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Contents

V6A1. What happens inside a moist chamber culture? Carlos Rojas.

V6A2. Biography: Harold W. Keller. Harold W. Keller.

V6A3. *Diderma effusum* (Schwein.) Morgan (Amoebozoa): a new record of a myxomycete from Antarctica. Steven L. Stephenson.

V6A4. A checklist of the myxomycetes of Arkansas. Steven L. Stephenson.

V6A5. Roland McHugh (1945-2025). Bruce Ing.

V6A6. Gary A. Laursen (1942-2026). Steven L. Stephenson.

V6A7. Mixomicetes neotropicales: ¿por qué no los estudiamos en ciertos territorios? Keitryn Calderón-Cubillo, Melissa Mardones and Carlos Rojas.

V6A8. New Records of Myxomycetes from Shenandoah National Park. Steven L. Stephenson and Barbara C. Stephenson.

V6A9. Adaptive Phototaxis in Response to Experience – Learning by Association in the Slime Mold *Physarum polycephalum*. Vanessa Dombrowski and Jannes Freiberg.

V6A10. First records of myxomycetes from Unalaska Island in the Aleutian Islands. Steven L. Stephenson and Barbara C. Stephenson.

In front cover: *Badhamia bryocrassipella* by Juan Francisco Moreno.

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About the journal

Slime Molds is an open access, electronic journal, with yearly publication (one volume per year for numbering purposes) but constant release of accepted contributions, that publishes scientific and non-scientific articles on mycetozoans (myxomycetes, dictyostelids and other amoebae with either phylogenetic or historical links to mycetozoans).

No geographical restrictions are in place and researchers and enthusiasts of mycetozoans from all over the world are invited and encouraged to submit their notes. No academic affiliations are required either. Scientific articles are single-blind peer reviewed and non-scientific articles are reviewed by members of the editorial board.

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What happens inside a moist chamber culture?

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Abstract: An entire subset of moist chamber cultures was used to document both the internal temperature and the moistness of the filter paper surface. These metrics are presented and studied in the context of both the temperature and the humidity of the room where the experiment was conducted. Overall, it seems that internal and external temperatures are independent, but internal and external measurements of air humidity and surface moistness seem to be related. The data presented herein are meant to generate only a discussion, but should be supported more robustly by experiments dedicated to studying the limitations of the moist chamber technique culture in the future.

Keywords: culturing, microbiology, monitoring, myxomycetes, Petri dish.

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In the modern context of myxomycete research it is very common to see an investigator using the moist chamber technique as it applies to myxomycetes for recording data in a laboratory environment. As mentioned by several authors, this technique has been very useful during the process of global documentation of these organisms, at least based on sporocarp data (Alexopoulos 1953, Stephenson and Stempen 1994). In recent years, the technique has been mentioned to be one of the key methods to study myxomycetes due to its complementary character to both field-based and molecular-driven approaches (Wrigley de Basanta and Estrada Torres, 2022).

During 2015-2016, in an effort to document myxomycetes along a gradient of precipitation in the dryer parts of Costa Rica (Arenas-Taborda et al. 2021), we established 720 moist chamber cultures. From those, we selected randomly, a total of 97 cultures (about 13% of total effort) for keeping track of both the internal temperature and surface moistness for 10 weeks, the length of time for which we decided to study the entire set of moist chambers. We also determined the barometric pressure, the temperature, and the humidity of the room where the moist chambers were set up. The goal of this little observational experiment was to increase our understanding of the dynamics taking place inside the moist chamber cultures during a real run intended to generate scientific data on these organisms.

We used infrared thermometers and pin-based protimeter moisture meters to obtain data on the internal temperature and moistness of the moist chambers. For this task, every week, right before checking the cultures for myxomycetes, we would place the moist chamber in a measuring station and open the lid

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about half an inch. This aperture was just enough to insert the moistness probe and to obtain the temperature reading of the filter paper, all within 10 seconds or so. Additionally, to determine some characteristics of the laboratory where the experiment was taking place, both a barometer and a temperature/relative humidity meter were placed next to the stacks of Petri dishes. For quantification, both room and culture temperature were recorded in the Celsius scale (°C), culture moistness was reported as surface moisture content (% w/w), relative humidity was recorded in the room air (%), and atmospheric pressure was measured in hectoPascals (hPa). From the 97 cultures studied in that manner, 33 were set up with material from a wet non-seasonal premontane forest, 37 used materials from a moist seasonal premontane forest, and 27 were set up with substrates from a lowland seasonal dry forest in Costa Rica.

The average recorded temperature, barometric pressure and relative humidity values of the room were determined as 23.1±1.9°C, 880.4±1.5 hPa and 73.7±5.6% during the 10-week experiment. Inside the moist chambers, the average temperature and surface moistness were 20.5±1.2°C and 31.3±8.4% w/w, respectively (see weekly values in Table 1). The observed variation in room temperature between the lowest and highest recorded weekly values was 7.7 degrees, whereas the same difference for culture values was 5.2 degrees, with a subsequent difference of 32.0% lower temperature inside the moist chambers. Contrastingly, the observed variation in room humidity between highest and lowest values was 23.1%, whereas the same variation in culture moistness was 35.0%, indicating that the variation inside the moist chambers was 34.0% higher than the variation of a similar metric in the laboratory. Despite this observation, it is important to remember that the two measurements are different, and it would be interesting to carry out the comparison with the same metric.

The average moistness value inside the moist chamber during the entire period represented about 63% of the highest possible value of 50% w/w and the decreasing values between weeks 2 and 5 and between weeks 7 and 10 displayed a loss rate of 3% per week. During the experiment, water was added to the moist chambers during week 1, at the start of the experiment, and during week 5, after reading the values. These results indicated that given the room conditions where the experiment was carried out, internal moistness decreased slow but steadily until more water was added, as expected. However, such surface moistness loss rate seemed less accelerated than in temperate areas, where the air humidity is invariably lower.

Table 1. Ranges of room humidity (RH) and room temperate (RT) as well as culture temperature (T) and culture moistness (W) all 97 studied cultures during the 10-week period.

Week	Range of RH (%)	Range of RT (°C)	Average T (°C)	Average W (% w/w)
W1	66.6-80.1	22.2-26.4		
W2	57.1-84.3	19.9-28.6	20.7±1.2	32.6±8.7
W3	54.9-76.6	20.1-28.5	20.4±0.8	31.2±8.9
W4	53.0-81.6	20.3-27.8	20.4±1.0	30.1±8.3
W5	55.9-81.3	20.2-29.1	20.4±1.0	29.5±8.0
W6	60.0-82.6	20.0-28.3	20.5±0.5	30.5±8.5
W7	62.5-83.1	19.9-28.0	20.9±0.9	33.9±7.8
W8	55.4-80.9	19.8-28.0	19.5±1.1	32.3±8.2
W9	62.1-83.5	19.8-27.0	21.3±1.1	31.5±8.7
W10	55.6-79.2	19.5-27.6	20.1±1.6	30.3±7.7

The internal temperature of the moist chamber cultures was clearly very steady, except during weeks 8 and 9, which coincided with the two lowest values overall. However, no direct mathematical relationship between this variable and room temperature was observed (Fig. 1), and instead, the highest correlation values of the culture average temperature were observed with both the minimum and maximum room humidity instead (ρ=0.82 and 0.86, respectively). Contrastingly, the average moistness inside the moist chamber varied in a very similar manner to the humidity of the room displaying high values during weeks 2 and 7 and low values during weeks 5 and 10 (Fig. 2). In this case, the association between the two variables showed a moderate correlation value (ρ=0.67).

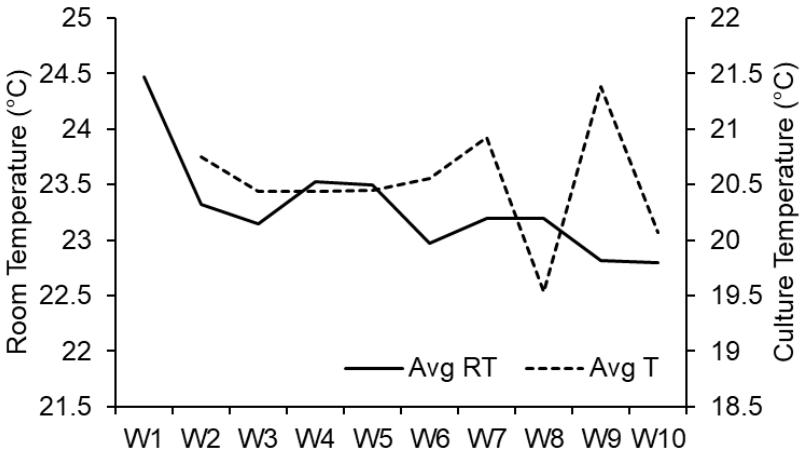

Figure 1. Average values of both room temperature (RT) and culture temperature (T) for the ten weeks of the experiment described herein.

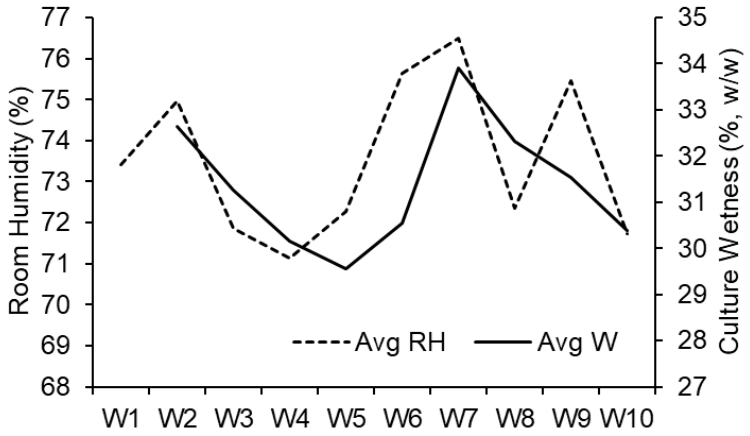

Figure 2. Average values of both room humidity (RH) and culture moistness (W) for the ten weeks of the experiment described herein.

These observations seem to point out that in the experiment that provided the results for the Arenas-Taborda experiment, the moist chamber cultures were affected more directly by the room humidity than

by the room temperature. Such remark makes sense when it is considered that some differences in microenvironmental conditions are simply determined by the position of the culture in space dedicated for examination. For instance, cultures are commonly stacked in columns that can range between 5-15 Petri dishes in most experiments (Fig. 3), and it would make sense that the cultures in the upper part of the stack display different microenvironments that those at the bottom. For this reason, some people recommend a rotation of cultures every week by placing the top cultures in bottom positions of a new stack and vice versa. However, this procedure would only affect those cultures in the end positions of stacks (the ones that really are switching) because the cultures in the middle of the stack would always be in the middle.

Figure 3. Stacks of moist chamber cultures documented herein. As observed, each culture has a specific microclimate given by the three-dimensional characteristics of the setup.

In a similar manner, if several stacks of cultures are placed next to each other forming a group, the dimensions of the entire setup (e.g., how many cultures wide by how many cultures deep) would determine some of the microclimatic characteristics as well. For this reason, in addition to the culture rotation within a stack, a stack rotation within a group could also be advisable. It would be interesting to carry out an entire experiment measuring those microclimatic variables again, but also considering the observations just mentioned herein.

From the 720 moist chambers studied by Arenas-Taborda et al. (2021), only 174 cultures or 24% yielded any positive evidence of myxomycetes. This is a very low value when compared to many other studies, but I have the impression that tropical substrates in tropical laboratories are more difficult for yielding myxomycete sporocarps than similar substrates in temperate laboratories, which can possibly point out at some differences in air quality (e.g., temperature and humidity) between regions. It would be interesting to carry out an experiment to test this idea. Interestingly, the cultures made with material from the wet non-seasonal premontane forest displayed a slightly higher positive percentage (28%) than the average, whereas those from the moist seasonal premontane forest and the lowland seasonal dry forest generated lower values (21 and 22%, respectively).

Contrastingly, the 33 cultures from the wet non-seasonal premontane forest yielded six morphospecies of myxomycetes, the 37 moist chambers from the moist seasonal premontane forest

produced only three morphospecies, and the 27 cultures from the lowland seasonal dry forest yielded nine morphospecies. These results would clearly indicate what many researchers have pointed out in recent years with respect to dry ecosystems being productive localities for studying myxomycetes. This observation seems to be a pattern in both tropical and temperate areas as well. A recent study from Stephenson et al. (2025) in the western section of the continental United States showed the presence of 419 morphospecies of myxomycetes, about 91% of the 460 morphospecies documented in the moister eastern section, with only 35% of the total collecting effort.

A lot of biodiversity or ecological work on myxomycetes has been done using the moist chamber technique, but little effort has been dedicated to understanding the limitations of the technique for those purposes. Since one of the research pressures today, at least in developing contries, is to come up with applications using biodiversity data, I feel that we should study the technique a little more so we can understand it better and standardize a protocol that can let us make comparisons more accurately. If we get to that point, maybe we can come up with real applications for the data represented in the sporocarps that we see in those cultures. For now, at least based on what was presented herein, it seems that what happens inside a moist chamber culture resembles partially what happens in the room where the experiment is being carried out.

References

Alexopoulos CJ. 1953. Myxomycetes developed in moist chamber culture on bark from living Florida trees, with notes on an undescribed species of *Comatricha*. Fla Sci. 16(4): 254-262.

Arenas-Taborda A, García Chaves MC, Niño-García JP, Rojas C. 2021. Myxomycete assemblage turnover across a moisture and elevation gradient in Costa Rica. Slime Molds 1: V1A4.

Stephenson SL, Stempen H. 1994. Myxomycetes: A Handbook of Slime Molds. Oregon: Timber Press. 200 p.

Stephenson SL, Stauffacher R, Rojas C. 2025. Myxomycetes collected in the western United States and patterns of relative biodiversity. Österr Z Pilzk. 32: 159-170.

Wrigley de Basanta D, Estrada-Torres A. 2022. Techniques for recording and isolating myxomycetes: updated. In: Rojas C, Stephenson SL, editors. Myxomycetes: Biology, Systematics, Biogeography and Ecology, 2nd ed. London: Academic Press. p. 417-451.

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Biography: Harold W. Keller

Harold W. Keller[1]

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Abstract: This is a short biography of Dr. Harold W. Keller, one of the most influential myxomycete researchers from North America. His scientific work, developed for more than 50 years, has impacted what is globally known about these organisms. In this note, Dr. Keller shares details of his life with the scientific community to develop awareness to the fact that hard work, focus and discipline are key elements to foster a scientific career.

Keywords: Kansas, myxomycetes, Texas, United States of America

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I was born December 10, 1937.

I grew up at a small farming and ranching community, Peabody, Marion County, in the state of Kansas, located on the edge of the Flint Hills —some of the finest cattle grazing tall grass prairie country in the United States of America (USA).

As a teenager, I clerked in Keller's Clothing Store in Peabody, participated in a Boy Scouts Explorer Troop, and operated farm trucks and field equipment (tractors, combines, and one-way plows). I was also in 4H and had a Hampshire swine fat-pig project. Although my family lived in town, I spent more time in the countryside with our farm equipment, working farmland that my grandfather Keller owned in western Kansas (1,280 acres) and feeding and caring for our swine and cattle.

I served as an acolyte at Saint Paul's Lutheran Church in Peabody and sang solos and first tenor in our high school quartette and octette.

My father died when I was 19 years old which prompted me to change from a business administration major to a biology (especially botany) major at Kansas Wesleyan University (KWU). We had planned to open a chain of clothing stores but my father's death changed my life ambitions and even resulted in lower grades at KWU and academic probation.

The summers of 1957 and 1958 were spent at the Powell Ranger District, in Idaho. I was a firefighter, trail crew worker in the Bitterroot Mountains, and a lookout observer located at Diablo Mountain Lookout, spotting fires in the Selway-Bitterroot Primitive area in Idaho. I also was a telephone lineman climbing trees, repairing and re-hanging telephone line in the Powell Ranger District, in the Lolo National Forest (Fig. 1). These experiences were highlighted with scenic photographs published in the Lookout Network magazine and posted on their website as a featured article.

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Figure 1. Harold W. Keller as a telephone lineman in 1957 resplicing and rehanging telephone line in Powell Ranger District in the Lolo National Forest in the state of Idaho, USA. Note the silver hardhat, double bitted axe, and lineman saddle gear around my waist. Not shown are my climbing spurs attached to my legs. This is when and where I got interested in trees that led to my interest in botany at Kansas Wesleyan University. I spent two summers working for the United States Forest Service at Powell Ranger District while at Kansas Wesleyan University working on my undergraduate degree in biology.

My firefighter U.S. Forest Service experience in Idaho changed my life, especially being mentored by my foreman Lennie Smith who taught me how to use fire equipment, especially the crosscut saw. His confidence in me to climb trees and rehang telephone line was the reason I got interested in trees and eventually botany. I improved academically at KWU (I took courses over with Ds and Cs and got As and Bs), and thus my research interest in trees today.

This Idaho forest service experience triggered my interest in plants with Professor Dr. Albert Robinson Jr. who was my botany professor at KWU. He supported my application for a teaching assistantship and graduate study at The University of Kansas. At this point in my life I did not have much confidence in myself for any future endeavor therefore Dr. Robinson's support made a big positive difference.

I graduated with a biology degree in 1960 from KWU located at Salina, Kansas, and a Master's Degree in botany from the University of Kansas (KU), at Lawerence, Kansas. My Master's thesis was titled "A comparative anatomical study of the genus *Echinacea*", under the direction of Professor Dr. Ronald L. McGregor who was head of the Botany Department.

I became interested in the myxomycetes in the early 1960s while at KU, collecting in the Lawrence and Manhattan, Kansas areas. This time was the beginning of the USA-Vietnam War Era and I volunteered as a Second Lieutenant and served in the United States Army Medical Service Corps for 3 ½ years, honorably discharged as a Captain. I received my officers training at Fort Sam Houston at San Antonio,

Texas and was later stationed at Fort McPherson headquarters for Third Army in Atlanta, Geogia (1964-1967).

In Atlanta I collected my earliest mushroom fungi and myxomycetes, including *Perichaena brevifila* Keller, which was published in Mycologia as a new myxomycete species while I was a doctoral graduate student at the University of Iowa in Iowa City (1967-1971). I found this myxomycete species *Perichaena brevifila* Keller in deep leaf litter behind a shopping center near where we lived in Atlanta, Georgia. I remember my wife Brenda J. Griffith Keller, now a Ph.D., scolding me for screening leaf litter on the kitchen table where we ate, even though I had newspapers covering the table top. After all, myxomycete collections were also a priority and some species had beautiful iridescent colors. This was a wet summertime and mushroom and myxomycetes were everywhere. Since then, I have actively pursued myxomycete collections and study ever since.

It was during my military service that I got interested in collecting and identifying fungi and myxomycetes and started sending myxomycete specimens and corresponding with Professor Dr. George W. Martin at the University of Iowa. He was the world authority on Myxomycetes at that time. I must confess I misidentified some of these early myxomycete collections but I learned a lot with Dr. Martin's help.

Immediately after my military service I went to the University of Iowa as a doctoral student to work with Dr. Martin as his last student. He had been in retirement for many years and had had several heart-attacks but he agreed to take me on as a graduate student and we mutually agreed I would do a monograph of the myxomycete genus *Perichaena*. During this time Dr. Martin published his world monograph with Professor Dr. C. J. Alexopoulos a world-famous mycologist. I had the good fortune to read drafts of the myxomycete book narrative as a graduate student. Dr. Martin lived to see me graduate with my Ph.D. in 1971. Shortly thereafter, I was selected as a one-year postdoctoral fellow in a nationwide competition by The University of Florida Graduate School to study the myxomycetes of Florida.

In 1971 I was selected as one of 25 recent Ph.D.'s nationwide to participate as a National Science Foundation Fellow in the "Summer Institute in Systematics V, Origin and Measurement of Diversity" held at the Smithsonian Institute. I was the recipient of numerous grants, including National Science Foundation grants to support my research entitled "Monographic and Floristic Studies of the Corticolous Myxomycetes" and more recently "Tree Canopy Biodiversity (Myxomycetes, Macrofungi, Mosses, Liverworts, and Lichens) in the Great Smoky Mountains National Park". My research interests are focused on the systematics, floristics and ecology of the corticolous myxomycetes as well as on fungi.

