographs, postcards, stationary, spectacularly artful mushroom mousepads, and even truffle mustard and truffle infused salt! We are so grateful for the collaboration with and support of our long-time friends and participating vendors: Toby Garrone of Far West Fungi, Mushroom Adventures of Don Simoni, and Taylor Lockwood’s “Treasures,” “Trilogy,” and a plethora of other intellectual enticements embellished with delightful rainbows of visual and auditory candy!

Following the “indoor program,” which proceeded from 9:30 am to 1 pm, there were several outdoor activities, including guided tours of the gardens, log plugging demos (with several fortunate individuals taking home their very own “pet
Of course, all of this glowing business begs the question of why some species of fungi are luminescent while most others (as least as far as we have thus far observed) are not? Does producing light infer some form of selective advantage to the species in which this phenomenon occurs, and if so, why is it not more widespread throughout the fungi? These, I must confess, are the sorts of as yet unanswered questions that evolutionary biologists lay awake at night puzzling over. Fungal luminescence has been hypothesized to attract invertebrates that aid in spore dispersal, which may be a suitable explanation for those species with luminescent basidiomes, but not for those in which only the mycelium emits light. Additional hypotheses include the attraction of predators of mycetophagous invertebrates, and even the function of emitted light as a warning to nocturnal heterotrophs that might consume the fungus or its substrate, similar to warning colorations observed in other organisms. In a study by Sivinski, leaves and twigs covered with a luminescent mycelia, as well as glowing basidiomes, were placed in sealed glass vials coated with a sticky substance, and used to trap arthropods at night. When compared with control tubes containing basidiomes that had been rendered non-luminescent by soaking in alcohol, significantly more Collembola and Diptera species were attracted to the tubes with bioluminescent material, lending support for such hypotheses.

It is also possible that bioluminescence in these fungi is nothing more than the by-product of some other metabolic process. Because the reaction is oxygen-dependent, it has been hypothesized that bioluminescence may have evolved as a method to consume excess oxygen produced in the cells of organisms during other metabolic processes (i.e., an antioxidant). Studies have suggested a link between lignin degradation and luminescence in fungi, with the oxygen-consuming reaction acting as a means of dealing with peroxides generated during the process. In the words of P. J. Herring, however, “such a prosaic explanation seems somehow unworthy of so splendid a phenomenon.” Fortunately, these hypotheses are not all mutually exclusive. It is possible that bioluminescence may have arisen as a by-product of a beneficial metabolic process, and subsequently been co-opted in a relatively small number of taxa for secondary use in attracting spore dispersal agents or deterring fungivores.

Whatever role bioluminescence may play in the lifecycle of the fungal species in which it occurs, it is by all means an intriguingly beautiful phenomenon to observe and study. Desjardin and colleagues recently reported six new observations of luminescence in *Mycena* species from a single site in Brazil, and they are currently investigating the origin of luminescence in mycenoid fungi and the mechanisms responsible for light emission. There are undoubtedly many additional luminescent species of fungi out there that we have yet to document. After all, most mycologists do not spend a great deal of time wandering the woods in complete darkness, at least not by choice! Next time you are out in the woods at night, take the time to turn off your flashlight, let your eyes adjust, and have a look around you. You just never know what you might encounter.

**Sources of Information and Suggested Reading:**


Mushroom Expedition to Soquel

Liana Hain

On Saturday, January 20, a scouting group from the MSSF traveled to the hills of the Aptos/Soquel area to survey a private land of 80 forested acres for mushrooms, habitat, and duff. We met at 10am at Summit Center Market on Summit Road, which is 3.5 miles from the summit on Highway 17 between San Jose and Santa Cruz. It took most people 75 minutes to arrive at Summit Center from San Francisco, then another 20 minutes to reach the Speer’s property.

