PROCEEDINGS OF THE

ICSEM 10
Costa Rica

10th International Congress on the Systematics and Ecology of Myxomycetes

Turrialba-Costa Rica

February 25-28, 2020

General Information

The ICSEM 10 took place in the City of Turrialba, approximately 68 km (42 miles) east of San José, the capital of Costa Rica. The Sede del Atlántico of the Universidad de Costa Rica system generously provided the space for the congress.

Archaeological documentation of Costa Rica has demonstrated scattered prehispanic presence across the country. However, the most important archaeological features in Costa Rica have been found in Turrialba and have been dated back approximately 10000 years. For this reason, the Costa Rican government, declared Turrialba a city of national archaeological interest (Decreto ejecutivo 14557, 1983). The ICSEM10 logo was based on the Chibcha-influenced petrogliphs found near Turrialba.

The campus of the Universidad de Costa Rica system is located about 1.5 km east of downtown Turrialba. Its history is an example of the role of local leaders on the establishment of education in rural Costa Rica and it started operations in 1971 with only 125 students and four professors (History, Spanish, Philosophy and Biology).

It is currently located in the former Finca La Hulera (a rubber farm) established by the USDA as the Cooperative Rubber Plant Field Station in the 1940s. This station was intended to do research on genetic improvement of rubber to meet the increasing demand for car tires after the United States lost access to plantations in Southeast Asia during the World War II. Some of the former research buildings still exist on campus.

Conceptual cloud of the event

Based on keywords, the ICSEM10 was all about…

Organization

The organization of the ICSEM10 was carried out by Universidad de Costa Rica through activity code 570-B9-7B4 from Finca Experimental Interdisciplinaria de Modelos Agroecológicos (FEIMA).

Administrative support was provided by Instituto de Investigaciones en Ingeniería (Engineering Research Institute) and Sede del Atlántico (UCR Turrialba Campus).

External support was gently provided by the Myxotropic Project from Real Jardín Botánico de Madrid (Spain), the Japanese International Cooperation Agency -JICA (Japan) and the Cumberland Mountain Research Center from Lincoln Memorial University (USA).

The organizing committee was composed by Universidad de Costa Rica´s employees and research associates: Pedro Rojas, Shiori Nakajima, Randall Valverde, Isabel Barboza, Gabriela Bonilla and Carlos Rojas.

Acknowledgements

The organizing committee wanted to acknowledge the important involvement and support from Werner Rodriguez Montero, Jesús Campos Carpio and Gabriela Bonilla Gamboa.

Dedication

The ICSEM10 was dedicated to the memory of David W. Mitchell, whose contribution and passion to the study of myxomycetes will always be remembered.

Participants

The ICSEM10 was attended by people from The Americas, Europe, Asia and Australia.

Alejandra Arenas Taborda
Angie Natalie Díaz Ruiz
Arturo Estrada-Torres
Carlos Lado Rodríguez
Christina Oettmeier
Dmitry Leontyev
Eder Flores Ramos
Elizaveta Shchepina
Frederick William Spiegel
Johann Gangl
Garrett Taylor
Hiroshi Azumo
Indira Kalyanasundaram
Iryna Yatsiuk
Italo Francisco Treviño Zevallos
Ivan Garcia Cunchillos
Izabel Cristina Moreira
J. Carolina Rincón Marín
Jan Woyzichovski
Kazunari Takahashi
Maria Carolina García Chaves
Maria Feliciana Benita Eloreta
María Isabel del Teso de Prada
Martin Schnittler
Mercedes Rodríguez Palma (represented)
Mia Trappeniers
Monica Policina
Myriam de Haan
Nikki Heherson Dagamac
Oleg Shchepin
Pedro Rojas Camacho
Randall Valverde Gonzalez
Randy Darrah
Renato Cainelli
Ricardo Enrique Morales Hernández
Ron Nagorcka
Sarah Lloyd
Seraoui El-Hacène
Shiori Nakajima
Solange Xavier dos Santos
Steven Stephenson
Thomas Edison dela Cruz
Tyler Bailey
Yuichi Harakon
Yury Novozhilov

Some images of the event











ICSEM 10 Costa Rica

INTERNATIONAL CONGRESS ON THE SYSTEMATICS AND ECOLOGY OF MYXOMYCETES

Turrialba, Costa Rica – February 25-28, 2019

SCIENTIFIC PROGRAM OF THE EVENT

Time	TUE 25	WED 26	THU 27	FRI 28
8:00-8:30	Registration until 12:00			
8:30-9:00		Session 3: Myxomycete Ecology	Field trip to La Marta Biological Station	Session 5: Myxomycete Morphology and Biology
9:00-9:30	Opening Ceremony			
9:30-10:00	Opening Lecture (Dr. Steven L. Stephenson)			
10:00-10:30				
10:30-11:00	Coffee Break	Coffee Break		Coffee Break
11:00-11:30	Poster presentation	Poster presentation		Session 6 (Part 1): Myxomycete Biogeography
11:30-12:00				
12:00-14:00	Group Photo/Lunch time	Lunch time		Lunch time
14:00-14:30	Session 1:Myxomycete Phylogeny and Classification	Session 4: Tropical Myxomycetes		Session 6 (Part 2): Myxomycete Biogeography
14:30-15:00				
15:00-15:30				Coffee Break
15:30-16:00				Closing Lecture (Dr. Arturo Estrada-Torres)
16:00-16:30	Coffee Break	Coffee Break		
16:30-17:00	Session 2: Associations of Myxomycetes with Other Organisms	Special lecture (Dr. Fred Spiegel)		Closing ceremony and selection of ICSEM 11 location
17:00-18:00				
18:00-19:00	Cultural Activity: Turrialba Municipal Band	Cultural Dinner		
19:00-20:00				

Sessions	Posters	Lunch	Lectures	Field Trip	Activities

Program of Activities – ICSEM 10

Tuesday, February 25, 2020

8:00 – Registration

9:00 – Opening Ceremony

9:30 - Opening Lecture
S1. On the track of the elusive slime mold (Dr. Steven L. Stephenson, slsteph@uark.edu)

11:00 - Poster presentations
P1. New records of myxomycetes for Colombia – Contact: Alejandra Arenas Taborda (alejandra.arenast@udea.edu.co)

P2. Do slime molds respond to sound? – Contact: Monica S. Policina (monica_policina@yahoo.com)

P3. Incidence of Myxomycetes in the air of Valle de Aburrá, Colombia – Contact: Janeth Carolina Rincón (jcarolina.rincon@udea.edu.co)

P4. A new *Perichaena* foliicolous species (Myxomycetes) from *Quercus* forests and cloud forests of Mexico – Contact: María Mercedes Rodríguez Palma (mrodriguezpalma@hotmail.com)

P5. Long-term evaluation of myxomycetes in a single location: the case of FEIMA in Costa Rica – Contact: Carlos Rojas (carlos.rojasalvarado@ucr.ac.cr)

P6. Can the location of the lab affect moist chamber-based data? – Contact: Pedro A. Rojas (pedro.rojas@ucr.ac.cr)

P7. Genetic structure of populations of the nivicolous myxomycete *Physarum albescens* at a large geographical scale – Contact: Oleg Shchepin (ledum_laconicum@mail.ru)

P8. Myxomycetes collected at Tanbara Plateau, Gunma Prefecture, Japan – Contact: Hiroshi Suzuki (myxom09@yahoo.co.jp)

P9. The diversity of myxomycetes in two forests of the Lesser Khinggan Mountains, China – Participation was cancelled

12:00 – Group Photo

14:00 - Session 1 Myxomycete Phylogeny and Classification
Chair (Dr. Oleg Shchepin)

O1.The evolutionary history of the order Trichiales in a new multi-gene phylogenetic framework – Contact: Iván García-Cunchillos (igcun@rjb.csic.es)

O2. Combining morphology and molecular data to unravel the systematics of the Myxomycetes (Amoebozoa), with special emphasis on the order Physarales – Participation was cancelled

O3. How DNA metabarcoding changes our understanding of myxomycete ecology, diversity and distribution – Contact: Oleg Shchepin (ledum_laconicum@mail.ru)

O4. Molecular phylogeny of *Lepidoderma* de Bary and its influence on inter- and infrageneric classification of Didymiaceae – Contact: Oleg Shchepin (ledum_laconicum@mail.ru)

O5. Information system on the DNA barcodes of myxomycetes – Contact: Oleg Shchepin (ledum_laconicum@mail.ru)

16:30 - Session 2 Associations of Myxomycetes with Other Organisms
Chair (MSc. Johan Gangl)

O7. Current and future investigations on the antagonistic activity of *Physarum* species from *Zea mays* on plant pathogenic fungi causing mycotoxin contaminations and damping off diseases – Contact: Johann Gangl (johann.gangl@boku.ac.at)

O8. Integrated Mechanisms of cellular behavior in *Physarum polycephalum*: Towards a General Model System for Cognition – Contact: Christina Oettmeier (coettmeier@biophysik.uni-bremen.de)

O9. A morphological and molecular study of Myxomycetes collected from *Zea mays* – Contact: Myriam de Haan (myriam.dehaan@plantentuinmeise.be)

18:00 - Cultural Activity: Turrialba Municipal Band

Wednesday, February 26, 2020

8:30 - Session 3 Myxomycete Ecology
Chair (Dr. Thomas Edison dela Cruz)

O10. Impacts of natural disasters on microbial diversity: a case study of myxomycetes from tropical forests and grasslands in the Philippines – Contact: Thomas Edison E. dela Cruz (tedelacruz@ust.edu.ph)

O11. Does myxobiota's response to burning differ with respect to fire intensity? – Contact: Izabel Cristina Moreira (izacristina26@yahoo.com.br)

O12. Impact of forest fragmentation to the diversity and distribution of myxomycetes in Mt. Isarog, Camarines Sur, Philippines – Contact: Maria Feliciana Benita M. Eloreta (meloreta67@gmail.com)

O13. Association between myxomycetes and the decay stage of coarse woody debris in an evergreen broadleaf forest in warm temperate Japan – Contact: Yuichi Harakon (harakon@nifty.com)

O14. Xylophilic myxomycetes: will the largest logs harbor the most, and the most rare, myxomycetes? – Contact: Martin Schnittler (martin.schnittler@uni-greifswald.de)

O15. Myxomycetes associated with mahogany trees in Angat Watershed Forest Reserve, Bulacan Province, Philippines – Contact: Monica S. Policina (monica_policina@yahoo.com)

11:00 - Poster presentations
P10. Modeling the Myxomycetes - A Proposal for the Teaching and Popularization of Science– Contact: Solange Xavier-Santos (solxav@yahoo.com.br)

P11. Dynamization of internationalization agreements in institutions of Higher Education: the case of collaboration between the University of Costa Rica and the University of Antioquia in favor of Myxomycetes biodiversity knowledge in Colombia– Contact: Angie Natalie Díaz Ruíz (natalie.diaz@udea.edu.co)

P12. The most well-studied local myxomycete biotas in Russia and Kazakhstan: present state and future directions – Contact: Yuri Novozhilov (yurinovozhilov@gmail.com)

P13. Microcosm of myxomycetes (Special exhibit) – Contact: Elizaveta Shchepina (storminka@mail.ru)

P14. Myxomycetes recovered from moist chamber cultures of plant remains from 50 families – Contact: Carlos Lado (lado@rjb.csic.es)

P15. Diversity of the Myxobiota from Lagunas de Montebello National Park, Chiapas, Mexico – Contact: María Mercedes Rodríguez-Palma (mrodriguezpalma@hotmail.com)

P16. Are myxomycetes affected by urban centers? Preliminary evidence using traditional isolation methods – Contact: Randall Valverde (nototriton@hotmail.com)

P17. Evaluating the moist chamber protocol for myxomycetes in three different forest types in Costa Rica – Contact: Ricardo Morales (ricardo.morales@ues.edu.sv)

14:00 - Session 4 Tropical Myxomycetes
Chair (Dr. Solange Xavier-Santos)

O16. Proposal of an online monograph of the Neotropical Myxomycetes – Contact: Carlos Lado (lado@rjb.csic.es)

O17. Myxomycetes of tropical forests of Vietnam: what moist chamber cultures can reveal – Contact: Yuri Novozhilov (yurinovozhilov@gmail.com)

O18. First reports of Fimicolous Myxomycetes from Brazilian Cerrado and Pantanal Biomes – Contact: Solange Xavier-Santos (solxav@yahoo.com.br)

O19. Ten years in Vietnam - observations on diversity and ecology of myxomycetes in Vietnam – Contact: Yuri Novozhilov (yurinovozhilov@gmail.com)

O20. Myxomycetes from Africa, an update – Contact: Myriam de Haan (myriam.dehaan@plantentuinmeise.be)

16:30 -Special Lecture
S2. A slime-molder's swan song – the work that is left to be done (Dr. Fred Spiegel, fspiegel@uark.edu) Participation was cancelled

18:00 -Cultural dinner

Thursday, February 27, 2020

Field Trip to La Marta Wildlife Refuge

During this day, the group will visit La Marta Wildlife Refuge, located near the town of Pejibaye, about 23 km southwest of Turrialba. This place encompasses a large area of premontane wet forest on the Caribbean side of Costa Rica. Based on previous data, the ICSEM10 group will carry out the first myxomycete survey in this area. A list of morphospecies will be generated as a return product to the station and in order to contribute to the knowledge on Costa Rican myxomycetes.

What to expect and what is La Marta?

The elevation varies between 750 and 1950 meters above the sea. The temperature fluctuates between 18 and 27 degrees Celsius. The relative humidity is high, averaging 90 %. Due to weather and topographical conditions a high number of microhabitats are present. Approximately 40% of the territory is primary forest and the other 60% is covered by secondary forest in various stages of natural regeneration.

The Wildlife Refuge is a protected area of approximately 1518 hectares, located in the Jimenez Canton of the Cartago Province. It is one of the most important forests detaining the progress of the spontaneous agricultural colonization in the western slopes of the Cordillera de Talamanca. It is surrounded by five rural communities whose main activities are subsistence farming and ranching .

It is also the gateway to the La Amistad and Tapantí/Death Massif National Parks, two of the 12 protected areas that make up the large block of territory incorporated into the La Amistad Biosphere Reserve and Natural World Heritage Site, nominations awarded to the Cordillera de Talamanca by UNESCO.

Friday, February 28, 2020

8:30 - Session 5 Myxomycete Morphology and Biology
Chair (Dr. Dmitry Leontyev)

O21. Secondary capillitium, tertiary stalk and false columella – Contact: Dmitry Leontyev (alwisiamorula@gmail.com)

O22. Nivicolous myxomycetes: will the same ribotypes reoccur every year? – Contact: Nikki H.A. Dagamac (nhadagamac@gmail.com)

O23. Study on the selection of environmental bacteria by plasmodia – Participation was cancelled

O24. Developmental characters and associated symbiont bacterial diversity in essential life cycle stages of one dictyostelids *Heterostelium colligatum* – Participation was cancelled

O6. Automated image analysis in determining the spore size of dark-spore myxomycetes – Contact: Jan Woyzichovski (jan.woyzichovski@uni-greifswald.de)

O30. Some hypothesis about columella in the genus *Didymium*. Contact: Renato Cainelli (myxocare@gmail.com)

11:00 - Session 6 (Part 1) Myxomycete Biogeography
Chair (Dr. Nikki Dagamac)

O25. Putting slimies on a predictive map: Applying species distribution models on myxomycete research – Contact: Nikki H.A. Dagamac (nhadagamac@gmail.com)

O26. “Lowland nivicolous” myxomycetes fruitify more regularly than we think? – Contact: Iryna Yatsiuk (yatsiuk@ut.ee)

O27. Myxomycetes associated with *Polylepis* forests "Queñua" in the Peruvian Andes – Contact: Italo Treviño Zevallos (ifrant01@gmail.com)

14:00 - Session 6 (Part 2) Myxomycete Biogeography

O28. Black Sugarloaf, northern Tasmania – a myxomycete hotspot? – Contact: Sarah Lloyd (sarahlloyd@iprimus.com.au)

O29. Contribution of the MYXOTROPIC Project to the knowledge of Neotropical Myxomycetes – Contact: Carlos Lado (lado@rjb.csic.es)

15:30 - Closing Lecture

S3. From La Malinche Volcano to Tierra del Fuego: Thirty years looking for myxos in Latin America (Dr. Arturo Estrada-Torres, arturomixo@hotmail.com)

16:30 - Closing ceremony and selection of ICSEM 11 location

Abstracts

All abstracts (including those from people who cancelled) were included. Due to a virus epidemic in China, our Chinese colleagues could not come to the ICSEM10 and due to health reasons (personal or relatives) some of our friends had to cancel in the weeks before the event. We deeply regret these issues and wanted to include the interesting contributions that could not be presented.

Special Lectures

S1. On the track of the elusive slime mold

Steven L. Stephenson[a]

[a]Department of Biological Sciences, University of Arkansas, Fayetteville, Arkansas 72701

In the fall of 1974, while taking a mycology course at Virginia Tech taught by Dr. Orson Miller, the author was first introduced to the slime molds (or myxomycetes, as they are known to people who collect and study these organisms). He began noticing myxomycetes in the field and soon discovered that their ecology was an understudied subject. With his background in forest ecology (the research the author carried out for both his M.S. and Ph.D. degrees involved studying the upland forests of the Central Appalachians), he was well prepared to undertake studies of myxomycete ecology. In the summer of 1982, with the support provided by a post-doc from the University of Virginia Mountain Lake Biological Station, a series of such studies began that would extend over the next four decades. These studies were carried out in a number of different areas of the world, including Alaska, Argentina, Australia, Costa Rica, Ecuador, India, Kenya, Mexico, New Zealand, northwestern Montana, Puerto Rico, subantarctic Macquarie Island and Thailand. The primary emphasis of these studies has been directed towards developing a better understanding of the distribution and ecology of myxomycetes in terrestrial ecosystems. These efforts have been funded in part by grants from the National Science Foundation, the National Geographic Society and a number of other institutions and agencies. Moreover, over his career, the author has been assisted in his studies by a considerable number of individuals. This presentation represents an overview of the journey the author has taken since he first became aware of the myxomycetes.

Keywords: biodiversity, ecology, myxomycetes, terrestrial ecosystems

S2. A slime-molder's swan song – the work that is left to be done

Frederick W. Spiegel[a]

[a]Department of Biological Sciences, University of Arkansas, Fayetteville, AR 72701, USA

As this is my last year as a formal academic researcher interested in mycetozoan members of Amoebozoa, I would like to suggest to the younger members of our community some areas of research that could be valuable for the discipline of Biology as a whole. The life repertoires of mycetozoan amoebozoans are among the most complex found in Amoebozoa. They involve fruiting in all cases, and the trophic stages can involve a number or different kinds of amoebae and/or amoeboflagellates as well as a number of kinds of cysts. The most complex life repertoires involve a complex alternation between an amoeboflagellate and an obligate amoeba with sex being a part of the scene. We now know that the amoebozoan slime molds are not a monophyletic group; rather, they are scattered throughout the amoebozoan Tree of Life in both major branches. However, the most common method of fruiting, sporocarpy, is unique to Amoebozoan among eukaryotes. We have suggested that this type of life repertoire could be the ancestral state for Amoebozoa. Were that actually the case, this would mean that the most common pattern of evolution in Amoebozoa is from complexity to simplicity of structure and life repertoire. While this is an interesting hypothesis, it has yet to be rigorously tested. This presentation will focus on several aspects of the mycetozoans that need to be fully examined in order to test the hypothesis, and it will become clear that a rigorous approach must include both classical and next-generation approaches to biological research.

Key words: Amoebozoan mycetozoans, classical biology, next-generation biology, sporocarpy, life repertoires

S3. From La Malinche Volcano to Tierra del Fuego: Thirty years looking for myxos in Latin America

Arturo Estrada-Torres[a], Carlos Lado[b], Diana Wrigley de Basanta[b]

[a] Centro Tlaxcala de Biología de la Conducta, Universidad Autónoma de Tlaxcala, Tlaxcala, 90,070, Mexico.
[b] Real Jardín Botánico, CSIC, Plaza de Murillo 2, 28014 Madrid, Spain.

Latin America is in one of the most biodiverse regions in the world, with six of the so-called mega-diverse countries: Brazil, Colombia, Ecuador. México, Perú and Venezuela. Its location includes three major biogeographic regions and all the main ecosystems of the world, from the evergreen Amazonian forests to the coniferous forests in the high mountains of Mexico, and from the driest hot deserts on the planet in northern Chile to the cold arid areas of Patagonia. Latin America is home of infinity of emblematic lineages that have borne and diversified in their lands, such as cacti, agaves, bromeliads and hummingbirds, among many others, that contribute to their biological attractiveness. Despite its high biological diversity, the first record of a myxomycete was made until the early nineteenth century, and since this date to 1976, year in which Farr published her monograph in the Flora Neotropica series, 250 species were recorded from this geographic area. In 1988, our work group began its explorations in this important geographical area. In the beginning, the fir forest of La Malinche National Park, in central Mexico, was its objective, registering more than 170 species that make it currently recognized as one of the world hot spots of myxomycete diversity. In the coming years, this action extended to other areas of Mexico, exploring 20 of its 32 states. Later, this exploration was extended to Argentina, Chile and Peru, emphasizing the study of the diversity of myxomycetes in arid environments, in addition to the fact that, in collaboration with colleagues from other institutions, we also made excursions to some areas of Brazil, Costa Rica, Cuba, Ecuador, Guatemala and Honduras. With thousands of kilometers traveled, hundreds of field collections and dozens of moist chambers of various substrates, our team has contributed substantially to the knowledge of Latin American myxomycetes. The main achievements of our work are: a) The enrichment of scientific collections with material of great documentary value mainly in Spain and Mexico, but also in the United States and Peru; b) The substantial increase in knowledge of the myxobiotas of the countries visited, mainly Argentina, Chile, Ecuador, Mexico and Peru; c) The description of twenty-seven species from the region, in several genera; d) A better understanding of the diversity, systematics, ecology and distribution of myxomycetes in arid zone environments; e) The clarification of the identity of the enigmatic genus *Schenella*; and f) The discovery of unique substrates for the development of myxomycetes, such as lianas and the remains of cushion-like plants from the cold regions of the Andes. Undoubtedly, much more needs to be done in this incredibly diverse region of the planet, but the research carried out so far is an example that teamwork will always be more productive and enriching.

Keywords: biodiversity, distribution, Neotropics, teamwork

Posters

P1. New records of myxomycetes for Colombia

Alejandra Arenas Taborda[a], Angie Natalie Díaz Ruíz[a], María Carolina García Chaves[a], Carlos Rojas[b]

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[b]Engineering Research Institute and Department of Biosystems Engineering, University of Costa Rica, San Pedro de Montes de Oca, Costa Rica

Microbial biodiversity has become increasingly interesting responding to the recognition of the fundamental role of microorganisms in the biogeochemical balance of ecosystems. However, a great variety of environments whose micro-biodiversity has been very little studied exist in the Neotropics. The low representativeness of research on range records of myxomycetes in this region, related to other latitudes, constitutes a good example of it. Therefore, the current study focused to contribute to the description of the pluralism of this group of microorganisms in Colombia. For so doing, two collections were made, one in the coastal habitat in Cartagena, and another in an urban system in Medellín. In Cartagena, dried leaves were collected in several city parks, which were incubated for a month in wet chambers to promote the development of visible myxomycetes structures. In Medellín, the sampling was carried out in green areas of the University of Antioquia, by collecting plant material in which myxomycetes structures were observed. The specimens obtained from both collections were taxonomically identified from the microscopic observation of the fruiting body. From the samples of Cartagena, 7 specimens were found; and, from the collection made in Medellín, a total of 13 specimens were obtained, of which 4 make up new reports for Colombia (*Comatricha nigra, Perichaena vermicularis, Cribraria violacea* y *Arcyria minuta)*. Taking into account that new species were found with a low sampling effort in this study, it can be stated that biodiversity of myxomycetes in Colombia has been underestimated. It is thus necessary to move forward in this line of research to cop the knowledge gap about the forms of these microorganisms in the Neotropics.

Keywords: biodiversity, myxomycetes, Neotropics, Colombia

P2. Do slime molds respond to sound?

Monica S. Policina[a], Thomas Edison E. dela Cruz[a]

[a]The Graduate School and Fungal Biodiversity, Ecogenomics, and Systematics Group, Research Center for the Natural and Applied Sciences, University of Santo Tomas, España Blvd. 1008 Manila, Philippines

Sound stimulation has been previously reported to influence growth and behavior of animals and plants. Studies also showed the effects of sound including noise to microorganisms such as bacteria and microalgae. Does sound also stimulate or retard the growth of myxomycetes? In this study, we tested whether slime molds just like any other organisms respond to sound, particularly to static noise. We initially cultured the plasmodia of the model myxomycete, *Physarum polycephalum*, on 1.5% water agar (WA-O) supplemented with 2% (w/v) powdered oatmeal. Plasmodial fronts were cut as a 6-mm diameter agar block and placed at the center of WA-O (12 plates per sound treatment). Culture plates were then placed in a sound chamber setup with speakers at opposite ends. *P. polycephalum* was then continuously exposed to the static sound (or noise) for 3 days. A similar set-up in the sound chamber without any sound served as control. Plasmodial growth was observed and photographed every 6 hours and then, the plasmodial front was measured after 24 hours. Generally, we observed a faster migration of plasmodia in the absence of noise. An average distance of 7.708 mm was measured when *P. polycephalum* was exposed to the static noise. In contrast, the plasmodia travelled an average distance of 9.984 mm in the absence of sound. We are currently testing the responses of *P. polycephalum* to different types of sound (or music). Our study highlighted the possible effects of sound, particularly noise, to the growth and behavior of myxomycetes.

Keywords: myxomycetes, noise pollution, plasmodial growth, sound stimulation

P3. Incidence of Myxomycetes in the air of *Valle de Aburra*, Colombia

Janeth Carolina Rincón[a], María Carolina García Chaves[a], Carlos Rojas[b]

[a]School of Microbiology, University of Antioquia. Medellín, Colombia
[b]Engineering Research Institute and Department of Biosystems Engineering, University of Costa Rica, San Pedro de Montes de Oca, Costa Rica

During the last years, the city of Medellín, located in the *Valle de Aburrá* on the Central Mountain range from Los Andes, has suffered significant air quality problems. Factors related to the topography of the valley, its meteorological characteristics, and the increase in the emission of pollutants favor the accumulation of pollutants in the air of the metropolitan area. This implies that a great number and diversity of particles are expected to be suspended in the air and dispersed by the winds. However, most air studies in the metropolitan area have focused on monitoring the concentration of particulate matter (PM 2.5), because of the risk that this type of contaminants represents for human health. Consequently, the dynamics of transport, dispersion and deposition of biotic particles in the air of Medellín are unknown. Therefore, in this work we proposed to describe the movement of Myxomycetes spores in the *Valle de Aburrá* caused by transport. To meet this objective, 70 air traps were exposed for 3 months at 3 points along the valley (north, center and south) and another 24 at a rural point outside the urban area. In order to capture the spores carried by the wind that blows in different directions, groups of 6 traps were placed towards the 4 cardinal points. After the exposure, the content of the traps were incubated in wet chambers for 4 months. These cameras were monitored every 15 days to record the presence of Myxomycetes and material with fruiting bodies was collected for identification. A higher incidence of Myxomycetes was found in the traps located on the north front for one of the sampling points in the urban area and, on the east front for the rural point; which corresponds to main wind direction at these two points. The above indicates that propagules are transported following the pattern of winds. However, in the other two points of the urban area, equal incidence values were found on the 4 fronts. This could indicate that at these points the concentration of propagules is as high that it confuses the wind pattern. This hypothesis makes sense if one takes into account that the wind in the *Valle de Aburrá* has predominantly a north-south direction, and therefore there is usually a higher concentration of pollutants in the southern area of the valley, where these 2 points of sampling were located. With this work we are providing the first data that demonstrate the presence of Myxomycetes in the air of the metropolitan area of the valley and, we present the first evidence that its propagules are transported by mean air flow along the valley.