My academic experience included several teaching and research activities at different universities. While during my military service in Atlanta, Georgia. I taught a General Botany course in downtown Atlanta at Georgia State University (at night). I was an Assistant Professor of Biological Sciences at Wright State University (1971-1978) where I taught biology courses such as Principles of Biology, Ecology and Organismic Biology, Honors Recitation, Biology of Lower Plants, Medical Mycology, Microbiology (for nurses), Plant Biology, Biology of Economic Plants, and Biology of Slime Molds. I was Associate Professor, Department of Biological Sciences, University of North Carolina at Wilmington. 1982-1983, and Associate Professor, Department of Biology, University of Texas at Arlington 1983-1990.

I was a full time Administrative Officer but in addition I taught a grant writing course for students and faculty. Visiting Professor, University of Central Missouri, Warrensburg, 2006-2008. I was a full-time administrative officer and taught a regular grant writing course for students and faculty.

Myxomycete workshops that highlight the collection and identification of colorful and fascinating myxomycetes were given at national and international meetings. In 1996 I delivered the invited Plenary

Address entitled "Biosystematics of Myxomycetes: A Futuristic View" at the Second International Congress on the Systematics and Ecology of Myxomycetes in Madrid, Spain. I delivered the keynote address at the International Congress on the Systematics and Ecology of Myxomycetes 7 held at Recife, Brazil (see Fig. 2) and ICSEM 8 in China (read in absentia).

Figure 2. Dr. Harold W. Keller (Dr. Myxo) in Recife, Brazil, during the 2011 myxomycete workshop given to both local and international students. Note the cap with Dr. Myxo in black letters which was worn at professional myxomycete meetings and in the field collecting myxomycetes. The red shirt with Tree Canopy Biodiversity was worn by the tree climbing team at the University of Central Missouri. The iridescent stalked sporangium of a new myxomycete species *Diachea arboricola* only known from the tree canopy discovered in the Great Smoky Mountains Nation Park is highlighted on the front of the shirt.

As a volunteer at the River Legacy Living Science Center in Arlington, Texas, I served as an interpretive trail guide for children and adults and as an instructor for outdoor education programs. In 1991 I received the Alumni Achievement Award from my alma mater, KWU, for outstanding accomplishment in a chosen field of research and administration. I also served from 1992 to 2001 on the KWU Board of Trustees. I served as a Resident Research Associate, Botanical Research Institute of Texas, Fort Worth, Texas, from 1990 to the present.

My current and past professional memberships have included the Mycological Society of America, the North American Mycological Society, the Association of Southeastern Biologists, Southern Appalachian Botanical Society, Sigma Xi, The Scientific Research Society, The Mycological Society of Mexico, and International Canopy Network. I have a special interest in the development and use of K through 12 teaching materials usings myxomycetes represented by laboratory exercises, videos, and books. I have taught different botany courses at several universities, including “Organismic Biology (Honors Sections)”; the "Biology of Lower Plants", "Plant Biology", “Biology of Economic Plants”; "Microbiology", and "Biology of Slime Molds".

I take great pride in the visiting scientists who studied and published with me including Jean D. Schoknecht, Ph.D., Associate Professor, Indiana State University, Department of Life Sciences and Department of Botany and Plant Pathology, Illinois Natural History Survey, spent her sabbatical leave

during 1987 working with me, Uno H. Eliasson, Ph.D., Professor and Director, The Botanical Museum, University of Gothenburg, Sweden, supported by the Swedish National Science Research Council to study Myxomycetes in my laboratory from September to October, 1987, June, 1991, and August, 1993. Takami Hatano, Ph.D., Professor of Biology, Department of Biology, Faculty of Education, Mie University, Japan, supported by a grant from the Japan Ministry of Education, September 1, 1993 to June 29, 1994, to study myxomycetes using scanning electron microscopy as a Visiting Professor at the University of Texas Health Science Center in Fort Worth and the University of Texas at Arlington. Thomas W. Gaither, Ph.D., Professor, Biology Department, Slippery Rock University, Slippery Rock, Pennsylvania, for his sabbatical leave of absence.

My undergraduate students (UG) and graduate students (G) who published with me include: Mary J. Buben-Zurey, UG Honors Project, Commander, U.S. Navy; David M. Smith, UG Honors Project, WSU-SOM, M.D; Justin G. Mills, Independent Study Project, WSU-SOM, M.D., Laura L. Anderson; (UG) Independent Study Project, The Ohio State University, M.D.; Angela R. Scarborough (UG) special awards for poster and oral standup presentations at Association of Southeastern Biology annual meeting and University of Central Missouri; Erica E. Parker (UG), first place award paper published in the Journal of the McNair Central Achievers Program, McNair Scholar, UCM; Melissa Skrabal (UG) coauthor on many published tree canopy papers; Kenneth L. Snell, (G), received two first place University-wide Central Missouri awards, based on his scholarship, research, Master's Thesis and citizenship. He was our research project leader for our tree canopy research in Great Smoky Mountains National Park. Sydney E. Everhart (G) received the Association of Southeastern Biologist (ASB) Research Award in Microbiology first place for her oral and poster presentation at the annual meeting. Christopher D. Crabtree, a Native American Cherokee, who graduated with His Master's Degree from UCMO based on macrofungi and myxomycetes at Ha Ha Tonka State Park near Camdenton, Missouri. Chris was presented with the Best Graduate Student Poster Award at the Central Scholars Symposium, April 2-4, 2007, and the Most Outstanding Graduate Student Award for the UCMO, Department of Biology. The Missouri Department of Natural Resources Annual Meeting held at Tan-Tar-A, Osage Beach, Missouri with a poster (30 entries) and Chris was judged the winner. Chris received the University of Central Missouri College of Science and Technology William L. Vacek Graduate Student Research Award. Chris was recognized as the outstanding graduate student at the annual University of Central Missouri Department of Biology and Earth Science Annual Banquet April, 2008. This is the second year in a row Chris has received this honor. The UCM Sigma Xi Chapter honored Chris at their Spring Banquet April, 2008 for the best graduate research project. Chris was the second-place recipient of the Outstanding Graduate Student Thesis awarded by the UCM University Research Council.

Courtney M. Kilgore was part of our student tree climbing team in the GSMNP and Daniel Boone National Forest in Kentucky. Her Master's Thesis research received the Nahm Award for the Outstanding Graduate Student from the University of Central Missouri College of Science and Technology. The Mycological Society of America (MSA) held their annual meeting at Pennsylvania State University (PSU), August 10-13, 2008. Each year there is a t-shirt design contest open to all MSA members. The winner has their design featured on the official conference t-shirt and posted on the MSA website, and included in the next issue of the national newsletter, Inoculum. Courtney submitted a pencil sketch design in black and white that was selected as the contest winner. Four edible mushroom cultivars were included in the winning design, Shiitake (*Lentinula edodes*), Hen of the Woods (*Grifola frondosa*), button mushroom and Portabella white and brown variety (*Agaricus bisporus*), and the velvet foot mushroom

(*Flammulina velutipes*), the latter three are native to the United States of America. Molds adorn the outer edge represented by *Penicillium*, *Trichoderma*, *Alternaria*, *Fusarium* and *Aspergillus*.

My publications include books, chapters, journal papers, newsletter articles (130+) presented at symposia, congress proceedings, and national meetings as published abstracts (147), as oral standup slide and poster presentations, and invited lectures. The two areas of myxomycete research study that I consider the most important are the 26 new taxa of Myxomycetes I described, including mostly tiny species of *Echinostelium* and *Licea*, and one genus *Kelleromyxa* and two-member myxomycete type cultures deposited with the American Type Culture Collection in Rockville, Maryland, during 1987: *Didymium saturnus* Keller, ATCC #64178; *Badhamia spinispora* (Eliasson & Lundq.) Keller & Schoknecht, ATCC #64201; *Didymium annulisporum* Keller & Schoknecht, ATCC #64200; and *Badhamia rhytidosperma* Keller & Schoknecht, ATCC #64199.

I am grateful for the office, research space, and fellowship of friendships at the recently merged Fort Worth Botanic Garden and Botanical Research Institute of Texas and the opportunity to serve on the Editorial Board of the Journal of the Botanical Research Institute of Texas.

My life recreational activities include ranching, raising cattle and swine, fishing, hunting, collecting fungi, playing racquet ball, water aerobics, swimming and teaching swimming lessons as a Water Safety Instructor, and listening to choir music. All of these activities are now limited because of my advanced age.

A selected list of my publications, from the 130+ articles I have published is listed below:

Bordelon, AP, Keller HW, Scarborough A. 2024. An inexpensive moist chamber culture technique for finding microbiota on live tree bark. APPS. 12(2): e11578.

Eliasson UH, Keller HW, Schoknecht JD. 1991. *Kelleromyxa*, a new generic name for *Licea fimicola* (Myxomycetes). Mycol Res. 95: 1201-1207.

Everhart SE, Keller HW. 2008. Life history strategies of corticolous myxomycetes: the life cycle, fruiting bodies, plasmodial types, and taxonomic orders. Fungal Divers. 29: 1-16.

Everhart SE, Keller HW, Ely JS. 2008. Influence of bark pH on the occurrence and distribution of tree canopy myxomycete species. Mycologia 100: 191-204.

Keller HW. 1996. Invited Plenary Address – Biosystematics of Myxomycetes: A Futuristic View [Second International Congress on the Systematics and Ecology of Myxomycetes Abstract/Volume: 23-37.] [Madrid, Spain]: Real Jardín Botánico de Madrid.

Keller HW. 2023. Diablo Mountain Lookout, Past and Present: Powell Ranger District, Idaho. Lookout Netw. 34(1/2): 26-28.

Keller HW. 2004. Tree canopy biodiversity: student research experiences in Great Smoky Mountains National Park. Syst Geogr Plants. 74: 47-65.

Keller HW. 2005. Undergraduate research field experiences: tree canopy biodiversity in Great Smoky Mountains National Park and Pertle Springs, Warrensburg, Missouri. CUR Quarterly. 25: 162-168.

Keller HW. 2012. Lookout and trail adventures in Powell Ranger District, Idaho (Part 1). Lookout Netw. 23(4): 16-19.

Keller HW. 2013. Lookout and trail adventures in Powell Ranger District, Idaho (Part 2). Lookout Netw. 24 (1): 14-20.

Keller HW. 2015. Keynote Address – More than 50 years with Myxomycetes (plasmodial slime molds): highlights and review [Eighth International Congress on Systematics and Ecology of Myxomycetes Abstract/Volume: 9-28] [Changchun, China]: Jilin Agricultural University.

Keller HW, Barfield KM. 2017. Great Smoky Mountains National Park: The people's park. Fungi 10: 44-64.

Keller HW, Bordelon A. 2022. Discovering the Microscopic World of Live Tree Bark: A Model Instructional Experience for Students and Teachers Using a Virtual iAdventure, Teacher Preparation Guide, Student Worksheets, and Moist Chamber Cultures. Plant Sci Bull. 68(1): 12-23.

Keller HW, Everhart SE. 2010. Importance of Myxomycetes in biological research and teaching. Fungi 3 (1): 29-43

Keller HW, Everhart SE, Skrabal M, Kilgore CM. 2009. Tree canopy biodiversity in temperate forests: exploring islands in the sky. SEB. 56: 52-74.

Keller HW, Skrabal M, Eliasson UH, Gaither TW. 2004. Tree canopy biodiversity in the Great Smoky Mountains National Park: ecological and developmental observations of a new myxomycete species of Diachea. Mycologia 96: 537-547.

Keller HW, Snell KL. 2002. Feeding activities of slugs on Myxomycetes and macrofungi. Mycologia 94: 757-760.

Keller HW, Snell KL. 2018. Hunting and collecting myxomycetes at night with a flashlight. Fungi 11: 43-44.

Keller HW, Everhart SE, Skrabal M, Kilgore CM. 2009. Tree canopy biodiversity in temperate forests: exploring islands in the sky. SEB. 56: 52-74.

Keller HW, Everhart SE, Kilgore CM. 2017. The Myxomycetes: Basic Biology, Life Cycles, Genetics and Reproduction. In: Stephenson SL, Rojas C, editors. Myxomycetes: Biology, Systematics, Biogeography and Ecology. 1st ed. London: Academic Press. p. 1-40.

Keller HW, Everhart SE, Kilgore CM. 2021. Myxomycetes: Basic Biology, Life Cycles, Genetics and Reproduction. In RojasC, Stephenson SL, editors. Myxomycetes: Biology, Systematics, Biogeography and Ecology, 2nd ed. London: Academic Press. p. 1-45.

Kilgore CM, Keller HW, Ely JS. 2009. Aerial reproductive structures on vascular plants as a microhabitat for myxomycetes. Mycologia 101: 303-317.

Kilgore CM, Keller HW, Everhart SE, Scarborough AR, Snell KL, Skrabal MS, Pottorff C, Ely JS. 2008. Research and student experiences using the doubled rope climbing method. JBRIT. 2: 1309-1336.

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Diderma effusum (Schwein.) Morgan (Amoebozoa): a new record of a myxomycete from Antarctica

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Abstract: Myxomycetes have been recorded from virtually every type of terrestrial ecosystem. However, the number of species known from Antarctica is very low, with only nine species in six genera representing the total myxobiota prior to the three records of *Diderma effusum* reported herein. This species appeared in moist chamber cultures prepared with samples of bryophytes

Keywords: bryophytes, moist chamber cultures, protists, slime molds

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Introduction

The limited availability of liquid water, low temperatures, low habitat heterogeneity, and the absence of woody substrates impose severe environmental restrictions on the presence of myxomycetes (slime molds or myxogastrids) in Antarctica. Velloso et al. (2024), who reviewed all reports of myxomycetes from Antarctica, listed only nine species representing six genera. Horak (1966) was the first to report a myxomycete from Antarctica, and additional species were added by Ing and Smith (1983), Arambarri and Spinedi (1989), Putzke et al. (2004), and Velloso et al. (2020). The nine species reported thus far from Antarctica include four (*Leptoderma megaspora* Aramb. & Spinedi, *Oligonema dancoii* Aramb. & Spinedi, *Trichia antarctica* Aramb. & Spinedi, and a species of *Diderma*, *D. antarcticola* Horak) that appear to be endemic. The remaining species are primarily associated with high-latitude ecosystems, with occasional reports from other ecosystems throughout the rest of the world. *Diderma effusum* is an exception to this general pattern since it is a widely distributed species worldwide (GBIF 2023). Myxomycetes are relatively more common in the subantarctic, with diversity increasing with decreasing latitude and increasingly less severe conditions (Stephenson et al. 1992, Stephenson et al. 2007, Stephenson 2011). For example, 26 species are known from subantarctic Macquarie Island, located at 54° S latitude (Stephenson et al. 2007).

Methods

In late December of 2004 and early January of 2005, Ina Timling a graduate student at the University of Alaska, visited the Antarctic as a tourist aboard one of the vessels that make the voyage from

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Ushuaia to the Antarctic Peninsula. During this visit, she collected samples of bryophytes from several different localities and then sent these samples to the author when she returned to the United States. Bryophytes commonly occur in areas of exposed rock in the localities from which the samples were collected (Fig. 1). These samples were processed in moist chamber cultures in the manner described by Stephenson and Stempen (1994).

Figure 1. Bryophytes on rocky outcrops near the Almirante Brown Scientific Station on the Antarctic Peninsula. (Photo by Steve Stephenson)

Results and Discussion

Several moist chamber cultures yielded fruiting bodies of *Diderma effusum* (Fig. 2), a species not previously recorded from Antarctica. The purpose of this paper is to report this addition to the myxomycete biota of Antarctica. Collections listed below were deposited in the herbarium of the University of Arkansas (UARK).

Diderma effusum (Schwein.) Morgan

ANTARCTIC PENINSULA, Livingston Island, 62°41′18″ S, 60°11′38 ″ W, specimens obtained in moist chamber cultures prepared with bryophytes, material collected on 29 December 2004, SLS 19816 and SLS 20797.

ANTARCTIC PENINSULA, Almirante Brown Scientific Station, 64°53′44″ S, 62°53′15″ W, specimen obtained in a moist chamber culture prepared with bryophytes; material collected on 1 January 2004, SLS 20801

It is interesting that *Diderma effusum* is the fourth species of *Diderma* reported from Antarctica. Bryophytes do not represent the typical habitat of this species, which is more likely to occur on leaf litter and other types of dead material derived from herbaceous plants (Martin and Alexopoulos 1969).

However, the occurrence of the fruiting bodies of *D. effusum* on mosses has been reported (e.g., Stephenson and Rojas 2020).

Figure 2. Fruiting bodies of *Diderma effusum* appearing on samples of bryophytes in moist chamber culture. (Photo by Steve Stephenson)

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References

Arambarri AM, Spinedi HA. 1989. Mixomicetes antárticos [Antarctic myxomycetes]. Buenos Aires: Instituto Antártico Argentino.

GBIF. 2023. *Diderma effusum* (Schwein.) Morgan, 1894 in GBIF Secretariat [Internet]. Denmark: GBIF Backbone Taxonomy. [visited 7 September 2025] Available from: https://doi.org/10.15468/39omei

Horak E. 1966. Sobre dos nuevas especies de hongos recolectados en el Antártico. Contr Int Antárt Argent. 104: 3-13.

Ing B, Smith RIL. 1983. Further myxomycete records from South Georgia and the Antarctic Peninsula. BAS Bull. 59: 80-81.

Martin GW, Alexopoulos CJ. 1969. The Myxomycetes. Iowa City: University of Iowa Press.

Putzke J, Pereira AB, Putzke MTL. 2004. A new record of myxomycetes to the Antarctic – Actas del V Simposio Argentino y I Latinoamericano de Investigaciones Antártica. Buenos Aires: Instituto Antártico Argentino.

Stephenson SL. 2011. Myxomycetes of the New Zealand subantarctic islands. Sydowia 63: 215-236.

Stephenson SL, Laursen GA, Seppelt RD. 2007. Myxomycetes of subantarctic Macquarie Island. Aust J Bot. 55: 439-449.

Stephenson SL, Seppelt RL, Laursen GA. 1992. The first record of a myxomycete from subantarctic Macquarie Island. Antarct Sci. 4: 431-432.

Stephenson SL, Stempen H. 1994. Myxomycetes: A Handbook of Slime Molds. Portland: Timber Press.

Stephenson SL, Rojas C. 2020. Mosses as spore traps for myxomycetes. Sydowia 72: 215-219.

Velloso JRP, Heberle MA, Costa AL, Lopes CF, da Silva1 FAB, Putzke J, Cavalcanti LH. 2024. Myxomycetes in the Antarctic: A review. Karstenia 51: 1-8.

Velloso JRP, Putzke J, Schmitz D, Pereira AB, Schaefer CER, Cavalcanti LH. 2020. *Dianema nivale*–a myxomycete (Amoebozoa) new to the Antarctic. Polar Sci. 26: 100598.

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A checklist of the myxomycetes of Arkansas

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Abstract: An updated checklist of myxomycetes is provided for the state of Arkansas based on all previously published records, records from MycoPortal, and more than 3000 specimens collected during the period of 2003 to 2023 by the author and colleagues, undergraduate students, and graduate students. A total of 184 species are now known from Arkansas. This total includes 33 species reported for the first time from the state.

Keywords: biota, field collections, moist chamber cultures, slime molds, University of Arkansas

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Introduction

Eliasson et al. (1988) published a checklist of myxomycetes from Arkansas in which 88 taxa, including one species described as new to science from material collected in the state, were reported. The 88 taxa included 83 identified to the level of species and five that could be identified only to genus but were considered as possible new species. The authors indicated that they could not locate any previous records of myxomycetes from Arkansas. The purposes of this paper are to update this earlier checklist with other taxa now known to occur in the state, to update the nomenclature of these taxa, and to provide data on the relative abundance of particular species of myxomycetes in Arkansas.

The state of Arkansas extends from 33°00′ to 36°30′ N latitude and 89°39′ to 94°37′ W longitude, with a total area of 137 732 km^2. Elevations in the state range from 17 m to 939 m on the summit of Mt. Magazine. The climate of Arkansas is classified as humid subtropical (Cfa in the Köppen climate classification) with hot and humid summers and mild to cool winters. However, peak precipitation typically occurs in May (annual mean of 12.4 cm), but by July (annual mean of 7.1 cm) and August (annual mean of 7.4 cm) conditions are quite dry and not particularly suitable for myxomycetes. During the latter part of some summers, based on the experience of the author, few fruiting bodies of myxomycetes can be found in the field.