Dennis and Lana Speer have generously invited the MSSF to lead future forays on their property; it also has great potential for weekend camp-outs, since it has a large fire pit and log area. There are five compost latrines on the property and a well maintained fire road, as well as numerous slash trails, springs, and little seasonal streams. Incidentally, the property was logged about 20 years ago. Liana Hain met Dennis and Lana through mutual friends in Santa Cruz and was impressed with their generosity and congeniality.

The goal of this survey was to determine if there was enough mushroom potential to host forays on the site in the future for other MSSF members. There was a wide variety of habitats such as redwood groves, manzanita, and tan oak areas. Much of the property has a nice ridge line where the duff was excellent. The team found a large variety of mushrooms, although mostly inedibles. The variety of mushrooms found, albeit not a great number in total, gave the team hope that if and when there is more rain and warmth, we may be able to pick many choice edibles.

J.R. Blair accompanied Liana Hain and her husband Jack and pet dog, Shiloh on the previous Tuesday to scout out if the road was passable. Although there is a “road closed” sign, the two-lane road narrows into a one-lane road with some slide areas, but is safe. J.R. found the habitat to be very favorable for mushrooms. Norm Andresen led the larger foray and was a wealth of information regarding mushroom characteristics and taxonomy. He also killed a bobcat with his bare hands and, after removing the pelt to make a cozy bathrobe, roasted it on a spit...just kidding!

Of course, we had a great potluck lunch in the redwood grove and fire pit area. There is nothing quite like the rewards of good Zinfandel and Merlot after a hunt, not to mention all the great food and company.

Species Collected on the Expedition

<table>
<thead>
<tr>
<th>Fungi</th>
<th>Description</th>
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<tbody>
<tr>
<td>Bovista pila</td>
<td>(puff ball)</td>
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<tr>
<td>Camarophyllus russocoriaceus</td>
<td></td>
</tr>
<tr>
<td>Caulorhiza umbonata</td>
<td>(red-wood rooter)</td>
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<tr>
<td>Coprinus atramentarius</td>
<td></td>
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<tr>
<td>Trametes versicolor</td>
<td>(turkey tale)</td>
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<tr>
<td>Crepidotus mollis</td>
<td></td>
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<tr>
<td>Crucibulum laeve</td>
<td>(birds nest)</td>
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<tr>
<td>Hypoxylon thouarsianum</td>
<td>(cramp balls)</td>
</tr>
<tr>
<td>Fomitopsis pinicola</td>
<td>(red belt conk)</td>
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<tr>
<td>Psathyrella hydrophila</td>
<td></td>
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<tr>
<td>Russula densifolia</td>
<td></td>
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<tr>
<td>Russula cyanoxantha</td>
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<tr>
<td>Trichaptum abietinum</td>
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</tbody>
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<table>
<thead>
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<th>Fungi</th>
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<tbody>
<tr>
<td>Laccaria amethysteo-occidentalis</td>
<td></td>
</tr>
<tr>
<td>Lactarius rubidus</td>
<td>(candy cap)</td>
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<tr>
<td>Lactarius xanthogalactus</td>
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<tr>
<td>Lenzites betulina</td>
<td></td>
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<tr>
<td>Mycena sp</td>
<td></td>
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<tr>
<td>Pseudoperispora rubea</td>
<td></td>
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<tr>
<td>Russula cyanocapha</td>
<td></td>
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<tr>
<td>Russula cyanoxantha</td>
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</tr>
<tr>
<td>Trichaptum abietinum</td>
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</tbody>
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Pictured from left to right kneeling are Carol Hellums and Cordelia Chadwick. Top row from left to right is David Eichorn, Bill Hellums, Jeannette Larsen, Jeff Fisher, Norm Andresen, and Al Carvajal. Not pictured is Liana Hain.
Although this event was designed with many of the same components that have comprised various events we have organized and presented over many years past, this was the first we have attempted at this venue, the Marin Art and Garden Center. There are some very special aspects to this venue—both in the facility itself and in those that represent the education and garden departments there. In particular, I acknowledge the Garden Education Council for their support, and, in particular, their Garden Education Manager and Volunteer Coordinator, Charlotte Torgovitsky. Charlotte, as she tells it, saw our display at the San Francisco Flower and Garden show a few years ago, and thought, “Wow, we should have an education event around mushrooms at MAAGC.” I don’t know all the details in between, but several months ago, she contacted us and asked if we would be interested in discussing this prospect.