Keywords: air, Medellín, spores, transport, wind pattern

P4. A new *Perichaena* foliicolous species (Myxomycetes) from *Quercus* forests and cloud forests of Mexico

María Mercedes Rodríguez Palma[a,c], Gabriel Moreno Horcajada[b], Misael García Flores[c], Angélica Romero Rodríguez[d]

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The genus *Perichaena* (Trichiales-Myxomycetes) was originally proposed by Fries in 1817. It is represented by both sporocarpic and plasmodiocarpic forms, with thick persistent peridium, and spores from yellow to reddish brown in mass. Most species have a well-developed capillitium formed by roughened tubes, with warts, spines or rings and totally lack spiral bands. Some species have a wide distribution, while others are only known from the type locality. During of the studies on myxobiota in different localities in Mexico, a stipitate species of the genus *Perichaena* was detected both in the field and in moist chamber cultures, growing on leaves of *Quercus rugosa*, in the state of Tlaxcala and in a cloud forest in the state of Chiapas. Initially, it was considered that the specimens corresponded with some species of the genus *Trichia* because of their macromorphological appearance, however, in a quick review of the micromorphological characters, particularly of the capillitium, it could be detected that it corresponded with a species of the genus *Perichaena* not yet described for science. The characterization of *Perichaena* sp. was performed considering macro and micromorphological structures through clear field microscopy and scanning electron microscopy (SEM). It was compared with specimens of nearby species deposited in the TLXM herbarium of the Tlaxcala University and the AH herbarium of the Alcalá de Henares, University, Madrid, Spain. *Perichaena* sp. grows on the underside of leaves of *Quercus rugosa* and in litter. It has been collected in 2017, 2018 and 2019. It is characterized by stipitated sporocarps, with blackish stipe, internal peridium with thick ridges and a low-marked low reticulum and by the reticulated capillitium with few warts. Morphological characters were constantly present in both specimens obtained in the field as well as those in the moist chamber. At least other six *Perichaena* species with a well developed stipe have been described, however, all of them show morphological characters that differ from the species found in this study. The validity of the new species should be complemented with a molecular phylogenetic analysis as suggested in recent studies.

Keywords: eumycetozoa, moist chambers, taxonomy

P5. Long-term evaluation of myxomycetes in a single location: the case of FEIMA in Costa Rica

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Few myxomycete studies have evaluated ecological patterns in one single location using a strong collecting effort. During two complete years, myxomycete fruiting bodies were looked for in field conditions on a monthly basis in selected locations within a 28-hectare moist premontane tropical forest patch in Costa Rica. An effort of 2880 minutes of field work, equivalent to 48 hours, were used for that task. Additionally, 864 samples for moist chamber cultures were taken to the laboratory for isolation. A total of 58 species, or approximately 6% of the world's morphological biodiversity, was recorded in the studied place. Most species did not show any type of “phenological” pattern and were recorded at different times. The only species that was recorded in every single month of sampling was *Hemitrichia calyculata*. *Arcyria denudata* and *Ceratiomyxa fruticulosa* were recorded most of the time. Both patterns of species richness and taxonomic diversity varied over time but showed low values during the middle part of the year, particularly around July. The drier months, between December and April, showed the highest values. When the data was analyzed using a series of environmental and structural parameters associated with the forest, some interesting patterns of fructification were observed. This type of long-term studies on myxomycetes are important to understand the effect of external and internal fluctuations on the forest and how their relationship may ultimately affect fructification patterns and ecological strategies on myxomycetes.

Keywords: climate change, field sampling, microbial ecology, monitoring

P6. Can the location of the lab affect moist chamber-based data?

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The use of moist chambers to generate data on myxomycetes has been very common during recent decades. Despite several shortcomings at the taxonomic level due its inherent bias on morphological information, the usefulness of this technique for the generation of data from most parts of the world is still recognized. However, few studies have critically analyzed the effect of laboratory location on the results obtained using this technique. In the present study, three sets of tropical substrates were collected and divided in two twin subsets that were placed in moist chambers in two laboratories separated by one mountain. Due incident winds and moisture, one side of the mountain was moister and cooler than the other. Results showed that general ecological patterns such as diversity or species richness were similar among datasets, but composition of species was slightly different. Some species such as *Arcyria afroalpina*, *Didymium clavus*, *Clastoderma debaryanum* and *Physarum superbum* were only recorded in one laboratory. The internal temperature of the moist chamber was higher on the dryer side of the mountain but both pH and humidity were similar between the two sets. These results show that even though the two laboratories yielded highly comparable data, external factors such as topography and climate may play a role in the generation of myxomycete information using moist chambers. This type of information could be useful to understand species sensitivity to external conditions when forming fruiting bodies and relevant in the context of climate change monitoring.

Keywords: bias, geography, methodology, standardization

[P7. Genetic structure of populations of the nivicolous myxomycete *Physarum albescens* at a large geographical scale]

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We investigated genetic structure of populations of the nivicolous myxomycete *Physarum albescens* by sequencing field collections of fruit bodies from different mountain systems of Northern Hemisphere for three independent genetic markers (18S RNA, EF1A, COI). For several regions of Eurasia, the occurrence data of environmental 18S rRNA gene sequences from DNA metabarcoding studies complement the sporocarp-based data. Despite the large genetic diversity discovered, all studied specimens form a monophyletic clade and possess a short spliceosomal intron in the first half of EF1A gene that is absent in all other sequenced species of Physarales and Stemonitidales. However, the structure of the phylogeny and the observed recombination pattern of three independently inherited gene markers can be best explained by presence of at least 17 cryptic biospecies within *Ph. albescens*. Most of the 17 putative biospecies have a limited geographic distribution and occur only in one or two studied regions, and in most of the studied regions at least two of them coexist. Some of them can be clearly separated into biospecies with ‘boreal’ or ‘southern’ ranges. In addition, the results of genotyping of 97 specimens from several most abundant biospecies from different regions will be discussed with a special accent on the question of clonal reproduction in natural populations of myxomycetes.The authors are grateful to Marianne Meyer, Paulina Janik, Yuka Yajima, Renato Cainelli and other researchers for providing specimens and photos. We acknowledge support from the Russian Foundation of Basic Research (18-04-01232 A) and the German Research Council (DFG: SCHN1080/2-1, RTG 2010).

Keywords: biogeography, cryptic speciation, DNA barcoding, genotyping, myxomycetes

P8. Myxomycetes collected at Tanbara Plateau, Gunma Prefecture, Japan

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The Tanbara Plateau is located in Kamihotchi-machi, near the city of Numata and oscillates between 1150 and 1600 m of elevation. This plateau is about 900 ha in dimension, has a cold temperate climate and its forest is composed primarily by beech trees. After an investigation was carried out in the summer of July 2018, we have confirmed 42 species of myxomycetes within 14 genera for this area (including the genus *Ceratiomyxa*). All vouchers were deposited in the Gunma Museum of Natural History and we have confirmed that in a previous expedition in 1995, 59 species within 15 genera were collected. We would like to thank Tomoko Anezaki and Satoshi Ito for providing access to this area for collection. We also acknowledge the guidance of the Society for Nature Appreciation of Tonenumata and thank the identification provided by Yukinori Yamamoto and Jun Matsumoto.

Keywords: Japan, myxomycetes, Tanbara, *Ursus thibetanus*

P9. The diversity of myxomycetes in two forests of the Lesser Khinggan Mountains, China

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Myxomycetes are widely distributed in forest ecosystems and play an important role in nutrient cycling. The diversity and distribution of myxomycetes in two forests of the Lesser Khinggan Mountains, China were examined in Tangwanghexing'anshilin Forest Park and Shengshan National Nature Reserve. A total of 248 samples of myxomycetes were collected and identified to 44 species belonging to 17 genera of eight families in four orders based on morphological characteristics. Ten new species were recorded in Heilongjiang Province, such as *Craterium dictyosporum*, *Physarum album* and *Reticularia splendens* var. *jurana*. The species diversity of myxomycetes was higher in Tangwanghexing'anshilin Forest Park (36 species) than in Shengshan National Nature Reserve (25 species). Among the 44 species, 17 species were found in both sites and the composition similarity (CS) was 55.7%. *Physarum viride* was the most dominant species in mixed coniferous and broad-leaved forests. *Hemitrichia serpula* was the most dominant species in *Pinus koraiensis* forest. This study suggests that vegetation type has an important influence on the species composition and diversity of myxomycetes.

Keywords: ecology, distribution, temperate forests

P10. Modeling the Myxomycetes - A Proposal for the Teaching and Popularization of Science

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Although textbooks remain the main pedagogical resource used by science teachers in basic education, didactic models can be an additional resource at different levels of education, providing more meaningful learning, especially in the case of abstract and difficult to understand content in Science Teaching. Models have also been used to promote the popularization and popularization of science, a topic that has received more interest in recent years in Brazil. However, much knowledge remains restricted to the scientific community. Such as knowledge about myxomycetes (Eumycetozoa, Amoebozoa), a group of living beings found in a wide diversity of habitats containing decaying organic matter, including residential yards and public parks. However, due to the ignorance of the group by the population, including many educators, the myxomycetes are still very neglected in Basic Education. In this sense, we developed didactic models, based on alternative materials, that represented species of myxomycetes common in Central Brazil and provide the tutorial of this procedure in digital format (video) in social media, including educational sites. Three species of myxomycetes (Hemitrichia calyculata, Diachea leucopodia and Diderma effusum) that have typical sporocarps and can be found in natural and anthropized areas were modeled. Images and descriptions of the species were researched in order to verify morphology details to support the development of the models. Molds were made of cardboard, which were used to make the models, which were sewn into fabric (felt) and filled with recycled silicone foam. The finishing was done using paint, hot glue and glitter. The model also included the natural substrate of these species, a wood trunk, which was characterized using Pinus spp bark. and mosses, to attribute reality to form. The modeling steps were filmed and compiled into a do-it-yourself step-by-step video. By providing models and step-by-step modeling of these living beings in digital (video) format on social media, we hope to contribute to the popularization of knowledge about these living beings in society, as well as providing a teaching tool with several possibilities for use in science education.

Keywords: didactic model, myxomycetes, science teaching

P11. Dynamization of internationalization agreements in institutions of Higher Education: the case of collaboration between the University of Costa Rica and the University of Antioquia in favor of Myxomycetes biodiversity knowledge in Colombia

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Internationalization processes in higher education institutions have emerged in response to globalization and are an excellent strategy to improve the quality of education. The University of Antioquia (UdeA) intend "to project the Institution internationally, through agreements and exchanges of scientific, academic and cultural collaboration, to international community organizations and foreign universities". Consequently, the International Relations Department signs international agreements with universities and other institutions on an ongoing basis. However, in many cases, initiatives for the execution of activities that promote the collaboration of already signed agreements are lacking. Therefore, with this poster we seek to illustrate the way in which simple and low-cost academic strategies can make these agreements dynamic. An example of this are the activities that have been developed within the framework of an agreement signed between UdeA and the University of Costa Rica (UCR). The processes started in 2018 with a talk given to motivate students and professors of the UdeA to propose and execute projects on the diversity, abundance and distribution of Myxomycetes in Colombia. As a product of this first interaction, a student from UdeA started to work on her proposal about the incidence of Myxomycetes in the air of Medellín, thus achieving the reactivation of the agreement between UdeA and UCR. On a second phase, a group of students assembled and set-up an experiment with air traps for Myxomycetes in the city of Medellín. Then in 2019, students and teachers of Biology and Microbiology at UdeA attended a 3-day workshop to discuss theoretical and practical aspects in the study of Myxomycetes. Other activities planned within the agreement include the participation of a professor from UCR in the Medellín Microbial Meeting event and, the signing of a specific agreement in order to establish a project that aims to analyze the potential of Myxomycetes as biological indicators of urban pollution processes. This experience shows that the development of simple activities and the transfer of knowledge between institutions of higher education allow the dynamization of agreements, expand the themes and objects of study of research groups, close gaps in scientific communication and promote the participation of students in research projects of global interest.

Keywords: agreement, higher education, international cooperation, myxomycetes, UCR, UdeA

P12. The most well-studied local myxomycete biotas in Russia and Kazakhstan: present state and future directions

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To date, about 450 morphospecies of myxomycetes of 53 genera have been registered in Russia and former Soviet republics. The last two decades have seen a rapid increase in the number of publications on the assessment of diversity, distribution and ecology of myxomycetes in various Russian regions, representing most Eurasian biomes. However, the degree of completeness of these surveys varies greatly depending on the methods of collecting sporocarps (field collections or/and specimens obtained from moist chamber cultures), the intensity of research, the time of collection, the experience and professional competence of collectors. To select the most well-studied regions we applied the following criteria: 1) intensive field studies of myxomycetes conducted for at least 2-3 years in the same area at different times of the year; 2) all occurrences of fruit bodies registered during the field surveys; 3) field collections accompanied by moist chamber cultures; 4) species coverage at least 75% (Chao1 index). Based on these criteria, we have selected a number of data sets on the species diversity of myxomycetes of various biomes in Russia and Kazakhstan (some of them are listed below), where we have conducted intensive research over the past 20 years. Arctic mountain tundra and forest tundra: Khibine Mts., Kola Peninsula (32 species, including nivicolous). Subalpine and alpine communities of North Caucasus, Teberda Biosphere reserve (39 species, including nivicolous). North taiga: Khibine Mts. and Laplandskiy Biosphere reserve (91 species). South lowland taiga, Central Forest Biosphere reserve, Tver' region (176 species). South continental mountain taiga, Eastern Sayan mountain ridge, Siberia (123 species). Dry pine forests of south Altay (72 species). Dark wet taiga and mixed forests of Altay Mts. (159 species). Broad-leaved and mixed forests of North Caucasus, Teberda Biosphere reserve (134 species). Broad-leaved and mixed forests of Far East, Sikhote-Alin Biosphere reserve, Kedrovaya Pad' reserve (209 species). Riparian broad-leaved forests of Volga-Akhtuba lowland, Volgograd region (160 species). Riparian willow forests of south Siberia (70 species). Steppes: Altay Kray, Siberia (45 species), Caspian lowland, Russia (99 species). Deserts: Caspian lowland, Russia (50 species). In addition, intensive research was carried out in steppes (103 species) and deserts of Kazakhstan (48 species). Despite this, the knowledge about myxomycetes of this part of Eurasia is still very far from being complete. Molecular phylogenetic studies and DNA metabarcoding have made significant changes in the taxonomy of myxomycetes and revealed a greater number of closely related (cryptic) species. This update will inform about the opportunities, challenges and future directions of studies exploring ecology and diversity of myxomycetes in Russia. We acknowledge support from the Russian Foundation of Basic Research (18-04-01232 A), and the program of the Komarov Botanical Institute RAS (AAAA-A19-119020890079-6) and the German Research Council (DFG: SCHN1080/2-1, RTG 2010).

Keywords: biodiversity, completeness, herbaria, species inventory

P13. Microcosm of myxomycetes

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On the ICSEM 10 I would like to present a series of paintings showing a journey into the microcosm of myxomycetes. What if a person had an opportunity to be as tiny as a springtail and look at the myxomycete colonies not down from the top but up from the bottom?
In this series I want to emphasize the monumentality and beauty of the world of myxomycetes, depict them as landscapes performed in the technique of digital painting printed on canvas. The series will show the selection of species from different geographical locations and ecological groups (e.g., nivicolous species, tropical species, Kamchatka species). I would like to thank my husband Oleg Shchepin for introducing me into the amazing world of myxomycetes.

Keywords: art, digital painting, myxomycetes

P14. Myxomycetes recovered from moist chamber cultures of plant remains from 50 families

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The results of moist chamber cultures of plant remains from over 170 plant species in more than 50 families have been examined for patterns in frequency of appearance, productivity, substrate preference, pH tolerance or other factors affecting the recovery of myxomycetes. The benefit of the moist chamber culture technique is that it is standardized in terms of size of sample, collection and preparation technique and so many variables of the cultures are controlled, and this enables a more direct analysis than looking at mixed data sets or field collections only. The technique also eliminates the bias of ephemerality that affects field collecting and allows detection of many minute species. Results of 1600 cultures of plant remains from 10 countries on 4 continents have been scrutinized and comments and conclusions will be presented in this contribution. This work would not have been possible without the support of the Myxotropic Project I-VI [REN2002-00445/GLO to PGC2018-094660-B-I00 (MCIU/AEI/FEDER, UE)] http://www.myxotropic org

Keywords: culturing, standardization, techniques

P15. Diversity of the Myxobiota from Lagunas de Montebello National Park, Chiapas, Mexico

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Although studies of myxomycetes in Mexico have increased in recent years, most have focused on conducting inventories of species and just a few of them have addressed ecological aspects, to understanding the diversity patterns of these organisms, especially in the Mexican Neotropic. The objective of this work was to evaluate and compare the diversity patterns in myxomycete communities developing in cloud and *Pinus-Quercus* forests from Lagunas de Montebello National Park, Chiapas (LMNP). To carry out the study, three plots of 10 x10 m were established in the sites near the lakes: Montebello, Pojoj, San Rafael and Cinco Lagos. A directed and intensive sampling of reproductive structures in the field was carried out. To complement the sampling, six different substrates were collected, in order to obtain myxomycetes in the laboratory, using the moist chamber (MC) technique. The specimens obtained were identified with the help of specialized taxonomic keys. Myxomycete communities were characterized by the LMNP and for each study site. The ecological analysis was carried out through the evaluation of, percentage of positive moist chambers, richness, abundance, diversity of species and the species/genus ratio (E/G) for each substrate and locality. A comparative analysis was performed between the myxomycete communities, present in each sampling site through the ecological variables obtained. A total of 67 species and one variety were found, belonging to 21 genera, nine families and six orders. 44 species were collected in the field and 51 in MC. 27 species are registered for the first time to Chiapas and to LMNP, and four are new records to Mexico. With the present study, the number of species for Chiapas, amounts to 131, placing the state in fourth place about myxomycetes richness in the country. The species and order composition of myxomycetes was different in each locality, establishing particular communities in each plant association. *Arcyria cinerea*, *Hemitrichia serpula*, and *H.calyculata* were the most abundant species and were shared in all localities. The species richness values are very similar in the different lakes, however, the abundance values were higher in San Rafael. The highest diversity corresponds to the Montebello area. Finally, the similarity value obtained showed that the comparative environments, present a particular and distinctive myxobiota, however, the similarity degree between lakes, had a geographical influence.

Keywords: biodiversity, myxomycetes, protected natural areas

P16. Are myxomycetes affected by urban centers? Preliminary evidence using traditional isolation methods

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Most myxomycete field research takes place in natural areas and urban centers are often not considered for ecological studies. Using three radial schemes around urban centers in Costa Rica, a series of ground litter samples was collected and taken to the laboratory for moist chamber isolation. These samples came from the urban center and three points at 2.5 and 5 times the distance of such center and the edge of the respective urban area. Results showed that urban area size, topographical situation and sampling site characteristics were more important to explain results than landscape and climatic variables. Moreover, these results demonstrated that urban myxomycete monitoring could be useful in the context of climate change.

Keywords: cities, landscape, urban ecology

P17. Evaluating the moist chamber protocol for myxomycetes in three different forest types in Costa Rica

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The extended region of Guanacaste in Costa Rica is represented by dry, moist and wet tropical forests. The last two are more typical of higher elevations than the former. In order to test the viability and usefulness of the moist chamber technique in a precipitation gradient, three areas were selected within Guanacaste. A series of 720 substrate samples represented by bark and ground litter were collected for this study, and during the moist chamber laboratory process, both environmental and microhabitat variables were determined. For the first, temperature, air humidity, light and barometric pressure of the laboratory were obtained; whereas humidity, temperature and pH were obtained at regular intervals inside the moist chambers. Results showed that the “typical” non-controlled laboratory conditions in Costa Rica´s central valley where close to 23.5°C, 74% humidity, 160 lux and 29.8 bars. The “typical” conditions of moist chambers were 20.7°C, 31.8% humidity and a pH around 6.3. With those conditions, samples from the driest forest yielded more species and showed more activity than those from the moist and wet forests. It is interesting to note the high laboratory humidity and the very mild temperature during the moist chamber process and the observation that cultures dehydrate slower than in laboratories with more controlled conditions. It is thought that those two factors along with the relative positioning of the cultures within the laboratory space may have an effect on results. In this manner, twin samples in different laboratories may yield different results. Similar evaluations on other laboratories would be useful to test the latter idea.

Keywords: laboratory, moist chamber cultures, results, standardization

Oral Contributions

O1. The evolutionary history of the order Trichiales in a new multi-gene phylogenetic framework

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The formation of spore-bearing fruiting bodies is the most noteworthy condition of Myxomycetes and what sets them apart from their closest ameboid relatives. The fruiting bodies and their features are the basis of the study of taxonomy in Myxomycetes. Based on these features several evolutionary hypotheses have been proposed for this group of organisms, resulting in distinct systematic classifications over time. The recent introduction of molecular tools in the systematics of Myxomycetes has brought to light totally unexpected phylogenetic relationships among the species. However, these pioneer phylogenetic studies lack an exhaustive taxa sampling and so is reflected in their conclusions. This is especially true for the order Trichiales. While this is the second richest group among the Myxomycetes, with around 200 currently accepted species, there is a really limited number of species for which molecular information is available. The aim of this study is to deep into the evolutionary relationships of the species of the order Trichiales, by increasing both the taxa sampling in the phylogeny and the number of analyzed genetic regions. A total of 60 species belonging to 12 of the 15 recognized genera in the order Trichiales are analyzed, covering the morphological variability of the order. In addition to the usually employed genetic regions for Myxomycetes, i.e. the nuclear 18S ribosomal DNA and the eukaryotic translation elongation factor 1 alpha 1, two different mitochondrial regions were also explored: the 12S ribosomal DNA (small subunit of the mitochondrial ribosome) and the cytochrome c oxidase I. Our results show major discrepancies between this multi-gene phylogeny and the current morphological-based classification. Some of the previously reported disagreements are herein also obtained, such as the position of the genus *Dictydiaethalium* within the Trichiales, questioning the consistency of the order Liceales. Additionally most of the represented genera are not recovered as monophyletic, which indicates a more complicated evolutionary history of the order Trichiales. Derived from these results, different morphological characters are re-evaluated in this new phylogenetic framework, focusing in the architecture of the capillitium- considering the dichotomy between net-forming capillitium or single tubules- as well as its ornamentation. Other features, as the spore ornamentation, presence and structure of the stalk and the characteristics of the peridium, are also discussed. In addition, ultrastructural features of the capillitium studied with Transmission Electron Microscopy (TEM) are also mapped in the phylogeny. The different derived ultrastructural types of capillitium are also discussed in this new phylogenetic framework. Deepen into the phylogenetic relationships among the species of Myxomycetes is challenging our understanding of their systematics. The further inclusion of molecular information in systematics will help us to solve that intricate puzzle which is the evolutionary history of the Myxomycetes. First author would like to acknowledge for the supporting PhD research grant (BES-2015-072763). This work is funded by the Spanish Government through the grant PGC2018-094660-B-I00 (MCIU/AEI/FEDER, UE).

Key words: capillitium, myxomycetes, phylogeny, systematics, TEM, ultrastructure.

O2. Combining morphology and molecular data to unravel the systematics of the Myxomycetes (Amoebozoa), with special emphasis on the order Physarales

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The Myxomycetes (Amoebozoa) is a diverse monophyletic group of amoeboid protists characterized by having a complex lifecycle that includes spore-bearing structures (sporophores), and free-living amoebae and flagellate cells. Given that these microscopic phases do not present obvious distinguishing characters, the taxonomy of Myxomycetes relies on sporophore morphology. Among others, the spore color and ornamentation, the features of the capillitium, stalk, peridium or columella, and the presence and type of lime deposits in the sporophores are considered taxonomically important characters. Nonetheless, some species present trait combinations that bridge the gap among different genera, even orders, making it difficult to establish their limits and phylogenetic affinities. In this work, we have generated the first and only comprehensive collection of transcriptomic data for Myxomycetes to test previous hypotheses on the relationships among the five orders currently recognized within this class. The monophyly of Myxomycetes and three of its orders has been proved, which confirms the validity of their respective synapomorphies to define high-level relationships. At a finer taxonomic level, we have focused our studies on the order Physarales, the largest group of Myxomycetes. By using a four-gene dataset and a greatly expanded taxa sampling, it has been confirmed that most genera are artificial and that morphological homoplasy is common, which makes morphology-based taxonomy challenging. Furthermore, even if several molecular synapomorphies have been identified for most clades in our multigene phylogeny, some internal relationships, especially in the family Physaraceae, remain unknown. Our results also indicate that the pre-molecular subdivision of Myxomycetes and, in particular, Physaraceae, is essentially flawed. Likewise, they show that transcriptomic analyses are a promising tool that along with other studies (*e. g*., ultrastructure), and an increased taxa sampling, will help us to disentangle the systematics of these elusive protists. This work was funded by the Spanish Government through a PhD research grant (BES2012-061641), awarded to the first author, and also by the Myxotropic Project (grant PGC2018-094660-B-I00 (MCIU/AEI/FEDER, UE).

Keywords: myxomycetes, phylogeny, Physarales, systematics, transcriptomics.

O3. How DNA metabarcoding changes our understanding of myxomycete ecology, diversity and distribution

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As the body of data produced by DNA metabarcoding studies (18S amplicon metagenomics) of myxomycete populations in different natural substrates keeps growing, new patterns of species diversity, as well as ecology and distribution of particular species, begin to emerge. Some aspects of these new patterns differ significantly from the picture created by the studies based on detection of fruit bodies in the field and in moist chamber cultures. We will present the results of the analysis of all myxomycete DNA metabarcoding datasets available to the moment, including our unpublished data, with an extended collection of reference 18S sequences used for taxonomic determinations, and discuss the impact of these findings on our understanding of myxomycete ecology and distribution. We acknowledge support from the Russian Foundation of Basic Research (18-04-01232 A), the program of the Komarov Botanical Insititute RAS "Biodiversity, ecology, structural and functional features of fungi and fungus-like protists" (AAAA-A19-119020890079-6) and the German Research Council (DFG: SCHN1080/2-1, RTG 2010).

Keywords: biogeography, DNA metabarcoding, molecular ecology, myxomycetes

O4. Molecular phylogeny of *Lepidoderma* de Bary and its influence on inter- and infrageneric classification of Didymiaceae

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At the moment, the genus *Lepidoderma* de Bary includes 15 species accepted in taxonomic database of Lado, which are characterized by cartilaginous or membranous peridium with lime scales on the outer layer. However, the taxonomic status of a number of morphological species, such as *L. chailletii*, *L. carestianum*, and *L. aggregatum*, has been a cause for debate over the past century. The aim of this work is to reconstruct a phylogeny of the genus *Lepidoderma* to clarify the composition of the genus and its relation to other genera of the Didymiaceae family. The partial sequences of 18S rRNA and COI genes were obtained from herbarium specimens of *Lepidoderma tigrinum*, *L. chailletii*, *L. carestianum*, *L. peyerimhoffii* and other species of the genus *Lepidoderma* and other genera of Didymiaceae. *Lamproderma* spp. were chosen as an outgroup. The 18S rRNA-based and two-gene phylogenetic trees showed that the two clades which include the majority of *Lepidoderma* spp. and number of *Diderma* spp. are sister groups, while the *Didymium* species occupy a more basal position. Several large monophyletic clades corresponding to morphological species are distinguished within the *Lepidoderma*. The results of the analysis showed that although some authors concluded that the morphology of *L. chailletii* and *L. carestianum* is similar, both species are independent and are located in distant branches within the genus. Moreover, sequences belonging to the *L. chailletii* morphological species are grouped into four clades with high statistical support, and the specimens belonging to these clades not only show different patterns of geographical distribution, but also differences in their macro- and micromorphology. It is important to note that the sequences of *Diderma fallax* fall into a clade that includes *L. peyerimhoffii*, *L. nevadense*, *L. trevelyanii*, and *L. echinosporum*, the four species similar to *D. fallax* as well in morphology. Finally, the analysis indicates that the type species of the genus *Lepidoderma* de Bary, *L. tigrinum*, is related to species of the genus *Diderma*: it forms a small branch with high support inside the «*Diderma*» clade. This indicates that both *Lepidoderma* and *Diderma* are paraphyletic genera, and large taxonomic rearrangements are needed to arrive to the natural system of Didymiaceae. We acknowledge support from the Russian Foundation of Basic Research (18-04-01232 A), the program of the Komarov Botanical Institute RAS "Biodiversity, ecology, structural and functional features of fungi and fungus-like protists" (AAAA-A19-119020890079-6) and the German Research Council (DFG: SCHN1080/2-1, RTG 2010).