During the twenty years (2003 to 2023) the author was on the faculty at the University of Arkansas, he along with his students and several colleagues carried out a series of projects involving surveys of the myxomycetes associated with particular localities or microhabitats (Tucker et al. 2011, Goad and Stephenson 2013, Massingill and Stephenson 2013, Clayton et al. 2014, dela Cruz et al. 2014, Fischer and Stephenson 2014, Stephenson et al. 2020, Rojas et al. 2020, Stephenson and Rojas 2020, Stephenson and Novozhilov 2021). These surveys yielded a database of 3276 specimens of myxomycetes collected in the

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state. One hundred and four (3% of the total) of these could be identified only to genus, and two could be identified only as being some type of myxomycete. The 3276 specimens included those that had developed under natural conditions in the field as well as those appearing in moist chamber cultures.

Annotated List of Species

In the list that follows, all species of myxomycetes known to have been collected within the state of Arkansas are arranged alphabetically by genus and then species. Information is provided on the source(s) of the record and the number of specimens represented in the Arkansas database. The nomenclature used follows Lado (2005-2025) except where noted. Recent molecular studies have resulted in a number of taxonomic rearrangements in the myxomycetes. As a result, some familiar species now have names that would not be immediately recognized by many of the people who collect and study myxomycetes.

Angioridium sinuosum (Bull.) Grev.

First reported by Eliasson et al. (1988) and represented by 18 specimens in the Arkansas database. In all but the most recent literature, this species is listed as *Physarum bivalve* Pers.

Arcyria afroalpina Rammeloo

Represented by one specimen in the Arkansas database. Not previously reported from Arkansas.

Arcyria cinerea (Bull.) Pers.

First reported by Eliasson et al. (1988) and represented by 364 specimens (11% of all specimens!) in the Arkansas database. This is one of the most common of all myxomycetes and appears both in the field as well as on all types of substrates in moist chamber cultures.

Arcyria denudata (L.) Wettst.

First reported by Eliasson et al. (1988) and represented by 47 specimens in the Arkansas database. This is one of the more common myxomycetes. Most specimens fruited under natural conditions in the field., but this species sometimes occurs in moist chamber cultures.

Arcyria helvetica (Meyl.) H. Neubert, Nowotny & K. Baumann

Represented by one specimen in the Arkansas database. Not previously reported from Arkansas.

Arcyria incarnata (Pers. ex. J.F. Gmel.) Pers.

First reported by Eliasson et al. (1988) and represented by 16 specimens in the Arkansas database. This species is similar in appearance to *A. denudata* but differs in the attachment of the capillitium.

Arcyria magna Rex

First reported by Eliasson et al. (1988) and not represented by any specimens in the Arkansas database.

Arcyria marginoundulata Nann.-Bremek. & Y. Yamam.

First reported by dela Cruz et al. (2014) and represented by four specimens in the Arkansas database.

Arcyria stipata (Schwein.) Lister

Represented by one specimen in the Arkansas database. Not previously reported from Arkansas.

Badhamia affinis Rostaf.

First reported by Massingill and Stephenson (2013) and represented by 10 specimens in the Arkansas database.

Badhamia capsulifer (Bull.) Berk.

First reported by Massingill and Stephenson (2013) and represented by one specimen in the Arkansas database.

Badhamia dubia Nann.-Bremek.

First reported by dela Cruz et al. (2014) and represented by five specimens in the Arkansas database.

Badhamia melanospora Speg.

First reported by Eliasson et al. (1988) and represented by four specimens in the Arkansas database. In the older literature, this species is listed as *Badhamia gracilis* (T. Macbr.) T. Macbr.

Badhamia nitens Berk.

First reported by Stephenson and Novozhilov (2021) and represented by two specimens in the Arkansas database.

Badhamia polycephala (Schwein.) J.M. García-Martín, J.C. Zamora & Lado

First reported by Eliasson et al. (1988) and represented by one specimen in the Arkansas database. In all but the most recent literature, this species is listed as *Physarum polycephalum* Schwein.

Badhamia rugulosa T.E. Brooks & H.W. Keller`

First reported by Eliasson et al. (1988) and not represented by any specimens in the Arkansas database.

Badhamia utricularis (Bull.) Berk.

Represented by three specimens in the Arkansas database. Not previously reported from Arkansas.

Badhamia versicolor Lister

First reported by Eliasson et al. (1988) and not represented by any specimens in the Arkansas database.

Badhamiopsis ainoae (Yamash.) T.E. Brooks & H.W. Keller

First reported by Eliasson et al. (1988) and not represented by any specimens in the Arkansas database.

Calomyxa metallica (Berk.) Nieuwl.

First reported by Eliasson et al. (1988) and represented by one specimen in the Arkansas database.

Calonema aureum Morgan

First reported by Eliasson et al. (1988) and not represented by any specimens in the Arkansas database.

Ceratiomyxa fruticulosa (O.F. Müll.) T. Macbr.

First reported by Eliasson et al. (1988) and represented by 20 specimens in the Arkansas database. *Ceratiomyxa fruticulosa* is not a "true" myxomycete and actually belongs to a sister group of eumycetozoans (Fiore-Donno et al. 2010). *Ceratiomyxa fruticulosa* is much more common than the number of specimens indicated. During rainy periods in the summer, it sometime appears to be present on virtually every large piece of coarse woody debris

Clastoderma debaryanum A. Blytt

First reported by Clayton et al. (2014) and represented by 15 specimens in the Arkansas database.

Clastoderma microcarpum (Meyl.) Kowalski

First reported by Eliasson et al. (1988) and not represented by any specimens in the Arkansas database.

Clastoderma pachypus Nann.-Bremek.

First reported by Eliasson et al. (1988) and not represented by any specimens in the Arkansas database.

Claustria didermoides (Pers.) Fr.

First reported by Eliasson et al. (1988) and represented by three specimens in the Arkansas database. In all but the most recent literature, this species is listed as *Physarum didermoides* (Pers.) Rostaf.

Collaria arcyrionema (Rostaf.) Nann.-Bremek. ex Lado

First reported by Massingill and Stephenson (2013) and represented by 78 specimens in the Arkansas database. Not previously reported from Arkansas. In all but the most recent literature, this species is listed as *Lamproderma arcyrionema* Rostaf.

Collaria biasperospora (Kowalski) Dhillon & Nann.-Bremek. ex Ing

First reported by Eliasson et al. (1988) and not represented by any specimens in the Arkansas database. In all but the most recent literature, this species is listed as *Lamproderma biasperosporum* Kowalski.

Collaria lurida (Lister) Nann.-Bremek.

First reported by Massingill and Stephenson (2013) and represented by two specimens in the Arkansas database.

Collaria rigidireta (Nann.-Bremek.) Nann.-Bremek.

Represented by three specimens in the Arkansas database. Not previously reported from Arkansas.

Comatricha elegans (Racib.) G. Lister

First reported by dela Cruz (2014) and represented by 11 specimens in the Arkansas database.

Comatricha laxa Rostaf.

First reported by Massingill and Stephenson (2013) and represented by 20 specimens in the Arkansas database.

Comatricha nigra (Pers. ex J.F. Gmel.) J. Schröt.

First reported by Massingill and Stephenson (2013) and represented by 17 specimens in the Arkansas database.

Comatricha pulchella (C. Bab.) Rostaf.

First reported by Goad and Stephenson (2013) and represented by 57 specimens in the Arkansas database.

Comatricha tenerrima (M.A. Curtis) G. Lister

First reported by Massingill and Stephenson (2013) and represented by 30 specimens in the Arkansas database.

Craterium aureum (Schumach.) Rostaf.

First reported by Clayton et al. (2014) and represented by two specimens in the Arkansas database.

Craterium concinnum Rex

First reported by dela Cruz et al. (2014) and represented by one specimen in the Arkansas database.

Craterium leucocephalum (Pers. ex J.F. Gmel.) Ditmar

First reported by Eliasson et al. (1988) and represented by one specimen in the Arkansas database.

Craterium minutum (Leers) Fr.

Represented by one specimen in the Arkansas database. Not previously reported from Arkansas.

Craterium roseum (Berk. & Broome) J.M. García-Martín & Lado

First reported by Eliasson et al. (1988) and represented by one specimen in the Arkansas database. In all but the most recent literature, this species is listed as *Physarum roseum* Berk. & Broome.

Cribraria aurantiaca Schrad.

Represented by one specimen in the Arkansas database. Not previously reported from Arkansas.

Cribraria cancellata (Batsch) Nann.-Bremek.

First reported by Eliasson et al. (1988) and represented by four specimens in the Arkansas database. In the older literature, this species is listed as *Dictydium cancellatum* (Batsch) T. Macbr.

Cribraria confusa Nann.-Bremek. & Y. Yamam.

First reported by Stephenson et al. (2020) and represented by nine specimens in the Arkansas database.

Cribraria intricata Schrad.

Represented by five specimens in the Arkansas database. Not previously reported from Arkansas.

Cribraria microcarpa (Schrad.) Pers.

First reported by Massingill and Stephenson (2013) and represented by 62 specimens in the Arkansas database.

Cribraria minutissima Schwein.

First reported by Stephenson et al. (2020) and represented by nine specimens in the Arkansas database.

Cribraria violacea Rex

First reported by Eliasson et al. (1988) and represented by 150 specimens in the Arkansas database.

Cribraria vulgaris Schrad.

Represented by two specimens in the Arkansas database. Not previously reported from Arkansas.

Diachea leucopodia (Bull.) Rostaf.

First reported by Tucker et al. (2011) and not represented by any specimens in the Arkansas database.

Diachea obovata (Peck) J.M. García-Martín, J.C. Zamora & Lado

Represented by seven specimens in the Arkansas database. Not previously reported from Arkansas. In all but the most recent literature, this species is listed *Craterium ovovatum* Peck.

Dictydiaethalium plumbeum (Schumach.) Rostaf.

First reported by Eliasson et al. (1988) and represented by four specimens in the Arkansas database.

Diderma chondrioderma (de Bary & Rostaf.) Kuntze

First reported by Eliasson et al. (1988) and represented by 10 specimens in the Arkansas database.

Diderma effusum (Schwein.) Morgan

First reported by Tucker et al. (2011) and represented by 110 specimens in the Arkansas database.

Diderma floriforme (Bull.) Pers.

First reported by Eliasson et al. (1988) and not represented by any specimens in the Arkansas database.

Diderma hemisphaericum (Bull.) Hornem.

First reported by Tucker et al. (2011) and represented by 97 specimens in the Arkansas database.

Diderma miniatum Nann.-Bremek.

Represented by two specimens in the Arkansas database. Not previously reported from Arkansas.

Diderma saundersii (Berk. & Broome ex Massee) E. Sheld.

First reported by dela Cruz et al. (2014) and represented by six specimens in the Arkansas database.

Diderma testaceum (Schrad.) Pers.

First reported by Goad and Stephenson (2013) and represented by 10 specimens in the Arkansas database.

Didymium anellus Morgan

First reported by Goad and Stephenson (2013) and represented by three specimens in the Arkansas database.

Didymium bahiense Gottsb.
Represented by two specimens in the Arkansas database. Not previously reported from Arkansas.

Didymium clavus (Alb. & Schwein.) Rabenh.
First reported by dela Cruz et al. (2014) and represented by 21 specimens in the Arkansas database.

Didymium difforme (Pers.) Gray
First reported by dela Cruz et al. (2014) and represented by eight specimens in the Arkansas database.

Didymium iridis (Ditmar) Fr.
First reported Tucker et al. (2011) and represented by 21 specimens in the Arkansas database.

Didymium megalosporum Berk. & M.A. Curtis
First reported by Eliasson et al. (1988) and not represented in the Arkansas database.

Didymium melanospermum (Pers.) T. Macbr.
Represented by one specimen in the Arkansas database. Not previously reported from Arkansas.

Didymium minus (Lister) Morgan
First reported by Eliasson et al. (1988) and represented by 35 specimens in the Arkansas database.

Didymium nigripes (Link) Fr.
First reported by dela Cruz et al. (2014) and represented by 57 specimens in the Arkansas database.

Didymium ochroideum G. Lister
First reported by Goad and Stephenson (2013) and represented by 12 specimens in the Arkansas database.

Didymium pertusum Berk.
First reported by Tucker et al. (2011) and represented by two specimens in the Arkansas database.

Didymium proximum Berk. & M.A. Curtis
First reported by Eliasson et al. (1998) and not represented by any specimens in the Arkansas database. In all but the most recent literature, this species is listed as *Didymium ovoideum* Nann.-Bremek.

Didymium serpula Fr.
First reported by dela Cruz et al. (2014) and represented by one specimen in the Arkansas database.

Didymium spongiosum (Leyss.) J.M. García-Martín, J.C. Zamora & Lado
First reported by Eliasson et al. (1988) and not represented by any specimens in the Arkansas database. In all but the most recent literature, this species is listed as *Mucilago crustacea* P. Micheli ex F.H. Wigg.

Didymium squamulosum (Alb. & Schwein.) Fr. & Palmquist
First reported by Tucker et al. (2011) and represented by 26 specimens in the Arkansas database.

Didymium sturgisii Hagelst.

First reported by Clayton et al. (2014) and represented by two specimens in the Arkansas database.

Didymium synsporon T.E. Brooks & H.W. Keller

First reported by Eliasson et al. (1988) and not represented by any specimens in the Arkansas database.

Echinostelium apitectum K.D. Whitney

First reported by Stephenson et al. (2020) and represented by three specimens in the Arkansas database.

Echinostelium bisporum (L.S. Olive & Stoian.) K.D. Whitney & L.S. Olive

Observed in laboratory culture but because of its extremely small size (it is the smallest of all myxomycetes) essentially impossible to preserve as a specimen. Not previously reported from Arkansas.

Echinostelium coelocephalum T.E. Brooks & H.W. Keller

First reported by Eliasson et al. (1988) and not represented by any specimens in the Arkansas database.

Echinostelium elachiston Alexop.

First reported by Eliasson et al. (1988) and not represented by any specimens in the Arkansas database.

Echinostelium fragile Nann.-Bremek.

First reported by Eliasson et al. (1988) and not represented by any specimens in the Arkansas database.

Echinostelium minutum de Bary

First reported by Eliasson et al. (1988) and represented by 40 specimens in the Arkansas database. The fruiting bodies of this tiny myxomycete are often abundant in the moist chamber cultures in which it occurs.

Enerthenema papillatum (Pers.) Rostaf.

First reported by Eliasson et al. (1988) and represented by five specimens in the Arkansas database.

Fuligo cinerea (Schwein.) Morga

First reported by Eliasson et al. (1988) and represented by two specimens in the Arkansas database.

Fuligo septica (L.) F.H. Wigg.

First reported by Eliasson et al. (1988) and represented by five specimens in the Arkansas database.

Gulielmina vermicularis (Schwein.) García-Cunch., J.C. Zamora & Lado

First reported by Massingill and Stephenson (2013) and represented by 25 specimens in the Arkansas database. In all but the most recent literature, this species is listed as *Perichaena vermicularis* (Schwein.) Rostaf.

Hemitrichia abietina (Wigand) G. Lister

Represented by two specimens in the Arkansas database. Not previously reported from Arkansas.

Hemitrichia calyculata (Speg.) M.L. Farr

First reported by Eliasson et al. (1988) and represented by 42 specimens in the Arkansas database.

Hemitrichia clavata (Pers.) Rostaf.

First reported by Eliasson et al. (1988) and represented by three specimens in the Arkansas database.

Heterotrichia insignis (Kalchbr. & Cooke) Yatsiuk, Leontyev & Schnittler

First reported by dela Cruz et al. (2014) and represented by one specimen in the Arkansas database. In all but the most recent literature, this species is listed as *Arcyria insignis* Kalchbr. & Cooke.

Hemitrichia lutescens (Lister) García-Cunch., J.C. Zamora & Lado

First reported by Massingill and Stephenson (2013) and represented by two specimens in the Arkansas database. Not previously reported from Arkansas.

Hemitrichia minor G. Lister

First reported by Massingill and Stephenson (2013) and represented by eight specimens in the Arkansas database.

Hemitrichia pardina (Minakata) Ing

First reported by Massingill and Stephenson (2013) and represented by eight specimens in the Arkansas database.

Hemitrichia serpula (Scop.) Rostaf. ex Lister

First reported by Eliasson et al. (1988) and represented by 22 specimens in the Arkansas database.

Heterotrichia obvelata (Oeder) Yatsiuk, Leontyev & Schnittler

First reported by Eliasson et al. (1988) and represented by one specimen in the Arkansas database. In all but the most recent literature, this species is listed as *Arcryia obvelata* (Oeder) Onsberg.

Heterotrichia pomiformis (Leers) Yatsiuk, Leontyev & Schnittler

First reported by Massingill and Stephenson (2013) and represented by six specimens in the Arkansas database. In all but the most recent literature, this species is listed as *Arcyria pomiformis* (Leers) Rostaf.

Lamproderma arcyrioides (Sommerf.) Rostaf.

First reported by Clayton et al. (2014) and represented by three specimens in the Arkansas database.

Lamproderma scintillans (Berk. & Broome) Morgan

First reported by Tucker et al. (2011) and represented by 123 specimens in the Arkansas database.

Leocarpus fragilis (Dicks.) Rostaf.

First reported by Eliasson et al. (1988) and not represented by any specimens in the Arkansas database.

Licea belmontiana Nann.-Bremek.

First reported by Massingill and Stephenson (2013) and represented by four specimens in the Arkansas database.

Licea biforis Morgan

First reported by Eliasson et al. (1988) and represented by 15 specimens in the Arkansas database.

Licea castanea G. Lister

First reported by Eliasson et al. (1988) and not represented by any specimens in the Arkansas database.

Licea chelonoides Nann.-Bremek

First reported by Eliasson et al. (1988) and not represented by any specimens in the Arkansas database.

Licea denudescens H.W. Keller & T.E. Brooks

First reported by Eliasson et al. (1988) and not represented by any specimens in the Arkansas database.

Licea inconspicua T.E. Brooks & H.W. Keller

First reported by Eliasson et al. (1988) and not represented by any specimens in the Arkansas database.

Licea kleistobolus G.W. Martin

First reported by Eliasson et al. (1988) and represented by four specimens in the Arkansas database.

Licea minima Fr.

Represented by one specimen in the Arkansas database. Not previously reported from Arkansas.

Licea operculata (Wingate) G.W. Martin

First reported by Eliasson et al. (1988) and represented by 14 specimens in the Arkansas database.

Licea parasitica (Zukal) G.W. Martin

First reported by Eliasson et al. (1988) and not represented by any specimens in the Arkansas database.

Licea pedicellata (H.C. Gilbert) H.C. Gilbert

First reported by Eliasson et al. (1988) and not represented by any specimens in the Arkansas database.

Licea perexigua T.E. Brooks & H.W. Keller

First reported by Eliasson et al. (1988) and not represented by any specimens in the Arkansas database.

Licea rufocuprea Nann.-Bremek. & Y. Yamam.

First reported by dela Cruz et al. (2014) and represented by one specimen in the Arkansas database.

Licea rugosa Nann.-Bremek. & Y. Yamam.

First reported by Stephenson and Novozhilov (2021) and not represented by any specimens in the Arkansas database.

Licea scyphoides T.E. Brooks & H.W. Keller

First reported by Eliasson et al. (1988) and represented by one specimen in the Arkansas database.

Lycogala epidendrum (L.) Fr.

First reported by Eliasson et al. (1988) and represented by 35 specimens in the Arkansas database. It is now known that what has been recognized as the *Lycogala epidendrum* morphospecies actually consists of at least 60 biological species.

Lycogala exiguum Morgan

First reported by Eliasson et al. (1988) and represented by one specimen in the Arkansas database.

Macbrideola cornea (G. Lister & Cran) Alexop.

First reported by Eliasson et al. (1988) and represented by 16 specimens in the Arkansas database.

Macbrideola decapillata H.C. Gilbert

First reported by Eliasson et al. (1988) and represented by five specimens in the Arkansas database.

Macbrideola declinata T.E. Brooks & H.W. Keller

Described as a species new to science by Eliasson et al. (1988) based on material collected in Arkansas and not represented by any specimens in the Arkansas database.

Macbrideola scintillans H.C. Gilbert

First reported by Eliasson et al. (1988) and represented by 25 specimens in the Arkansas database.

Metatrichia vesparia (Batsch) Nann.-Bremek. ex G.W. Martin & Alexop.

First reported by Eliasson et al. (1988) and represented by 145 specimens in the Arkansas database. The vast majority of specimens were collected in the field, but this species occasionally appears in moist chamber cultures.

Nannengaella globulifera (Bull.) J.M. García-Martin, J.C. Zamora & Lado

First reported by Eliasson et al. (1988) and represented by 11 specimens in the Arkansas database. In all but the most recent literature, this species is listed as *Physarum globuliferum* (Bull.) Pers.