Being rather “Marin-centric” in my life and travels these days, I welcomed the opportunity to help bring such an event to Marin, so I agreed to meet with Charlotte and see what they had in mind. Well, I could go on and on about how enthusiastic and supportive Charlotte and MAAGC have been in making this event happen, helping to size and scope it such that it would be workable and yet offer a “great program,” providing a very functional and comfortable facility, printing and distributing the postcards and flyers, etc. Charlotte has a passion for her educational mission and its relationship to community, humanity, and the wonders of the natural world that is so in harmony with the like passions of those MSSF members who bring this very type of event to the lives of those who wish to enter this magic portal! As such, I very much look forward to future collaborations with Charlotte and MAAGC.

Which reminds me, we have already scheduled next year’s Marin Mushroom Mania for February 9, 2008!

Ken Litchfield is the MSSF Cultivation Chair, and was so instrumental in this event that it never would/could have happened without his support, participation, and hands-on, down in the dirt, do that Ken do! Which even Ken might not have been able to do without the help of several of his Merrit College students, in particular Carl Grether, John Mendonca, and Jesse Hersh (the three of whom constructed the pre-event Mushroom Demonstration Garden, log plugging demos, and Cultivation table), and George Willis and Therese Halula for display table setup and cultivation educational table.

I would be seriously remiss if I did not acknowledge P.J. Bremer, Marin Independent Journal Correspondent, who wrote a very thoughtful, educational, and ever spritely article about this event in the context of our pre-event planting of a mushroom demonstration garden at MAAGC. As an adjunct to the article, he provided the event and foray details as part of the weekend calendar section of the IJ. You can still find the article at http://www.marinij.com/fastsearchresults/ci_5002471. The pre-event planting of the mushroom garden, the Marin IJ interviews, and the event itself were captured on HD video for future enjoyment and archival purposes by John Neff, whose present and thoughtful videography have captured its various aspects beautifully and in cutting edge format for future education and enjoyment.

Given that this was our first year with this event, we had erred on the side of being conservative about costs, scale, and length of the event. On this note, I must acknowledge our President, David Campbell, for his support and close collaboration in working with MSSF Council in approving our participation in this event, contributing to the distribution of the postcards, ensuring the MSSF tables were staffed, and for his attendance at meetings, presence at the event, and especially for his beautiful, welcoming words to the participants, in which he truly conveyed the essence of the MSSF in both its “mycological” and “societal” aspects.

Special thanks to Ron Pastorino, Lynn Marsh, Lisa Bacon, Peggy and Dave Manuel, and all of those who staffed the MSSF tables at various junctures throughout the day! Thanks also to George Collier, who ensured Membership’s representation, and also subsequently acknowledged a noticeable increase in new members in the few weeks following the event. Book and t-shirt sales have also reported worthwhile results.

Given that this event was well publicized, was a logistical success, was financially viable, and was enthusiastically attended, we plan to expand it a bit next year. I hope many of you will be interested in participating in the planning and in the event itself in 2008!

Until then, may your hearts leap at the discovery of the natural treasures, and may your baskets bulge with fruits of field and forest!

For a complete list of the species collected for Marin Mushroom Mania, visit http://www.mssf.org/sp_lists/marin06sp.html
Mushrooms can be found throughout the public and private lands of Marin County. Each public agency that administers public land makes its own regulations regarding recreational mushroom picking. This compendium is current as of January, 2007.

Golden Gate National Recreation Area (GGNRA)– No picking permitted on any Marin County GGNRA land, including the Marin Headlands, Tennessee Valley, Muir Woods National Monument, and all of the west/ocean facing slope above Stinson Beach out to Tomales Bay.