Keywords: 18S rRNA, COI, *Diderma*, Didymiaceae, *Lepidoderma*, myxomycetes, molecular phylogeny, taxonomy

O5. Information system on the DNA barcodes of myxomycetes

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Species identification based on comparison of short nucleotide sequences (DNA barcodes) with reference sequences that have a reliable taxonomic annotation has become a routine for plants, metazoans, prokaryotes, fungi and many groups of protists within the last 15 years. This approach is successfully applied for identification of cultures, herbarium specimens, environmental DNA sequences etc. and is especially useful when morphological characters do not allow identification of a specimen to the desired taxonomic level. However, for myxomycetes DNA barcoding is at the initial stage of development: DNA barcodes with the suitable taxonomic resolution are found and primer combinations with reasonably broad specificity are developed, but taxonomic coverage of the available sequences in public databases is still unsatisfactorily small. Furthermore, many of these sequences have wrong taxonomic annotation and cannot be used as barcodes. To change this situation, several working groups united their efforts to create an information system of nucleotide sequences of myxomycetes that would contain quality-checked barcode sequences linked to herbarium specimens stored in large mycological herbaria of Russia and Germany. Sequences will be accompanied by metadata, such as light and SEM micrographs of sporocarps and spores, geographical data on the origin of the specimens and locality descriptions, which will allow anyone to check the correctness of taxonomic determination. Information system will be available via a web interface with the data stored on server of the Komarov Botanical Institute RAS.
We acknowledge support from the Russian Foundation of Basic Research (18-04-01232 A) and the German Research Council (DFG: SCHN1080/2-1, RTG 2010).

Keywords: DNA barcoding, information system, database, herbaria, myxomycetes,

O6. Automated image analysis in determining the spore size of dark-spore myxomycetes

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Spore size measurements are, in general, a tedious and time-consuming work that is flawed by human errors. These pitfalls often result in low sample sizes, non-reproducibility and inconsistent data, and low statistical power. We developed a new approach to measure the size of spores (myxomycetes, mosses, ferns ...) or pollen and other spherical propagules in a semi-automated method. With this method, we analyzed and compared over nine billion spores of *Physarum albescens* from different locations and putative biospecies. This method allows for achieving high sample sizes with large effect sizes that will positively influence the overall statistic power. At the same time, results are reproducible. A computer and an automated microscope do most of the analyzing steps. If the associated filters are adjusted to a representative sample, all the following samples will produce consistent results within and between the groups. Also, this method allows further analysis of each sample within the full spectrum of ImageJ tools on a level of single selected spores. This new approach consists of a pipeline that works with an automated brightfield microscope for image acquisitions and ImageJ-scripts for image decomposition. By using a newly developed sample preparation protocol, we could reduce noise effect (dirt particles, sporocarp fragments) and increase the spore count per image drastically. At the same time, we ease-up the image acquisition by focusing all spores on nearly one z-level by applying high-frequency vibration on the samples. First studies on *Ph. albescens* show leptokurtic distributions skewed towards larger spore size. These distributions are, in most cases, nearly identical between sporocarps of the same individual. We could reach margins of errors in a single-digit nm scale (1.3–4.6 nm) by an average spore size range from 10 to 12 µm. In addition, we could analyze rare events of macrospores with this method as well as disturbed spore formation on a few samples. We will use this method to investigate the reliability of one of the most often used traits in myxomycete determination: spore size.

Keywords: spore size measurement, *Ph. albescens*, myxomycetes, computer vision

O7. Current and future investigations on the antagonistic activity of *Physarum* species from *Zea mays* on plant pathogenic fungi causing mycotoxin contaminations and damping off diseases

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Some Myxomycete species are fungivorous *e.g. Badhamia utricularis* and some of them produce antifungal substances. Therefore, they hold the potential to be used in biocontrol as antagonists to fungal plant pathogens. Mycotoxigenic fungi contaminating feed and food with secondary metabolites bear considerable health risks for animals and humans and are an unsolved problem in agriculture. Damping off diseases caused by a variety of soil born fungi, attacking seedlings and small plantlets via the root system are one of the most difficult problems to be managed in nurseries and in the field. Both groups of fungi cause significant economic losses and alternative approaches to combat these plant pathogens are needed.
In our laboratory wild isolates of several *Physarum* species, collected in agricultural experimental fields in Austria from maize plants (*Zea mays*), are tested on their antagonistic activity against plant pathogenic fungi causing mycotoxin contaminations and damping off diseases. Results of *in vitro* confrontation tests between *P. gravidum* against the mycelium and spores of mycotoxigenic fungi belonging to the genera *Fusarium, Aspergillus, Penicillium* and *Alternaria* as well as results for *P. cinereum* against a set of plant pathogenic damping off fungi belonging to the genera *Phytophtora, Pythium, Rhizoctonia, Sclerotinia etc.* are presented.
A project - in pipeline - which aims to, elucidate the behavior of plasmodia in soil or soil like environments, establish the production of biomass of different Myxomycete life cycle stages in small scale, and investigate the *in vivo* activity of plasmodia in a real plant-pathogen system is presented and discussed.

Keywords: corn, crops, pathogens, slimemolds

O8. Integrated Mechanisms of cellular behavior in *Physarum polycephalum*: Towards a General Model System for Cognition

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Physarum polycephalum, probably the most prominent acellular slime mold, has garnered a lot of public interest in recent times. This is due to some fascinating research starting twenty years ago and concerning its apparent 'intelligence': The slime mold demonstrates abilities long thought to be restricted to neural organisms, among them learning, memory and the ability to solve problems. Not only is *P. polycephalum* capable of constructing networks optimized for transport. It has also been shown to solve mazes, connect multiple food sources via the mathematically shortest pathway, and tackle the traveling salesman problem. Furthermore, the slime mold makes decisions, evaluates food sources based on their nutrient conditions, and possesses a memory. These features are usually associated with life-forms which have a higher degree of information-processing sophistication, e.g. which possess brains or neuronal structures. Nonetheless, much of the slime mold's behavior is similar to that of higher organisms. The underlying functions are not neuron-based, but are emergent phenomena, resulting from mechanochemical processes on the tubular network. However, an understanding of these underlying mechanisms and processes is still lacking. Since the structure of the cell and its dynamics are strongly interconnected, we investigated the ultrastructure and motility of *P. polycephalum*, which form the basis for the observed behavior. Large-scale patterns and other phenomena, which can be observed on the entire network, are based on locally occurring cellular and molecular processes. The interplay of these mechanistic interactions, and especially the resulting intracellular fluid flow, is hypothesized to constitute the information processing in *P. polycephalum*. Furthermore, and in light of the observed complex behavior, we wonder whether a detailed investigation of the unique cell biology, genetics, network analysis and metabolism of the slime mold could lead to an understanding emergent phenomena such as minimal cognition.

Keywords: minimal cognition, fluidic information processing, *Physarum*

O9. A morphological and molecular study of Myxomycetes collected from *Zea mays*

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Maize (*Zea mays* L.) is one of the most important crops and staple food in our world. Plant diseases, like infections by mycotoxigenic fungi play an important role in the loss of crop yield. Because of global climate change species of these fungi that thrive in warmer climatic conditions are migrating into Northern areas, consequently there is continuous demand for new methods of eradication of these parasitic moulds. In the framework of an ongoing survey of mycotoxigenic fungi in a mist irrigated test field of different cultivars of maize, several taxa of myxomycetes have been detected. These are now being studied as potential antagonists against crop damaging and toxigenic pathogens. It is therefore imperative that these myxomycetes are correctly identified, well documented and that molecular voucher data is available for each of the taxa. Field samples of myxomycetes were collected during four consecutive years (2016-2019) from mid-August until the plants were ensiled around mid-October. In the same period of 2018 and 2019 substrates for moist chamber cultures were taken from different parts of the maize plants to ascertain if there were differences in species assemblages between ground leaf litter, aerial leaf litter, ears and silks. A morphological study of the sporocarps from a selection of the field collections and moist chamber cultures was performed. From each colony two sporocarps were isolated and separately use for DNA extraction, subsequently PCR was performed with primers to amplify about 1800 bp of the small subunit ribosomal RNA gene (SSU). We present the methods and results of this study.

Keywords: corn, slimemolds, techniques

O10. Impacts of natural disasters on microbial diversity: a case study of myxomycetes from tropical forests and grasslands in the Philippines

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Natural disasters such as typhoons and volcanic eruptions negatively impact our biodiversity, particularly the flora and fauna. Can this negative impact be also true for microorganisms as exemplified by myxomycetes or slime molds? In this study, we assessed the occurrence and diversity of myxomycetes in forest habitats from two provinces, both situated in coastline areas and are frequently exposed to tropical cyclones. Leaf litter and twigs were collected eight months after a typhoon hit Aurora Province and a month after a typhoon hit Quezon Province for the preparation of moist chambers. Our results documented 63 species of myxomycetes belonging to 21 genera in the two forest habitats in both provinces. The inland forests had a higher species richness and diversity than the beach forests. Interestingly, a higher species richness and diversity was observed when sampling of substrata was conducted a month after a typhoon. We also prepared moist chambers from grass litter collected from grasslands in areas covered by “lahar flow” following volcanic eruptions of Taal (40 years ago), Pinatubo (26 years ago) and Mayon (11 years ago). A total of 40 species belonging to 11 genera were noted from the grasslands in Taal, Pinatubo and Mayon Volcanoes. Thirteen species were recorded common in all sites, with majority from the order Physarales. The assessment of species diversity showed that Taal had higher species diversity and richness than Mayon and Pinatubo. Our results clearly suggested that natural disturbances such as typhoons and volcanic eruptions could alter the diversity of myxomycetes, albeit not always negatively. A recovery among the microbial communities is expected.

Keywords: biodiversity, disturbance, natural calamities, slime molds, tropical myxomycetes

O11. Does myxobiota's response to burning differ with respect to fire intensity?

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Fire is a major cause of disturbance in savanna biomes. On the other hand, recent studies have demonstrated the importance of fire management in preventing environmental impacts, conserving species and maintaining phytophysiognomies. However, this practice is not yet common in Cerrado (Brazilian Savanna), and most research conducted in these areas is focused on plants, mammals and insects. This work aimed to analyze the impact of different types of managed burning on the Cerrado mixobiota. The study area corresponds to a fragment of cerrado *sensu stricto*, with about 107 ha, located in the territory of the quilombola Kalunga Community, municipality of Cavalcante, Goiás, Brazil. Within this area, four quadrants of 200x200m were delimited, three of which were subjected to different types of burning: fire against the wind (low intensity), fire in L (intensity intermediate), circular fire (high intensity) and one quadrant was not burned (control). In each quadrant, 4 to 20 random points were collected for substrate collection (leaflet), which were performed 6 and 12 months after burning. In the first sample, 16 samples were collected and in the second 80 samples, they were fractionated into three subsamples, which were incubated in humid chambers, and monitored over three months for the appearance of myxomycetes sporocarps and then verified the richness, composition and species diversity among the types of burning. Thirty-six specimens of myxomycetes belonging to 24 species, 11 genera, six families and four orders were obtained. Species richness varied among treatments, being higher in the control area, followed by low intensity, intermediate intensity and high intensity fire treatment. Species composition also differed between treatments, with more heterogeneous communities in wind control and treatment. The partition of beta diversity showed variation in species composition, attributed to differences in richness, which indicates selective loss of species with increasing fire intensity. Thus, we found that the intensity of the fire negatively influenced the Cerrado myxobiota, promoting a decrease in species richness, homogenization of communities and reduction of diversity through the selective loss of less resistant species. These data provide subsidies for eventual fire prevention and management programs in the Cerrado and, consequently, for the conservation of this biodiversity. We acknowledge the Goiás State Research Support Foundation (FAPEG) for the Masters scholarship to ICM and to Higher Education Personnel Improvement Coordination (CAPES), for the PhD scholarship to FVA and WPR. Also, the National Forest Fire Prevention and Fighting Center (PREvfogo/IBAMA) in the state of Goiás for the assistance and execution of the fires. To the Quilombola Kalunga community by the authorization for research in the area and for logistical support.
Keywords: biodiversity conservation, controlled burning, fire impact, myxomycetes

O12. Impact of forest fragmentation to the diversity and distribution of myxomycetes in Mt. Isarog, Camarines Sur, Philippines

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Forest fragmentation alters the habitat area, thereby contributing to the loss of species diversity. While its negative effects on plants and animals are widely reported, little is known about their impacts on microbiota, specifically myxomycetes. This happens in spite of the critical roles microbes play in the ecosystems. In this study, we assessed the occurrence, distribution and diversity of myxomycetes in intact and fragmented forests within Mt. Isarog National Park in the Bicol Region, Philippines. Ground leaf litter (GL) and decaying twigs (TW) were collected from three sampling localities in Mt. Isarog. A total of 540 moist chamber cultures were prepared. The disturbance and forest land area of the collection sites were determined and correlated with the species diversity and distribution. Our results identified a total of 21 species of myxomycetes belonging to 9 genera: *Arcyria* (2 taxa), *Comatricha* (1 taxon), *Cribraria* (1 taxon), *Diderma* (2 taxa), *Didymium* (3 taxa), *Hemitrichia* (2 taxa), *Perichaena* (2 taxa), *Physarum* (6 taxa), and *Stemonitis* (2 taxa). Comparison of communities of myxomycetes showed that less disturbed forest habitats had higher species diversity than that of forest sites with man-made activities, e.g. eco-tourism. Our research study reports the possible impacts of man-made disturbances to the communities of myxomycetes.

Keywords: forest disturbance, habitat loss, slime molds, tropical forests

O13. Association between myxomycetes and the decay stage of coarse woody debris in an evergreen broadleaf forest in warm temperate Japan

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Myxomycetes inhabit coarse woody debris in varying stages of decay; however, their ecology in the dead wood of evergreen broadleaf trees is not well known. In this study, we examined the relationships between myxomycete species and the decay stage of wood from fallen trees in an evergreen broadleaf forest in Japan. Myxomycete species richness and abundance were calculated for eight stages of decay in fallen logs, according to the appearance and wood hardness of log portions. A total of 70 myxomycete species (including varieties) were found on the logs. Moderately decayed wood was the preferred habitat of myxomycetes (57 species; 81% of the total) and most species inhabited moist decayed wood. Analysis by nonmetric multidimensional scaling enabled the differentiation of myxomycete assemblages, with five groupings recognized across the progression of decay. Forty-two species preferred a particular decay stage, represented by the decay index (Fig.1). Physarum viride and Stemonitis splendens particularly preferred the less-decayed wood and Stemonitopsis typhina var. similis especially inhabited the well-decayed wood. Species from the order Physarales dominated the less-decayed wood, whereas Trichiales and Liceales species dominated the softer well-decayed wood. Myxomycetes diversity was high in and varied among logs with various stages of decay in a typical Japanese evergreen forest.

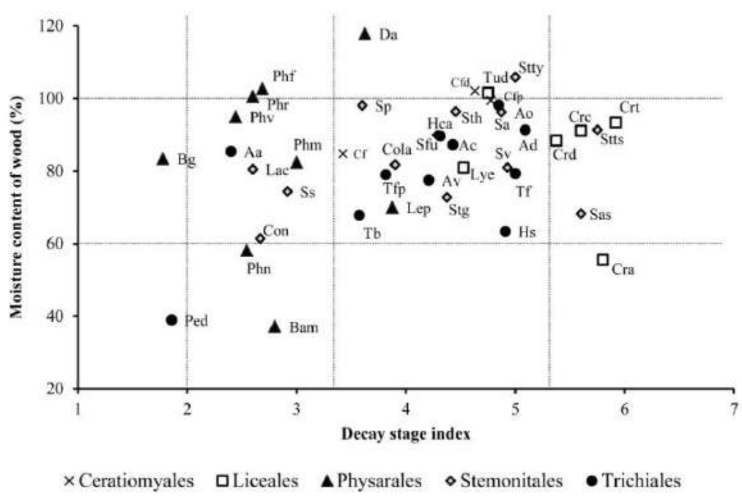

Fig. 1. Myxomycetes habitat associating with decay stages and moisture content of decaying wood in an evergreen broadleaf forest.

Keywords: coarse woody debris, decay index, habitat preference, myxomycetes, species diversity

[O14. Xylophilic myxomycetes: will the largest logs harbor the most, and the most rare, myxomycetes?]

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Coarse woody debris is well known as a hot spot of fungal diversity, underlining the importance of pristine woodlands for conservation. But does this hold true for myxomycetes as well? These organisms share the dispersal biology (fruit bodies releasing airborne spores) with myxomycetes, but not the mode of nutrition: fungi take up dissolved organic compounds, myxomycetes are predators of other micro-organisms. We used several data sets from pristine forest throughout the northern hemisphere (Germany: Bavarian Forest; Russia: Sikhote-Aline reserve, Interior Kamchatka, Northern Caucasus) to answer these questions. In these surveys, a log was systematically surveyed for all fruiting myxomycetes and its length and maximum diameter was recorded. We found indeed a trend of increasing diversity with increasing diameter of the log – up to 15 species were found on well-decayed coniferous logs. However, in a given survey the rarest xylophilous species were not necessarily found on the largest logs, although certainly a number of species seem to require a minimum diameter of logs for successful fruiting. A good example seem to be the species of *Siphoptychium*, forming large compound fructifications. Data loggers place in the center but as well at the surface of logs hint on the influence of the microclimate: large logs provide a nearly frost free retreat for amoebae, which can endure winters inside the wood.

Keywords: deserts, distribution, ecology

O15. Myxomycetes associated with mahogany trees in Angat Watershed Forest Reserve, Bulacan Province, Philippines

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Myxomycetes are associated with a wide range of different microhabitats or substrata including aerial and ground litter, decaying woody debris, mosses, soil and animal dung. While leaf litter and twigs were commonly studied for myxomycetes in the Philippines, other substrata such as the barks of *Swietenia macrophylla*, locally known as mahogany, could also potentially host species of myxomycetes. In this study, we collected bark samples from 88 host trees (four directions per tree, i.e., north, east, south, west) in 4 sampling localities within the Angat Watershed Forest Reserve in Northern Philippines. A total of 352 moist chambers were set-up for the study, of these 119 showed evidences of myxomycetes either as fruiting bodies or plasmodia. Different bark properties, e.g. pH, texture, direction, water-holding capacity, were also determined and correlated with the species composition. Our results showed a total of 15 species of myxomycetes. These were identified as *Arcyria cinerea*, *Ceratiomyxa fruticulosa*, *Comatricha* sp., *Cribraria* sp., *Cribaria violacea*, *Diderma hemisphaericum*, *Didymium* sp., *Hemitrichia serpula*, *Lamproderma scintillans*, *Lepidoderma tigrinum*, *Licea* sp., *Perichaena* sp., *Physarum album*, and *Physarum melleum*. We are currently correlating the bark properties with the species composition of corticolous myxomycetes. Our study highlights tree barks as special microhabitats for myxomycetes.

Keywords: biodiversity, slime molds, species listing, tree barks

O16. Proposal of an online monograph of the Neotropical Myxomycetes

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The name e-Taxonomy is applied to the taxonomic works that are produce or develop by the use of computing tools or electronic resources. Under this idea, we present a proposal to develop an online monograph of Myxomycetes for the Neotropics. This monograph will represent the knowledge of these organisms in this part of the world. The e-monograph has the ability to incorporate new data as it is generated, which guarantees its continuous update. Currently, the Neotropical region has more than 500 species of Myxomycetes recorded, this figure represent more than 50% of the species worldwide known. Taking the information of Farr's monograph of 1976 for Flora Neotropica as baseline, a new prototype with an electronic design will be presented. The information will be structured in seven main groups of data: 1) Nomenclature, with accepted name and synonyms, and including information of the type specimen, this item will be directly linked to nomen.eumycetozoa where the pdf file of the original publication can be consulted. 2) Taxonomy, including keys and description of the taxa with a standardization of the terms employed and generated by computing tools. 3) Digital images, at high resolution, from the taxonomic structures, including macro, micro and SEM photographs of the habit and more relevant morphological features. 4) Distribution, represented by a map with optional zoom showing the distribution of the species in the Neotropical countries. Each point is link to repositories of biodiversity information (GBIF, ALA, Discoverlife, Myxotropic, etc.) where detailed information (bibliographic records, preserved specimens, human observations) of the records, are provided. 5) Phylogeny, including molecular signatures or bar-coding that serve to characterize species, GenBank reference numbers and links, will be also included. 6) Notes or observations, where taxonomic comments or complementary data such as new evidences of the life cycle, ecological data, etc. will be included. 7) References, with links to the pdf file of the more relevant monographs or papers where complementary information could be consulted. The prototype is currently under develop, is conceived as a collaborative network, and all specialist and people interested in Myxomycetes will be welcome. The online monograph has the support of the Spanish Government through the grant PGC2018-094660-B-I00 (MCIU/AEI/FEDER, UE).

Keywords: biodiversity, distribution, Eumycetozoa, myxogastria, Neotropical region, nomenclature, slime moulds, taxonomy

O17. Myxomycetes of tropical forests of Vietnam: what moist chamber cultures can reveal

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The moist chamber culture technique (MCC) can supplement the information obtained from the field collections (FC) and thus represents a major source of data for diversity studies in myxomycetes. Despite its importance, MCC does have some limitations. Since MCC creates non-natural conditions, such as a long-lasting period of moisture, it may produce records of species from dormant stages that would not or very rarely would have formed fruiting bodies under natural conditions. During ten years of intensive work we used 1661 MCC in total to reveal myxomycete diversity in Vietnam. We are going to show the possibilities and limitations of MCC to detect the diversity of myxomycetes in the tropical forests of Vietnam including lowland monsoon tropical forests (834 MCC, 619 records, 71 species), different types of mountain tropical forests (524 MCC, 324 records, 54 species) and dry tropical forests (303 MCC, 181 records, 47 species). We would like to clarify the questions: 1) what is the species composition of substrate complexes detected in different types of forests in Vietnam by MCC? 2) How well can MCC reveal species diversity in different types of forests compared to FC? 3) Which rare and new species for Vietnam have been identified by this method? We found that the data sets from MCC and FC from different reserves of Vietnam showed a low degree of similarity, if the coefficient of community similarity (C_{cs}) and the number of shared species were calculated. This applies to all substrate types (average C_{cs} = 0–0.536, 0–10 shared species). For example, in the lowland semi-deciduous monsoon forests these values increase slightly from litter of fruits and leafy litter of herbs (no shared species) over bark (0.057, 1 shared species), litter of twigs (0.074, 1) and wood (0.182, 4) to aerial litter (0.224, 3) and leafy ground litter (0.536, 10). The completeness of the survey for different myxomycete assemblages varies greatly depending on the collecting method. For example, no field observations in the mountain tropical forests of the Dalat Plateau were made for corticolous myxomycetes with their mostly tiny sporocarps, but MCC component of our survey was fairly complete (25 taxa from 158 records, 64% completeness according to the Chao1 estimator). Aerial litter shows a similar relation (MCC: 16 taxa, 21 records, 64% completeness *vs*. FC: 6 taxa, 10 records, 37.5% completeness), in contrast to lignicolous myxomycetes (MCC: 14 taxa, 28 records, 50% completeness *vs*. FC: 66 taxa, 275 records, 71% completeness). For myxomycetes recovered from ground litter, the level of completeness is comparable for both methods (MCC: 23 taxa, 67 records, 67.6% completeness *vs.* FC: 28 taxa, 73 records, 63.6% completeness). These observations underpin the importance of the moist chamber culture technique for diversity studies in tropical myxomycetes. Travel and laboratory work of the first and third author was supported by the program “Ecolan 1.2” (Russian-Vietnamese Tropical Centre) and the program AAAA-A19-119080990059-1 (Komarov Botanical Institute RAS).

Keywords: biodiversity, myxomycetes, Southeast Asia, species inventory

O18. First reports of Fimicolous Myxomycetes from Brazilian Cerrado and Pantanal Biomes

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Fimicolous organisms are those that can use dung, especially from herbivores, as an option of substrate and source of nutrients. Dung offers conditions that favor colonization by various microrganisms such as bacteria, fungi and myxomycetes. Among these, we highlight the humidity and egested nutrients. Myxomycetes are the most diverse group of ameboid protists in phylum Amoebozoa (Eumycetozoa). Currently, there are about 250 species of myxomycetes from Brazil, distributed in all geographical regions and plant formations of the country, mainly on vegetal substrates. However, there are few reports about the diversity of these organisms occurring as fimicolous, represented only by ten species (*Arcyria cinerea, Cribraria cancellata, C. microcarpa, C. violacea, Comatricha mirabilis, Hemitrichia minor, Licea tenera, Metatrichia vesparia, Physarum cinereum, P. roseum*). Herein, we present the first reports of fimicolous myxomycetes from two Brazilian biomes, Cerrado and Pantanal, with records of five and one species, all them occurring in the dung of herbivores. Between 2017 and 2018, dung were collected in areas from Goiás (GO) and Mato Grosso (MT) states, Midwest Region of Brazil, in the municipalities of Anápolis, Pirenópolis, Goiás and Porangatu (GO, Cerrado areas) and Poconé (MT, Pantanal area). Samples of these substrates were incubated in moist chambers and observed during four months. Fruiting bodies of myxomycetes were observed under a stereomicroscope and light microscope and photographed. Macro and microscopic features were used to identify the material by specific literature. Vouchers of all materials were deposited at the Herbarium of Universidade Estadual de Goiás (HUEG). We identify five species of fimicolous myxomycetes occurring in areas of Brazilian Cerrado: *Arcyria cinerea* in Anápolis and Pirenópolis, *Physarum melleum* and *P. viride* in Porangatu and Anápolis,. *Physarum cinereum* in Goiás and a unique species from Pantanal, *Perichaena corticalis*, in Poconé. These represent the first records of fimicolous myxomycetes from both Brazilian Cerrado and Pantanal biomes, as well as the first records of these myxomycetes species as dung-resources explorers from Brazil Central. We acknowledge the Goiás State Research Support Foundation (FAPEG) for the PhD scholarship granted to the FJSC and Masters to the ICM.

Keywords: Amoebozoa, brazilian biomes, dung-inhabiting microrganisms, substrates

O19. Ten years in Vietnam - observations on diversity and ecology of myxomycetes in Vietnam

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The talk reports the results of the ongoing long-term survey of myxomycete communities in different forest types of Vietnam. With the current dynamics of destruction of the primary tropical forests of Southeast Asia, in particular Vietnam, it is now the last opportunity to collect scientific data and specimens in a number of areas of the country. Preservation, restoration and sustainable use of tropical forest ecosystems is impossible without understanding of the full picture of their structural and functional organization, in which myxomycetes and fungi occupy a significant place. The authors found several trends in distribution of myxomycetes in tropical forests of Vietnam. First, myxomycete species richness and abundance appear to be lower in the high mountain forests compared to the lowland tropical forests. Second, both abundance and richness of myxomycetes decrease with increasing moisture. Third, some microhabitats with no equivalents in temperate regions support distinct assemblages of myxomycetes. In mountain tropical forests of Vietnam a pattern of decreasing diversity with increasing elevation was found. In contrast, the specificity of myxomycete assemblages increased progressively in the sequence of vegetation types from middle mountain polydominant to high mountain cloud forest. In addition, artificial banana plantations comprised the most distinctive but as well the least diverse myxomycete assemblage among all studied vegetation types. Compared to the mountain forests, species assemblages of the lowland monsoon forests are clearly different, and even the common species of the mountain forests are replaced by others in the respective habitats in the lowland forests. Thus, on bark of trees *Cribraria confusa* (the most common mountain species) is replaced by *C. violacea*, on ground litter *Comatricha spinispora* by *Diderma effusum* and *Lamproderma scintilans*. Interestingly, in the tropical mountain forests of Vietnam several myxomycete taxa (*Barbeyella minutissima*, *Echinostelium brooksii*, *E. colliculosum*, *Lamproderma columbinum*, *Licea kleistobolus*, *Siphoptychium* cf. *reticulata*, *Paradiacheopsis rigida* and *Trichia persimilis*) were recorded that were known to be common in coniferous forests in temperate zones. Travel and laboratory work of the first and the second author was supported by the program “Ecolan 1.2” (Russian-Vietnamese Tropical Research and Technological Centre) and the program “Taxonomic diversity, ecology and physiological and biochemical features of fungi and fungus-like protists of Vietnam” AAAA-A19-119080990059-1 (Komarov Botanical Institute RAS).