Nannengaella leucopus (Link) J.M. García-Martín, J.C. Zamora & Lado

First reported by Eliasson et al. (1988) and not represented by any specimens in the Arkansas database. In all but the most recent literature, this species is listed as *Physarum leucopus* Link.

Nannengaella mellea (Berk. & Broome) J.M. García-Martín, J.C. Zamora & Lado

First reported by Clayton et al. (2014) and represented by 26 specimens in Arkansas database. In all but the most recent literature, this species is listed as *Physarum melleum* (Berk. & Broome) Massee.

Oligonema favogineum (Batsch) García-Cunch., J.C. Zamora & Lado

First reported by Eliasson et al. (1988) and represented by 90 specimens in the Arkansas database. In all but the most recent literature, this species is listed as *Trichia favoginea* (Batsch) Pers.

Oligonema flavidum (Peck) Peck

First reported by Eliasson et al. (1988) and not represented by any specimens in the Arkansas database.

Oligonema schweinitzii (Berk.) G.W. Martin

First reported by Eliasson et al. (1988) and represented by one specimen in the Arkansas database.

Ophiotheca chrysosperma Curr.

First reported by Eliasson et al. (1988) and represented by 370 specimens in the Arkansas database. In all but the most recent literature, this species is listed as *Perichaena chrysosperma* (Curr.) Lister.

Ophiotheca pedata (Lister & G. Lister) García-Cunch., J.C. Zamora & Lado

First reported by Eliasson et al. (1988) and represented by 20 specimens in the Arkansas database. In all but the most recent literature, this species is listed as *Perichaena pedata* (Lister & G. Lister) G. Lister ex E. Jahn.

Paradiacheopsis fimbriata (G. Lister & Cran) Hertel ex Nann.-Bremek.

First reported by Eliasson et al. (1988) and not represented by any specimens in the Arkansas database.

Paradiacheopsis solitaria (Nann.-Bremek.) Nann.-Bremek.

First reported Stephenson et al. (2020) and represented by one specimen in the Arkansas database.

Perichaena corticalis (Batsch) Rostaf.

First reported by Clayton et al. (2014) and represented by two specimens in Arkansas database.

Perichaena depressa Lib.

First reported by Eliasson et al. (1988) and represented by 42 specimens in the Arkansas database.

Perichaena dictyonema Rammeloo

Represented by one specimen in the Arkansas database. Not previously reported from Arkansas.

Perichaena longipes L.M. Walker, Leontyev & S.L. Stephenson

Represented by one specimen in the Arkansas database. Not previously reported from Arkansas.

Perichaena microspora Penz. & Lister

First reported by Eliasson et al. (1988) and represented by one specimen in the Arkansas database.

Perichaena quadrata T. Macbr.

Represented by one specimen in the Arkansas database. Not previously reported from Arkansas.

Physarum aeneum (Lister) R.E. Fr.

First reported by Clayton et al. (2014) and represented by six specimens in the Arkansas database.

Physarum album (Bull.) Chevall.

First reported by Eliasson et al. (1988) and represented by 46 specimens in the Arkansas database. In the older literature, this species is listed as *Physarum nutans* Pers.

Physarum auriscalpium Cooke

First reported by Eliasson et al. (1988) and represented by two specimens in the Arkansas database.

Physarum bogoriense Racib.

First reported by Clayton et al. (2014) and represented by three specimens in the Arkansas database.

Physarum cinereum (Batsch) Pers.

First reported by Tucker et al. (2011) and represented by 46 specimens in the Arkansas database.

Physarum citrinum Schumach.

First reported by Fischer and Stephenson (2014) and represented by one specimen in the Arkansas database.

Physarum compressum Alb. & Schwein.

First reported by Tucker et al. (2011) and represented by nine specimens in the Arkansas database.

Physarum crateriforme Petch

First reported by Eliasson et al. (1988) and represented by 119 specimens in the Arkansas database.

Physarum decipiens M.A. Curtis

First reported by Massingill and Stephenson (2013) and represented by 24 specimens in the Arkansas database.

Physarum flavicomum Berk.

Represented by one specimen in the Arkansas database. Not previously reported from Arkansas.

Physarum galbeum Wingate

First reported by Stephenson et al. (2020) and represented by seven specimens in the Arkansas database.

Physarum hongkongense Chao H. Chung

First reported by Clayton et al. (2014) and represented by 21 specimens in the Arkansas database.

Physarum lateritium (Berk. & Ravenel) Morgan

First reported by dela Cruz et al. (2014) and represented by one specimen in the Arkansas database.

Physarum murinum Lister

Represented by one specimen in the Arkansas database. Not previously reported from Arkansas.

Physarum notabile T. Macbr.

Represented by four specimens in the Arkansas database. Not previously reported from Arkansas.

Physarum nudum T. Macbr.

First reported by Massingill and Stephenson (2013) and represented by one specimen in the Arkansas database.

Physarum oblatum T. Macbr.

First reported by dela Cruz et al. (2014) and represented by one specimen in the Arkansas database.

Physarum pusillum (Berk. & M.A. Curtis) G. Lister

First reported by Massingill and Stephenson (2013) and represented by 40 specimens in the Arkansas database.

Physarum rubiginosum Fr. & Palmquist

First reported by Goad and Stephenson (2013) and represented by one specimen in the Arkansas database.

Physarum serpula Morgan

First reported by Goad and Stephenson (2013) and represented by 16 specimens in the Arkansas database.

Physarum superbum Hagelst.

First reported by Eliasson et al. (1988) and not represented by any specimens in the Arkansas database.

Physarum stellatum (Massee) G.W. Martin

Represented by one specimen in the Arkansas database. Not previously reported from Arkansas.

Physarum superbum Hagelst.

First reported by Eliasson et al. (1988) and not represented by any specimens in the Arkansas database.

Physarum viride (Bull.) Pers.

First reported by dela Cruz et al. (2014) and represented by 21 specimens in the Arkansas database.

Reticularia intermedia Nann.-Bremek.

Not recorded in print as occurring in Arkansas but represented by a specimen (BPI827542) collected by T. E. Brooks in 1965 and deposited in the National Fungus Collections.

Reticularia jurana Meyl.

First reported by Eliasson et al. (1988) and not represented by any specimens in the Arkansas database.

Reticularia lycoperdon Bull.

Represented by one specimen in the Arkansas database. Not previously reported from Arkansas.

Reticularia splendens Morgan

Represented by five specimens in the Arkansas database. Not previously reported from Arkansas.

Stemonitis axifera (Bull.) T. Macbr.

First reported by Eliasson et al. (1988) and represented by eight specimens in the Arkansas database.

Stemonitis flavogenita E. Jahn

Represented by nine specimens in the Arkansas database. Not previously reported from Arkansas.

Stemonitis fusca Roth

First reported by Eliasson et al. (1988) and represented by ten specimens in the Arkansas database.

Stemonitis herbatica Peck

First reported by Goad and Stephenson (2013) and represented by 11 specimens in the Arkansas database.

Stemonitis mussooriensis G.W. Martin, K.S. Thind & Sohi

First reported by dela Cruz (2014) and represented by one specimen in the Arkansas database.

Stemonitis nigrescens Rex

First reported by Tucker et al. (2011) and represented by 137 specimens in the Arkansas database. *Stemonitis nigrescens* has not always been recognized as distinct from *S. fusca* Roth. Both Martin and Alexopoulos (1969) and Ing (1999) did recognize *S. nigrescens*. The latter author pointed out that the two species are biologically different, with *S. nigrescens* appearing in moist chamber cultures while this is not typically the case for *S. fusca*.

Stemonitis pallida Wingate

First reported by Eliasson et al. (1988) and not represented by any specimens in the Arkansas database.

Stemonitis smithii T. Macbr.

First reported by Eliasson et al. (1988) and not represented by any specimens in the Arkansas database. Like *Stemonitis nigrescens*, *S. smithii* is not always regarded as distinct from another species—in this case *Stemonitis axifera* (Bull.) T. Macbr. However, *S. smithii* was recognized by both Martin and Alexopoulos (1969) and Ing (1999). In the experience of the author, this species is not common, but the small fruiting bodies, typically occurring in small clusters, distinguish *S. smithii* from *S. axifera*.

Stemonitis splendens Rostaf.

Represented by two specimens in the Arkansas database. Not previously reported from Arkansas.

Stemonitis uvifera T. Macbr.

Represented by one specimen in the Arkansas database. Not previously reported from Arkansas.

Stemonitopsis hyperopta (Meyl.) Nann.-Bremek.

First reported by Eliasson et al. (1988) and represented by 11 specimens in the Arkansas database. In all but the most recent literature this species is listed as *Stemonitis hyperopta* Meyl.

Stemonitopsis typhina (F.H. Wigg.) Nann.-Bremek.

First reported by Eliasson et al. (1988) and represented by four specimens in the Arkansas database. In all but the most recent literature this species is listed as *Comatricha typhoides* (Bull.) Rostaf.

Trichia botrytis (J.F. Gmel.) Pers.
Represented by one specimen in the Arkansas database. Not previously reported from Arkansas.

Trichia contorta (Ditmar) Rostaf.
First reported by Eliasson et al. (1988) and represented by two specimens in the Arkansas database.

Hemitrichia decipiens (Pers.) García-Cunch., J.C. Zamora & Lado
Represented by two specimens in the Arkansas database. In all but the most recent literature, this species is listed as *Trichia decipiens* (Pers.) T. Macbr.

Trichia scabra Rostaf.
Represented by one specimen in the Arkansas database. Not previously reported from Arkansas.

Trichia subfusca Rex
First reported by dela Cruz (2014) and represented by 47 specimens in the Arkansas database.

Trichia varia (Pers. ex J.F. Gmel.) Pers.
First reported by Eliasson et al. (1988) and represented by nine specimens in the Arkansas database.

Tubifera ferruginosa (Batsch) Gmel.
Represented by one specimen in the Arkansas database. Not previously reported from Arkansas.

Willkommlangea reticulata (Alb. & Schwein.) Kuntze
First reported by Clayton et al. (2014) and represented by 18 specimens in the Arkansas database.

Discussion

The vast majority of specimens in the Arkansas database were obtained with the use of moist chamber cultures and do not reflect the relative abundance of a particular species in nature. However, *Arcyria cinerea* (364 specimens) and *Metatrichia vesparia* (145 specimens) might represent exceptions. Based on the experience of the author, both are among most common myxomycetes encountered in the field in Arkansas. The former species frequently appears in moist chamber cultures, but this is rarely the case of the latter. Eight other species (*Cribraria violacea*, *Diderma effusum*, *Lamproderma scintillans*, *Ophiotheca chrysosperma*, *Physarum crateriforme*, and *Stemonitis nigrescens*) were represented by more than 100 specimens in the Arkansas database, and all of these are species commonly appearing in moist chamber cultures.

The general pattern of abundance, when the entire database is considered, is for a few species to be exceedingly abundant, others moderately abundant (>50 but <100 specimens), still others common (<50 but >10 specimens), and the majority of all species represented by only a few specimens (<10) or in some instance by only one or two specimens. This is consistent with what is typically observed in natural communities and also what was indicated in an analysis of a much larger database consisting of records of myxomycetes from all of the eastern United States (Stephenson et al. 2020).

The data presented in this paper provide additional evidence that in order to capture the diversity of myxomycetes in a given locality or for a particular microhabitat, it is imperative that both collecting specimens that develop under natural conditions in the field and processing samples of dead plant material in moist chamber cultures be part of the overall effort. The appreciable number of species (33) recorded as new to Arkansas also reflects the fact that collecting/culturing of myxomycetes extended over the period of twenty years. It is important to note that the 184 species now known for Arkansas certainly do not

represent all of the species that occur in the state. Additional collecting in habitats not yet investigated would surely yield more new records.

References

Clayton ME, Rollins AW, Stephenson SL. 2014. Patterns of occurrence of corticolous myxomycetes on white oak trees of two different size classes. Fungal Ecol. 7: 9-15.

dela Cruz TEE, Rea MAD, Tran HTM, Ko Ko TW, Stephenson SL. 2014. A comparative species listing of myxomycetes from tropical (Philippines) and temperate (United States) forests. Mycosphere 5: 299-311.

Eliasson UH, Keller HW, Hutchison JA. 1988. Myxomycetes from Arkansas. Mycotaxon 32: 375-398.

Fischer HE, Stephenson SL. 2014. Myxomycetes associated with two types of grassland in northwest Arkansas. Aust J Mycol 23: 125-129.

Goad AE, Stephenson SL. 2013. Myxomycetes appearing in moist chamber cultures on four different types of leaves. Mycosphere 4: 707-712.

Ing B. 1999. The Myxomycetes of Britain and Ireland: an Identification Handbook. Slough, United Kingdom: The Richmond Publishing Company.

Martin GW, Alexopoulos CJ. 1969. The Myxomycetes. Iowa City, Iowa: University of Iowa Press.

Massingill JM, Stephenson SL. 2013. Myxomycetes appearing in moist chamber cultures on samples of bark and wood collected from coarse woody debris. Mycosphere 4: 627-633.

Rojas C, Stephenson SL, Rojas PA. 2020. Myxomycete colonization on translocated and non-translocated dead leaves from temperate and tropical forests. Stud Fungi. 5: 462-470.

Stephenson SL, Marbaniang TM, Gupta P, Rojas C. 2020. Assemblages of corticolous myxomycetes associated with species of *Pinus* (Pinaceae) in four different regions of the world. Nova Hedwigia 111: 199-217.

Stephenson SL, Novozhilov YK. 2021. Myxomycetes associated with a residential ecosystem. Karstenia 59: 70-77.

Stephenson SL, Rojas C. 2020. Mosses as spore traps for myxomycetes. Sydowia 72: 215-219.

Stephenson SL, Stauffacher RW, Rojas C. 2020. Myxomycetes collected in the eastern United States and the relative abundance of particular species. Mycology 11(4): 287-296.

Tucker DR, Coelho IL, Stephenson SL. 2011. Household slime molds. Nova Hedwigia 93: 177-182.

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Slime Molds
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Roland McHugh (1945-2025)

Bruce Ing[1]

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Abstract: The community of people who work with myxomycetes lost one of its members late last year. Roland McHugh spent his academic career at the University of Dublin. Working in collaboration with Bruce Ing, the two men greatly expanded what was known about the myxomycetes of Ireland. McHugh also collected and studied the myxomycetes of Nigeria. In addition to his interest in myxomyucees, he became an authority on the writings of James Joyce, especially the latter's book Finnegan's Wake. McHugh regularly attended the international congress on myxomycetes, held every three years.

Keywords: England, myxomycetes, Wicklow Mountains.

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Figure 1. Dr. Roland McHugh (image from an online post by the *The James Joyce Centre Dublin*).

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Roland McHugh (Fig. 1) was brought up in Newhaven, a Channel Port on the south coast of England. In the inland countryside he developed his love of all things natural. He studied sciences at Imperial College, London, and it was here that he became interested in myxomycetes. He would often come to my office nearby to talk about them! In 1962 he was a member of the university's expedition to northern Nigeria. Among the specimens he brought back were the types for *Metatrichia horrida* and *Comatricha* (now *Paradiacheopsis*) *erythropodia*. The following year he went back on the second part of the expedition and added more records, which we published together.

For his doctorate research Roland studied the acoustics and songs of grasshoppers, carrying out his fieldwork in the Calais region of France. Unsurprisingly, he became fluent in French! His first post took him to the Republic of Ireland, where he taught biology at the Dublin College of Dairying, now part of the University of Dublin. Ireland was relatively unknown for slime molds, but Roland soon changed that. Together we updated the records that David Mitchell and myself had put together in the past. He married one of his students, and they set up home in the delightful Jonquil Cottage in the little town of Greystone in the Wicklow Mountains, south of Dublin. Nearby was a fine ancient oak wood and Roland, with his usual attention to detail, studied the distribution of the uncommon *Clastoderma pachypus*. He also added *Physarum squamosum* to the Irish list. (Apart from Germany it is only known from one site in Scotland.) He also collaborated with David Mitchell on some new species of *Licea*.

Soon after he arrived in Ireland, he became fascinated by the writings of James Joyce, especially Finnegan's Wake. He became something of an authority on the language used by Joyce and toured Europe and America giving lectures as well as writing his book, Annotations to Finnegan's Wake. As the conservation of fungi became more important, Roland worked with other Irish mycologists, concentrating on waxcaps; Ireland has some of the best grasslands in Europe as habitats for these fungi!

Not long after Roland retired, he developed a severe form of Parkinson's Disease and had to give up his scientific activities. He died late last year and leaves a wife, Elizabeth, daughter Lydia and son Christopher. He will be missed for his quirky sense of humor and his wide-ranging intellect.

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Gary A. Laursen (1942-2026)

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Abstract: A mycologist who was involved in studies of the dictyostelids and myxomycetes associated with high-latitude regions of the world passed away early this year. Gary Laursen worked with the author in both the Arctic and the subantarctic, including on expeditions to Macquarie Island, Campbell Island, and the Auckland Islands.

Keywords: Arctic, dictyostelids, myxomycetes, subantarctic

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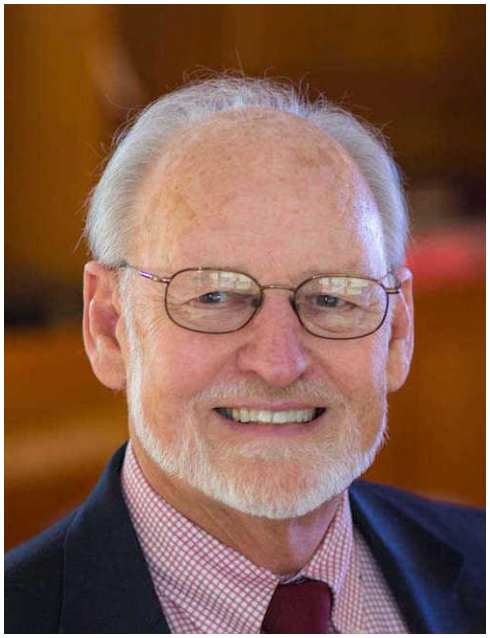

Figure 1. Dr. Gary A. Laursen (photo courtesy of the University of Alaska).

Gary Laursen (Fig. 1) earned his Ph.D. from Virginia Tech, where he studied soil fungi in Arctic tundra. His major professor was Dr. Orson K. Miller. I first met Gary when he was a teaching assistant in Miller's mycology course that I was taking. He left Virginia Tech before I completed my Ph.D., and I had no direct contact with Gary until the late 1980's when I reached out to him to express my interest in coming to Alaska. I knew that he was at the University of Alaska, and I wanted to extend my studies of

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myxomycetes to the Arctic. I eventually went to Alaska during the summer of 1989 and began a collaboration with Gary that ultimately resulted in extensive work in the Arctic during the summers of 1991, 1992, 1993, 1994, 1995, and 1998. In 1995, Gary and I extended our work to the subantarctic when we spent the period of mid-January to early May at the Australian Antarctic Division research station on Macquarie Island, one of the most remote places in the world. This led to expeditions to subantarctic Campbell Island in 2000 and to the Auckland Islands in 2006.

Gary's primary interest was in the basidiomycetes, especially the agarics. However, while working with me he was an active collaborator on studies that yielded a number of papers on dictyostelids and myxomycetes, and he co-described species in both groups (the myxomycete *Diderma boreale* and the dictyostelids *Dictyostelium ammophilum* and *Heterostelium boreale*). In his field guide entitled "Common Interior Alaska Cryptogams: Fungi, Lichenicolous Fungi, Lichenized Fungi, Slime Molds, Mosses, and Liverworts" and published by the University of Alaska Press in 2010, there is a section on myxomycetes.

A list of some of his publications in scientific journals is given below.

Novozhilov YK, Schnittler M, Stephenson SL. 1998. The myxomycetes of Russian subarctic and arctic areas. Mikol Fitopatol. 32(1): 18-29.

Novozhilov YK, Stephenson SL, Overking M, Landolt JC, Laursen GA. 2007. Studies of Frostfire myxomycetes including the description of a new species of *Diderma*. Mycol Prog. 6: 45-51.

Stephenson SL, Laursen GA. 1998. Myxomycetes from Alaska. Nova Hedwigia 66: 425-434.

Stephenson SL, Laursen GA, Seppelt RD. 2007. Myxomycetes of subantarctic Macquarie Island. Aust J Bot. 55: 439-449.

Stephenson SL, Laursen GA, Landolt JC, Seppelt RD. 1998. *Dictyostelium mucoroides* from subantarctic Macquarie Island. Mycologia 90: 368-371.