Point Reyes National Seashore– Mushroom pickers are permitted to take “eight liters (two gallons) of mushrooms plus one mushroom per adult per day.” This regulation might appear somewhat confusing on first reading, because liters and gallons are liquid measures, and mushrooms appear in liquid form only after someone has made them into soup. The Point Reyes staff has a very practical and sensible reason for writing the regulation in this form. They recognize that pickers generally don’t go out on a mushroom expedition carrying a scale, so a regulation based on weight would be difficult for pickers to apply. Alternatively, they recognize that most people do have a mental image of how large a gallon bucket is, and can generally estimate how many mushrooms would fit into two gallon buckets. The bonus mushroom feature is intended to accommodate pickers who find a humongous mushroom that wouldn’t fit into a gallon bucket or even a two gallon bucket. So, the regulation permits taking one major mushroom plus two buckets’ worth of smaller mushrooms.

Mount Tamalapais State Park– Picking is permitted, but limited to five pounds per person per day. This is a weight-based regulation, and our suggestion to ensure compliance is to buy a small hand-held scale with a hook at a bait and tackle shop, most frequently used to weigh recently caught fish on a boat or to weigh a sack of mussels or clams picked from the shore. You can hang the bag or basket you have for the mushrooms on the scale’s hook when empty, and then fill it up with mushrooms until it reaches five pounds plus the weight of the container.

Samuel P. Taylor State Park– Same as Mount Tamalpais

Tomales Bay State Park– Same as Mount Tamalpais

China Camp State Park– No picking permitted

Olompali State Park – No picking permitted

Marin Municipal Water District – No picking permitted. This is a large area that includes all of the land east of the Bolinas Ridge through the Kent Lakes area.

Marin County Parks – No picking permitted. This includes Deer Park in Fairfax and Tiburon Uplands Reserve.

Marin County Open Space Districts – No picking permitted. The County of Marin manages 32 Open Space Districts that include some of the most beautiful terrain in the area, such as Ring Mountain and Bolinas Lagoon. All of the districts are described at www.co.marin.ca.us/depts/PK.

This compendium was prepared by Eric Multhaup, a member of MSSF, but any errors, omissions, etc. are entirely his responsibility. Please feel free to address any comments or concerns to Eric at mullewcomcast.net. The vast majority of public land in Marin County falls within the administration of the public agencies listed here, but there are some other very small parcels of public property, such as community service districts, sprinkled throughout the County that have not been included.
MSSF Calendar, March 2007

Monday, March 5, 2007, 7pm. Culinary Group Dinner. Hall of Flowers, Golden Gate Park, SF. $14. Reservations are required and must be no later than Friday, March 2nd. Call Pat George at (510) 204-9130 or email plgeorge33@yahoo.com to make your reservation. Bring your own tableware, beverage, and an appetizer to share. Future dates for Culinary Group Monday dinner meetings are April 2, May 7, September 10, October 1, and November 5.

Tuesday, March 20, 2007, 6:30-7:30pm. Randall Museum. Final NAMA slide program of the season: “Morels, Truffles, and Other Spring Fungi.” Included will be morels, false morels, cup fungi, truffles, false truffles, puffballs, earthballs, and gilled and pored mushrooms likely to be found in spring.

Tuesday, March 20, 2007. MSSF General Meeting. Randall Museum. 7pm mushroom identification and refreshments (provided by the Hospitality Committee). 8pm, Charmoon Richardson will discuss Wild Culinary Mushrooms of Northern California.

May 4-6, 2007. San Jose Family Camp Foray. Registration for the weekend includes six meals from (Friday dinner to Sunday lunch), lodging, group forays, and Saturday program. The cost is $116 for MSSF members, $70 for children, and $136 for non-members. To register, write a check to MSSF and send to Tom Sasaki, 1506 Lyon St., San Francisco, CA 94115. For questions, contact Tom at 415-776-0791 or sasakitom@sbcglobal.net.


Deadline for the April 2007 issue of Mycena News is March 15.
Please send your articles, calendar items, and other information to:
mycenanews@mssf.org