Keywords: biodiversity, myxomycetes, Southeast Asia, species inventory

O20. Myxomycetes from Africa, an update

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Africa is a vast continent with its protist biodiversity still very much unexplored. This is no different in the case of the Myxomycetes or Myxogastria. Since 2010 we have been gathering data concerning this topic from field records, herbaria and publications. The original aim was to compile a monograph of African myxomycetes in the series of Fungus Flora of Tropical Africa published by Meise Botanic Garden. Recently the printed format was changed into a website, a more contemporary and flexible way of presenting such data. We have followed this example and created a separate website treating the myxomycetes recorded on the entire African continent. The link to this website will be made available during the presentation and after ISCEM 10 to the public. On the date of publication, the site will still be incomplete and we certainly welcome all who want to contribute with data from their field surveys in African countries, especially those that are poorly studied or have never been visited.
One of the 36% of the African countries with no records of myxomycetes is Mauritania, a West African country, which consist of roughly 90% Saharan desert, 7% steppes and only 3% water mass. We present results from moist chamber cultures of shrubs and dromedary dung collected in Mauritanian dessert localities from sea level up to 400 m altitude.
Malawi is a South-eastern African country with predominantly savannah woodland in the lowlands. Most of the 52 species of Myxomycetes known from this country were recorded from the Mulanje Massif in the South East. We report additional and new records from the northern highlands of Nyika National Park. This park has a temperate climate and a vegetation consisting mainly of montane grasslands, submontane evergreen forest, Miombo woodlands and some exotic plantations.To conclude additional interesting species from South Africa, Namibia, Tanzania and Ethiopia are presented.

Keywords: biodiversity, moist chamber, techniques

O21. Secondary capillitium, tertiary stalk and false columella

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Recent phylogenetic studies disclosed the general consequence of evolutionary steps, which led to the formation of major myxomycete taxa. As the myxomycete genealogy emerges from the fog of time, we receive more and more opportunities to analyze the history of morphological structures in different groups of these organisms. One of conclusions we can already made is that the most important structures, like stalk, columella or capillitium, evolved independently in dark-spored (Columellomycetidae) and brigh-spored (Lucisporomycetidae) myxomycetes, and even emerged several times within these groups.The common ancestor of Myxomycetes probably had the *primary stalk*, excreted from the surface of the pre-spore mass. This structure is still typical for Echinosteliales and, probably, for some of Cribrariales. Later, the intraprotoplasmic secretion of amorphous matter into vacuoles led the formation of capillitium and columella. At a certain moment columella went down beyond the sporotheca and formed the *secondary stalk*, usually called epihypothallic. This important event is still visible in Clastodermatales, where the basal part of the stalk is hollow and stuffed with granular matter, as it may happen in a primary stalk, while the upper part, smoothly passing into the columella, may represent a rudiment of the epihypothallic stalk. In Meridermatales, Stemonitidales and part of Physarales (Lamprodermataceae) the primary stalk was completely replaced by the secondary one. Finally, in common ancestor of Didymiaceae and Physaraceae the secondary stalk was replaced by *tertiary*, subhypothallic one, formed by a constriction of the peridium around the base of sporocarp. Somewhat different event happened in Lucisporomycetidae, where the primary stalk was replaced by subhypothallic, bypassing the epihypothallic stage. The *primary capillitium* appeared in the Columellomycetidae together with primary columella and epihypothalic stalk. All these structures represent a system of connected threads, formed inside the vacuoles. In Didymiaceae the epihypothallic stalk was lost, but the primary capillitium seem to be preserved. However, it was definitely lost in Physaraceae, where the tubular threads, formed as impressions of the peridium, took over its functions. These peridial tubules can be interpreted as the *secondary capillitium*. It is noteworthy, that only this type of capillitium may accumulate lime granules. This is explainable: the inner surface of tubes of the secondary capillitium represents nothing else than the extension of the outer surface of peridium, where the lime usually crystallizes. Similarly to the Physaraceae, the secondary capillitium evolved in Lucisporomycetidae; one of the most archaic examples of it can be seen in *Alwisia lloydiae*. The *primary columella*, connected with the capillitium, appeared early in the evolution of the subclass Columellomycetidae (see *Echinostelium arboretum* and *Barbeyella minutissima*), and first coexisted with a primary, later with a secondary stalk. Together with the latter, it was lost in Didymiaceae and Physaraceae. However, in some species of these families the tip of the subhypothallic stalk forms a rounded extension protruding into the sporotheca. This structure may be considered as the *secondary columella*. Another example of the independent evolution of columella-like structures is the axial tubule known in bright-spored species *Siphoptychium casparyi*. As suggested by Leontyev et al. (2019), it may represent a single capillitial tube that remained within the sporotheca when the latter became too narrow for a bunch of capillitial threads. However, being sometimes reinforced with fibrous strands, this structure can not be interpreted as a typical capillitium. From the other hand, in contrast to the axial structure that is formed by immature spore mass, lime or amorphous debris, it also cannot be considered as a pseudocolumella. One of the available options is to call this structure the *false columella*.

Key words: molecular phylogeny, morphology, parallel evolution, taxonomy.

O22. Nivicolous myxomycetes: will the same ribotypes reoccur every year?

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From 2013-19 we monitored fruiting of nivivolous myxomcetes at a transect in the northern limestone Alps (Garmisch-Partenkirchen, Kreuzjoch, 1000-1900 m a.s.l.). Around 1200 collections were made over the years, and ca. 1000 were successfully barcoded. Beside location, inclination and exposition of the site, a set of ecological parameters (substrate type, height of fruiting above ground, vegetation cover, distance from melting snow) was recorded for each collection. This data set was used to answer the following questions: 1. Is there an elevational zonation of species? 2. Is this more pronounced at the level of ribotypes compared with morphospecies? 3. Will the same ribotype occur in subsequent years at the same place?
The ecological niches of species seem to be broad, and microhabitat conditions, like moisture, seem to be more decisive than elevation alone. For instance, *Lamproderma* spp. seem to prefer moister, often waterlogged places and have more mobile plasmodia fruiting at greater heights, if shrubs are available, whereas *Lepidoderma* spp. prefers open, and drier places. The elevational zonation is slightly more pronounced at the level of ribotypes. Most interesting, ribotypes see to be locally persistent: a ribotype can be found at one place over several years.
This has interesting implication for the life cycle of myxomycetes in nature. The same ribotype does not necessarily mean that the respective fructifications are genetically identical, but at least this points to dispersal limitation. More investigations, either via multiple independent markers or with true genotyping, are needed to check if fructifications from subsequent years indeed represent the same genet. If so, there are several conceivable possibilities. For the sexual cycle, amoebal populations persist and mate repeatedly, plasmodia may endure for a longer time, i.e. as sclerotia, and fruit over several years. Assuming as well asexual reproduction via diploid amoebae, these only need to built up persistent populations in soil.

Keywords: biogeography, distribution, snow

O23. Study on the selection of environmental bacteria by plasmodia

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Myxomycetes have a unique life cycle in eukaryotes. They can thrive in many different microhabitats, including wood, bark, leaves, soil, etc. Bacteria are important food resources for vegetative stage of myxomycetes. And a potential co-evolution relationship happened between myxomycetes and bacteria. For understanding the tendency of myxomycetes to select environmental bacteria, the associated bacteria community in plasmodia and substrata were studied by 16S rRNA amplicon sequencing. A total of 877 OTUs were obtained from 3 plasmodia and their living substrata in a moist-chamber culture, and were annotated to 16 phyla and 277 genera. There are 812 OTUs from substrata and 849 OTUs from plasmodia. An obvious similarity of bacterial population and relative abundance was here in plasmodia and substrata. Proteobacteria bacteria were the dominant and core population in all samples. Based on the analysis of relative abundance of bacterial communities in each sample, it was speculated that the dominant bacteria in plasmodia are mainly derived from substrata, and a large number of rare bacteria may come from the plasmodia selves. Comparing the significant differences between the plasmodia and substrata, Acidobacteria and Sphingobacteriia mainly exist in the environment, and are relatively rare in the plasmodia. We found gram-negative bacteria and aerobic bacteria were predominant in the plasmodia. In addition, we describe for 6 plasmodia of Physarales bacterial communities across 2 families while exploring the difference of species identity during long-term culture. Total 88 OTUs were annotated to 52 bacterial genera belonged to 7 phyla from 6 plasmodia samples. Comparing bacterial communities of plasmodia between moist-chamber culture and oat culture, OTUs of bacteria were significantly reduced, leaving almost 40 to 50 OTUs in each sample. Based on diversity analysis, we found great difference in bacterial communities of family taxonomy level. Although the bacterial communities were rich in diversity, the predicted functions were very similar without significant differences in 6 plasmodia. This study was supported by National Natural Science Foundation of China (31770011, 31370065).

Key words: 16S, diversity, slime mold, substratum

O24. Developmental characters and associated symbiont bacterial diversity in essential life cycle stages of one dictyostelids *Heterostelium colligatum*

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Dictyostelid cellular slime molds (dictyostelids) are the second largest group of slime molds. Members of the group occur in the soil microhabitat and feed upon bacteria. The vegetative stage consists of single-celled amoeboid forms that live in the soil, grow, and multiply until the available food supply is exhausted. When this happens, the amoeboid forms aggregate together in large numbers to form multi-celled pseudoplasmodia, which then give rise to fruiting bodies (sorocarps) which consist of supportive stalks and non-walled sori containing propagative spores (Raper 1973, 1984). *Dictyostelium discoideum* is a specialized amoebozoan protist that can feed on, carry and disperse bacteria. However, the symbiont bacterial diversity in other species of dictyostelids and the diversity associated with essential life cycle stages are still unknown until now. Here, another species of dictyostelids, *Heterostelium colligatum*, a new record for tropical China, was isolated from the soil collected in Xishuangbanna Tropical Botanical Garden, Yunnan Province, China. We describe the complete life cycle of this species and illustrate details of spore-to-spore development. The symbiont bacterial diversity and relative abundance associated with life cycle stages of *H. colligatum*, including the aggregation, pseudoplasmodium, and sorocarp stages, were investigated by high throughput metagenomic techniques. *H. colligatum* appears to be capable of carrying different types of bacteria during its life history in addition to those used as a food resource. The dominant groups of those three stages in its life cycle were the Proteobacteria, Actinobacteria and Firmicutes. The relative abundance of the dominant phyla and shared OTUs were different for the aggregation, pseudoplasmodium, and sorocarp stages. A comparison of the symbiont bacterial assemblages associated with *D. discoideum* and *H. colligatum* indicated that different dictyostelid species carried different species of symbiont associated bacteria. This work was supported by the National Natural Science Foundation of China (No.
31870015, 31300016).

Keywords: cellular slimemolds, coexistence, ecology

O25. Putting slimies on a predictive map: Applying species distribution models on myxomycetes research

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Predicting the distribution of a particular species on a suitable geographical space using correlative modeling approach has gained popularity over the last years. With vast machine learning algorithms such as maximum entropy and intuitive GIS software that are freely accessible, this technique has been certainly employed on many myxomycete research to help uncover (1) local range distribution of myxomycete species on changing climate scenarios, (2) forecast that support moderate endemicity on putative myxomycete biospecies and (3) potential suitable habitats for rare taxa. Hence, this presentation would provide about the underlying principles, implications, and considerations that such models have generated over different myxomycetes species. Specifically, this will highlight selected studies that tackled how species distribution models were used to interpret such distribution patterns for myxomycete species such as *Badhamia melanospora*, *Barbeyella minutissima*, *Diderma hemisphaericum*, *Hemitrichia serpula*, and *Physarum albescens*. These species stand for certain ecological groups (deserts, montane forests, tropical forest, subtropical forests, nivicolous habitats) – but will the models confirm such predictions derived from a collectors' expertise?

Keywords: biogeography, distribution, slimemolds

O26. "Lowland nivicolous" myxomycetes fruitify more regularly than we think?

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Nivicolous myxomycetes are the ecological group of myxomycetes including more than 100 species and infraspecific taxa that develop fruitbodies at the edge of melting snow in the spring. In early publications, nivicolous myxomycetes were referred to as a group strictly confined to alpine and subalpine biotopes, but later studies have shown that the majority of nivicolous species prefer to fruit in mountain forests rather than in alpine habitats. Furthermore, during the last decades as many as 20 species of these organisms have been found globally in lowland areas. During three spring seasons 2017-2019, we observed abundant fruitifications of two species of nivicolous myxomycetes in the lowlands (116–192 m a.s.l.) of the Eastern Ukraine. After morphological examination, 25 collected specimens were assigned to 2 species of the genus *Lamproderma*: *L. pseudomaculatum* and *L.* aff. *pulchellum*, species previously considered as strictly montane. Two partial 18S rDNA sequences, obtained from collections, initially identified as *L. pseudomaculatum*, were found to be 100% identical to the 2 of previously known sequences of this species, thus the morphological identification was confirmed. However, this was not the case for our collections of *L.* aff. *pulchellum.* The closest sequence of the corresponding gene belongs to the *L. pulchellum*, and matches with our specimen with 94.98% similarity. According to current practices of species delimitation for the dark-spored myxomycetes, such a level of similarity is too low for the members of one species. Additional genetic studies are necessary to determine whether or not our material represents a new species of *Lamproderma*, related to *L. pulchellum*. The analysis of climate conditions for autumn-winter seasons, that preceded fruitifications of nivicolous myxomycetes in the Eastern Ukraine, showed that autumn frosts, which occurred before the formation of a stable snow cover, as well as the limited number of days with snow cover exceeding 30 cm, did not prevent the abundant fruiting of these myxomycetes in all three seasons. Our results support the existing theory that nivicolous myxomycetes may possess rather broad elevation niches and some of them are not necessarily alpine or even montane. At least two species are able to fruit regularly in lowland conditions.

Keywords: climate, *Lamproderma*, lowlands, nivicolous myxomycetes,

O27. Myxomycetes associated with *Polylepis* forests "Queñua" in the Peruvian Andes

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A study on the diversity and richness of Myxomycetes that inhabit the forests of *Polylepis* "Queñua", one of the few trees in the Andean mountain range, is presented. As a result of the sampling of the Myxotropic Project, a total of 650 myxomycete specimens were collected in Peru during 6 years of study (2012-2018). In total, 43 localities with forest of *Polylepis* were sampled. These localities are situated between 3600 - 4600 m of elevation, and cover a range of 9° to 17°S latitude. A total of 97 different species of Myxomycetes were recorded, this value suppose almost 10% of the species known worldwide, which is surprisingly high taking account the adverse climatic conditions of the Andean environment. These species correspond to 4 orders and 17 genera. The best represented was the order Physarales with 59 species, followed by the order Trichiales with 27 species. The most diverse genera were *Physarum* and *Didymium* with 21 and 20 species respectively, followed by *Diderma* with 12 and *Trichia* with 11. Other common genera such as *Stemonitis* or *Lamproderma*, nevertheless are barely represented. The most productive substrate was the dead bark fallen on the ground, followed by leaf litter and woody debris. The multi-layers feature of the bark of the trees of *Polylepis* allows retention of water, and this phenomenon seems to favor the development of Myxomycetes, the pH of this bark is acidic, with values of 4-5. The most abundant species were *Didymium squamulosum* (66 collections), *Didymium nigripes* (57), *Diderma globosum* (49), *Physarum bivalve* (46), *Trichia contorta* (36) and *Diderma asteroides* (31), interestingly all of these species are frequent on temperate regions. Patterns of geographical and altitudinal distribution of some species, as well as areas of greater richness, are also analyzed. This work has been funded by the Spanish government, grant PGC2018-094660-B-I00 (MCIU/AEI/ FEDER,EU).

Keywords: Amoebozoa, Distribution, Diversity, Ecology, Myxogastria, Tropical Andes.

O28. Black Sugarloaf, northern Tasmania – a myxomycete hotspot?

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Since moving to a wet eucalypt forest in 1988 I have documented the birds, flowering plants, fungi, bryophytes and numerous invertebrates for various citizen scientist projects. I was introduced to myxomycetes through the Fungimap project and in 2010 started to photograph and collect fruiting bodies. My personal herbarium has 1950 specimens with 690 duplicates deposited at the National Herbarium of Victoria (MEL). All specimens have been collected within one kilometre of our house. The survey method involves walking the same trail each morning, regularly checking substrates, photographing developing fruiting bodies and collecting mature specimens. Colour plates of 340 collections have been compiled with descriptions and photographs of fructifications, capillitium and spores. Determinations number 120 taxa from 40 genera and 14 families. Of these, 78 are new records for Tasmania including four novel taxa. Many collections are yet to be determined and are likely to include more undescribed species. Myxomycetes appear in every month with different species fruiting in different seasons: litter-dwelling myxomycetes (*Didymium squamulosum, D. nigripes*, *Craterium minutum* and *Elaeomyxa reticulospora*) appear after autumn rain in March/April and continue to do so for several months; *Lamproderma* species and *Elaeomyxa cerifera* start to appear on large bryophyte-covered logs in June and continue through September/October; Trichia species appear in September on logs of all sizes, and large aethalia and pseudoaethalia (*Fuligo septica, Tubifera glareata* and *T. tomentosa*) generally appear in the warmer months of December and January. Many species appear repeatedly over several months. A fascinating phenomenon is the “hotspots” that occur during winter in the shadiest part of the forest. Here logs, standing dead trees or dead vines remain wet for months and a concentration of different species co-occur. There are usually only one or two such hotspots each season in the approximately two-hectare area I regularly check. The logs have been productive for only one year and no fruiting bodies have been found on the substrate in the following year/years. My observation that the abundance and occurrence of fruiting bodies varies greatly from one year to the next suggests that many years of study are necessary to fully document myxomycetes in temperate areas of the world; this possibly applies to all regions. The characteristics of the wet eucalypt forest at Black Sugarloaf, the plant assemblage, the variety of different substrates, and daily visits to the study site probably account for the high number of taxa found within a small area.

Key words: Australia, ecology, myxomycetes, new taxa, slime moulds

O29. Contribution of the MYXOTROPIC Project to the knowledge of Neotropical Myxomycetes

Carlos Lado[a]

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The Neotropics is one of the richest biogeographic areas of the world with many biodiversity hotspots, but the knowledge of their Myxomycetes is limited. From 1976, year of the publication of the Farr's monograph of Flora Neotropica, no others floras or monographs have been published, and enormous regions remain unexplored. To redresss this situation, in the year 2003 the MYXOTROPIC Project started with the objective of discover and understand the diversity and biology of Myxomycetes in these areas not previously studied. From this date, and in periods of three years, a total of five phases of the Project has been developed, focused in arid or semiarid environments, one of the most unexplored. The Tehuacán-Cuicatlán Desert in Mexico, the Atacama Desert in Chile, the Monte Desert and Patagonia in Argentina, and the coastal desert and the Andean "altiplano" of Peru are the areas investigated so far. Despite being apparently inappropriate areas for the development of myxomycetes, they have been shown to have a high species richness, and several new species have been discovered. After a brief historical review and an analysis of the areas studied, the most relevant results obtained in the different phases are presented. Currently, the number of species reported in the Neotropical region has been almost duplicate and much information already published can be found on the official website of the project (www.myxotropic.org). The current phase (MYXOTROPIC VI), that started in January 2019 and will run through December 2021, is focused on the study of the Andean salt flats in Bolivia, Argentina and Chile. These salt flats form in endorheic basins above 3000 m elevation. The climatic conditions are extreme and the high concentration of salts implies an additional survival stress for the species found in these territories. In this phase a related group of amoeboid protists, the Arcellinida, have been added to the study of Myxomycetes. They are defined by their protective structures (testate amoebae) that enable them to survive desiccation and predation. They are commonly found in soils, sediment, peat bogs and associated vegetation where his micro-predator life strategy complement that of the Myxomycetes. Understanding how living organisms can efficiently colonise these inhospitable environments, how they specialize and how species are distributed are some of the objectives of this sixth phase of the project. The project thanks all the researchers who have participated in the different phases, and to all those students who have collaborated in the field works. The Project is funded by the Spanish Government through the grant PGC2018-094660-B-I00 (MCIU/AEI/FEDER,UE).

Keywords: arid lands, biodiversity, Eumycetozoa, Myxogastria, Neotropics, slime moulds

O30. Some hypothesis about columella in the genus *Didymium*

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The historical definition of columella "as an extension of the stalk inside the sporangium" is not adequate for the Didymium genus , and we can find in literature basal columella, secondary columella and hypocolumella as already defined concepts
These concepts refer to a peridial origin of the columella as it is explained in the book Les Myxomycetes by Michel Poulain, Marianne Meyer and Jean Bozonnet (2011), to which substantial reference is made for the interpretation of photographic documentation related essentially to Didymium with limy stalk.
In the light of the works in the literature on the formation of sporocarps in Physarales (starting from Welden 1955), hypotheses are formulated on the processes that lead to the formation of the different structures observed.
The concept of collapse of the columella is introduced, occurring when the space destined for its formation is not adequately filled with crystalline material and it is drastically reduced with drying.
Particular attention is paid to the need to identify the morphological aspects deriving from variations of quantitative type processes, which may depend on environmental conditions, from qualitative elements that may indicate the presence of genetic difference.
In this regard, some collections of Didymium of the squamulosum complex from the herbarium of M. Meyer are presented, which could aspire to a taxonomic dignity.

Key words: basal columella, collapsed columella, capillitium detachment

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Arturo Estrada-Torres	S3
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ICSEM 10
Costa Rica

Turrialba – Costa Rica
25-28 February 2020

New records of Myxomycetes for Colombia

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Introduction

Neotropic region harbors a great diversity of mammals, plants and insects, but its micro-biodiversity is still poorly studied. The lack of information on Myxomycetes diversity in the Neotropic is a good example of this situation. In Colombia there are few reports regarding this group of microorganisms. According to Rojas, Herrera and Stephenson, (2012) there are only 108 species of Myxomycetes registered in Colombia. Therefore, this study aimed to expand the description of Myxomycetes diversity in Colombia. Here we are showing the results obtained from an exploratory sampling in two cities of Colombia.

Methods

Sampling points

Cartagena

Medellín

Sampling of sticks → Installation of moist chambers → Maintain at 22°C for a month

Collection of vegetal material with Myxomycetes fruiting bodies → Identification base on the observation of fruiting bodies

Sampling points: location and characteristics

Parameter	Cartagena	Medellín
Average altitude (m.a.s.l.)	1	1490
Average anual temperature (°C)	28,3	24,1
Relative humidity (%)	81,3	59,5

Results

The first exploratory sampling allowed to identify the following 7 species of Myxomycetes in Cartagena, and 13 species in Medellín:

Cartagena	Medellín	
Physarum cinereum	*Ceratiomyxa fruticulosa*	*Dydimium bahiense*
Perichaena chrysosperma	*Physarum bogoriense*	*Arcyria cinérea*
Arcyria aurea	*Arcyria insignis*	*Perichaena vermicularis* *
Lamproderma scintillans	*Physarum compressum*	*Cribraria violácea* *
Stemonitis fusca	*Comatricha nigra* *	*Physarum pusillum*
Perichaena depressa	*Comatricha tenerrima*	*Arcyria minuta* *
Physarum sepula	*Didymium squamulosum*	

* New récords for Colombia

New records for Colombia and its worldwide distribution

Comatricha nigra

Perichaena vermicularis

Cribraria violacea

Arcyria minuta

Species distribution showed three main points:

- ❖ None of those 4 species have been reported yet in Colombia, therefore, this exploration increase to 112 the number of registered species in our country.
- ❖ These 4 species are ubiquitous and present at a wide range of latitudes.
- ❖ There are fewer reports of these species in the Neotropical region in comparison to other latitudes, which probably reflects the lack of research on Myxomycetes in the region.

Conclusions

- ❖ Four unreported species from Colombia were identified in this study with a low sampling effort, indicating that Myxomycetes' Colombian biodiversity is currently underestimated.
- ❖ Therefore, it is necessary to encourage research on this area in order to fill the gap of knowledge on the diversity of this group of microorganisms in the Neotropic.

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DO SLIME MOLDS RESPOND TO MUSIC?

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INTRODUCTION

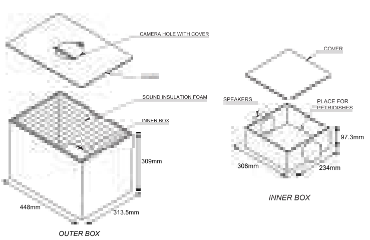
Sound has been shown to influence the growth and behavior of animals and plants, even microorganisms (Zhao et al., 2002; Lestard et al., 2016; Christwardana et al., 2017). Interestingly, slime molds have also been recognized as a "learning" organism. So we ask this question:

Do slime molds respond to different sounds?

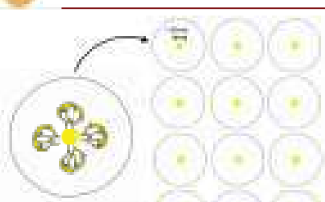
In this study, we measured the growth of the plasmodium of *Physarum polycephalum* under different sound stimuli. Understanding their growth and/or behavior may shed some light on how non-neural organisms such as slime molds respond to external stimuli.

MATERIALS & METHODS

A. Sound Chamber Set-Up



B. Preparation of Test Organism



P. polycephalum grown on ½-strength PDA

For each sound treatment, we tested 12 slime molds. Each slime molds were placed at the center of the Petri plates pre-filled with ½-strength PDA. All plates were placed inside the inner box of the sound chamber set-ups.

C. Sound Treatment

5 Different Types of Music/Sound

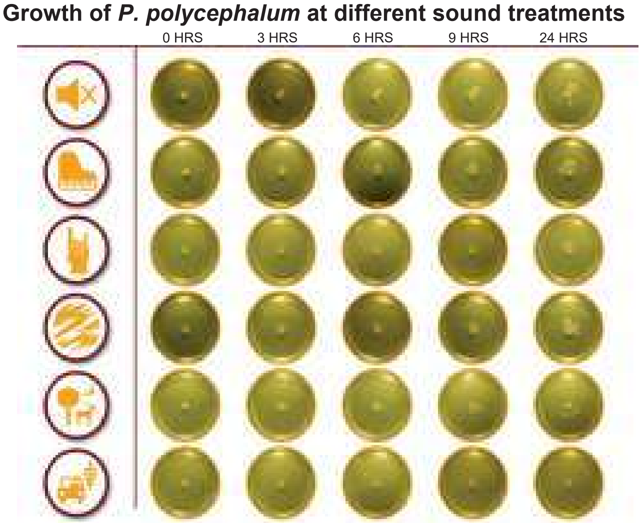
Classical Music	Heavy Metal	Static Noise	Nature Sounds	Urban Noise
Sonata For Two Pianos In D Major, KV. 448, 1st Movement by Wolfgang Amadeus Mozart	**Hammer Smashed Face** by Cannibal Corpse	**TV Static Noise**	**Flowing water with birds and insects**	**Vehicles and Pedestrians**

For each sound treatment, the slime molds were exposed for 24 hrs. Sound levels were maintained within 50-70 dB range. A similar set-up was prepared without any sound as control. All treatments were done in two trials.

Images of the plasmodial growth were taken with a DSLR camera (Canon EOS 80D) at different time intervals, i.e. at 0, 3, 6, 9 and 24 hours. Plasmodial growth was then analyzed using the ImageJ software.

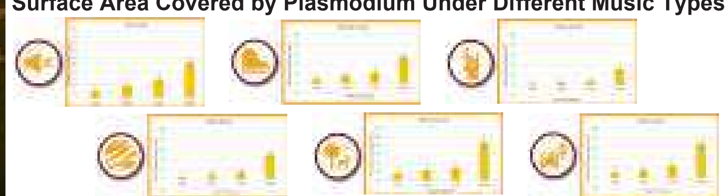
FINDINGS

Growth of *P. polycephalum* at different sound treatments



Soothing sounds, e.g. **classical music and nature sounds**, facilitated growth of plasmodia within three hours of incubation. This was also observed in the control, **no sound**. On the other hand, sounds that are often considered as "loud" such as **heavy metal music, urban noise** and **static sound**, showed growth after 6 hours of incubation.

Surface Area Covered by Plasmodium Under Different Music Types



Expressed as mean plasmodial growth area, **unconventional sound bordering to noise** appears to have detrimental effects on the growth of the plasmodium of *Physarum polycephalum*. In contrast, **sounds known for its soothing effects**, e.g. classical music and nature sound, have positive effects on plasmodial as similarly observed in the absence of any sound (control).

TAKE HOME POINTS

Slime molds appear to **respond** to sounds with growth promotion observed in **"soothing" sound** such as classical music and nature sound.

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Incidence of Myxomycetes in the air of the Aburrá Valley, Colombia

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ICSEM 10 Costa Rica

Introduction

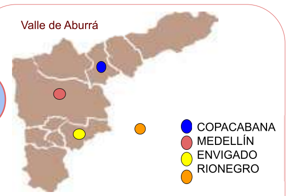
During the last years, the city of Medellín, located on the Central Cordillera of Colombia, has suffered significant air quality problems. Factors related to the topography of the valley, its meteorological characteristics, and the increase in industrial and vehicular emissions, favor the accumulation of pollutants in the atmosphere of the Metropolitan area. This implies the suspension of a great diversity of particles in the air and their dispersion with the winds. However, the dynamics of transport, dispersion and deposition of biological particles in the air of Medellín are ignored. Therefore, this project proposed to describe the transport of Myxomycetes' spores in the metropolitan area of the Aburrá valley.