Stephenson SL, Landolt JC, Laursen GA. 1997. Dictyostelid cellular slime molds from western Alaska and the Russian Far East. Arct Alp Res. 29: 222-225.

Stephenson SL, Novozhilov YK, Shchepin ON, Laursen GA, Leontyev DV, Schnittler M. 2022. Myxomycetes of Alaska: species diversity and distribution. Nova Hedwigia 115: 519-534.

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Mixomicetes neotropicales: ¿por qué no los estudiamos en ciertos territorios?

Neotropical myxomycetes: why are we not studying them in certain territories?

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Resumen: Desde la síntesis de los mixomicetes neotropicales realizada por Lado y Wrigley de Basanta en el 2008, el conocimiento sobre su distribución regional ha aumentado de manera desigual. En el presente estudio se analizaron los datos de 53 publicaciones (2009–2024) para actualizar los patrones de distribución en la región. Los resultados mostraron que, aunque algunos países han incrementado sus registros, más de una docena de territorios de Centro y Sudamérica tales como Nicaragua, Bolivia, Surinam, Guyana y la Guayana Francesa, así como gran parte del Caribe, no han reportado aumentos en el número de especies de mixomicetes en casi dos décadas. Se plantea que estas brechas reflejan limitaciones estructurales asociadas con la producción científica que están relacionadas con aspectos como barreras logísticas, concentración de la experticia taxonómica y baja visibilidad de la literatura local. Estos hallazgos resaltan la necesidad de fortalecer capacidades regionales y mejorar la integración del conocimiento existente para lograr una representación más completa de la diversidad de mixomicetes en el Neotrópico.

Palabras clave: brechas de conocimiento, patrones de biodiversidad, mixobiota, sesgo de muestreo.

Abstract: Since the synthesis of Neotropical myxomycetes conducted by Lado and Wrigley de Basanta in 2008, our knowledge of their regional distribution has increased unevenly. In the present study, data from 53 publications (2009–2024) were analyzed to update distributional patterns across the region. The results showed that, although some countries have increased their records, more than a dozen territories of Central and South America such as Nicaragua, Bolivia, Suriname, Guyana and French Guiana, as well as much of the Caribbean, have not reported increases in species numbers of myxomycetes for nearly two decades. These gaps are interpreted as reflecting structural limitations in scientific production that are related with aspects such as logistical barriers, concentration of taxonomic expertise, and low visibility of local literature. These findings highlight the need to strengthen regional capacities and improve the integration of existing knowledge to achieve a more comprehensive representation of myxomycete diversity in the Neotropics.

Keywords: biodiversity patterns, knowledge gaps, myxobiota, sampling bias.

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Introducción

La región Neotropical es ampliamente reconocida como un punto crítico global de biodiversidad; sin embargo, nuestra comprensión de sus componentes microbianos y protistas sigue siendo notablemente fragmentaria (de Freitas y Junior 2025). Entre estos, los mixomicetes, un grupo de microorganismos eucariotas fagotróficos, desempeñan roles aparentemente relevantes, pero todavía poco cuantificados, en el ciclo de nutrientes terrestres y en la ecología del suelo (Stephenson et al. 2011). Aunque décadas de investigación han permitido establecer inventarios robustos de especies para países como Argentina, México, Brasil y Costa Rica, una porción significativa del Neotrópico permanece invisible en la literatura especializada.

Desde la revisión exhaustiva de los mixomicetes neotropicales realizada por Lado y Wrigley de Basanta en 2008, la documentación ha aumentado significativamente en varios territorios (Treviño-Zevallos y Lado 2020, Wrigley de Basanta et al. 2009, 2010a, 2010b, 2012). Sin embargo, una revisión preliminar de la literatura sugiere que más de una docena de países y territorios, incluyendo amplias secciones del Neotrópico, no han publicado datos primarios en casi dos décadas. Estas brechas geográficas en la producción científica seguramente no reflejan una baja diversidad biológica sino que constituyen un síntoma de problemas sistémicos asociados con la ciencia regional (ver López et al. 2025).

La falta de datos en estas regiones puede atribuirse a muchos factores dentro de los cuales tres de ellos podrían ser clave. Por ejemplo, las barreras logísticas e institucionales crean un escenario donde la concentración de la experticia taxonómica en unos pocos centros globales a menudo deja territorios huérfanos de infraestructura local (Muñoz-Rodríguez 2025) para apoyar el monitoreo a largo plazo o los estudios mediante cultivos en cámara húmeda. De forma similar, la invisibilización de la producción local, bien documentada en el Sur Global, contribuye a que datos significativos de la llamada literatura gris, incluyendo tesis universitarias, informes profesionales y boletines de museos locales, no lleguen a la comunidad internacional debido a barreras idiomáticas o a la falta de integración digital (Laufer 2007).

Sin embargo, en el contexto moderno también se observa un fenómeno de acción científica como resultado de incentivos académicos y de "colonización científica" (Sánchez-Tarragó et al. 2015). En este sentido, lo que se percibe como una falta de interés por parte de la comunidad científica a menudo se deriva de una preferencia por sitios de estudio accesibles y ampliamente explorados, donde los resultados de alto impacto son más probables. El fenómeno anterior genera un ciclo de retroalimentación en el que las áreas ya estudiadas reciben más financiamiento, marginando aún más a los territorios subexplorados (Ramírez y Salcedo 2023).

Este estudio examina los factores sociales e históricos que han moldeado los patrones biogeográficos de los mixomicetes en la región Neotropical, con el objetivo de identificar y cuantificar los vacíos de conocimiento. Para ello, se realizó una revisión bibliográfica de nuevos registros publicados en un periodo definido, actualizando la lista base de especies y estimando, mediante una diferencia relativa porcentual, los cambios en el conocimiento reportado por país o territorio. Los resultados evidencian desigualdades en el esfuerzo de investigación y resaltan la necesidad de enfoques más inclusivos y colaborativos para fortalecer la comprensión biogeográfica y la conservación regional.

Materiales y métodos

En este estudio tomamos como base el artículo de Lado y Wrigley de Basanta (2008) titulado "A Review of Neotropical Myxomycetes (1828-2008)" e hicimos una búsqueda bibliográfica de nuevos registros de mixomicetes en los diferentes países de la región bajo estudio para el periodo 2009-2024. Esta nueva revisión fue hecha en Google Scholar y tuvo como criterios que 1). la referencia fuera un artículo científico, 2). que no hubiera sido citada en la revisión base y 3). que mencionara nuevos registros de mixomicetes para el territorio bajo estudio.

Todas las especies de mixomicetes mencionadas en las nuevas fuentes de información fueron usadas para actualizar la lista de la publicación base y para calcular la diferencia en el número de especies originalmente comunicadas y las registradas acá. Tal diferencia fue dividida entre el número total de especies conocidas para la región completa y multiplicada por 100 para obtener lo que acá llamamos "diferencia relativa porcentual", que denota claramente los países o territorios en donde se han enfocado los esfuerzos de trabajo en el periodo 2009-2024. Este resultado, por exclusión, muestra los países o territorios donde la producción científica ha sido escasa o nula en el mismo periodo.

Con estos datos se creó un mapa en QGIS 3.40.8, que al ser comparado con mapas similares mostrando el número de especies de mixomicetes reportadas y el número de especies del pool regional presentes en cada para cada país o territorio, evidencian claramente las zonas donde todavía se encuentran los vacíos de información regional.

Resultados

Encontramos 53 publicaciones que mencionan nuevos registros de mixomicetes en el periodo 2009-2024 (Cuadro 1). Con base en ellas, determinamos que el número de especies conocidas de mixomicetes en la zona estudiada aumentó alrededor de un 4% (de 431 a 447 especies) en este periodo de 15 años.

Cuadro 1. Referencias a las publicaciones encontradas en este trabajo con mención de registros nuevos o descripción de nuevas especies de mixomicetes para el periodo 2009-2024. Ver las referencias para la cita completa.

País	Referencias recientes
Argentina	Lado et al. 2009, Lado et al. 2011, Lado et al. 2014, Moreno et al. 2024, Ronikier et al. 2013, Ronikier y Lado 2013, Wrigley de Basanta et al. 2015, Wrigley de Basanta et al. 2009, Wrigley de Basanta et al. 2010, Wrigley de Basanta et al. 2010b, Wrigley de Basanta et al. 2017
Bahamas	Velloso et al. 2024
Brasil	Damasceno et al. 2009, Tenório et al. 2009, Alves et al. 2010, Costa et al. 2014, Cavalcanti et al. 2016, Parentes y Cavalcanti 2023, Oliveira et al. 2024
Chile	Lado et al. 2013, Wrigley de Basanta et al. 2009, Wrigley de Basanta et al. 2010, Wrigley de Basanta et al. 2011, Wrigley de Basanta et al. 2012
Colombia	Herrera Loaiza et al. 2012, Rojas y García Chaves 2022

Costa Rica	Rojas y Calvo 2014, Rojas et al. 2015, Rojas et al. 2017, Lado et al. 2018, Rojas et al. 2018, Walker et al. 2015
Ecuador	Lado et al. 2016, Leontyev et al. 2024
El Salvador	Rojas et al. 2013, Rojas et al. 2014, Rojas et al. 2017
Guatemala	Rojas et al. 2010
Honduras	Rojas y Calvo 2014, Rojas et al. 2017
México	Estrada-Torres et al. 2015, Estrada-Torres et al. 2019, Lizárraga et al. 2015, Lizárraga et al. 2016, Lizárraga et al. 2017, Moreno et al. 2018, Rojas et al. 2010, Salazar-Márquez et al. 2013
Panamá	Rojas et al. 2017, Walker et al. 2015, Walker et al. 2024
Paraguay	McHugh 2009
Perú	Lado et al. 2016, Lado et al. 2019, Lado et al. 2022, Muñuico et al. 2023, Rojas et al. 2011, Treviño-Zevallos et al. 2020, Wrigley de Basanta et al. 2015, Wrigley de Basanta et al. 2019

Con base en la Figura 1 pudimos observar que, si bien el número de especies conocidas para la mayoría de países de la región se incrementó (A, izquierda), territorios como Perú, Argentina, Paraguay, Chile y Costa Rica vieron sus listados de especies crecer más rápidamente (B, centro). México lidera actualmente con el registro de aproximadamente 75% de las especies conocidas de mixomicetes en la región (C, derecha). El Cuadro 2, muestra los valores individuales para cada jurisdicción o zona.

Sin embargo, fue aún más notable observar que la región insular caribeña (Figuras 1A1, 1B1 y 1C1) así como otros territorios de Centro y Sudamérica tales como Nicaragua, Bolivia, Surinam, Guyana y la Guayana Francesa siguen retrasados notablemente con respecto al resto de países y tampoco incrementaron sus listados de mixomicetes en el periodo de estudio.

Discusión

Los resultados presentados evidencian que la distribución del conocimiento sobre mixomicetes en el Neotrópico no responde a patrones biológicos, sino a desigualdades estructurales profundamente arraigadas en la práctica científica (Ricardo-Jiménez et al. 2025). La ausencia de incrementos en los registros de especies en numerosos territorios durante casi dos décadas no puede interpretarse como un vacío natural, sino como una manifestación directa de la exclusión sistemática de amplias regiones de los circuitos formales de producción de conocimiento (Ramírez y Salcedo 2023).

Las limitaciones logísticas e institucionales no solo restringen la investigación, sino que configuran activamente qué territorios “existen” científicamente. La falta de infraestructura básica para el estudio de mixomicetes, incluyendo laboratorios funcionales, colecciones de referencia y programas de monitoreo, no es un accidente, sino el resultado de una distribución desigual de recursos que históricamente ha desfavorecido a múltiples países de la región (Rojas y Doss 2013). En este contexto, la ausencia de datos no es una sorpresa, sino una consecuencia esperable.

Aun más preocupante es la marcada concentración de la experticia taxonómica en un número reducido de centros y actores. Este fenómeno no solo limita la capacidad de generar conocimiento local,

sino que también reproduce dinámicas de dependencia científica (Rivera-Cusicanqui et al. 2016), donde los territorios submuestreados quedan sujetos a agendas externas. Bajo este modelo, la investigación sobre mixomicetes se desarrolla de manera selectiva, privilegiando regiones accesibles, institucionalmente conectadas o tradicionalmente estudiadas, mientras que otras permanecen sistemáticamente ignoradas.

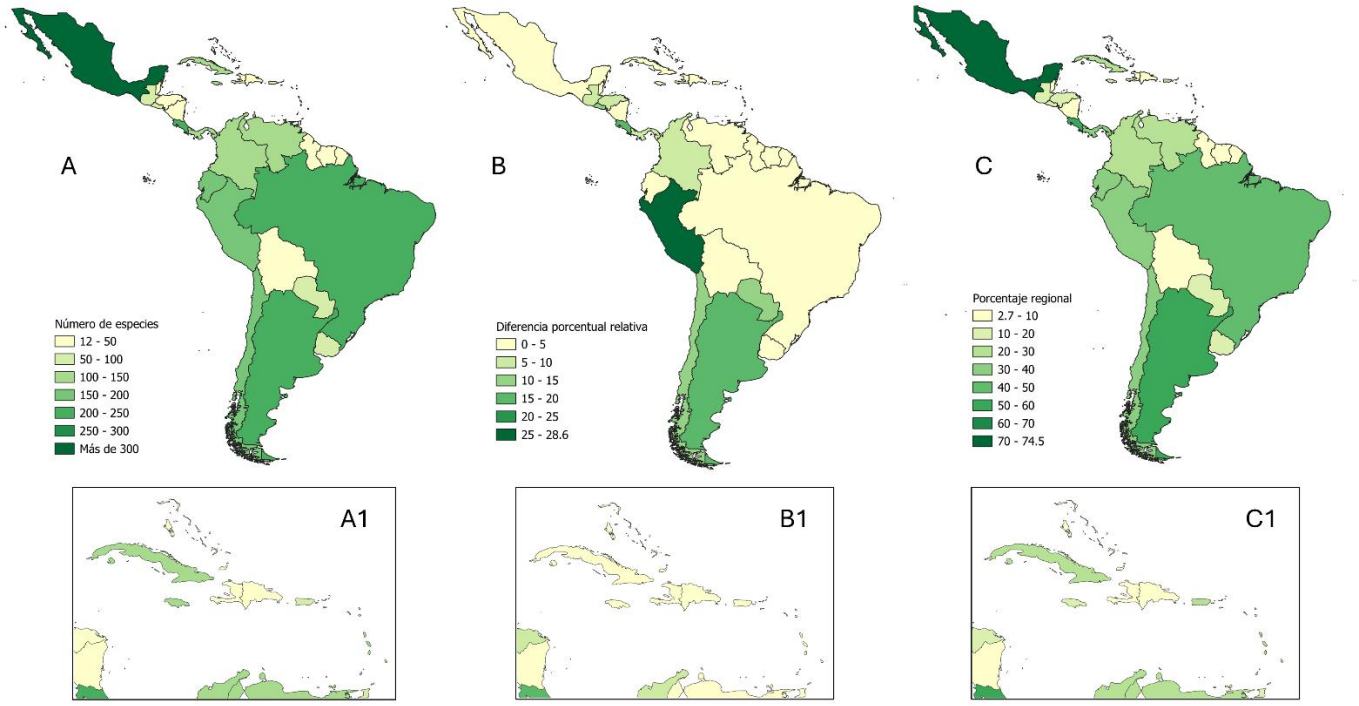

Figura 1. Mapas de la región neotropical (en el sentido amplio usado por Lado y Wrigley de Basanta, 2008) mostrando el número aproximado de especies de mixomicetes conocido para cada país (A), la diferencia relativa porcental entre el año 2009 y el año 2024 (B) y el porcentaje de especies del pool regional conocido para cada país (C), con sus respectivos equivalentes para la zona insular caribeña (A1, B1 y C1).

En este sentido, el hecho de que Perú haya avanzado más que otros países en la documentación mostrada acá tiene claramente un vínculo con el desarrollo de capacidades locales, ya que el investigador Ítalo Treviño Zevallos se formó en taxonomía de mixomicetes justamente durante la segunda década del siglo actual (su tesis doctoral fue publicada en el 2021). Otros territorios como México y Costa Rica cuentan desde hace varios años con experticia local y países como Argentina, Chile y Paraguay fueron objeto de estudio durante años recientes por el proyecto Mixotropic, financiado por el Consejo Superior de Investigaciones Científicas de España.

Así, los casos considerados “exitosos” dentro de la región no deben interpretarse únicamente como ejemplos de avance científico, sino también como evidencia de las condiciones mínimas necesarias para que dicho avance ocurra. La presencia de instituciones sólidas, financiamiento sostenido y capital humano especializado no es la norma en el Neotrópico, sino la excepción (Ricardo-Jiménez et al. 2025). En

consecuencia, el crecimiento desigual en los inventarios de especies refleja más fielmente la geografía del poder científico que la de la biodiversidad.

Cuadro 2. Valores calculados en el presente trabajo y con los cuales se denota la desigualdad en el estudio de los mixomicetes neotropicales.

País	Número aproximado de especies	Diferencia Relativa Porcentual	Porcentaje de especies del pool regional
Argentina	236	17.00	52.80
Bahamas	12	0.45	2.68
Belice	41	0.00	9.17
Bolivia	44	0.45	9.84
Brasil	211	1.12	47.20
Chile	153	11.41	34.23
Colombia	131	7.83	29.31
Costa Rica	224	18.12	50.11
Cuba	101	0.00	22.60
Ecuador	153	3.80	34.23
El Salvador	61	13.65	13.65
Guatemala	60	7.61	13.42
Guayana Francesa	37	0.00	8.28
Guyana	13	0.22	2.91
Haití	20	0.00	4.47
Honduras	49	8.28	10.96
Islas de Barlovento	107	0.22	23.94
Islas de Sotavento	83	0.00	18.57
Jamaica	119	0.00	26.62
México	333	2.24	74.50
Nicaragua	33	0.00	7.38
Panamá	143	8.28	31.99
Paraguay	84	14.32	18.79
Perú	159	28.64	35.57
Puerto Rico	95	0.45	21.25
Repúb. Dominicana	39	0.00	8.72
Surinam	12	0.67	2.68
Trinidad y Tobago	62	0.00	13.87
Uruguay	52	0.00	11.63
Venezuela	111	0.00	24.83

Esta distribución del conocimiento científico general está, además, fuertemente relacionada con crecimiento económico y agendas de desarrollo internacional (ver Parra López et al. 2024 específicamente para mixomicetes), por lo que la falta de documentación sobre estos organismos en territorios como Nicaragua, Bolivia, Surinam, Guyana, Guayana Francesa y la mayor parte de la región del Caribe insular, tampoco es una sorpresa. La coincidencia de los datos acá mostrados y los del estudio de González-Parias et al. (2022) sobre la producción científica latinoamericana entre 2010-2021 es, por tanto, alta y esperada, pero refleja de forma más profunda las disparidades acá mencionadas.

El problema es que la invisibilización de la producción local agrava aún más este panorama (Sánchez-Tarragó et al. 2015). La persistencia de barreras idiomáticas, tecnológicas y editoriales asegura que una proporción significativa del conocimiento generado en la región permanezca fuera del alcance de la comunidad internacional. Este fenómeno no solo distorsiona nuestra comprensión de la diversidad de mixomicetes – o de ciencia en general – sino que también refuerza jerarquías epistémicas en las que ciertos tipos de conocimiento son sistemáticamente desvalorizados (Svampa 2019).

Finalmente, los patrones observados revelan la existencia de un sistema de retroalimentación que perpetúa estas desigualdades. Las regiones con mayor tradición de estudio continúan atrayendo atención, financiamiento y publicaciones, mientras que las áreas con menor visibilidad (p.e. Nicaragua o el Caribe insular) quedan atrapadas en un estado de abandono científico (ver Lado y Wrigley de Basanta 2008). Este ciclo no es neutral (Sánchez-Tarragó et al. 2015), y su mantenimiento implica aceptar una representación inherentemente sesgada de la biodiversidad neotropical.

En este sentido, avanzar hacia una comprensión más completa de la diversidad de mixomicetes requiere no solo intervenciones técnicas, sino una revisión crítica de las estructuras que definen qué se estudia, dónde y por quién. Sin este cuestionamiento, los vacíos de información y la desigualdad epistemológica persistirán, no como reflejo de la naturaleza, sino como evidencia de las limitaciones del propio sistema científico.

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Referencias

Alves M, Costa AA, Andrade L. 2010. Myxomycetes, State of Ceara, northeastern Brazil. Check List 6(4): 555-558.