Materials and methods

1

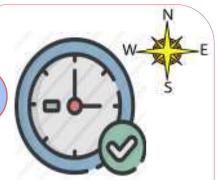
ASSEMBLING OF AIR TRAPS

2



LOCATION OF AIR TRAPS (4 POINTS)

3



3 MONTHS EXPOSITION OF THE TRAPS

4

WET CHAMBER 4 MONTHS INCUBATION

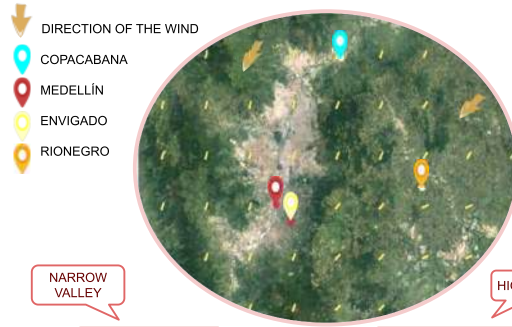
5

BIMONTHLY OBSERVATION AND COLLECTION OF FRUITING BODIES

6

ANALYSIS OF DATA

Satellite image of the Aburrá valley and rural surrounding area



VALLE DE ABURRÁ

- ★ Narrow valley
- ★ Three monitored points
- ★ Urban area
- ★ Wind routes: north to south.

RIONEGRO

- ★ High plain southeast of the Valley
- ★ One monitored point
- ★ Rural area
- ★ Wind routes: east to west

Results

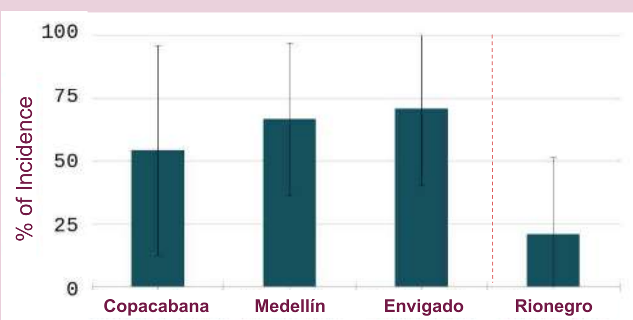


Figure 1. Comparison of the percentage of incidence of Myxomycetes spores between sampling points. (Error bars, error bars indicate 1+/- Standard deviation)

The highest incidence of Myxomycetes spores was observed in Medellín (center of the valley) and Envigado (south of the valley).

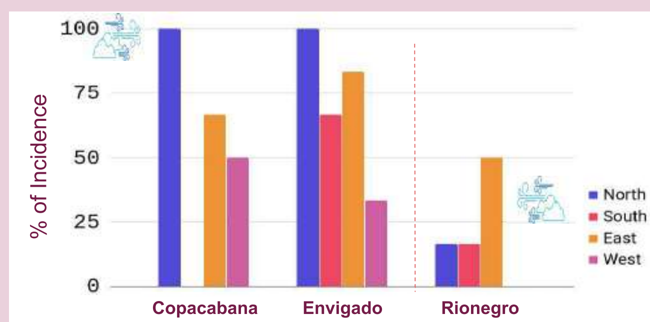


Figure 2. Comparison between the percentage of incidence in the traps located on the four cardinal points

In three of the four monitored points there was a higher incidence of spores on the traps coinciding with the direction of the wind.

Conclusions

- ★ The presence of Myxomycetes was evidenced for the first time in the metropolitan area of the Aburrá Valley
- ★ The results suggest that the spores of Mixomycetes are being transported by the wind current both in the urban and the rural area of the sampled region.
- ★ However there is evidence indicating that there may be other factors influencing the movement of the spores, for example the low fluidity of the air, or the turbulence of the winds

A NEW PERICHAENA FOLIICOLOUS SPECIES (MYXOMYCETES) FROM *QUERCUS* FORESTS AND CLOUD FORESTS OF MEXICO.

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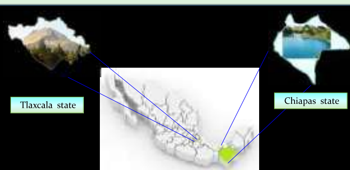
INTRODUCTION

The genus *Perichaena* (Trichiales-Myxomycetes) is represented by both sporocarpic and plasmodiocarpic forms, with thick persistent peridium, and spores from yellow to reddish brown in mass. Most species have a well-developed capillitium formed by roughened tubes, with warts, spines or rings but not marked with spiral bands. Some species have a wide distribution, while others are only known from the type locality (Walker *et al.*, 2015). During of the studies on the myxobiota in different localities in Mexico, a stipitate species of the genus *Perichaena* was detected both in the field and in moist chamber cultures, growing on leaves of *Quercus* in Tlaxcala and Chiapas states, Mexico.

STUDY AREAS

The collection was carried out in *Quercus* forests of the state of Tlaxcala and in cloud forests of the Lagunas de Montebello National Park in Chiapas, Mexico.

Quercus forest, Huexoyucan, Tlaxcala



Location of Tlaxcala and Chiapas in Mexico

Cloud forest, Lagunas de Montebello National Park, Chiapas

METHODOLOGY

This study is based on specimens of *Perichaena* obtained in dead leaves of *Quercus rugosa* from field collections and moist chamber cultures of Huexoyucan Tlaxcala in 2017, 2018 and 2019. Similarly were obtained in *Quercus* leaf litter were collected on the cloud forest in the Lagunas de Montebello National Park in 2019. The morphology of the *Perichaena* sp. was examined using light microscopy and scanning electron microscopy (SEM). It was compared with specimens of nearby species deposited in the TLXM herbarium of the Tlaxcala University and the AH herbarium of the Alcalá de Henares University, Madrid, Spain.

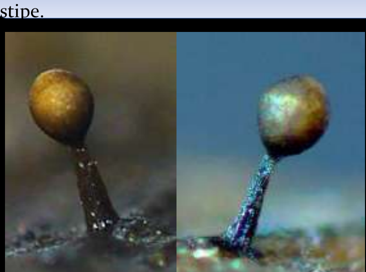
leaf litter

Moist chambers

Taxonomic identification

RESULTS

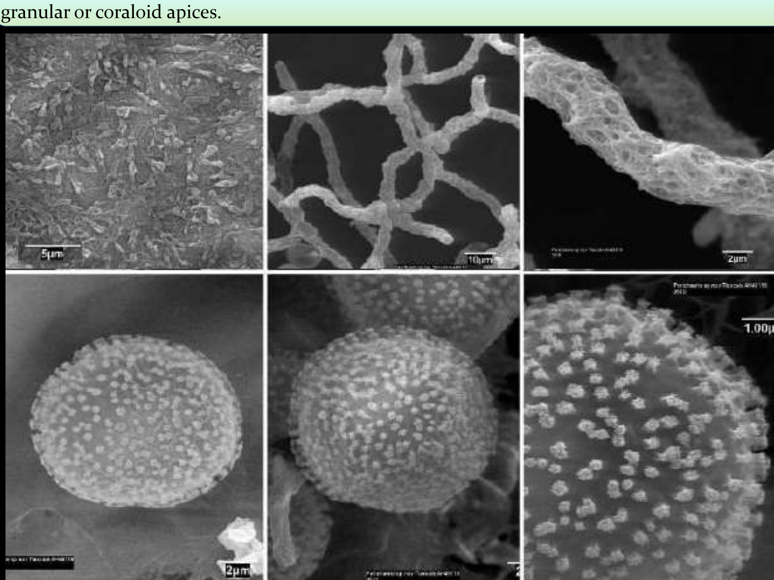
Perichaena sp. it grows on the underside of the leaves of *Quercus rugosa* and on the leaf litter of the cloud forest. It is characterized by obovoid sporocarps, with dark brown to blackish stipe.



Inmature sporocarps

Mature sporocarps

Microscopically, the internal peridium has thick ridges and a poorly marked low reticulum; reticulated capillitium with few warts. Globose spores, homogeneously warts, warts with granular or coraloid apices.



Its macroscopic appearance resembles species of the genus *Trichia*, however, microscopically it is located in the genus *Perichaena*. This new species differs from other nearby species by the combination of the characters shown in the following table (Walker *et al.*, 2015).

Character	*Perichaena longipes*	*Perichaena pedata*	*Perichaena stipitata*	*Perichaena* sp.
Total height (mm)	0.5-0.8	0.2-0.8	0.08-038	0.5-0.9
Diam of sporocarp (mm)	0.15-0.25	0.2-0.5	0.1-0.5	0.2-0.4 X 0.2-0.3
Color of sporotheca	Bright yellow to ochraceous	Ochraceous or fawn	Orange yellow to dark brown	Yellowish Brown to dark brown
Shape of sporotheca	Globose to subglobose	Subglobulose	Subglobose to subhemispheric	Subglobose to obovoid
Color of stipe	Dark brown to blackish	Dark brown to blackish	Calcareous and white, or brown to black without calcium	Dark brown to blackish
Length of stipe (mm)	0.3-0.7	0.45-0.60	0.1-0.5	0.3-0.5
Diam of stipe (mm)	0.25-0.80	1/2 to twice the diam of the sporophore	0.05-0.38	0.04-0.06
Structure of stipe	Plicate	Stout and roughened	Filled with crystalline deposits and refuse matter, sometimes striated	Roughened to longitudinally estriated
General structure of capillitium	Branching, tubular, free ends are scanty and obtuse	Profuse and branching	Scanty, branching, tubular, few free ends	Branching, reticulated, abundant.
Ornamentation of capillitium	Densely ornamented with irregular spines and warts	Small, regular, scattered spines	Irregular with large holes (3.8–6.8 mm)	Ornamented with scarce, small and irregular warts
Ornamentation of capillitium by SEM (µm)	Pits (0.5)	Not reticulate or pitted	Holes (3.8–6.8)	Double reticulum (with holes) and scarce short warts
Diam of capillitium (µm)	3.2–5.8	1.5-3.5	1.4-3.6	3-6
Spore size (µm)	7.8–9.1	9.0–11.0	12.0–15.0	12-14
Color of spore mass	Bright yellow	Bright yellow	Orange yellow	Yellow
Spore ornamentation	Prominent and abundant warts, flattened at apex and resembling a star shape	Minutely warted	Very flattened warts	Warts with star shape apex or coraloid
Peridium	Single, thick, persistent	Single, thick, persistent	Single, membranous	Single, membranous
Inner peridial ornamentation	Densely verrucate	Short, rounded ridges and various sparce verrucate elements	Ocellate and weakly wrinkled	With thick ridges anda low marking low reticulum

CONCLUSION

The characters that make this species unique apart from the stalk, which in the genus *Perichaena* is not common, are the obovoid form of the sporocarp, the capillitium with double reticulum (with holes) and scarce short warts, inner peridial ornamentation with thick ridges and a low marking reticulum and the ornamentation spores with warts with star shape apex or coraloid. The unique set of morphological characters and their stability between field specimens of different areas and moist chamber corroborate it as a new species, however, their status should be validated with phylogenetic analyzes using molecular data.

REFERENCES:

Walker L M, D V Leontyev , S L Stephenson. 2015. *Perichaena longipes*, a new myxomycete from the Neotropics. Mycologia 107(5):1012-1022.

We thank the Regional Biodiversity Laboratory, UNAM for macroscopic image capture.

Long-term evaluation of myxomycetes in a single location: the case of FEIMA in Costa Rica

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Abstract: During two complete years, myxomycete fruiting bodies were looked for in field conditions on a monthly basis in selected locations within a 28-hectare moist premontane tropical forest patch in Costa Rica. A total of 58 species has been recorded thus far. *Hemitrichia calyculata* was the only species recorded in every single month of sampling. *Arcyria denudata* and *Ceratiomyxa fruticulosa* were recorded most of the time. Both patterns of species richness and taxonomic diversity varied over time but showed low values during the middle part of the year, particularly around July. The drier months, between December and April, showed the highest values. This type of long-term studies on myxomycetes are important to understand the effect of external and internal fluctuations on the forest and how their relationship may ultimately affect fructification patterns and reproductive strategies on myxomycetes.

Methods: A series of 18 sampling locations within the 28 hectares of FEIMA (a research forest from University of Costa Rica, Fig 1) have been surveyed for 24 months with a total effort of 2880 minutes of field work, equivalent to 48 hours. In addition, 864 samples of bark, litter and twigs were taken to the laboratory for isolation using the moist chamber technique. The purpose of this study was to evaluate phenology of sporocarp production.Therefore only the reproductive visible stage of myxomycetes has been used to generate data.

Fig 1. Overview of the forest at FEIMA during the transitional period between dry and wet seasons

Results: A total of 1723 records of myxomycetes have been observed, with an average of 71.8 records per visit. The maximum number of records has been 110 and the minimum only 20. Similarly, the average number of species registered per month was 13.8 with a range between 6-24 species (Fig 2 top). The average taxoxomic diversity index was 1.6 with a range between 1.2-2.1 (Fig 2 bottom)

Overall, myxomycete sporocarps were more common during the drier periods and their fructifications were rarer during the rainier periods. Interestingly, some species appear to show some type of relationship with the ENSO phenomenon (see Fig 3). For instance, *Physarum melleum*, *Fuligo septica* and *Craterium aureum* were only recorded during the most intense period of the ENSO phenomenon. However, a more thorough examination of the data is required before conclusive evidence can be obtained.

In the type of forest studied, *Hemitrichia calyculata*, *Arcyria denudata* and *Ceratiomyxa fruticulosa* were the most frequently recorded species. No differences were found in the species composition of assemblages associated with bark at 0, 1 and 2 m of elevation above the ground. The middle section of FEIMA, with higher and more robust trees, is where most myxomycetes were recorded (**Fig 4**)

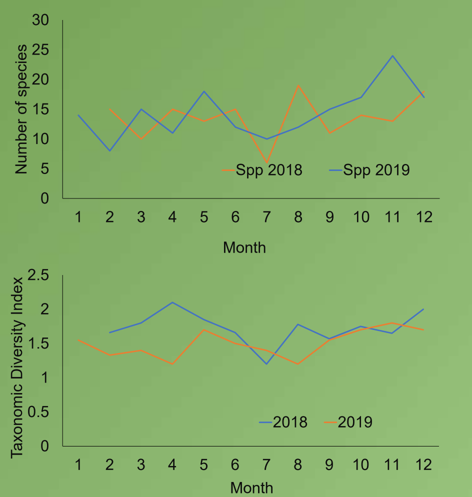

Fig 2. Number of species (top) and taxonomic diversity index (bottom) recorded during the two years of observation at FEIMA.

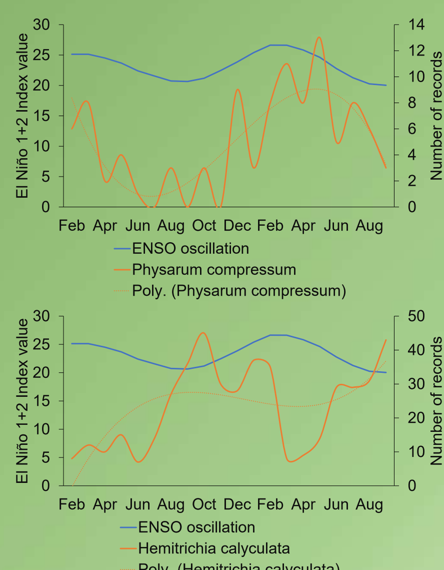

Fig 3. ENSO oscillations and sporocarp occurrence for two species of myxomycetes in FEIMA. The data is not conclusive but suggests a relationship.

Neither the number of records or the number of species recorded were associated with forest parameters such as tree height, diameter and basal area.

Fig 4. FEIMA map showing the different land-use sections. A=agriculture, G=cattle ranching, B=forest. The latter is divided in three main sections from which the average number of myxomycete records per visit is 43 for B1, 59 for B2 and 46 for B3.

Discussion: This is the first time a long-term project on myxomycetes has been conducted in Costa Rica. At first, the FEIMA forest did not look like the best site for a project of this kind, but it is really representative of the patchy, successional forests of the southern premontane caribbean areas of Costa Rica.

Just based on morphospecies and reproductive stages, the myxomycetes are well represented in this area. However, the most interesting aspect of the project carried out herein, is that it generated data on phenological patterns of myxomycetes for a tropical zone.

In that sense, and also based on previous evidence from Costa Rica, it looks like fruiting bodies are more common during dryer periods. Some rare species may fruit in association with macroenvironmental phenomena affecting the entire area. Also, common species are practically present at all times.

Based on the latter and beyond taxonomic considerations, the physical presence of myxomycete fruiting bodies can be studied under the scope of macroecological patterns to answer questions related with their basic biology. Even more interesting, some of those explorations, may be coupled with applied projects to provide data showing that myxomycetes can be used for environmental monitoring.

Can the location of the lab affect moist chamber-based data?

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The use of moist chambers to generate data on myxomycetes has been very common during recent decades. Despite several shortcomings at the taxonomic level due its inherent bias on morphological information, the usefulness of this technique for the generation of data from most parts of the world is still recognized. However, few studies have critically analyzed the effect of laboratory location on the results obtained using this technique.

Methods

In the present study, three sets of ground litter samples were collected and divided in two twin subsets that were placed in moist chambers in two laboratories separated by one mountain. The sets of litter were collected in 1) a lower montane moist forest, 2) a lowland wet forest and 3) a premontane wet forest. The linear distance between the two laboratories was 34 km and the elevations were similar (Fig 1). Due incident winds and moisture, the northern side of the mountain (Manú) was moister and cooler than the southern side (Turrialba). All substrates were placed in moist chambers and checked for three months and both environmental conditions of the labs as well as temperature and humidity of the moist chambers were measured. A basic evaluation of results between the two labs was carried out.

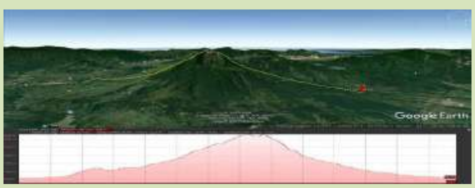

Fig 1. Google Earth image of the Turrialba Volcano showing the direct path between the two labs used for this experiment. The elevational profile is at the bottom. The right side corresponds to the northern Caribbean side (rainier) and the left side to the southern Caribbean slope (dryer).

Results

General ecological patterns such as diversity or species richness were similar among datasets, but composition of species was slightly different based on both the laboratory were the experiment was based (Table 1) and the origin of the material for isolation (Table 2). Some species such as *Arcyria afroalpina*, *Didymium clavus*, *Clastoderma debaryanum* and *Physarum superbum* were only recorded in one laboratory. The internal temperature of the moist chamber was higher on the dryer side of the mountain but both pH and humidity were similar between the two sets (Table 3). These results show that even though the two laboratories yielded highly comparable data, external factors such as topography and climate may play a role in the generation of myxomycete information using moist chambers. This type of information could be useful to understand species sensitivity to external conditions when forming fruiting bodies and relevant in the context of climate change monitoring.

Table 1. Species recorded in this study and records associated with each lab were moist chambers were studied.

Species	Laboratory	
	Manu	Turrialba
Arcyria afroalpina	4	0
Arcyria cinerea	29	33
Clastoderma debaryanum	0	3
Comatricha elegans	2	0
Comatricha nigra	4	0
Comatricha pulchella	9	6
Comatricha tenerrrima	4	4
Cribraria violacea	1	1
Didymium bahiense	21	14
Didymium clavus	4	0
Didymium difforme	4	1
Didymium nigripes	0	1
Disymium squamulosum	11	3
Echinostelium minutum	2	1
Lamproderma scintillans	6	2
Perichaena chrysosperma	18	13
Perichaena corticalis	4	4
Perichaena depressa	0	2
Perichaena minor	1	1
Physarum cinereum	2	0
Physarum compressum	12	15
Physarum didermoides	1	2
Physarum galbeum	1	1
Physarum pusillum	1	2
Physarum superbum	0	2
Stemonitis fusca	10	6
Non identified plasmodia	33	49

Table 2. Species recorded in this experiment according to original forest type were ground litter was collected. PWF=premontane wet forest, LWF=low elevation wet forest, LMMF=low montane moist forest.

Species	Litter original forest type		
	PWF	LWF	LMMF
Arcyria afroalpina		2	2
Arcyria cinerea	28	17	17
Clastoderma debaryanum		2	1
Comatricha elegans		1	1
Comatricha nigra	2	1	1
Comatricha pulchella	1	7	7
Comatricha tenerrrima	7	1	
Cribraria violacea			
Didymium bahiense	12	14	9
Didymium clavus	1	3	
Didymium difforme	3	2	
Didymium nigripes		1	
Disymium squamulosum	5	4	5
Echinostelium minutum	1	1	1
Lamproderma scintillans		6	2
Perichaena chrysosperma	23		8
Perichaena corticalis	8		
Perichaena depressa			
Perichaena minor	1	1	
Physarum cinereum	1		1
Physarum compressum	7	1	19
Physarum didermoides	3		
Physarum galbeum		2	
Physarum pusillum	1		2
Physarum superbum	1	1	
Stemonitis fusca	1	11	4
Non identified plasmodia	21	33	28

Table 3. Basic micro and macroenvironmental parameters measured in both sets of moist chambers and laboratories along with two diversity-based indices

Parameter	Laboratory	
	Manú	Turrialba
Microenvironment		
Moist chamber pH	7.2 (0.3)	7.1 (0.2)
Moist chamber temperature	22.3 (1.1)	28.6 (0.9)
Moist chamber humidity	79.8 (9.9)	83.3 (16.4)
Macroenvironment		
Air temperature	22.6 (2.3)	24.9 (3.9)
Air humidity	87.6 (4.1)	51.7 (18.7)
Atmospheric pressure	955.0 (0.9)	943.1 (2.2)
Diversity		
Simpson´s Index of Diversity	0,87	0,83
Taxonomic Diversity Index	2,01	1,96

Fig 2. Images depicting the ecological situation where samples were collected from. Left: PWF; Right: LMMF.

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Genetic structure of populations of the nivicolous myxomycete *Physarum albescens* at a large geographical scale

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Background and Objectives

A number of culture-based studies and recent molecular phylogenetic researches demonstrated that some of the morphologically defined species of myxomycetes split into reproductively isolated entities (cryptic biological species). It still remains unknown how common is this cryptic speciation, what is their usual mode of reproduction, how widely such biospecies are distributed and do they occupy different ecological niches. Trying to answer these questions, we investigated genetic structure of populations of the nivicolous myxomycete *Physarum albescens* in different mountain ranges of Northern Hemisphere (**Fig 1**) using three independent genetic markers (18S ribosomal RNA gene, SSU; protein elongation factor EF1A, mitochondrial cytochrome oxidase COI).

Here, we have…

- conducted field sampling of fruiting bodies in different mountain ranges in Europe, on Kamchatka (Russia) and in the Rocky Mts. (USA),
- sequenced 370 specimens for SSU and 182 for SSU, EF1A and COI,
- genotyped 98 specimens using GBS (genotyping by sequencing) to increase marker resolution.

Fig 1 Geographic distribution of the studied collections of *Ph. albescens*. Pie charts are scaled to the number of specimens sequenced. Colored sections correspond to the proportions of specimens from different clades (see **Fig 2**) within a collection site.

Fig 2 Three-gene Maximum Likelihood phylogeny showing 18 putative cryptic biospecies within *Ph. albescens*. Geographic regions where the specimens originated from are indicated for each clade. Outgroup (*Ph. polycephalum*) not shown.

Fig 3 Observed combinations of COI, SSU and EF1A sequence variants. Number of specimens per clade is shown in brackets.

Preliminary results

Three-gene phylogeny

All specimens determined as *Ph. albescens* form a monophyletic clade in the phylogeny of Physaraceae (not shown). Phylogenies based on each of the three studied independently inherited genes, as well as a three-gene phylogeny, reveal groups of specimens that always fall into the same clades (**Fig 2**). Analysis of combinations of genetic variants of the three studied genes suggests absence of genetic recombination between the specimens forming these clades, even though some of them occur in the same mountain ranges (**Fig 3**). NeighbourNet graph showing reticulate evolution patterns reproduces the same 18 groups, although there is an incomplete separation between Ha and Hb (**Fig 4**). The SNP-based phylogeny for the 98 genotyped specimens selected from seven clades produced the same fully supported clades (**Fig 5**). This can be best explained by presence of at least 18 cryptic biospecies within *Ph. albescens*.

Geographic patterns

Most of the 18 putative biospecies have a limited geographic distribution and occur only in one or two studied regions (**Figs 1, 2**). Mountain ranges of the west of US and south of Spain seem to harbour the highest diversity of the cryptic biospecies of *Ph. albescens* (8 and 7, respectively). In some cases up to four biospecies were registered from 50x50 m area.

Some of the biospecies can be clearly separated into biospecies with 'boreal' and 'southern' ranges. We are planning a more thorough investigation of the ecological niches of these biospecies.

Subclades within putative biospecies in SNP-based tree are always formed by specimens coming from the same region. This could be a sign of restricted gene flow between mountain ranges.

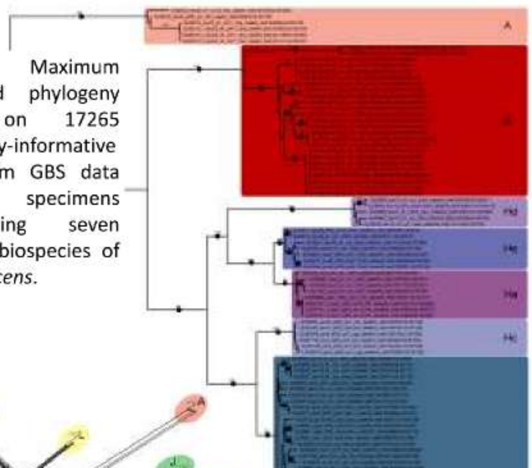

Fig 5 Maximum Likelihood phylogeny based on 17265 parsimony-informative SNPs from GBS data for 98 specimens representing seven putative biospecies of *Ph. albescens*.

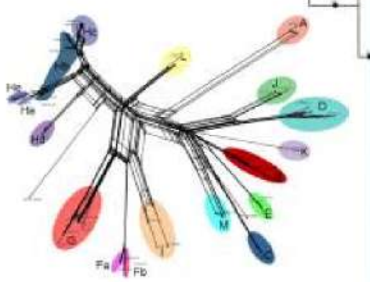

Fig 4 NeighbourNet graph produced for the three-gene alignment of 182 specimens of *Ph. albescens* using SplitsTree5 5.0.0_alpha.

Conclusions and Outlook

- The nivicolous myxomycete *Physarum albescens* represents a monophyletic group of at least 18 closely related putative cryptic biospecies.
- Most of these putative biospecies show a limited geographic distribution. Hypothesis to test: putative biospecies of *Ph. albescens* are adapted to local climatic conditions.
- The more thorough analysis of GBS data will hopefully provide clues to understanding the reproduction mode of natural populations of *Ph. albescens*.

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Ботанический институт

RESPONSE

DFG

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Photos by Renato Cainelli

Myxomycetes collected at the Tanbara Plateau, Gunma Prefecture, Japan

Hiroshi Suzuki, Hiromitsu Hagiwara and Takuya Miyamoto [The Japanese Society of Myxomycetology]

The Tanbara Plateau is located in the eastern part of Japan (Kamihotchi-machi, Gunma Pref.: 36.775261, 139.068717). This plateau is at an altitude between 1150 - 1600 m, about 900 ha., and has a cold temperate climate. The area is covered with a primary temperate forest of Japanese beech (*Fagus crenata* Blume). The field investigation of this study was carried out in the summer of July, 2018. As a result, 42 species within 14 genera were confirmed for this area. The voucher specimens were deposited in the Gunma Museum of Natural History (GMNHJ).

We would like to thank Dr. Tomoko Anezaki and Dr. Satoshi Ito, the Gunma Museum of Natural History, for supporting the application for the permission of this field research and for acceptance the voucher specimens. We also thank the members of "Tonenumata-no-shizen-wo-aisuru-kai (Tonenumata Nature club)" for supporting this field investigation, and Mr. Yukinori Yamamoto and Dr. Jun Matsumoto for identifying the specimens.

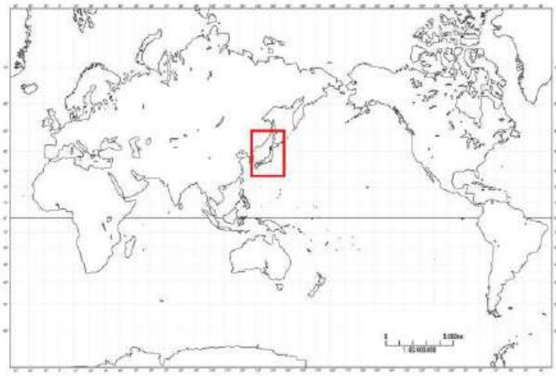


Fig. 1. Map showing Japanese archipelago.

Fig. 2. Map of Japanese archipelago showing location of study area (☆).

Fig.3. Map of the investigation area showing research route (-----)

Fallen wood of Japanese beech.

Stemonitis spendens on fallen Japanese beech.

On fallen leaves

Craterium minutum

Physarum cremiluteum

Physarum bivalve

Physarum conglomeratum

Didymium minus

Didymium squamulosum

Didymium clavus

Didymium megalosporum

Diderma testaceum

Diderma effusum

On fallen woods

Arcyria cinerea

Arcyria denudata

Stemonitopsis typhina

Stemonitopsis typhina var. similis

Lycogala epidendrum

Lycogala conicum

Cribraria cancellata

Cribraria cancellata var.fusca

Hemitrichia calyculata

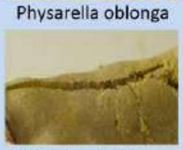
Metatrichia vesparium

Trichia favoginea var.persimilis

Physarum viride

Rare species

Physarella oblonga



Dictydiaethalium plumbeum

Myxomycetes confirmed at the Tanbara Plateau

Ceratiomyxales ツノホコリ目

1. *Ceratiomyxa fruticulosa ツノホコリ

Liceales コホコリ目

2. *Cribraria cancellata* クモノスホコリ
3. *Cribraria cancellata* var. *fusca* サラクモノスホコリ
4. *Cribraria microcarpa* アシナガアミホコリ
5. **Cribraria tenella* アミホコリ
6. **Dictydiaethalium plumbeum* ハシラホコリ
7. **Lycogala conicum* イクビマメホコリ
8. *Lycogala epidendrum* マメホコリ
9. *Lycogala exiguum* コマメホコリ

Trichiales (Trichiida) ケホコリ目

10. *Arcyria cinerea* シロウツボホコリ
11. *Arcyria denudata* ウツボホコリ
12. *Hemitrichia clavata* var. *calyculata* ホソエノヌカホコリ
13. *Hemitrichia serpula* ヘビヌカホコリ
14. *Metatrichia vesparium* ハチノスケホコリ
15. **Trichia alpina* ヤマケホコリ
16. **Trichia favoginea* var. *persimilis* トゲケホコリ
17. **Trichia scabra* キンチャケホコリ

Physarales (Physarida) モジホコリ目

18. **Craterium leucocephalum* var. *cylindricum* ツツサカズキホコリ
19. *Craterium minutum* サカズキホコリ
20. *Diderma effusum* ホネホコリ
21. **Diderma saundersii* バークレイホネホコリ
   = *Diderma platycarpum* var. *berkeleyanum*
22. *Diderma testaceum* マンジュウホネホコリ
23. *Didymium clavus* ナベカタホコリ
24. *Didymium megalosporum* クラカタホコリ
25. *Didymium minus* コカタホコリ
26. *Didymium squamulosum* シロエノカタホコリ
27. **Fuligo septica* ススホコリ
28. **Physarella oblonga* チョウチンホコリ
29. Physarum album シロモジホコリ
   = *Physarum nutans*
30. *Physarum bivalve* ガマグチフクロホコリ
31. *Physarum conglomeratum* オシアイフクロホコリ
32. *Physarum cremiluteum* コシロジクモモジホコリ
   = *Physarum melleum* f. *luteum*
33. *Physarum globuliferum* シロジクモジホコリ
34. **Physarum nigripodum* アシグロモジホコリ
35. *Physarum viride* アオモジホコリ

Stemonitales (Stemonitida) ムラサキホコリ目

36. *Stemonitis axifera* サビムラサキホコリ
37. **Stemonitis axifera* var. *smithii* スミスムラサキホコリ
38. *Stemonitis fusca* ムラサキホコリ
39. *Stemonitis fusca* var. *rufescens* ムラサキホコリ
40. *Stemonitis splendens* オオムラサキホコリ (図3)
41. *Stemonitopsis typhina* ダテコムラサキホコリ
42. *Stemonitopsis typhina* var. *similis* ハダカコムラサキホコリ

Trichia alpina
Collected at summer

Hemitrichia serpula
Infected by white fungi like pin (*Polycephalomyces* sp.)

Modeling the Myxomycetes - A Proposal for the Teaching and Science Popularization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INTRODUCTION

Didactic Models

- **Pedagogical resource**
- **Learning of abstract content / difficult to understand**
- **Playful teaching**
- **Meaningful learning**
- **science dissemination and popularization**

Myxomycetes

- **Found in a wide diversity of habitats**
- **Models organisms for teaching biological phenomena**
- **little known and neglected in Basic Education**

We are proposing the modeling of myxomycetes as a pedagogical resource and popularization of science.

PROCEDURE

- Search for images and description for characteristics about the myxomycetes
- Choice of species and structures ideal for modeling
- Draw the molds on cardboard in increased size, but maintaining the real proportions
- Making the models with pleasant to eyes and touch materials (Ex. fabric felt and foam silicone)
- Finish imitating natural peculiarities with diversified and safe materials (Fig. 1)
- The tutorial step by step and the mold of some pieces is provides on video on educational websites (https://micologiaueg.wixsite.com/fungilab or http://www.ppec.ueg.br/conteudo/11824_outros_produtos) so that teachers or students can reproduce these models and create others.

Figure 1 - Making myxomycetes models with synthetic (felt, silicone foam) and natural materials (*Pinus* spp. bark and mosses). **A-F**: Filling with silicone foam of the molds made of felt, **G-I:** Molds, **J-R**: Bonding the molds and final characterization.

RESULTS

Figure 2 - Natural sporocarps of myxomycetes and their respective didactic models. **A e B**: *Diachea leucopodia*, **C e D**: *Hemitrichia calyculata*, **E e F** *Diderma effusum*. **G**: Model of a community of myxomycetes on a rotten wood.

We hope this proposal can providing a teaching tool with several possibilities for use in Science Education, as well as contribute to the popularization of knowledge about the myxomycetes in society, promoting the "Myxophilia"!. It is part of the master project "Myxomycetes as a teaching tool - A kit to support pedagogical and popularizationof Science" developed in the Laboratory of Applied Basic Mycology and scientific dissemination, within the scope of the Professional Master's Program in Science Teaching (PPEC/UEG).

Dynamization of internationalization agreements in institutions of Higher Education:

The case of collaboration between the University of Costa Rica and the University of Antioquia in favor of Myxomycetes biodiversity knowledge in Colombia

TEAMWORK

Professors from both institutions and students from University of Antioquia setup a preliminary experiment in Medellin. 96 air traps were assembled in order to study the movement of Myxomycetes along a urban area in comparison with a rural point.

The University of Antioquia organized a workshop in Medellin which included: Theoretical discussions on Myxomycetes, review of the scientific research in Latin America, field work and Myxomycetes identification.

The University of Antioquia organized a symposium on Microbiology in Medellin; where Carlos Rojas, from UCR, gave the opening lecture.

Three students from the University of Antioquia are presenting a poster at the ICSEM 10, organized by the University of Costa Rica.

COMUNICATION

A student from the University of Antioquia is carrying out her undergraduate thesis on the air transportation of Myxomycetes in urban settings in Medellín.

AGREEMENT

An institutional agreement was renewed in order to develop collaboration projects in Colombia. The objectives are: 1) To update the list of Myxomycetes from Colombia and, 2) To advance in the understanding of the regional dynamics of this group of microorganisms

UNIVERSIDAD DE ANTIOQUIA

UNIVERSIDAD DE COSTA RICA

The most well-studied local myxomycete biotas in Russia and Kazakhstan: present state and future directions

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ICSEM 10 Costa Rica

THE OBJECTVES OF THE PRESENT STUDY is to obtain data on the distribution and ecology of myxomycetes in Russia and Kazakhstan.

Within the investigation area the following ecological groups of slime molds can be expected:

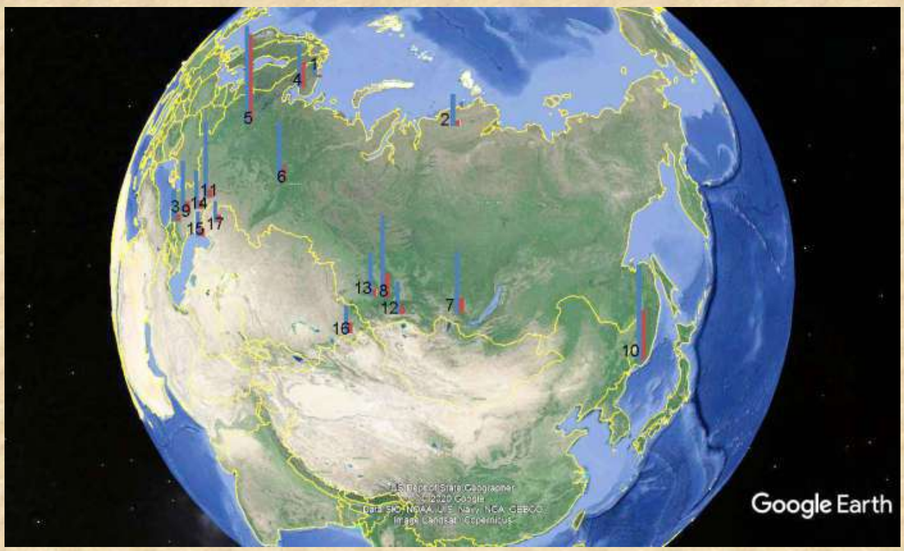
1 lignicolous myxomycetes (coarse wood debris of all kinds).
2 corticolous species (bark of living trees, and shrubs).
3 litter-inhabiting myxomycetes (ground liiter of plants).
4 coprophilous species (droping of herbivorous animals, especially horses, camels, sheeps, saiga antelope, and rodents).

Direct observations of myxomycetes in desert regions will be only occasionally possible, the main sources of information are substrate samples and moist chamber cultures.
For each sample, microclimatic conditions such as light, wind exposure, but also substrate features (texture, moisture, degree of decay) were recorded with a modular description system (SCHNITTLER & LUDWIG 1994).
The assemblages of species associated with the different study areas were compared using a coefficient of community (CC) index).

For each record the following information will be recorded (if available):
- geographical coordinates;
- short locality description;
- microhabitat description according to a catalogue or to a detailed and standardized description procedure;
- an approximate abundance estimation;
- taxonomic remarks.

INTRODUCTION

To date, about 450 morphospecies of myxomycetes of 53 genera have been registered in Russia and former Soviet republics. The last two decades have seen a rapid increase in the number of publications on the assessment of diversity, distribution and ecology of myxomycetes in various Russian regions, which represent the majority of Eurasian biomes. However, the degree of completeness of these surveys varies greatly depending on the methods of collecting sporocarps (field collections or/and specimens obtained from moist chamber cultures), the intensity of research, the time of collection, the experience and professional competence of collectors. To select the most well-studied regions we applied the following criteria: **1**) intensive field studies of myxomycetes conducted for at least 2-3 years in the same area at different times of the year; **2**) all occurrences of fruit bodies registered during the field surveys; **3**) field collections accompanied by moist chamber cultures; **4**) species coverage at least 75% (Chao1 index). Based on these criteria, we have selected a number of data sets on the species diversity of myxomycetes of various biomes in Russia and Kazakhstan (some of them are listed below), where we have conducted intensive research over the past 20 years. We used in this presentation only part of the total data, this data set contains 452 species represented by 18152 records.



BEST STUDIED LOCAL MYXOMYCETE BIOTAS IN MAIN ECOSYSTEMS OF RUSSIA AND KAZAKHSTAN
Note: blue columns - percent of total number of morphospecies used in this analysis (452) and red columns – percent of total number of records (18152). The numbers of columns correspond to the numbers of the datasets in the list (see below).

Arctic mountain tundra and forest tundra: (**1**) Khibine Mts., Kola Peninsula (132 records, 27 species, including nivicolous; Novozhilov & Schnittler, 1997; Erastova et al., 2017); (**2**) Taimyr Peninsula (370 records, 56 species; Novozhilov et al., 1999).
Subalpine and alpine communities of North Caucasus: (3) Teberda Biosphere reserve (395 records, 39 species, including nivicolous; Novozhilov et al., 2013).
Taiga: (**4**) Khibine Mts. and Laplandskiy Biosphere reserve (1337 records, 77 species, unpublished data); (**5**) Central Forest Biosphere reserve, Tver' region (4897 records, 176 species, unpublished); (**6**) Ural Mts., Sverdlovsk oblast (930 records, 105 species); (**7**) Eastern Sayan mountain ridge, Siberia (977, 122 species, Kosheleva et al., 2009); (**8**) Altay Mts. (1488 records, 161 species, Novozhilov & Schnittler, 2010).
Broad-leaved and mixed coniferous-broad-leaved temperate forests: (9) Teberda Biosphere reserve (698 records, 101 species, unpublished data); (**10**) Far East, Sikhote Alin Biosphere reserve (3230 records, 158 species, Novozhilov et al., 2017).


Arctic mountain tundra in the Khibine mountains


Forest tundra in the Khibine mountains


Alpine communities of North Caucasus


Taiga in the Khibine mountains


Broad-leaved oak forest of f the Sikhote-Alin Range


Riparian broad-leaved forests of Volga-Akhtuba lowland


Steppe in the Caspian lowland


Desert in the Caspian lowland

Riparian broad-leaved forests of Volga-Akhtuba lowland and south Siberia: (**11**) Volgograd region (531 records, 151 species, Zemlyanskaya et al., 2016); (**12**) Riparian willow forests of south Siberia (516 records, 70 species, A.V. Vlasenko, unpublished data).
Steppes: (13) Altay Kray, Southern Siberia (310 records, 45 species, A.V. Vlasenko pers. comm. unpublished data); (**14**) Caspian lowland (509 records, 63 species, Novozhilov et al., 2006).
Deserts: (15) Caspian lowland, Russia (571 records, 40 species, Novozhilov et al., 2006).
In addition, intensive research was carried out in different arid regions of Kazakhstan: (**16**) Zaisan depression: 689 records, 45 species, Zemlyanskaya, Novozhilov, 2018; (**17**) Inder salt-dome region, 572 records, 36 morphospecies, Zemlyanskaya, Novozhilov, 2020, in press).

In spite of a number of serious efforts that have been carried out during the last few decades, the knowledge about myxomycetes of this part of Eurasia is still very far from being complete. Molecular phylogenetic studies and DNA metabarcoding have made significant changes in the taxonomy of myxomycetes and revealed a greater number of closely related (cryptic) species.
The major reason is the inaccessibility of their tropic stages, and most of the available data are based on collections of fruiting, which may represent only a minor fraction of the real diversity of myxomycetes in different habitats. Advanced molecular methods (environmental PCR connected with metagenomic approaches together with attempts at barcoding) may help to visualize the real diversity of their trophic stages. This will open up new opportunities for studying ecology and the distribution of myxomycetes.

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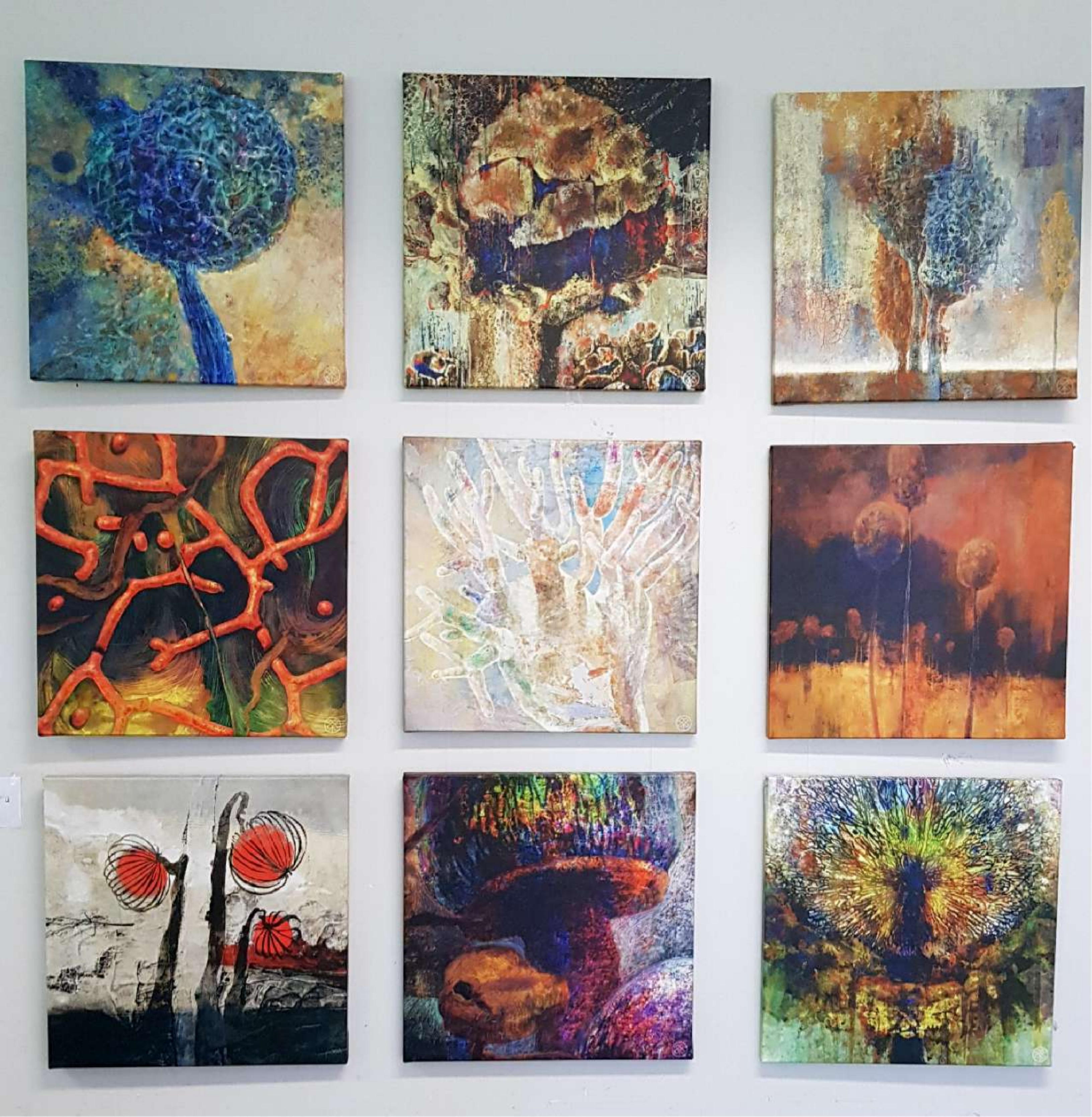

Myxomycetes recovered from moist chamber cultures of plant remains from 50 families

Diana Wrigley de Basanta

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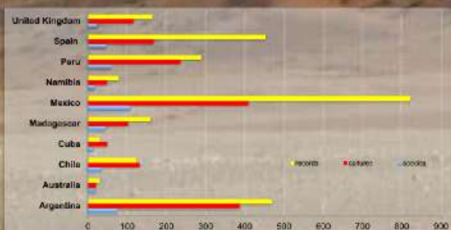
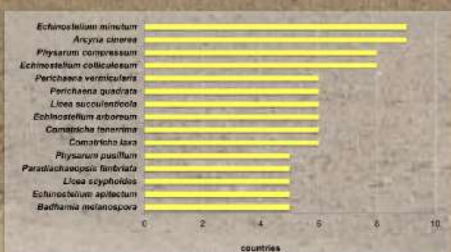
- Data have been examined from moist chamber cultures of plant remains from over 170 plant species in more than 50 families from 10 countries.

- 1666 cultures were included.
- Substrates were collected from 0 m to 5000 m elevation.
- pH range of substrates pH 3 - pH 9.
- Most pH 6.5 - pH 7.5 [mode pH 6.8].

Data on number of different species obtained by country of substrate origin



15 species recovered from 5 or more countries
100 species only recovered from one country



Most productive plant families

Family	Genera	species	records	cultures	Most common species	countries
[illegible]	[illegible]	61	210	76	Licea succulenticola	3
Bromeliaceae	Puya, Tillandsia, Deuterocohnia	43	[illegible]	[illegible]	Perichaena quadrata	4
Cactaceae (27 genera)	Copiapoa, Echinopsis, [illegible], Opuntia	62	284	144	Badhamia melanospora	4
Fabaceae	Prosopis, Acacia, [illegible]	72	[illegible]	[illegible]	Physarum decipiens	7
Fagaceae	Quercus	[illegible]	[illegible]	[illegible]	Macbrideola cornea	3
Pinaceae	Pinus, Abies	28	112	62	Echinostelium colliculosum	4

>Legume family the most productive with average 3 records per culture and the most species

Cultures 64% positive for identifiable Myxomycetes, 202 species from 30 genera, 17 new species

New Species

Didymium wildpretii *Didymium umbilicatum*
Didymium infundibuliforme *Licea eremophila*[2]
Perichaena calongei[1] *Licea succulenticola*
Lamproderma argenteobrunneum
Macbrideola andina[5] *Didymium operculatum*[4]
Physarum atacamense[3] *Perichaena nigra*
Perichaena madagascariensis
Perichaena megaspora *Didymium xerophilum*
Didymium azorellae *Licea aurea*
Cribraria spinispora

This work was supported by the myxotropic project www.myxotropic.org and grants from the National Science Foundation and the National Geographic Society

DIVERSITY OF THE MYXOBIOTA FROM THE LAGUNAS DE MONTEBELLO NATIONAL PARK, CHIAPAS, MÉXICO

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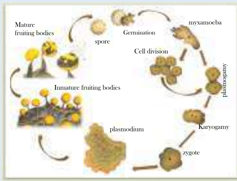
Introduction

The Lagunas de Montebello National Park (PNLM) is known as the "Central American Nucleus of Diversity" as it count with 53% of floristic composition of woody species and presents 80% of tropical tree species in Mexico. Despite the great diversity of this emblematic park, the diversity of many soil microorganisms is still unknown, including myxomycetes, which are eukaryotic organisms with an ameboid and plasmodial phase and a phase where they form spores. Its function in the ecosystem is relevant as it is the main controllers of bacterial populations, however, studies that address ecological aspects of the myxobiota associated with these ecosystems are almost nil, so this work is a contribution to the ecological knowledge of myxobiota present in different plant associations of the PNLM.

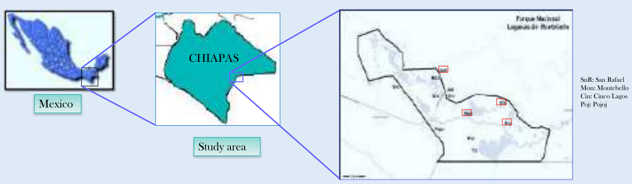


Life cycle of a myxomycete

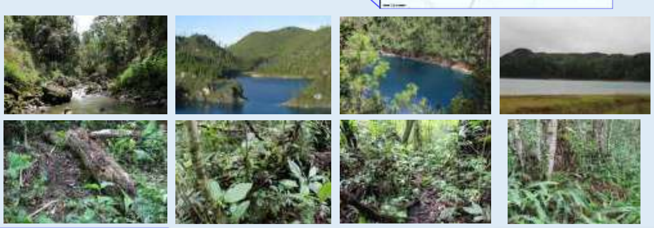

"Cinco Lagos" PNLM

Methodology

The study was carried out in four sites in the PNLM, Chiapas. Each site with different plant composition. Field sampling was carried out in each site, marking three quadrants of 10x10 m (Stephenson, 1988).



Mexico
Study area


Grutas de San Rafael: *Pinus-Quercus-Liquidambar* Forest
Pojoj: Cloud Forest
Cinco Lagos: Cloud Forest
Montebello: *Pinus-Quercus-Liquidambar* Forest

Panoramic and interior view of the selected sites

To complement the sampling, six different substrates were collected to obtain myxomycetes in the laboratory, using the moist chamber technique (MC). The specimens obtained were identified with the help of specialized taxonomic keys. The specimens were deposited in the TLXM herbarium, Tlaxcala University, Mexico.


Pinus sp. bark
Liquidambar styracillua
Quercus sp.
Aechmea sp.
Lianas
Leaf litter


MC preparation and review

Myxomycete communities were characterized for the PNLM and for each study site. The ecological analysis was carried out through the evaluation of the percentage of positive moist chambers, richness, abundance, diversity of species and the species/genus ratio (E/G) for each substrate and locality. In the same way, a comparative analysis was performed between the myxomycete communities present in each sampling site through the ecological variables obtained.

We thank all the authorities, instances and people that made possible the development of this study.

Results

A total of 67 species and one variety were found, belonging to 21 genera, 9 families and 6 orders. From the species found: 27 species were registered for the first time for Chiapas and for the PNLM; and 4 were new records for Mexico. The current number of myxomycetes for Chiapas is 131, reaching the fourth place with more richness of myxomycetes in Mexico. The most abundant species were:


Hemitrichia calyculata
Arcyria cinerea
Arcyria denudata
Cribraria confusa
Hemitrichia serpula

The locality with the highest richness and abundance values was Grutas de San Rafael (Figure 1), both in the field and in MC; however, the diversity values indicate that Montebello was the most diverse locality (Figure 2).

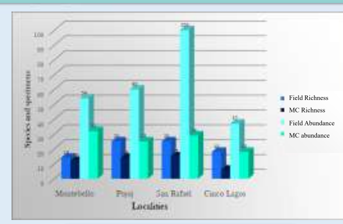


Figure 1. Richness and abundance by locality

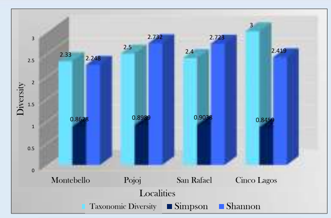


Figure 2. Diversity and taxonomic diversity by locality

In the substrates, the percentage of MC indicate that the most favorable for the development of myxomycetes were the bark of *Pinus* and lianas in all locations (Figure 3), and also, were the substrates with the highest richness and abundance values (Figure 4).

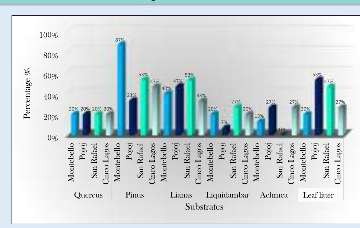


Figure 3. Positive moist chambers by substrate

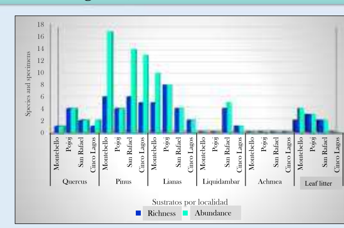


Figure 4. Richness and abundance by substrate

In the qualitative similarity analysis it was observed that Pojoj and Cinco Lagos had greater similarity, although very low, both have the same type of vegetation (CF) and have greater spatial proximity (Figure 5). In the quantitative analysis, Montebello and Pojoj were the closest (Figure 6).

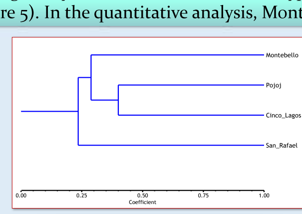


Figure 5. Qualitative similarity analysis (J)

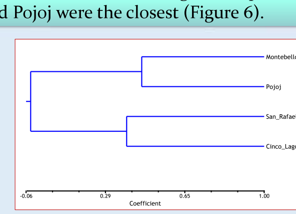


Figure 6. Quantitative similarity analysis (Im)

Conclusion: Similarity analyses showed that the environments have a particular and distinctive myxobiota; however, the degree of similarity they present is influenced by the type of vegetation and its spatial or geographical ubication.

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Are myxomycetes affected by urban centers? Preliminary evidence using traditional isolation methods

UNIVERSIDAD DE COSTA RICA

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Abstract: Most myxomycete field research takes place in natural areas and urban centers are often not considered for ecological studies. Using three radial schemes around urban centers in Costa Rica, a series of ground litter samples was collected and taken to the laboratory for moist chamber isolation. These samples came from the urban center and three points at 2.5 and 5 times the distance of such center and the edge of the respective urban area. Results showed that urban area size, topographical situation and sampling site characteristics were more important to explain results than landscape and climatic variables.