Cavalcanti LH, Bezerra ACC, Barbosa DI, Agra LANN, Powell NV, Lima VX, Costa AAA. 2016. Occurrence and distribution of *Perichaena* (Trichiaceae, Myxomycetes) in the Brazilian Northeastern Region. Acta Bot Bras. 30(1): 102–111.

Costa AAA, Bezerra ACC, Lima VX, Cavalcanti LH. 2014. Diversity of myxomycetes in an environmentally protected area of Atlantic Forest in northeastern Brazil. Acta Bot Bras. 28(3): 445–455.

Damasceno G, Costa AAA, Passavante JZO, Cavalcanti LH. 2009. *Stemonaria fuscoides* (Stemonitaceae, Myxomycetes): a new record for Brazil. Mycotaxon 108: 215–221.

de Freitas PD, Junior PMG. 2025. Why study biodiversity in the Neotropics? In: Bohrer Monteiro Siqueira MV, Konzen ER, Galetti PM Jr, editors. Population genetics in the Neotropics. Cham: Springer.

Estrada-Torres A, Wrigley de Basanta D, Conde E, Lado C. 2009. Myxomycetes associated with dryland ecosystems of the Tehuacán-Cuicatlán Valley Biosphere Reserve, Mexico. Fungal Divers. 36: 17–56.

Estrada-Torres A, Wrigley de Basanta D, Lado C, Rodríguez-Palma MM. 2015. *Cornuvia* (Myxomycetes: Trichiales), a new genus for Mexico. Rev Mex Biodivers. 86(1): 9–13.

Herrera Loaiza N, Rojas Alvarado C, Stephenson SL. 2012. An update on the myxomycete biota (Amoebozoa: Myxogastria) of Colombia. Check List 8(4): 617–619.

Lado C, Wrigley de Basanta D. 2008. A review of neotropical myxomycetes (1828–2008). An Jard Bot Madr. 65(2): 211–254.

Lado C, Estrada-Torres A, Rojas C. 2018. New records of genera and species of myxomycetes (Amoebozoa) from the Neotropics. Check List 14(3): 509–518.

Lado C, Estrada-Torres A, Wrigley de Basanta D, Schnittler M, Stephenson SL. 2016. A rapid biodiversity assessment of myxomycetes from a primary tropical moist forest of the Amazon basin in Ecuador. Nova Hedwigia 104: 293–320.

Lado C, Treviño-Zevallos I, García-Martín JM, Wrigley de Basanta D. 2022. *Diachea mitchellii*: a new myxomycete species from high elevation forests in the tropical Andes of Peru. Mycologia 114(4):798–811.

Lado C, Wrigley de Basanta D, Estrada-Torres A. 2011. Biodiversity of myxomycetes from the Monte Desert of Argentina. An Jard Bot Madr. 68(1): 61–95.

Lado C, Wrigley de Basanta D, Estrada-Torres A, García-Carvajal E. 2014. Myxomycete diversity of the Patagonian steppe and bordering areas in Argentina. An Jard Bot Madr. 71(1): 1–35.

Lado C, Wrigley de Basanta D, Estrada-Torres A, Stephenson SL. 2013. The biodiversity of myxomycetes in central Chile. Fungal Divers. 59: 3–32.

Lado C, Wrigley de Basanta D, Estrada-Torres A, Stephenson SL. 2016. Myxomycete diversity in the coastal desert of Peru with emphasis on the lomas formations. An Jard Bot Madr. 73(1): e032.

Lado C, Wrigley de Basanta D, Estrada-Torres A, Stephenson SL. 2019. Diversity of myxomycetes in arid zones of Peru. II. The cactus belt and transition zones. An Jard Bot Madr. 76(2): e083.

Lado C, Wrigley de Basanta D, Estrada-Torres A, García Carvajal E, Aguilar M, Hernández-Crespo JC. 2009. Description of a new species of *Perichaena* (Myxomycetes) from arid areas of Argentina. An Jard Bot Madr. 66(S1): 63–70.

Laufer M. 2007. ¿Qué hacer con la literatura gris? Interciencia 32(1): 5.

Leontyev D, Johannesen E, Moreno G, Yatsiuk I, Schnittler M. 2024. A new species of the *Trichia botrytis* complex from the cloud forest in Ecuador. Eur J Protistol. 96: 126123.

Lizárraga M, Moreno G, Esqueda M. 2017. A new species of *Macbrideola* (Myxomycetes) from Mexico. Bol Soc. Micol. Madr. 41: 37–41.

Lizárraga M, Moreno G, Esqueda M. 2016. New records of myxomycetes from Mexico. Mycotaxon 131: 511–520.

Lizárraga M, Moreno G, Esqueda M, Salazar-Márquez C, Coronado ML. 2015. Myxomycetes of Chihuahua (Mexico). IV. Central plains of the Chihuahuan Desert. Mycotaxon 130: 1073–1101.

López C, Bonecker C, Perbiche-Neves G, Elías-Gutiérrez M. 2025. The lack of researchers: a critical threat to studies on freshwater zooplankton in Latin America. Diversity 17(6) :381.

McHugh R. 2009. Field and moist chamber collections of Paraguay myxomycetes. Karstenia 48(2) :49–56.

Moreno G, Dios MM, López-Villalba A, Castillo A, Manjón JL, Frías JE. 2024. Studies on the myxomycetes of Catamarca (Argentina). I. Bol Soc Micol Madr. 48: 9–29.

Moreno G, Lizárraga M, Flores-Romero I, Jiménez-Vega F. 2018. Una nueva especie de *Physarum* (Myxomycetes) de Chihuahua, Mexico. Bol Soc Micol Madr. 42:21–26.

Muñoz-Rodríguez P. 2025. Bringing taxonomy back into the spotlight. In: Williams DM, Wheeler QD, editors. The new taxonomy. Boca Raton: CRC Press.

Muñuico J, Treviño-Zevallos I, Lado C. 2023. Adiciones a la mixobiota de la selva central de Perú: nuevos registros y primera cita de *Craterium roseum*. Folia Amaz. 32(2):e32725.

Oliveira VRTD, Barbosa DI, Cavalcanti LH. 2024. Distribution of *Badhamiopsis* and *Badhamia* (Physaraceae, Myxomycetes) in Brazilian biomes. An Acad Bras Ciênc. 96(1): e20220698.

Parra López C, Mardones M, Rojas C. 2024. Normalized results of Latin America's mycological visibility: are they a good proxy of potential impact? Funga Latina 2:V2A8.

Parentes JMS, Cavalcanti LH. 2023. Myxomycetes of the Atlantic Rainforest: species on the ground litter from Pedra Talhada Biological Reserve (Alagoas, Brazil). Rodriguésia 74:e01212021.

Ramírez T, Salcedo A. 2023. América Latina y la producción de artículos científicos: un crecimiento desigual y asimétrico. Rev Prax Educ. 19(50): e12001.

Ricardo-Jiménez S, Bueno-Fernández MM, Herreño-Munera ML, Mejía-Ríos J. 2025. La producción científica en Latinoamérica: logros, desafíos y oportunidades. Cienciamatria 11(20): 79–103.

Rivera Cusicanqui S, Domingues J, Escobar A, Leff E. 2016. Debate sobre el colonialismo intelectual y los dilemas de la teoría social latinoamericana. Cuest Sociol. 14: e009.

Rojas C, Doss RG. 2013. Brief research history and conservation implications of myxomycetes from Costa Rica. Brenesia 79: 37–43.

Rojas C, Lado C, Rojas PA. 2018. Myxomycete diversity in Costa Rica. Mycosphere 9(2): 227–255.

Rojas C, Calvo E. 2014. Additions to the myxobiota of Central America. Mycosphere 5(3): 488–495.

Rojas C, García-Chaves MC. 2022. New records of myxomycetes (Amoebozoa) from Colombia. JNBR. 11(1): 10–15.

Rojas C, Lado C, Valverde R. 2015. First record of the myxomycete genus *Colloderma* in Central America. Check List. 11(4): 1716.

Rojas C, Morales R, Walker L, Valverde-Gonzalez R. 2017. New records of myxomycetes for Central America and comments on their regional distribution. JNBR. 6: 63–70.

Rojas C, Morales RE, Calderón I, Clerc P. 2013. First records of myxomycetes from El Salvador. Mycosphere 4(6): 1042–1051.

Rojas C, Stephenson SL, Pavlich M. 2011. New additions to the myxobiota of Peru. Mycosphere 2(5): 583–592.

Rojas C, Stephenson SL, Estrada-Torres A, Valverde R, Morales O. 2010. New records of myxomycetes from high-elevation areas of Mexico and Guatemala. Mycosphere 1: 73–82.

Ronikier A, Lado C. 2013. *Physarum andinum*, a new nivicolous species of myxomycete from the Patagonian Andes. Mycologia 105(1): 162–171.

Ronikier A, Lado C, Wrigley de Basanta D. 2013. *Perichaena megaspora*, a new nivicolous species of myxomycete from the Andes. Mycologia 105(4):938–944.

Salazar-Márquez C, Esqueda M, Lizárraga M, García-Casillas P. 2013. Primer registro de *Didymium flexuosum* (Myxomycetes) para México. Rev Mex Micol. 38: 19–22.

Sánchez-Tarragó N, Bufrem LS, Santos RNM. 2015. La producción científica latinoamericana desde una mirada poscolonial. Tend Pesqui Bras Ciênc Inf. 8(2): 182–202.

Stephenson SL, Fiore-Donno AM, Schnittler M. 2011. Myxomycetes in soil. Soil Biol Biochem. 43(11): 2237–2242.

Svampa M. 2019. Debates latinoamericanos: indianismo, desarrollo, dependencia y populismo. Barcelona: Edhasa.

Tenório JG, Bezerra MFA, Costa AAA, Cavalcanti LH. 2009. Mixobiota do Parque Nacional Serra de Itabaiana, SE, Brasil: Stemonitales. Acta Bot Bras. 23(3): 644–656.

Treviño-Zevallos IF, Lado C. 2020. New records of myxomycetes from Peru. Check List 16(2): 253–264.

Velloso JRP, Cavalcanti LH, Putzke J. 2024. Neotropical distribution of *Leocarpus* (Physaraceae, Myxomycetes) and rediscovery of *L. fragilis* in Brazil. Slime Molds. 5: V5A2.

Walker LM, Stephenson SL. 2024. Myxomycetes of Barro Colorado Island and Panama. In: Muller-Landau HC, Wright SJ, editors. The first 100 years of research on Barro Colorado: plant and ecosystem science. Vol 2. Washington (DC): Smithsonian Institution Scholarly Press. p. 809–817.

Walker LM, Leontyev DV, Stephenson SL. 2015. *Perichaena longipes*, a new myxomycete from the Neotropics. Mycologia 107(5): 1012–1022.

Wrigley de Basanta DW, Lado C, Estrada-Torres A. 2010a. *Licea eremophila*, a new myxomycete from arid areas of South America. Mycologia 102(5): 1185–1192.

Wrigley de Basanta D, Lado C, Estrada-Torres A, Stephenson SL. 2009. Description and life cycle of a new *Didymium* (Myxomycetes) from arid areas of Argentina and Chile. Mycologia 101(5): 707–716.

Wrigley de Basanta D, Lado C, Estrada-Torres A. 2011. Spore to spore culture of *Didymium operculatum*, a new myxomycete from the Atacama Desert of Chile. Mycologia 103(4): 895–903.

Wrigley de Basanta D, Lado C, Estrada-Torres A. 2012. Description and life cycle of a new *Physarum* (Myxomycetes) from the Atacama Desert in Chile. Mycologia 104(5): 1206–1212.

Wrigley de Basanta D, Estrada-Torres A, García-Cunchillos I, Cano Echevarría A, Lado C. 2017. *Didymium azorellae*, a new myxomycete from cushion plants of cold arid areas of South America. Mycologia 109(6): 993–1002.

Wrigley de Basanta D, Estrada-Torres A, Lado C. 2019. *Licea aurea*, a new myxomycete from the Peruvian Andes. Phytotaxa 391(3): 218–224.

Wrigley de Basanta D, Lado C, García-Martín JM, Estrada-Torres A. 2015. *Didymium xerophilum*, a new myxomycete from the tropical Andes. Mycologia 107(1): 157–168.

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New Records of Myxomycetes from Shenandoah National Park

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Abstract: A list is provided of species of myxomycetes recorded from Shenandoah National Park in Virginia as a result of surveys carried out during 2025. The species reported are based on specimens that developed in the field under natural conditions and also specimens that appeared in moist chamber cultures. Fifteen species representing 13 genera are reported as new from the park. This brings the number of genera and the number of species known from the park to 36 and 94, respectively. These numbers do not represent the total number of species likely to occur in the park, which can only be determined by intensive sampling over an extended period of time.

Keywords: biodiversity, moist chamber cultures, slime molds, temperate forests

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Introduction

Stephenson and Stephenson (2025) provided a checklist of all the species of myxomycetes reported from or known to occur in Shenandoah National Park in the Blue Ridge Mountains of Virginia. The majority of these species (87% of the 79 species in the checklist) were the result of surveys carried out during 2024. These surveys considered both specimens that had fruited under natural conditions in the field and specimens that were recorded from moist chamber cultures. The purpose of this paper is to report the results of additional surveys carried out during 2025.

Materials and methods

In the present study, all specimens of fruiting bodies collected in the field along with samples of bark, ground litter, aerial litter, and woody twigs were collected from areas adjacent to the Skyline Drive. This highway extends through the entire park and over most of its length is flanked by relatively xeric oak-hickory forests (Fig. 1). For the field surveys, all substrates upon which the fruiting bodies of myxomycetes might be expected to occur were examined in an opportunistic manner as described by Cannon and Sutton (2004). When fruiting bodies were observed, they were collected along with the portion of the substrate upon which fruiting had occurred. All samples of the various types of plant material were returned to the laboratory and used to prepare moist chamber cultures in the manner described by Stephenson and Stempen (1994).

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Figure 1. Oak-hickory forest along the side of the Skyland Drive as viewed in spring before full foliage has developed (Photo by Steve Stephenson).

When fruiting bodies were observed in the moist chamber cultures, they were removed along with the piece of the substrate upon which fruiting had occurred. These were dried at room temperature. Afterwards, pieces of the substrates with fruiting bodies present were glued to paper trays and the latter placed in small pasteboard boxes for permanent storage. The same method used for specimens collected in the field. All specimens of myxomycetes are deposited in the herbarium (JMUH) of James Madison University.

Results

A total of 120 specimens were recorded during 2025. Most of these could be identified to the level of species, but a few were too aberrant for this to be possible. These specimens represented 15 species in 13 genera new to Shenandoah National Park.

Annotated List of Species

In the list that follows, all species of myxomycetes recorded as new for Shenandoah National Park are arranged alphabetically by genus and then species. Information is provided on the source(s) of the record. The nomenclature used follows Lado (2005-2025) except where noted. Recent molecular studies have resulted in a number of taxonomic rearrangements in the myxomycetes. As a result, some familiar species now have names that would not be immediately recognized by many of the people who collect and study myxomycetes. Numbers given in parentheses are the collecting numbers of the first coauthor.

Comatricha reticulospora Ing & P.C. Holland

Represented by one specimen (SNP-355) appearing in a moist chamber culture on twigs of white pine (*Pinus strobus*).

Comatricha rigida (Brândza) G. Moreno, A. Sánchez & A. Castillo

Represented by one specimen (SNP-352) appearing in a moist chamber culture on bark from red cedar (*Juniperus virginiana*).

Cribraria intricata Schrad.

Represented by two specimens (SNP-292 and SNP-300) collected in the field from decaying logs of red spruce (*Picea rubens*).

Cribraria vulgaris Schrad.

Represented by one specimen (SNP-271) collected in the field from a decaying pine log of pitch pine (*Picea rigida*).

Diderma testaceum (Schrad.) Pers.

Represented by one specimen (SNP-257) appearing in a moist chamber culture of leaf litter.

Didymium iridis (Ditmar) Fr.

Represented by one specimen (SNP-335) collected in the field from a piece of dead bark.

Fuligo septica (L.) F.H. Wigg.

Represented by one specimen (SNP-309) collected in the field from a decaying log.

Hemitrichia leiotricha (Lister) G. Lister

Represented by one specimen (SNP-231) appearing in a moist chamber culture on twigs of an unidentified tree.

Hemitrichia pardina (Minakata) Ing

Represented by one specimen (SNP-245) appearing in a moist chamber culture on bark from red cedar (*Juniperus virginiana*).

Licea bulbosa Nann.-Bremek. & Y. Yamam.

Represented by two specimens (SNP-251 and SNP-274) appearing in moist chamber cultures on twigs of balsam fir (*Abies balsamea*).

Lycogala exiguum Morgan

Represented by one specimen (SNP-331) appearing in the field from decaying wood of an unidentified tree.

Nannengaella leucopus (Link) J.M. García-Martín, J.C. Zamora & Lado

Represented by one specimen (SNP-310) collected in the field from bark covered with mosses. In all but the most recent treatments of the myxomycetes, this species is listed as *Physarum leucopus* Link.

Nannengaella mellea (Berk. & Broome) J.M. García-Martín, J.C. Zamora & Lado

Represented by one specimen (SNP-283) that fruited in a culture prepared with a plasmodium collected in the field. In all but the most recent treatments of the myxomycetes, this species is listed as *Physarum melleum* (Berk. & Broome) Massee.

Perichaena corticalis (Batsch) Rostaf.

Represented by one specimen (SNP-229) appearing in a moist chamber culture on bark of white oak (*Quercus alba*).

Stemonitis flavogenita E. Jahn

Represented by one specimen (SNP-290) collected in the field on dead wood from an unidentified tree.

The 15 species recorded as new for Shenandoah National Park bring the number of genera and the number of species now known from the park to 36 and 94, respectively. It is anticipated that additional surveys carried out in the future will yield even more species for the park.

References

Cannon P, Sutton B. 2004. Microfungi on wood and plant debris. In: Mueller G, Bills G., Foster M, editors. Biodiversity of Fungi: Inventory and Monitoring Methods. Massachusetts: Elsevier Academic Press. p. 217-239.

Lado C. 2005-2021. An on-line nomenclatural information system of Eumycetozoa [Internet]. Madrid: Real Jardin Botánico de Madrid, CSIC; [visited 10 Apr 2026]. Available from: http://www.eumycetozoa.com

Stephenson SL, Stempen H. 1994. Myxomycetes: A Handbook of Slime Molds. Oregon: Timber Press.

Stephenson SL, Stephenson BC. 2025. A preliminary checklist of the myxomycetes of Shenandoah National Park. Slime Molds 5: V5A12.

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Adaptive Phototaxis in Response to Experience – Learning by Association in the Slime Mold *Physarum polycephalum*

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Abstract: Cognitive processes such as learning by association are traditionally considered exclusive to organisms with nervous systems. However, increasing evidence suggests that some aneural organisms, such as the slime mold *Physarum polycephalum*, exhibit behaviors indicative of basal cognition. In this study, we investigated whether *P. polycephalum* is capable of associative learning by combining light stimuli with food rewards. Using a controlled light gradient environment, we conducted three experiments: training plasmodia to move toward an aversive blue light, toward a neutral red light, and away from neutral red light. Following initial baseline tests, plasmodia underwent four training sessions with food cues, after which their phototactic behavior was reassessed without food. Results show that plasmodia significantly altered their behavior when trained toward both aversive and neutral stimuli, with the strongest effect observed in the aversive (blue light) condition. While these behavioral shifts suggest associative learning, the potential role of habituation could not be fully excluded. Our findings contribute to the growing body of evidence supporting cognitive-like capacities in aneural organisms and highlight the need for further investigation into the mechanisms underlying memory and learning in *Physarum*.

Keywords: aneural cognition, basal organisms, habituation, learning by association.

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Introduction

Cognition and learning have long been thought of as properties unique to animals with nervous systems. In the last 30 years, however, increased research has been conducted on adaptive behavior in organisms without nervous systems. Aneural cognition – sometimes called minimal or basal cognition (Lyon 2020) – is still viewed as controversial among the cognitive sciences (Lyon et al. 2021). Nonetheless, a growing body of evidence shows reactions in aneural organisms that would be deemed cognition in organisms with brains. Therefore, new frameworks have been developed to categorize the behavior of aneural organisms to keep them comparable to what is traditionally thought of as cognition

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(Lyon et al. 2021; Manicka and Levin 2019). These frameworks allow for a more structured evaluation of cognitive capabilities in aneural organisms, such as unicellular amoebae.