Methods: Three cities in Costa Rica were selected for this study. One large (San José) and one smaller city (Cartago), both with "spider" configuration (where conurbations exist in the periphery of the city) and one small city (San Ramón de Alajuela) with "block" configuration (no conurbations) were studied. In all of them, the distance between the periphery and the centroid of the urban patch was determined and used to generate two radiuses around the town (at 2.5 and 5 times such distance). Three sampling locations were selected at each radius (similar elevation and forest type) and one sampling location was selected around the center of the urban patch. A series of 30 samples of ground litter were collected in each one of the seven locations and taken back to the laboratory for isolation using the moist chamber technique. A total of 630 samples were studied. Satellite images were used to generate land-use metric associated with each sampling location.

Results: In **Figure 1** it is shown the spatial arrangement of urban patches and sampling locations used in the present study. Due the overlap between some areas of San José and Cartago, the city of San Ramón was also used during a separate analysis. For this study, the distance between the urban centroid and the further radius were 5.5, 7 and 12.5 kilometers for San Ramón, Cartago and San José.

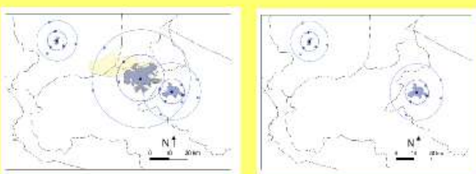

Figura 1. Map showing all (left) and small (right) urban centers studied herein (polygons) and sampling locations (points) with the calculated radiuses around the urban centroids

Using satellite imagery from 2017, a series of landscape-based variables were calculated. These parameters as well as the number of records and species of myxomycetes associated with the different sampling locations are presented in **Table 1**.

Table 1. Number of records and species of myxomycetes found in the present study arranged by radius and urban center analyzed (CTG=Cartago, SJO=San José, SRM=San Ramón) along with average values of three landscape-level indicators and associated diversity indices.

	Records	Species	NDVI*	% Forest	% Buildings	Simpson DI*	Shannon DI*
CTG 0	4	3	0.35	25.00	30.00	0.63	1.21
CTG 2.5	23	9	0.38	24.85	26.66	0.63	1.26
CTG 5.0	31	8	0.45	32.20	26.48	0.71	1.50
SJO 0	26	12	0.30	23.00	0.00	0.89	2.44
SJO 2.5	107	23	0.40	42.23	29.87	0.90	2.60
SJO 5.0	156	23	0.49	48.05	15.21	0.87	2.54
SRM 0	19	9	0.30	3.00	92.00	0.84	2.12
SRM 2.5	40	10	0.47	30.77	13.86	0.51	1.09
SRM 5.0	18	8	0.47	64.95	2.70	0.63	1.33

On **Table 2**, it is shown the complete record of myxomycetes observed. The most productive combination was found in San José at 5 times the distance from the urban centroid. Similarly, Cartago showed the same pattern. However, San Ramón, the only block-configured city, showed that the urban centroid was the most productive location.

Analyzing the radiuses around the cities (**Figure 3**), it seems obvious that there can be other parameters such as wind direction, topography and temperature isoclines that can affect results.

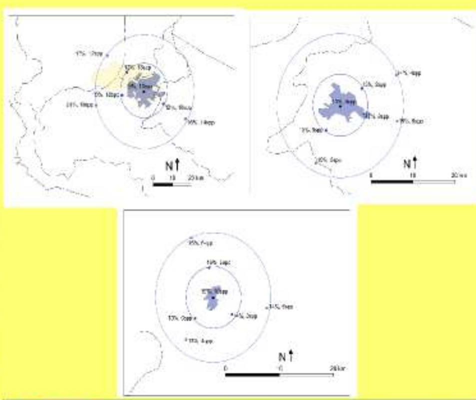

Figura 3. Percentage of records and number of species found in each sampling location of: San José (top left), Cartago (top right), San Ramón (bottom)

Table 2. Number of records per species (codes at the bottom) observed in each radius associated with each urban center. Values in parenthesis are averages of the three replicates in each case.

Especies	CTG 0	CTG 2.5	CTG 5.0	SJO 0	SJO 2.5	SJO 5.0	SRM 0	SRM 2.5	SRM 5.0
ARCafr					3	3			
ARCcin	1	1		5	10	12	1	2	
ARCden					1				
ARCmin								1	
COMnig						1		1	1
COMpul					2	1			
COMten			1						
DDYane							1		
DDYbah		1	9	3	12	7	1	1	1
DDYcla				1	2	3			
DDYdif		1		5	19	18	1		5
DDYdub					2				
DDYiri				1	3	4			
DDYmin		1		2	10	6			
DDYsqu					11	25		1	3
DIAleu				1	2			20	1
DIDhem	2	1	2	2	5	36	1	5	2
FULint		1					2		
HEMpar				1	1	1			
LAMsci					3	10			1
PERchr		1	2		2	3	4		
PERdep					3	1			
PERped				1		3			
PERver					1	1			
PHYaur					1				
PHYbiv					1				
PHYcin		2	1		1	2			
PHYcit				1		1			
PHYcom	1	14	14	3	10	11	7	7	4
PHYdio			1		2		1		
PHYgal								1	
PHYmel						1			
PHYpus						5			
PHYspe			1						
PHYsup								1	
STEfus						1			
Total	4	23(7.6)	31(10.3)	26	107(35.6)	156(52)	19	40(13.3)	18(6)

Species abbreviations:, ARCcin= *Arcyria cinerea*, ARCden= *Arcyria denudata*, ARCmin= *Arcyria minuta*, COMnig= *Comatricha nigra*, COMpul= *Comatricha pulchella*, COMten= *Comatricha tenerrima*, DDYane= *Didymium anellus*, DDYbah= *Didymium bahiense*, DDYcla= *Didymium clavus*, DDYdif= *Didymium difforme*, DDYdub= *Didymium dubium*, DDYiri= *Didymium iridis*, DDYmin= *Didymium minus*, DDYsqu= *Didymium squamulosum*, DIAleu= *Diachea leucopodia*, DIDhem= *Diderma hemisphaericum*, FULint= *Fuligo intermedia*, HEMpar= *Hemitricha pardina*, LAMsci= *Lamproderma scintilians*, PERchr= *Perichaena chrysosperma*, PERdep= *Perichaena depressa*, PERped= *Perichaena pedata*, PERver=*Perichaena vermicularis*, PHYaur= *Physarum auriscalpium*, PHYbiv= *Physarum bivalve*, PHYcin= *PHysarum cinereum*, PHYcit= *Physarum citrinum*, PHYcom= *Physarum compressum*, PHYdio= *Physarum didermoides*, PHYgal= *Physarum galbeum*, PHYmel= *Physarum melleum*, PHYpus= *Physarum pusillum*, PHYspe= *Physarum spectabile*, PHYsup= *Physarum superbum*, STEfus=*Stemonitis fusca*.

Recommendations: 1) to continue studying the effect of urban centers on myxomycete fruiting patterns. 2) to design new experiments (colonization, for example) in the same areas as a strategy to correct experimental errors associated with site effect. 3) to include a series of local indicators of disturbance (for instance, chemical variables at soil level) for a more integrated evaluation.

Evaluating the moist chamber protocol for myxomycetes in three different forest types in Costa Rica

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c Engineering Research Institute, University of Costa Rica, San Pedro de Montes de Oca, 11501-Costa Rica

INTRODUCCION

The extended region of Guanacaste in Costa Rica is represented by dry, moist and wet tropical forests. The last two are more typical of higher elevations than the former. In order to test the viability and usefulness of the moist chamber technique in a precipitation gradient, three areas were selected within Guanacaste. A series of 720 substrate samples represented by bark and ground litter were collected for this study, and during the moist chamber laboratory process, both environmental and microhabitat variables were determined. For the first, temperature, air humidity, light and barometric pressure of the laboratory were obtained; whereas humidity, temperature and pH were obtained at regular intervals inside the moist chambers. Results showed that the "typical" non-controlled laboratory conditions in Costa Rica´s central valley where close to 23.5°C, 74% humidity, 160 lux and 29.8 bars. The "typical" conditions of moist chambers were 20.7°C, 31.8% humidity and a pH around 6.3. With those conditions, samples from the driest forest yielded more species and showed more activity than those from the moist and wet forests. It is interesting to note the high laboratory humidity and the very mild temperature during the moist chamber process and the observation that cultures dehydrate slower than in laboratories with more controlled conditions. It is thought that those two factors along with the relative positioning of the cultures within the laboratory space may have an effect on results. In this manner, twin samples in different laboratories may yield different results. Similar evaluations on other laboratories would be useful to test the latter idea.

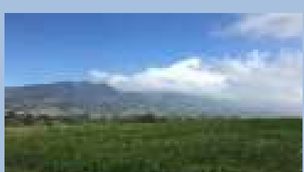
METHODS & TECHNICALS

Sampling was as follows: two sampling zones were selected at each site (successional forest and old-growth forest) and within each zone 10 microsites (12 samples in each) were sampled. Thus, 240 samples were collected per site for a total of 720 samples. Half of the samples were from bark of living trees and the other half from leaf litter. All the material was taken to the laboratory where it was processed with the wet chamber technique. Lab and wet chamber conditions were measured and all isolation was performed.

Laboratory conditions
23.5 ° C
74% humidity
160 lux
29.8 bars

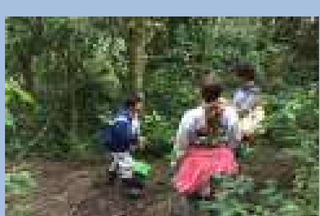
Wet chamber conditions
20.7 ° C
31.8% humidity
pH around 6.3

Conditions of the three sites
Palo Verde: 25 ° C, 1300 mm rain / year
Tenorio: 20 ° C, 3500 mm rain / year



Marked microclimates in Guanacaste ... view of Miravalles volcano from the east. On the left you can see the blue and non-cloudy sky of the southern part (where the green stick is), on the right you can see the clouds and the characteristic humidity of the north of the Guanacaste mountain range (where it is tenorio). Miravalles is in the center ...

View of the dry forest of Palo Verde



Principal investigator and assistants collecting material in Tenorio Volcano National Park.

RESULTS

After the whole process, we observed that there was more record of species and observations associated with Palo Verde (the driest zone). As no molecular work has been done, the above is simply an indication that small variations in natural sites have an effect on the data of myxomycetes that can be recorded. This may be related to the type of trees present, the phenological dynamics of myxomycete species and other biological processes (symbiosis, depredations, etc.) associated with forest types.

Working group after the collection at the Miravalles volcano. This project was supported by Lincoln Memorial University

Species List

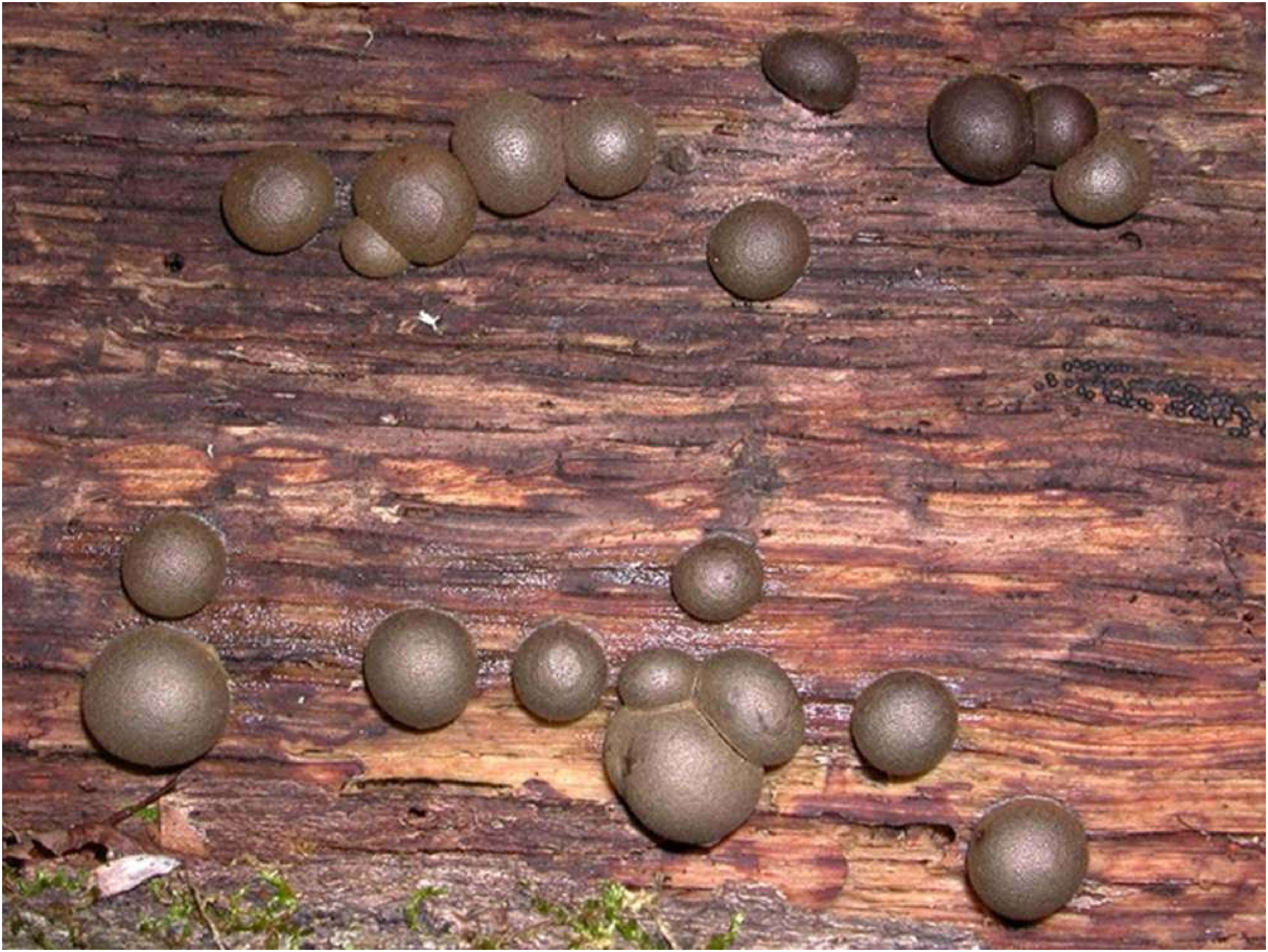
Species	Miravalles	Palo Verde	Tenorio
Arcyria cinerea	14	57	19
Arcyria denudata		2	
Arcyria incarnata		1	4
Clastoderma debaryanum			2
Comatricha aequalis		7	
Comatricha laxa	1		
Comatricha nigra	1	3	3
Comatricha tenerrima	6	3	2
Cribraria microcarpa	1	1	2
Cribraria tenella	1	6	7
Cribraria violacea	5	19	
Didymium anellus		3	
Didymium bahiense		1	1
Didymium difforme	3		
Didymium dubium		1	
Didymium minus			1
Didymium squamulosum		1	
Diachea leucopodia		1	
Diderma hemisphaericum		3	
Diderma rugosum	2		
Hemitrichia calyculata			1
Lamproderma scintillans	2		2
Licea pusilla			1
Perichaena chrysosperma	8	8	1
Perichaena depressa	2	12	
Perichaena pedata		3	
Perichaena vermicularis		1	
Physarum album		6	
Physarum bivalve		16	
Physarum compressum		10	
Physarum decipiens		18	
Physarum didermoides		1	
Physarum javanicum		2	
Physarum leucopus		1	
Physarum pusillum	4	10	
Physarum viride		1	
Stemonitis fusca	3	5	2
Trichia decipiens		1	
Number of species	14	30	14
Number of records	53	204	48
Taxonomic Diversity Index	1.55	3	1.4

Species	Successional	Old-growth
Arcyria cinerea	39	51
Arcyria denudata		2
Arcyria incarnata		5
Clastoderma debaryanum	2	
Comatricha aequalis	2	5
Comatricha laxa		1
Comatricha nigra	1	6
Comatricha tenerrima	8	3
Cribraria microcarpa	2	2
Cribraria tenella	14	
Cribraria violacea	15	9
Didymium anellus	1	2
Didymium bahiense	1	1
Didymium difforme	1	2
Didymium dubium		1
Didymium minus		1
Didymium squamulosum		1
Diachea leucopodia	1	
Diderma hemisphaericum	1	2
Diderma rugosum		2
Hemitrichia calyculata	1	
Lamproderma scintillans	3	1
Licea pusilla		1
Perichaena chrysosperma	8	9
Perichaena depressa	3	11
Perichaena pedata	2	1
Perichaena vermicularis		1
Physarum album	4	2
Physarum bivalve	16	
Physarum compressum		10
Physarum decipiens	10	8
Physarum didermoides		1
Physarum javanicum	1	1
Physarum leucopus		1
Physarum pusillum	7	7
Physarumm viride		1
Stemonitis fusca	4	6
Trichia decipiens		1


On the Track of the
Elusive Slime Mold


Tracks!


Pandapas Pond
DAY USE AREA
JEFFERSON
National Forest
FOREST SERVICE
U S
DEPARTMENT OF AGRICULTURE




HOBBS HALL


VirginiaTech

Steps along the way

- Lynchburg College (General Botany Class)
- Virginia Polytechnic Institute (Miller's Introductory Mycology)
- Field research for my Ph.D. degree (forest ecology of the Central Appalachians)
- Started to notice myxomycetes in the field
- First few collections (*Stemonitis axifera* was Stephenson #1)
- Post-doc at Mountain Lake during the summer of 1982


WVU


MOUNTAIN LAKE BIOLOGICAL STATION
OF THE
UNIVERSITY OF VIRGINIA
THE STATION WAS FOUNDED IN 1930 BY THE UNIVERSITY FOR INSTRUCTION AND RESEARCH IN FIELD BIOLOGY. THE STATION INCLUDES OVER 600 ACRES AND BORDERS ON AN ADDITIONAL 1500 ACRES DESIGNATED BY THE FOREST SERVICE AS A SCENIC AREA TO BE KEPT IN ITS NATURAL STATE.
COLLECTION OF PLANTS AND ANIMALS WITHOUT PERMISSION FROM THE DIRECTOR IS PROHIBITED.

What the heck are myxomycetes??

- Group of fungus-like organisms
- Only about 1000 species worldwide
- Not something the average person knows very much (if anything) about
- Most are small and easily overlooked
- Not a particularly attractive common name ("slime mold")

YES

NO

Why study myxomycetes?

- There are places in the world where they have never been studied
- We know relatively little about their patterns of distribution worldwide
- There is a lot we don't know about their role in nature
- How they interact with other organisms is still largely a "black box"

Some Basic Definitions

- **Habitat – a particular type of ecological community (e.g., forest, grassland or desert)**
- **Microhabitat – one of the component parts of the larger habitat**

Microhabitats

- Coarse woody debris
- Ground litter
- Bark surface of living trees
- Dung of herbivores
- Aerial litter
- Lianas (in tropical forests)
- Inflorescences of large herbs

Microhabitats

- Epiphylls (in tropical forests)
- Bryophytes
- Soil (major microhabitat!)
- Submerged plant debris
- Succulent plants
- Canopy soil (in rainforests)

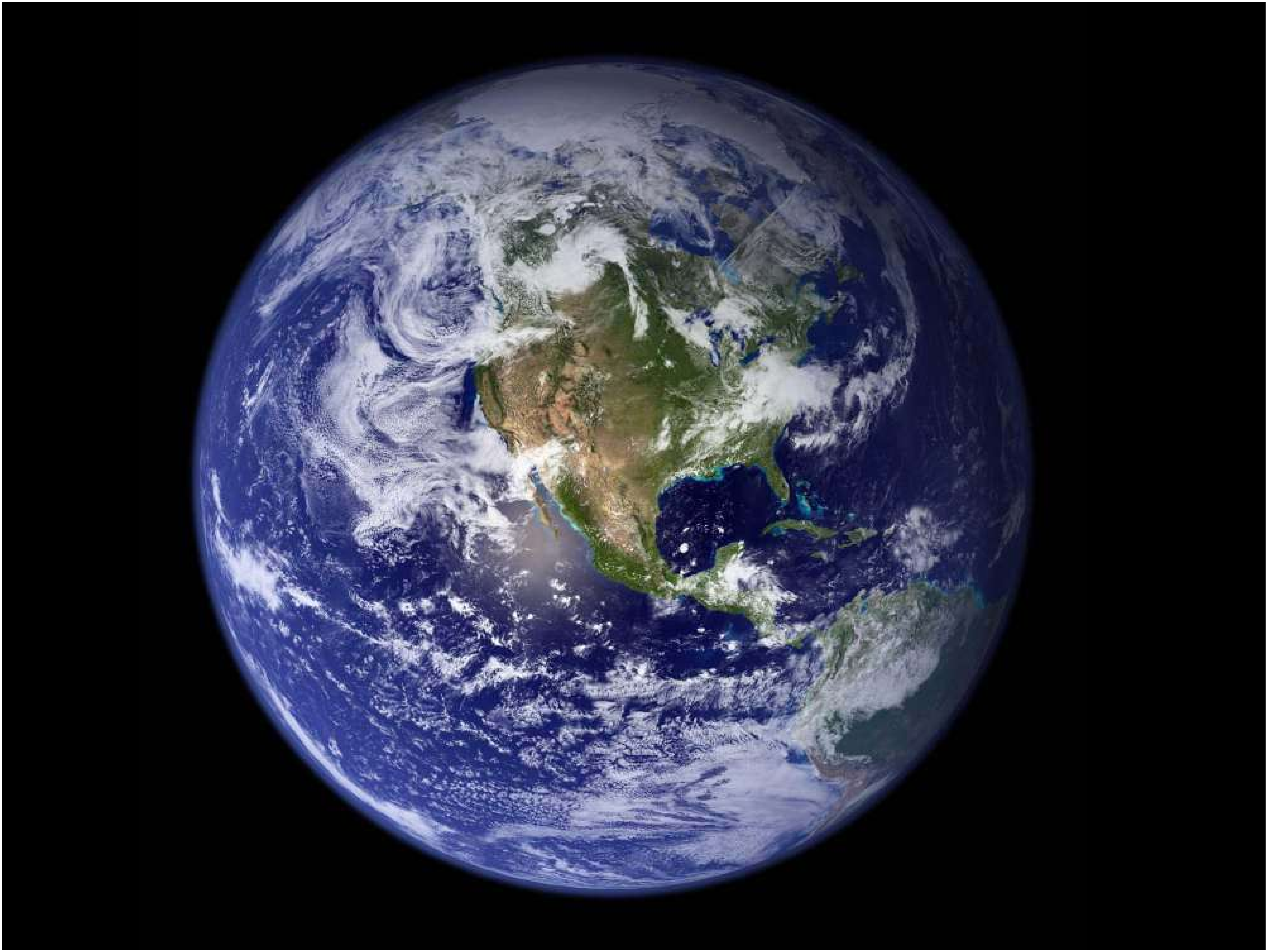

Methods of Study

- Specimens that have developed under natural conditions in the field
- Specimens that appear on samples of organic material used to prepare moist chamber cultures in the laboratory


Echinostelium minutum

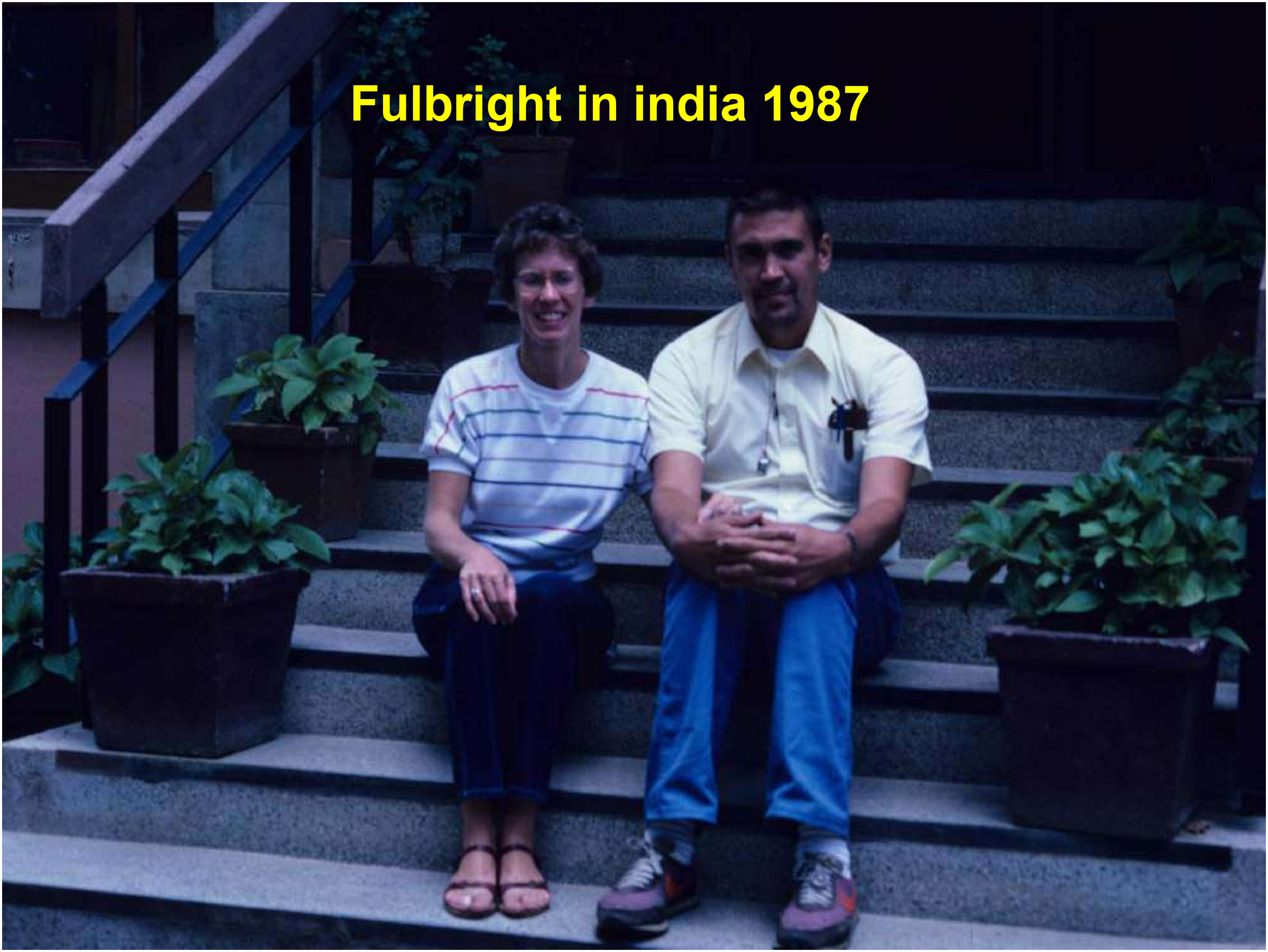
Factors that influence the distribution of myxomycetes

- Moisture
- Temperature
- Availability of suitable substrates
- Dispersal of spores



Research is
a process
of exploration
and discovery

….but the process requires funding!