The acellular slime mold *Physarum polycephalum* is a compelling model organism for the study of adaptive behavior in a unicellular organism. During its vegetative state, *Physarum* forms a multinucleated syncytium called plasmodium. Plasmodia resemble macroscopic amoeboid cells and can easily grow up to a few centimeters in diameter, moving by extending filament-like pseudopodia (Rojas and Stephenson 2021). *Physarum* is capable of sensing its environment in various ways. It is capable of processing chemical stimuli (Carlile 1970; McClory and Coote 1985), can distinguish between various wavelengths of light (Adamatzky 2013), seek out optimal temperatures (Wolf et al. 1997), as well as react to gravity (Block et al. 1992; Wolke et al. 1987), magnetic fields (Shirakawa et al. 2012) and vibration (Gehrke and Freiberg 2025).

These features are prerequisites for learning: *Physarum* actively forages in its environment, interacting with and reacting to the above-mentioned stimuli. Furthermore, it is capable of modifying its responses to stimuli. *Physarum* has been shown to habituate to aversive stimuli, learning to ignore them over time (Boisseau et al. 2016) and even sharing the learned behavior with previously naïve plasmodia (Vogel and Dussutour 2016). Further complex information processing includes complex decision making (Dussutour et al. 2010) and anticipation of rhythmic events (Saigusa et al. 2008).

Overall, *Physarum* shows a degree of environmental awareness, behavioral flexibility and complexity often associated with nervous systems. According to the framework given by Lyon et al. (2021), it shows many capacities listed in the proposed toolkit of basal cognitive abilities. Therefore, it is of particular interest to explore the limits of *Physarum* cognition. An especially difficult task is learning by association, as it does not only involve adaptive behavior but also the integration of multiple sensory inputs into new meaningful environmental interactions (Loy et al. 2021).

The first and only experiment concerning learning by association in *Physarum polycephalum* has been conducted by Shirakawa et al. (2011). The authors aimed to change the plasmodium's natural thermotaxis response using food as an additional stimulus. This was done by placing a plasmodium in the center of a chamber with a controlled temperature gradient to provide a colder (aversive) and warmer (attractive) side. Food was placed on the colder side, and the plasmodium was observed for seven days. For the first three days, the plasmodium showed the normal thermotactic behavior of moving toward the warmer side. Subsequently, the plasmodium started moving toward the colder side, apparently reversing its thermotaxis due to associating cold with nutrition. The authors themselves, however, conclude that this experiment does not prove learning by association, but may instead be explained by habituation to the cold (Shirakawa et al. 2011).

Inspired by that experiment, we developed a similar approach using gradients of light to test *Physarum* learning. Light was used instead of temperature since light can be, depending on its wavelength and intensity, both an aversive and a positive stimulus (Adamatzky 2013), possibly even a neutral stimulus. Therefore, we tried to train *Physarum* to move toward an aversive stimulus, toward a neutral stimulus and away from that neutral stimulus. The aim of this study is to further explore possible associative learning with both neutral and aversive stimuli to distinguish association from habituation.

Materials and methods

The plasmodia used in all experiments were grown from a single sclerotium of unknown age that was purchased online from a commercial provider. According to the provider, the original plasmodium was collected in a forest in Germany. After resuscitation in our lab (Fig. 1), the plasmodium was maintained and regularly divided to form a clonal line. In one clone, sporulation was induced to morphologically confirm the species, because that is only possible by examination of the spores (Nannenga-Bremekamp 2022). Except during the experiments, the plasmodia of this clone line were kept at 20°C in total darkness on 12x12cm Petri-dishes filled with nutrition-free 2%-water agar (20g Agar Agar (CarlRoth GmbH) per 1000ml tap water).

Each plasmodium was maintained every two days by resettling to a fresh Petri-dish, provided with fresh food in the form of rolled oat flakes (Koelln-Flocken, Peter Kölln GmbH & Co. KGaA) and sprayed with demineralized water to raise humidity. During this procedure, each plasmodium was exposed to light for up to 30 minutes. During growth the plasmodia were regularly divided onto multiple Petri-dishes thus growing the clonal line to supply material for the experiments.

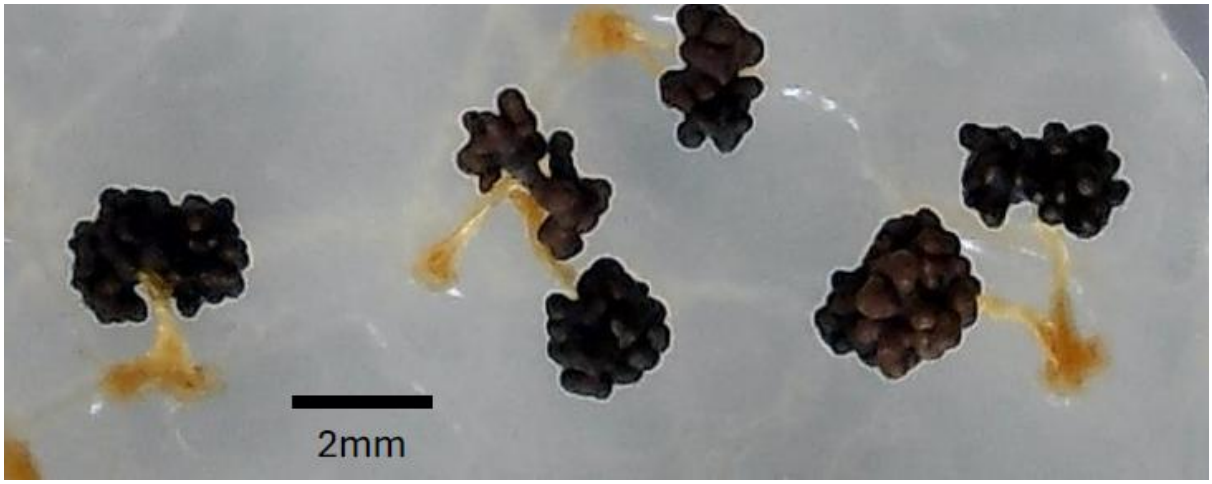

Figure 1. Photograph of the fruiting bodies of the used *Physarum*-culture. The specimen is preserved (as dried sporangia) in the fungarium of the Senckenberg Museum of Natural History Görlitz, Germany (GLM-F148003).

Experiments

All experiments were conducted in a custom-made wooden box designed to minimize outside influences. The design of the box is shown in Fig. 2. The box was divided into two parts: one half was equipped with an LED light strip for illumination, while the other was kept dark. A black divider was hung in the middle of the box, dividing both halves and blocking part of the light from entering the darker side, forming a pronounced light gradient. The temperature of the room was kept at 20°C during the experiments. The temperature inside the box was stable at 20°C on both sides of the box.

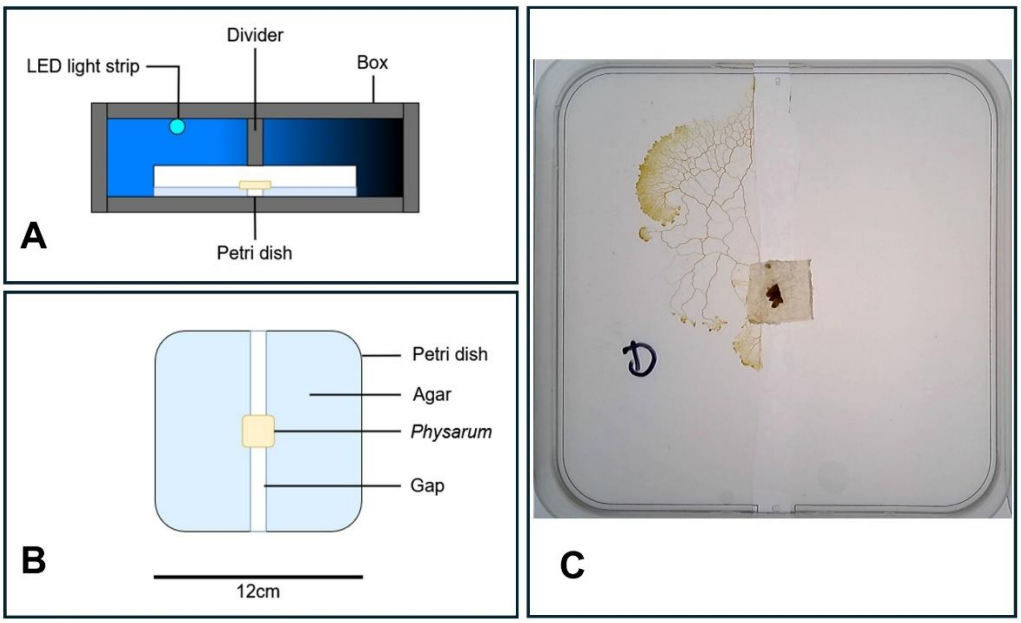

Figure 2. Visualization of the experimental setup. A. Side-view of the experimental box in which the slime molds were tested and trained. B. Top view of the Petri-dish prepared for the experiment. C. Photograph of a Petri-dish after the experiment. The letter D indicates the dark side, showing that *Physarum* has fully moved away from the light after being placed in the middle of the dish.

For stimulation, an LED light-strip containing multiple LEDs (SimpLED RGB Komplettset 1.5m, 8W, Paulmann Licht GmbH, Springe-Völksen, Germany) was used, as it was both capable of dimming to regulate the light intensity and of emitting multiple wavelengths. For the experiments, blue light and red light were used since these are relevant for *Physarum* phototaxis (Adamatzky 2013). Spectral analysis of the chosen stimuli revealed narrow wavelength distributions with peaks around 630nm for the red light, and 465nm for the blue light.

For each trial, 2% water agar Petri-dishes similar to those used to cultivate the plasmodia were divided by cutting out a channel of approximately 1cm diameter through the middle. Since *Physarum* prefers to stay on the agar, it was forced to make a decision toward or away from the stimulus, simplifying the analysis by dividing the Petri-dish into two halves. During the experiments, each plasmodium was placed in the middle of the channel on an agar square of approximately 15x15mm. The plasmodia were always scraped onto the agar in order to destroy any pre-existing structures and movement directions. To ease the stress of reorganization, a single oat flake was additionally placed on the plasmodium in the middle of the square.

Each plasmodium underwent an initial testing session, then four consecutive training sessions, and then a final testing session. A visualization of the procedure can be found in Fig. 3. For the testing sessions, no other food was added. During the training sessions, however, a trace of four oat flakes was added to lead the plasmodium into the desired direction. The aim of providing a trace of food was to attract the plasmodia into the intended direction, because it has been shown that *Physarum* is capable of following traces of food (Reid et al. 2016). It is, however, unclear whether they are capable of sensing unscented oat

flakes over distances, therefore the first flake of the food trace was always placed to touch the plasmodium and thus promote movement into that direction. Following a 48 hour exploration period, the spatial distribution of the plasmodium was documented using a high-definition document camera (Optoma DC455, Optoma Europe Ltd., London).

For the main experiments, each test spanned 12 days, during which images were captured and the plasmodium was transferred to a fresh Petri-dish every 2 days. A total of three distinct experiments were conducted. In Experiment 1, aversive blue light was used, and the plasmodia were guided toward the blue light during the training sessions. In Experiment 2, neutral red light was used, and the plasmodia were guided toward the red light during training. In Experiment 3, the setup was similar to Experiment 2, but the plasmodia were trained away from the red light to move into darkness instead. For each of the 3 experiments, a total of 16 plasmodia was used. Before the main experiments, pretests were conducted to find the ideal light intensities for the main experiments. *Physarum* reacts differently to different intensities of light, therefore for the blue light the aim was to find an intensity that was aversive for *Physarum*. In the case of the red light, the aim was to find an intensity that would elicit neither positive nor negative phototaxis to provide a truly neutral stimulus. For the pretests, various light intensities were tested on four plasmodia each, using the setup described for testing without traces of oat flakes. The intensities are given in percentages as fractions of the possible output (152lm) of the LEDs.

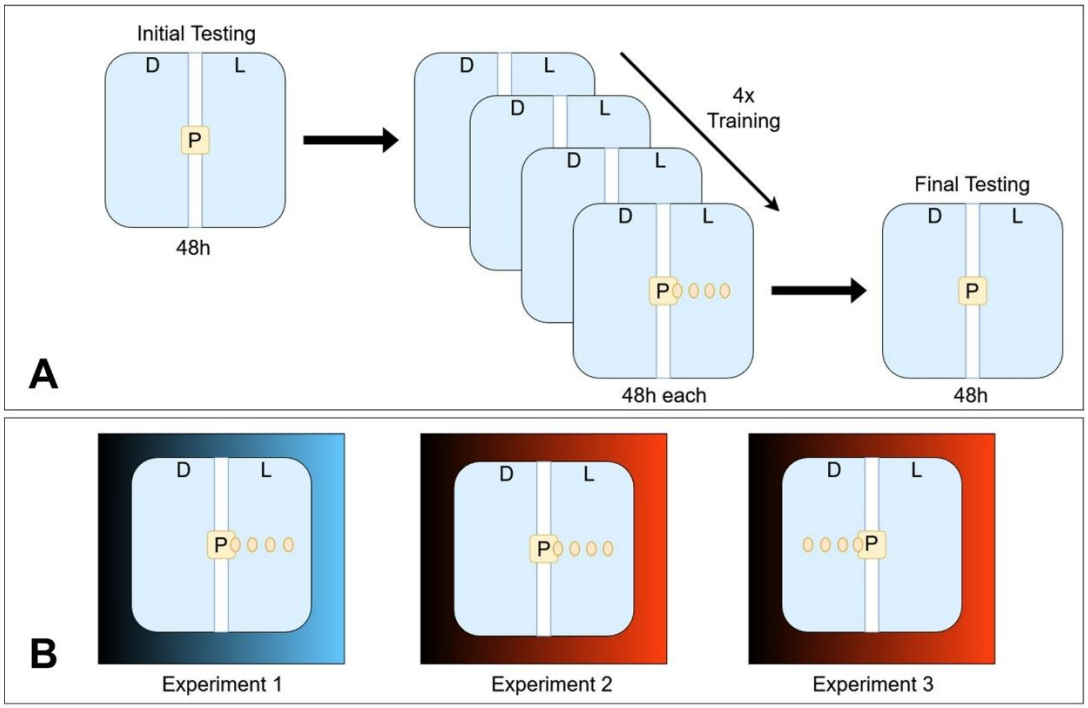

Figure 3. Visualization of the experimental procedure. A. Schematic representation of the experimental process inside the box, with manual maintenance and imaging every 48 hours, for a total of 12 days. P denotes the initial position of the *Physarum*, D denotes the dark side, and L denotes the illuminated side of the dish. B. Schematic representation of the three experiments: Experiment 1 - training toward blue light; Experiment 2 - training toward red light; Experiment 3 training to avoid red light.

Data analysis

The images obtained during the initial and final testing sessions were analyzed using the open source platform FIJI (Schindelin et al. 2012), determining the surface area of the plasmodia separately for both field halves, measured in pixels. From these pixels, individual percentages of *Physarum* detected for each image were calculated and statistical analysis was performed using paired t-Tests. All datasets contained multiple instances of extreme values of either 0% or 100%. Due to the particular distribution of the data that prohibited the use of the Wilcoxon-Tests because of the high number of ties, additionally non-parametric Sign-Tests were performed as well to account for the possible unreliability of the t-tests due to violation of requirements. Moreover, the images obtained after the training sessions were evaluated manually to determine the number of oat flakes reached during each session to quantify the plasmodial progress during learning.

Results

To determine the light intensity of the LED-strip in the main experiments, pretests were conducted, using percentages of the maximum light intensity the LEDs could produce to gauge the reaction of the plasmodia. The results of the pretests are shown in Table 1. Due to the aversive reaction observed at higher light intensities, 10% of the maximum blue light intensity was deemed an ideal light strength for Experiment 1. Due to the success at the shown intensities, no higher intensities were tested for the blue light. For the red light, the goal was to find an intensity that would elicit a neutral response. In the intensities from 100% to 50%, an aversive reaction could be observed. At 25% light intensity, *Physarum* showed movement toward the light. 10% light intensity was chosen for the second and third experiments because it led to an even spread of *Physarum* in both directions and was therefore deemed neutral.

Table 1. Results of the pretests, showing the mean percentage of surface area spread of *Physarum* toward the light and the dark side under various light intensities. SEM= standard error of the mean.

Color	Light intensity	*n*	$M_{\%\ light}$	$M_{\%\ dark}$	$SEM_{\%\ light}$
Red	100%	4	0.147	0.853	0.147
Red	75%	4	0.246	0.754	0.226
Red	50%	4	0.256	0.744	0.248
Red	25%	4	0.750	0.250	0.250
Red	10%	4	0.444	0.556	0.163
Blue	25%	4	0.282	0.718	0.241
Blue	10%	4	0.153	0.847	0.120

Due to the stressful procedure of scraping, not all plasmodia survived the testing periods. For all analyses, only data from surviving plasmodia were used. The number of plasmodia, results of the statistical tests and the mean percentages of plasmodium spread both into the light and dark half of the Petri-dish are listed in Table 2.

To test if *Physarum* would choose to move toward aversive blue light after training more than during the initial testing, a one-tailed paired t-test and and a one-tailed paired sign-test were conducted. Both showed a significant increase in surface area after training (p t-test = .015, p sign-test = .011). The same tests were applied to the next paradigm to test if *Physarum* would spread more toward red light after

training. However, despite a tendency of increase visible in the mean percentage, both tests showed no significant increase in surface area (p t-test = .305, p sign-test = .055). Finally, to test if the surface area spread toward light would decrease after training toward darkness, the aforementioned tests were calculated showing a significant change (p t-test = .029, p sign-test = .028). The different mean percentages are depicted in Fig. 3.

Table 2. Results of the main experiments including mean percentage of surface spread toward the light, SEM and the results of the paired t-tests and nonparametric paired sign-tests. SEM = standard error of mean.

Experiment	Stimulus	Goal	*n*	Before training		After training		$p_{t\text{-Test}}$	$p_{\text{Sign-Test}}$
				$M_{\%\ \text{light}}$	SEM	$M_{\%\ \text{light}}$	SEM		
1	Blue	Light	13	.10	.088	.60	.143	.015 *	.011 *
2	Red	Light	13	.45	.145	.75	.128	.305	.055
3	Red	Dark	15	.70	.125	.25	.120	.029 *	.028 *

Note. The results are ordered by which color of light was used (Blue in Experiment 1, Red in Experiment 2 and 3) and the direction toward which the plasmodia were trained (toward light in Experiment 1 and 2, away from the light in Experiment 3). Significant p-values are denoted with an asterisk.

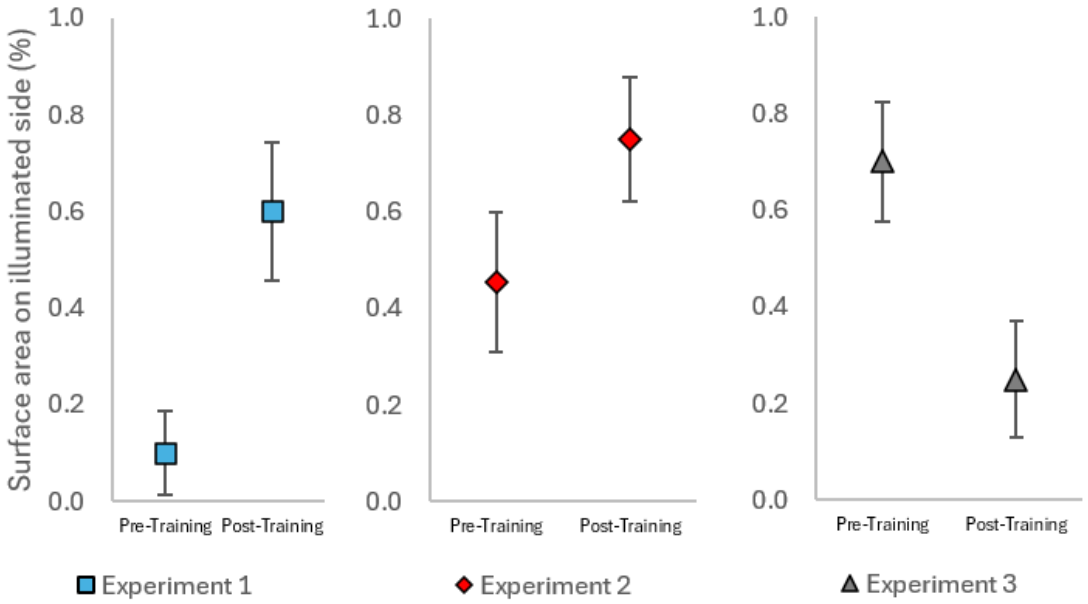

Figure 3. Changes in phototactic behavior before and after training. Mean proportion of *Physarum polycephalum* surface area located on the illuminated side of the Petri dish during the initial (pre-training) and final (post-training) test sessions. Experiment 1 used aversive blue light and trained plasmodia toward the illuminated side. Experiment 2 used neutral red light and trained plasmodia toward the illuminated side. Experiment 3 used neutral red light and trained plasmodia toward the dark side. Higher values indicate a greater proportion of plasmodial movement toward the illuminated side. Error bars represent ± SEM.

Discussion

Associative learning as a sign of complex information processing is an evolutionary milestone that has only been rarely shown in aneural organisms. The only study addressing learning by association in the slime mold *Physarum polycephalum* by Shirakawa et al. (2011) showed a movement towards an aversive temperature stimulus after training with food as reward. Although the results pointed toward a change in thermotactic behavior, it was not possible to differentiate between true associative learning and simpler habituation. The aim of this study was to expand the behavioral analysis using various light stimuli instead of temperature, and using not only aversive, but also neutral stimuli. This was done to differentiate between habituation and learning by association, since while a change in response to an aversive stimulus might be caused by habituation, a systematic change in response to a neutral stimulus cannot. Altogether, three experiments were conducted: training toward an aversive stimulus, training toward a neutral stimulus and training away from a neutral stimulus.

Experiment 1: Training toward an aversive stimulus

The results of Experiment 1 seem to be in line with the findings of Shirakawa et al. (2011), as an initial aversion to the aversive stimulus was observed that is significantly decreased after four consecutive training sessions. Despite our use of a different aversive stimulus, this result shows that a change in behavior is possible in *Physarum* (in this case phototaxis) after a period of training, and that *Physarum* performs the new behavior even after training in the absence of the nutrition used as incentive. This is only possible through the formation of memory. Nevertheless this result alone does not allow to infer learning by association. It is already known that *Physarum* is capable of ignoring aversive light in the acquisition of nutrients (Latty and Beekman 2010), and that it is capable of habituating to aversive stimuli through consecutive exposure (Boisseau et al. 2016). It is therefore likely that the food trails leading towards the blue light in our study have led to a high exposure to the aversive stimulus as the plasmodia were incentivized to move towards it instead of away, thereby facilitating the process of habituation. Even so, the result shows that habituation is not only possible to cold (Shirakawa et al. 2011) or chemical stimuli such as quinine (Boisseau et al. 2016), but also to light.

Experiment 2: Training toward a neutral stimulus

The second experiment was conducted to test if *Physarum* is able to associate a neutral stimulus with food as positive stimulus to alter the phototactic response. During the initial testing, the plasmodia preferred neither darkness nor red light, and after the training phase no statistically significant change occurred despite an increase of spread toward the red light. While the tendency is in line with the hypothesis that learning by association would lead to a preference for red light, the non-significant effect might either be a product of chance or due to a too small sample size and can therefore not be seen as proof of associative learning.

Experiment 3: Training away from a neutral stimulus

The results of this experiment show a significant decrease of spread toward the red light between the initial and the final training session. This can be interpreted as a sign of associative learning, as it shows that a significant change in behavior towards a neutral stimulus occurred over the course of the consecutive training sessions. It must be mentioned, however, that the movement towards the red light was unusually high during initial testing despite no change in the experimental setup, indicating a high variation in response toward red light. In spite of this observation, the significant systematic change in phototactic response implies a process of learning that, unlike the results of Experiment 1, cannot be explained by habituation. Both the literature (Adamatzky 2013; Hato et al. 1976) and the results of this study show that red light in the used intensity is not an aversive stimulus, and that it may even function as an attractant. Therefore, the observed behavior may be interpreted as learning by association.

General Discussion

Our results show that systematic behavioral change, or learning, can occur in *Physarum* due to the combination of aversive or neutral stimuli with sources of nutrition. While the results are not completely conclusive, in two of the experiments significant changes in phototactic behavior were observed. Habituation alone does not explain the result of Experiment 3 and the tendency observed in Experiment 2; therefore, it is not possible to rule out learning by association.

The mechanism behind the behavioral change is unclear, but it is possible to propose explanations from what is already known in literature. As *Physarum* does not produce electrical action potentials, information processing and learning occur differently from neural systems. Instead, it has been proposed that *Physarum* uses its structure to store information (Cheng 2022), and the interplay of the oscillations in these structures for information processing (Boussard et al. 2021). In the present work, these two elements cannot be the only factor influencing plasmodial behavior, since between each session, the macrostructure of the plasmodia was destroyed by scraping the plasmodia onto new Petri-dishes.

Baluška and Levin (2016) suggest that the cytoskeleton, DNA-methylation and bioelectricity are possible mechanisms for information retention in unicellular organisms. In this case, bioelectricity does not refer to action-potentials but instead the shifting concentration of ions along the cell membranes that can be interpreted as signaling cues among the cells (Zhang and Levin 2025). None of these can be ruled out, even though the cytoskeleton of Amoebozoa such as *Physarum* is very different from other eukaryotes, allowing for the slime mold's constant change of shape (Tekle and Williams 2016). It is also possible that memory in *Physarum* is formed by an interplay of macrostructure, oscillation and cell physiology: While the macrostructure of the tubuli is spontaneously formed during plasmodial movement as a reaction to stimuli, which in turn is mediated by oscillations, it can be thought of as a "short-term memory" in the slime mold. As our results show, this memory can then be transferred into a form of "long-term memory" possibly based on epigenetics and/or bioelectricity. This might lead to the reconstruction of previously successful behavioral patterns such as a particular expansion toward a light gradient that previously led to successful foraging, even after destruction of the plasmodium's physical structures, possibly explaining the behaviors observed in our study.

One challenge in testing association with a neutral stimulus is finding a stimulus that does not elicit a specific response by itself but can still be perceived by the organism. In *Physarum*, perception of a stimulus is mainly assessed by testing if it shows either a positive or a negative response, i.e. moving toward or away from the stimulus. Therefore, proof of stimulus detection in *Physarum* is always associated with assigning valence to the stimulus. Red light was chosen here, because *Physarum* has an ambivalent response to it- while higher intensities are proven to be aversive, lower intensities seem to elicit positive phototaxis (Hato et al. 1976). This effect could be replicated in this study, as seen in Table 1. Therefore, we strived to find an intensity of light that would elicit no phototaxis, hoping that it was still perceptible to the plasmodia but having no positive or aversive effect. The observed change in behavior in Experiment 2 and 3 might serve as an indicator for red light perception in the plasmodia, as the light gradient was the only marker of direction the plasmodia could have used.

Building on these results, more work is needed to further explore the observed behavioral change in *Physarum*. Repeating the experiments with higher numbers of plasmodia can help clarify whether the result observed in Experiment 2 was a product of chance or of learning, while observing oscillations and bioelectricity in the plasmodia during the experiments might help unravel the mechanisms involved in the behavioral changes. Further controls could be realized by either keeping *Physarum* in the setup without food trails or with randomized food trails to assess if changes in behavior still occur, such as habituation. At the same time, replicating and expanding the experimental setup opens the possibility of new cognitive tasks such as reverse-learning, and possibly the identification of other neutral stimuli. Since it has been shown that *Physarum* is capable of sharing learned behavior through exchange of cytoplasm (Vogel and Dussutour 2016), it would be also be of great interest to investigate if the change in phototaxis can be transmitted as well.

Overall, this study demonstrates that *Physarum* is capable of learning by association, leading to a further establishment of cognition in an aneural organism.

Open Practices Statement

The original data presented in this study are openly available in OSF at https://doi.org/10.17605/OSF.IO/PVNJK (accessed on 13 May 2025). The experiments were not preregistered.

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References

Adamatzky A. 2013. Towards slime mould colour sensor: recognition of colours by *Physarum polycephalum*. Org Electron. 14(12): 3355–3361.

Baluška F, Levin M. 2016. On having no head: cognition throughout biological systems. Front Psychol. 7: 902.

Block I, Wolke A, Briegleb W, Wohlfarth-Bottermann KE, Merbold U, Brinckmann E, Brillouet C. 1992. Graviresponse of *Physarum*: investigations in actual weightlessness. Cell Biol Int Rep. 16(11): 1097–1102.

Boisseau RP, Vogel D, Dussutour A. 2016. Habituation in non-neural organisms: evidence from slime moulds. Proc R Soc B Biol Sci. 283(1829): 20160446.

Boussard A, Fessel A, Oettmeier C, Briard L, Döbereiner HG, Dussutour A. 2021. Adaptive behaviour and learning in slime moulds: the role of oscillations. Philos Trans R Soc B Biol Sci. 376(1820): 20190757.

Carlile MJ. 1970. Nutrition and chemotaxis in the myxomycete *Physarum polycephalum*: the effect of carbohydrates on the plasmodium. Microbiology 63(2): 221–226.

Cheng K. 2022. Bodily memory in slime mold. Learn Behav. 50(2):203–204.

Dussutour A, Latty T, Beekman M, Simpson SJ. 2010. Amoeboid organism solves complex nutritional challenges. Proc Natl Acad Sci USA. 107(10): 4607–4611.

Gehrke R, Freiberg J. 2025. Revisiting chirality in slime mold: on the emergence and absence of lateralized movement in *Physarum polycephalum* influenced by various stimuli. Symmetry 17(5): 756.

Hato M, Ueda T, Kurihara K, Kobatake Y. 1976. Phototaxis in true slime mold *Physarum polycephalum*. Cell Struct Funct. 1(3): 269–278.

Latty T, Beekman M. 2010. Food quality and the risk of light exposure affect patch-choice decisions in the slime mold *Physarum polycephalum*. Ecology 91(1): 22–27.

Loy I, Carnero-Sierra S, Acebes F, Muñiz-Moreno J, Muñiz-Diez C, Sánchez-González JC. 2021. Where association ends: a review of associative learning in invertebrates, plants and protista, and a reflection on its limits. J Exp Psychol Anim Learn Cogn. 47(3): 234–251

Lyon P. 2020. Of what is "minimal cognition" the half-baked version? Adapt Behav. 28(6): 407–424.

Lyon P, Keijzer F, Arendt D, Levin M. 2021. Reframing cognition: getting down to biological basics. Philos Trans R Soc B Biol Sci. 376(1820): 20190750.

Manicka S, Levin M. 2019. The cognitive lens: a primer on conceptual tools for analysing information processing in developmental and regenerative morphogenesis. Philos Trans R Soc B Biol Sci. 374(1774): 20180369.

McClory A, Coote JG. 1985. The chemotactic response of the myxomycete *Physarum polycephalum* to amino acids, cyclic nucleotides and folic acid. FEMS Microbiol Lett. 26(2):195–200.

Nannenga-Bremekamp NE. 2022. Descriptive, illustrated keys to the world's myxomycetes. 1st ed. Madrid (Spain): Consejo Superior de Investigaciones Científicas.

Reid CR, MacDonald H, Mann RP, Marshall JAR, Latty T, Garnier S. 2016. Decision-making without a brain: how an amoeboid organism solves the two-armed bandit. J R Soc Interface. 13(119): 20160030.

Rojas C, Stephenson SL. 2021. Myxomycetes: biology, systematics, biogeography and ecology. 2nd ed. London (UK): Academic Press.

Saigusa T, Tero A, Nakagaki T, Kuramoto Y. 2008. Amoebae anticipate periodic events. Phys Rev Lett. 100(1):018101.

Schindelin J, Arganda-Carreras I, Frise E, Kaynig V, Longair M, Pietzsch T, Preibisch S, Rueden C, Saalfeld S, Schmid B, Tinevez JY, White DJ, Hartenstein V, Eliceiri K, Tomancak P, Cardona A. 2012. Fiji: an open-source platform for biological-image analysis. Nat Methods. 9(7): 676–682.

Shirakawa T, Gunji YP, Miyake Y. 2011. An associative learning experiment using the plasmodium of *Physarum polycephalum*. Nano Commun Netw. 2(2): 99–105.

Shirakawa T, Konagano R, Inoue K. 2012. Novel taxis of the *Physarum* plasmodium and a taxis-based simulation of *Physarum* swarm. In: Proceedings of the 6th International Conference on Soft Computing and Intelligent Systems and the 13th International Symposium on Advanced Intelligence Systems; Kobe, Japan. p. 296–300.

Tekle YI, Williams JR. 2016. Cytoskeletal architecture and its evolutionary significance in amoeboid eukaryotes and their mode of locomotion. R Soc Open Sci. 3(9): 160283.

Vogel D, Dussutour A. 2016. Direct transfer of learned behaviour via cell fusion in non-neural organisms. Proc R Soc B Biol Sci. 283(1845): 20162382.

Wolf R, Niemuth J, Sauer H. 1997. Thermotaxis and protoplasmic oscillations in *Physarum* plasmodia analysed in a novel device generating stable linear temperature gradients. Protoplasma. 197(1–2): 121–131.

Wolke A, Niemeyer F, Achenbach F. 1987. Geotactic behavior of the acellular myxomycete *Physarum polycephalum*. Cell Biol Int Rep. 11(7): 525–528.

Zhang G, Levin M. 2025. Bioelectricity is a universal multifaced signaling cue in living organisms. Mol Biol Cell. 36(2): pe2.

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First records of myxomycetes from Unalaska Island in the Aleutian Islands

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Abstract: Samples of bark, woody twigs, ground litter, and aerial litter were collected on Unalaska Island in July of 2025 and processed for myxomycetes in moist chamber cultures. Eighty-one percent (55/68) of the moist chamber cultures yielded evidence (plasmodia or fruiting bodies) of myxomycetes. However, only 16 specimens representing six species were recorded. All six are new records for the Aleutian Islands. The vast majority of plasmodia appearing in moist chamber cultures failed to produce fruiting bodies. A few vigorous examples persisted for as long as ten months without fruiting, but most produced sclerotia or simply died off.

Keywords: island biogeography, moist chamber cultures, slime molds, tundra

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Introduction

The myxomycetes are a group of terrestrial amoebozoans that have been reported from virtually every ecosystem examined to date. These organisms mostly occur in association with decaying plant material such as dead wood (from trees and shrubs) and various types of dead plant debris (e.g., dead leaves) on the ground. Myxomycetes produce fruiting bodies that for some species resemble those of certain macrofungi (mushrooms) but are much smaller (usually no more than 1–2 mm tall). Myxomycete fruiting bodies can be collected directly from the field or isolated in moist chamber cultures from samples of various types of plant debris collected in the field and then processed under laboratory conditions using moist chamber cultures (Stephenson and Stempen 1994).

Study area

Unalaska Island (58°38′ N, 167°00′ W) is a volcanic island in the Fox Island group of the Aleutian Islands and located off the southwestern coast of Alaska. The island has a total area of 545 km^2, and the highest point is Mount Makushin (elevation 2036 m). Unalaska Island and all the rest of what is now recognized as the state of Alaska belonged to Russia until 1869. The naturally occurring vegetation type on the island is tundra (Fig. 1). The island does not have any naturally occurring trees, but Sitka spruce (*Picea sitchensis*) was planted at one locality by the Russians in 1808, and this species has both persisted

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and spread to a limited extent on the island since then. Sitka spruce is a very large tree in its natural habitat but does not get very large (<10 m) on Unalaska Island (Fig. 2).

Figure 1. Typical area of tundra on Unalaska Island (Photo by Barbara Stephenson).

Figure 2. Sitka spruce forest on Unalaska Island (Photo by Barbara Stephenson).

Materials and methods

On July 15 and 16 of 2025, samples of woody twigs, ground litter, bark, and aerial litter were collected at several sites on Unalaska Island. These samples were returned to Virginia and used to prepare 68 moist chamber cultures in the manner described by Stephenson and Stempen (1994). Water was added to the moist chamber cultures whenever it became apparent that they were drying out. When fruiting bodies appeared, the portion of the substrate on which they occurred was removed, allowed to dry out, and then mounted in a small pasteboard box for storage. All specimens of myxomycetes were deposited in the personal herbarium (SLS) of the first coauthor.

Results and discussion

Some evidence (plasmodia and/or fruiting bodies) of myxomycetes appeared in eighty-one percent (55/68) of the moist chamber cultures prepared in the present study. However, only 16 specimens representing six species were recorded. The most surprising aspect of the moist chamber cultures was the length of time required for fruiting bodies to appear. The first fruiting body did not appear until after more than two months, and additional specimens appeared at irregular intervals over the next six months. Most of the moist chamber cultures produced vigorous plasmodia that survived for several months or more before producing sclerotia or dying off. Two plasmodia survived for ten months without fruiting before the present study ended.

Annotated List of Species

In the list that follows, all species of myxomycetes recorded on Unalaska Island are arranged alphabetically by genus and then species. Information is provided on the source(s) of each record. The nomenclature used follows Lado (2005-2026).

Arcyria denudata (L.) Wettst.

Represented by three specimens (UI-012, UI-013, and UI-014) appearing on Sitka spruce ground litter (consisting mostly of small twigs) in moist chamber cultures and one specimen (UI-015) appearing on a dead aerial stem of blackberry (*Rubus* sp.) in a moist chamber culture.

Cribraria cancellata (Batsch) Nann.-Bremek.

Represented by one specimen (UI-010) appearing on Sitka spruce ground litter (consisting mostly of small twigs) in a moist chamber culture.

Diderma effusum (Schwein.) Morgan

Represented by two specimens (UI-003 and UI-009) appearing on Sitka spruce ground litter (consisting mostly of small twigs) and one specimen (UI-011) appearing on Sitka spruce bark in moist chamber cultures. *Diderma effusum* and *D. saundersii* are morphologically very similar but can be distinguished by the thickness of the plasmodiocarp (typically 0.4 mm in *D. effusum* and 0.2 mm in *D. saundersii*) and the size of the spores (7–9 µ in *D. effusum* and 10–11 µ in *D. saundersii*).

Diderma saundersii (Berk. & Broome ex Massee) E. Sheld.

Represented by two specimens (UI-001 and UI-002) appearing on Sitka spruce ground litter

(consisting mostly of small twigs) in moist chamber cultures and one specimen (UI-018) appearing on Sitka spruce bark in a moist chamber culture.

Didymium melanospermum (Pers.) T. Macbr.

Represented by one specimen (UI-008) appearing on ground litter from low-growing herbaceous plants in a moist chamber culture.

Metatrichia vesparia (Batsch) Nann.-Bremek. ex G.W. Martin & Alexop.

Represented by three specimens (UI-004, UI-005, and UI-007) appearing on Sitka spruce ground litter (consisting mostly of small woody twigs) in moist chamber cultures and one specimen (UI-006) appearing on a dead aerial stem of blackberry (*Rubus* sp.) in a moist chamber culture.

The percentage of positive moist chamber cultures was relatively high in the present study, but the low number of specimens obtained (only 12) and species recorded (6) were disappointingly low. The only comparable study of which the first coauthor is aware was a study carried out on Macquarie Island in the subantarctic (Stephenson et al. 2007). In the latter study, non-fruiting plasmodia appeared in the majority of moist chamber cultures prepared. Interestingly, Macquarie Island is located at 54°37′ S, which is not too different from the location of Unalaska Island at 58°38′ N. Whether or not this similarity in latitude (and climate) is a factor of some significance is unknown. In any case, myxomycetes do not appear to be particularly common in tundra. Stephenson and Laursen (1993, 1998) listed only 13 species recorded from areas of tundra in Alaska based on studies carried out during three (1989, 1991, and 1992) field seasons. Only a single species (*Metatrichia vesparia*) reported by these authors also was recorded in the present study.

There are no previous records from the Aleutian Islands, so the six species reported in this paper are new records for both Unalaska Island and the Aleutian Islands. There have been few studies carried out in the tundra ecosystems that occur at higher elevations in the Northern Hemisphere. As such, additional studies are clearly warranted. Hopefully, the present study will serve as a starting point for these studies.

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References

Lado C. 2005-2026. An on-line nomenclatural information system of Eumycetozoa [Internet]. Madrid: Real Jardin Botánico de Madrid, CSIC; [visited 10 May 2026]. Available from: http://www.eumycetozoa.com

Stephenson SL, Laursen GA. 1993. A preliminary report on the distribution and ecology of myxomycetes in Alaskan tundra. Bibl Mycol. 150:251-257.

Stephenson SL, Laursen GA. 1998. Myxomycetes from Alaska. Nova Hedwig. 66:425-434.

Stephenson SL, Laursen GA, Seppelt RD. 2007. Myxomycetes of subantarctic Macquarie Island. Aust J Bot. 55:439-449.

Stephenson SL, Stempen H. 1994. Myxomycetes: A Handbook of Slime Molds. Portland: Timber Press.