Fulbright in india 1987

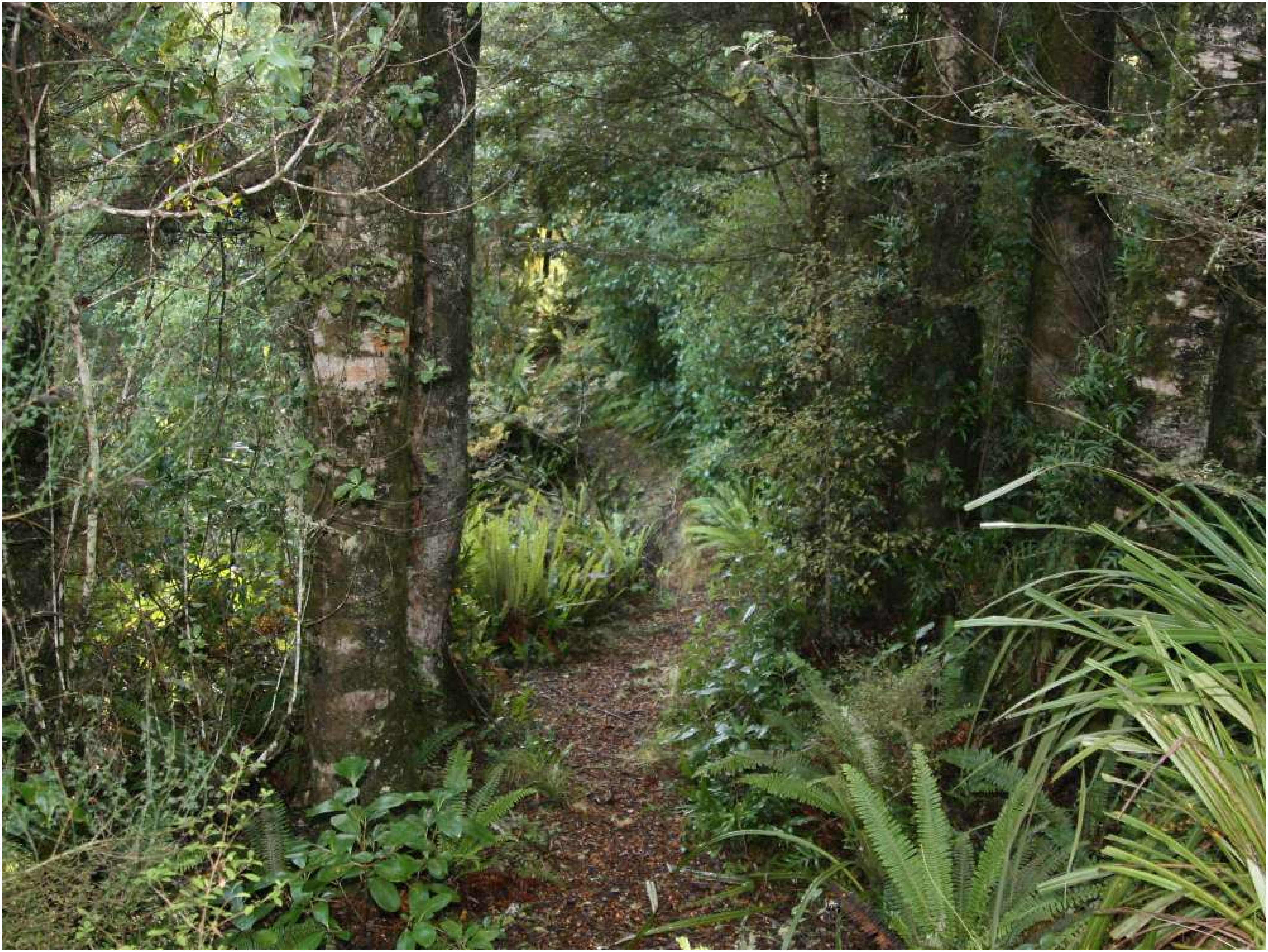

PHILIPS
SUPER ELECTRONICS
FOUR SQUARE
Stop
HP 25
0766
Himachal Road Transport Corporation


BORDER ROADS ORGANISATION
WEL COME TO ROHTANG TOP
A GATE WAY TO LAHAUL VALLEY
38TF ALT-13050 FT 70RCC

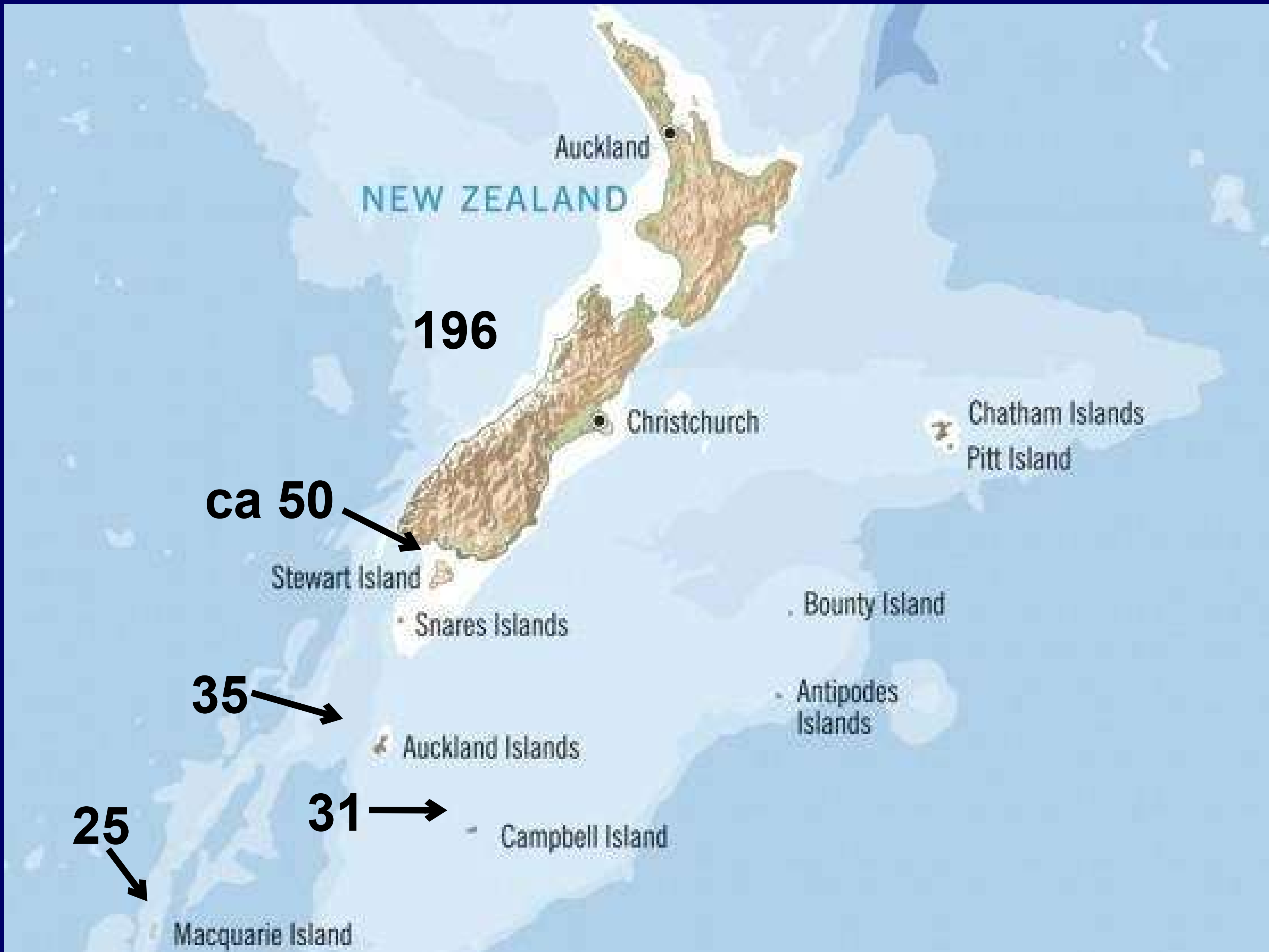

Research in Alaska from 1989 onwards
funded by the National Park Service


New Zealand 1992 onwards funded by
the National Geographic Society


DLK235




Egmont National Park
Around the Mountain Circuit
Around the Mountain Circuit
Information
You are in a mountain area.



Auckland
NEW ZEALAND
196
Christchurch
Chatham Islands
Pitt Island
ca 50
Stewart Island
Snares Islands
Bounty Island
35
Antipodes Islands
Auckland Islands
31
Campbell Island
25
Macquarie Island

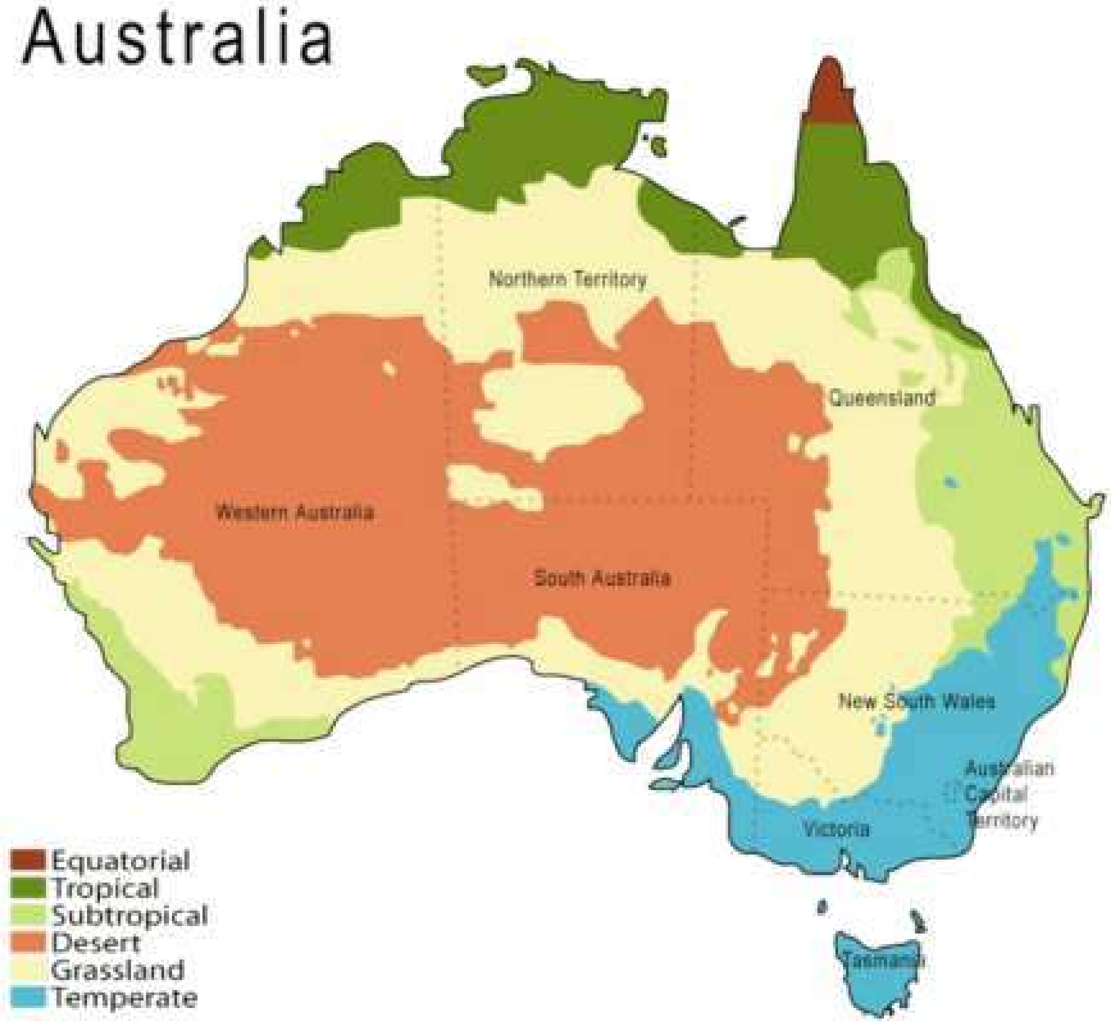

Australian Antarctic Division
National Science Foundation
National Geographic Society


Continent Number 7!


Neotropics 1996 onwards funded
by the National Science Foundation


SE Asia 2008 onwards funded by
the National Science Foundation


สูงสุดแดนสยาม
THE HIGHEST SPOT IN THAILAND
2565.3341 Meters Above Mean Sea Level

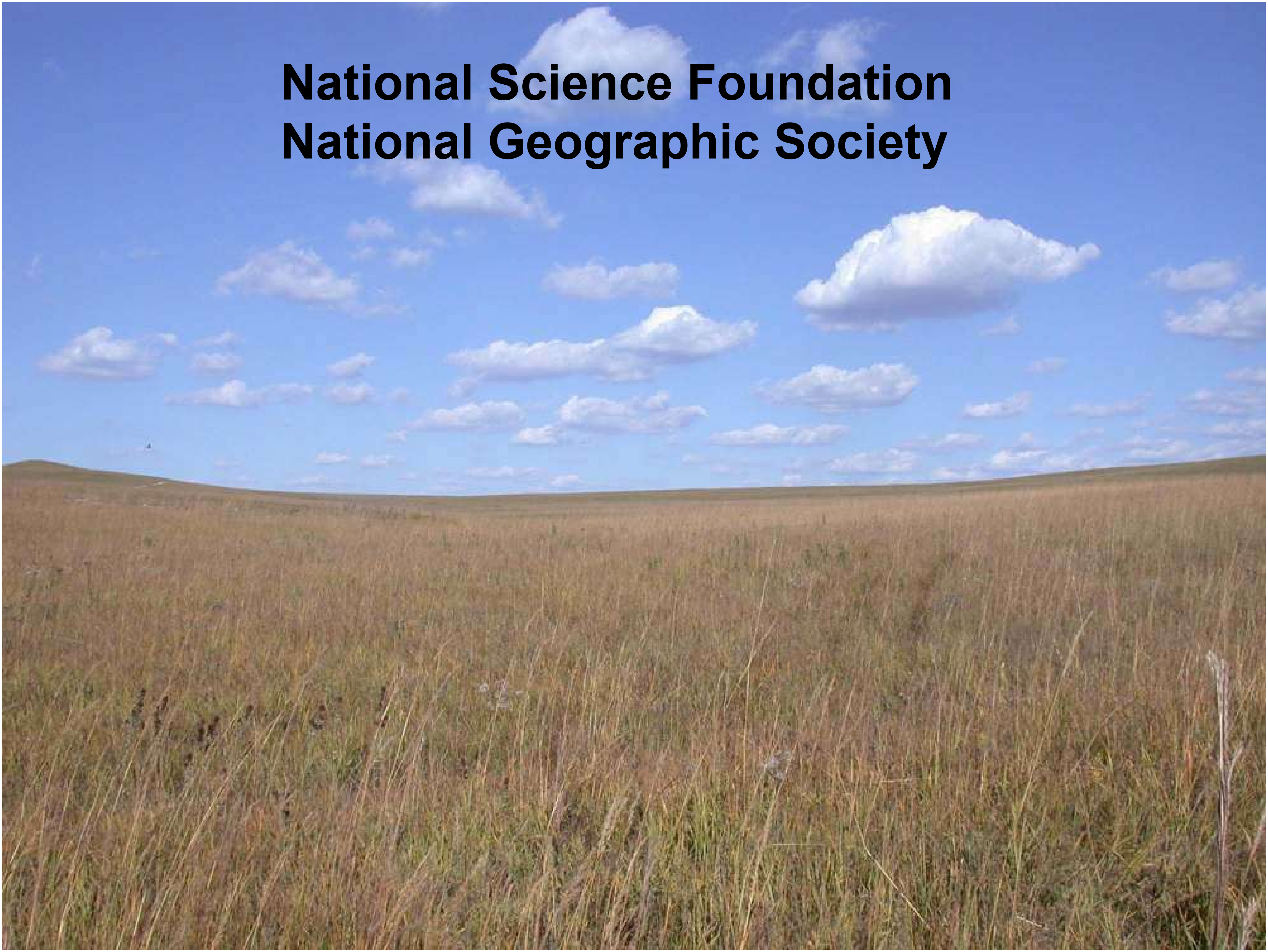


Australian Biological Resources Study Programme
National Science Foundation (several grants)
National Geographic Society

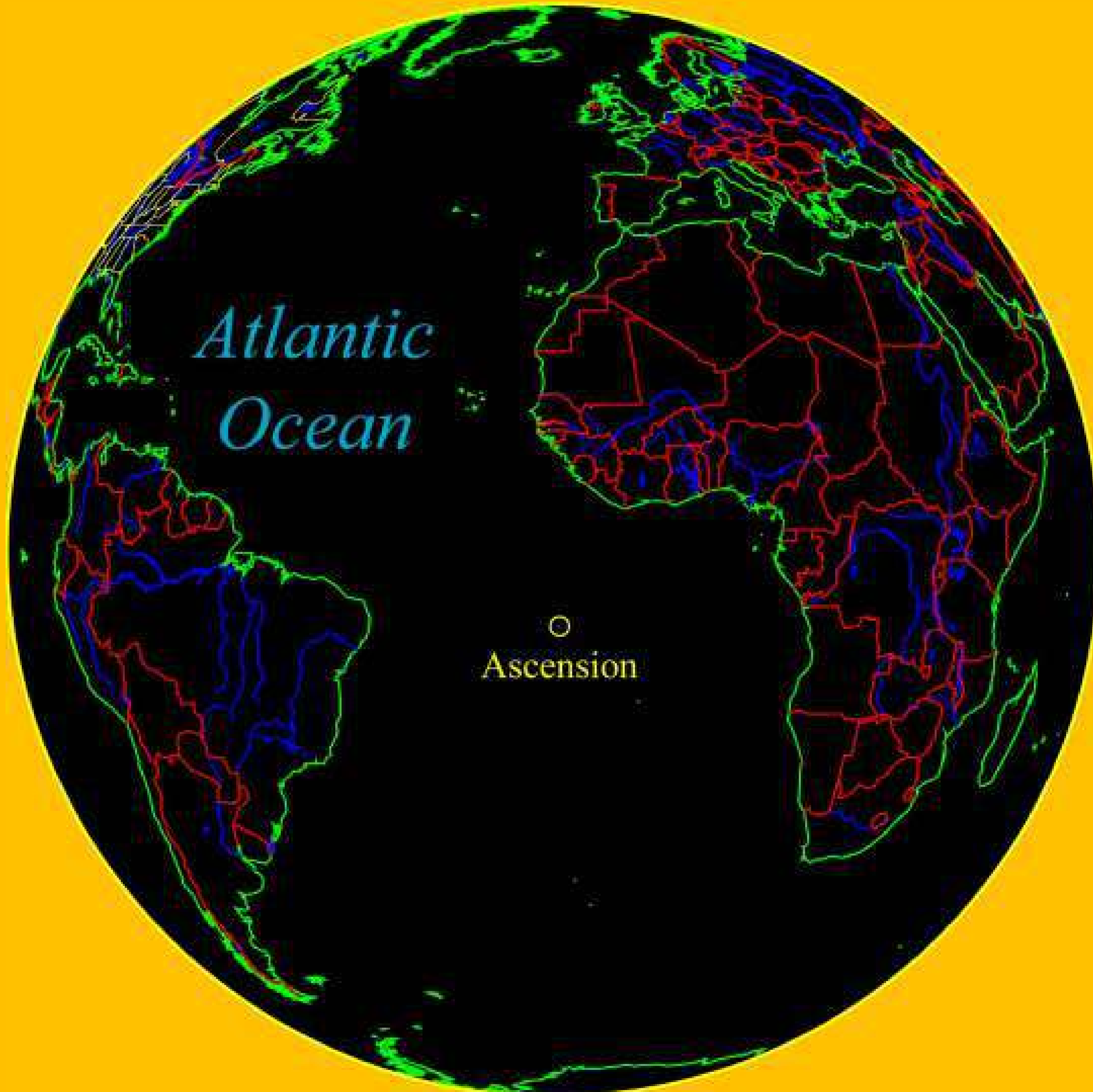

AUSTRALIAN
TROPICAL MYCOLOGY
RESEARCH CENTRE

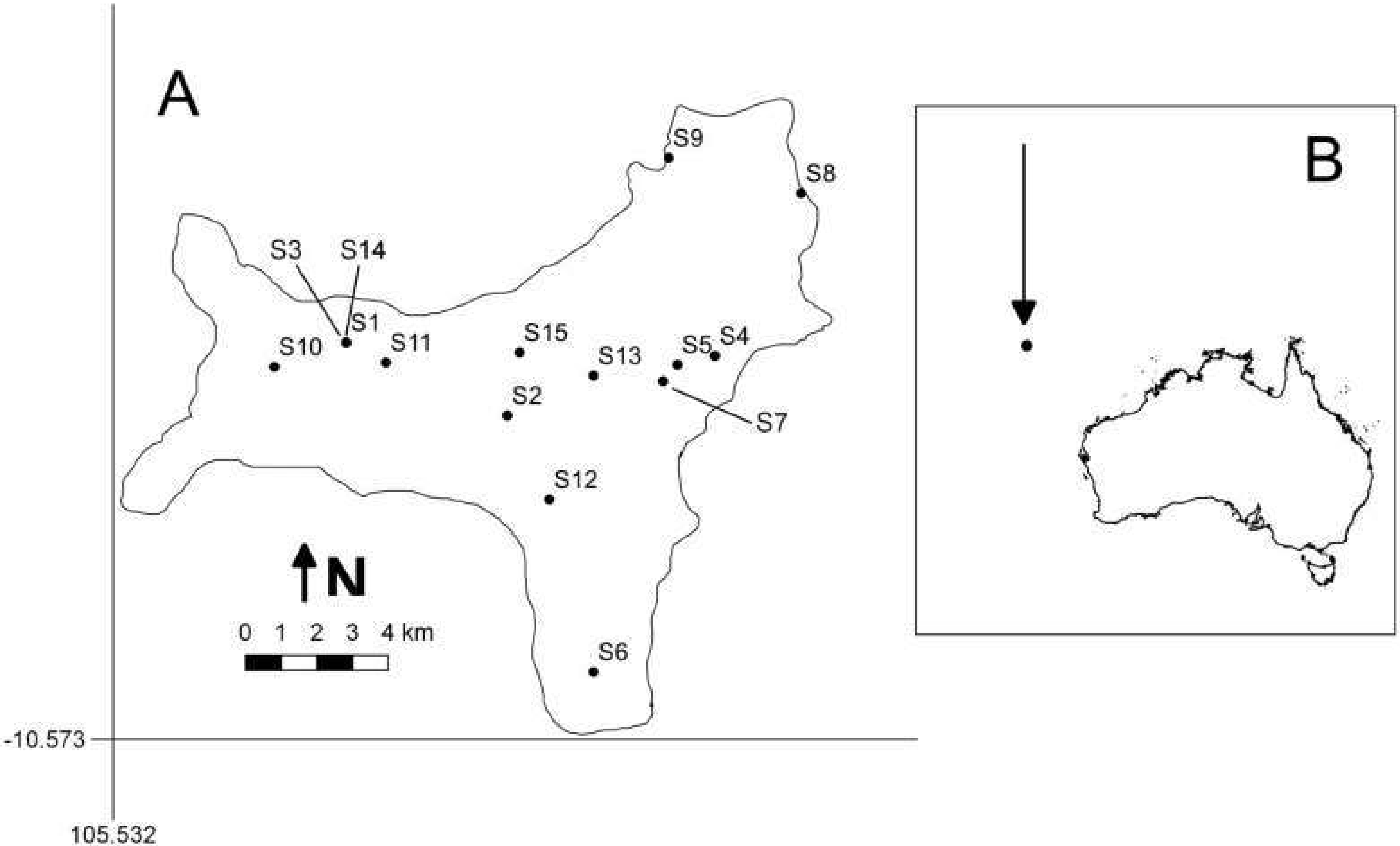

KOSCIUSZKO
NATIONAL PARK


1859!


National Science Foundation
National Geographic Society


Physarum atacamense


Atlantic
Ocean
Ascension



15 study sites

Species new to science

Alwisia lloydiae
Comatricha pseudonigra
Cribraria bicolor
Diderma novaezelandiae
Didymium macquariense
Elaeomyxa australiensis
Lepidoderma cristatosporum
Licea metallica
Perichaena echinolophospora
Trichia brimsiorum

Acknowledgments

- My wife Barbara, for her constant support (and considerable assistance in the field)
- The funding sources listed in this presentation, including nine grants from the National Geographic Society, 18 grants from the National Science Foundation and various other sources of financial support
- Numerous individuals, including under-graduate students, graduate students, colleagues and collaborators throughout the world

Special People

- Randy Darrah
- Arturo Estrada-Torres
- Thida Win Ko Ko
- Carlos Lado
- John Landolt
- Gary Laursen
- David Mitchell
- Yura Novozhilov
- Carlos Rojas
- Adam Rollins
- Martin Schnittler
- Fred Spiegel
- Hanh Tran
- Diana Wrigley de Basanta

Thanks for letting me "ramble on" about myxos!

A SLIME-MOLDER'S SWAN SONG – THE WORK THAT IS LEFT TO BE DONE

FREDERICK W. SPIEGEL
UNIVERSITY OF ARKANSAS

How I got to the cusp of retirement:

- **Until just a few years ago, I considered myself a mycologist who worked in an obscure corner of mycology, which is an obscure corner of botany, which is an obscure corner of eukaryote biology.**

- **Now, I am a protistologist working with Amoebozoa, a big chunk of protistology, which is still, unfortunately, an obscure corner of eukaryote biology.**

- **So, what can I do to encourage the recent converts to slime mold studies to do to kick butt in biology?**

Gayle Hansen

This is Gayle Hansen, a fellow Botany grad student at UNC in the mid-1970s.

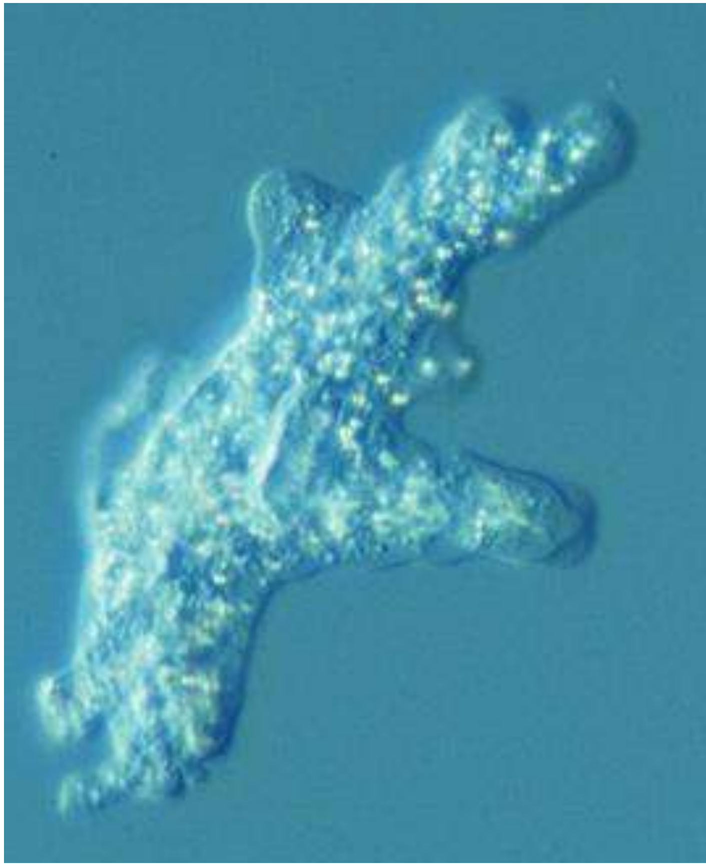
Her field of study is in marine phycology, especially in red algae.

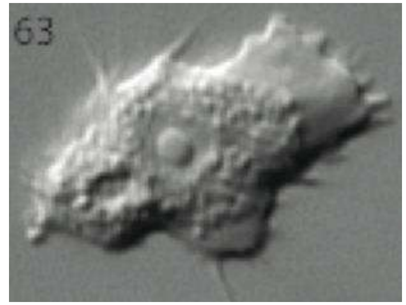
In a hallway conversation one day, she said:

"Fred, wouldn't it be great if we cryptogamic botanists had colleagues like the higher plant people have? They have taxonomists, physiologists, ecologists, morphologists, geneticists, etc., and we have to do everything ourselves."

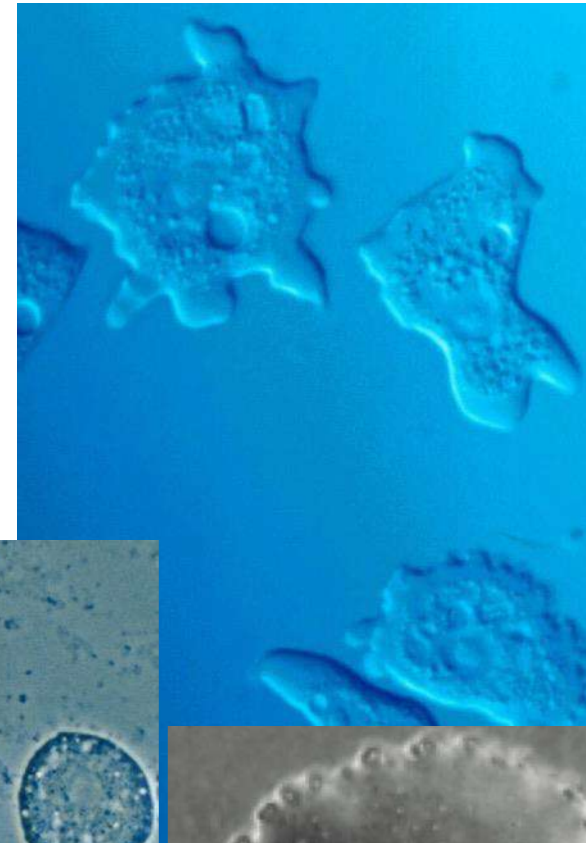
Though this is something of a lament, it is also a blessing since those of us who work on the marginalized part of the biotic world learn to be much more complete biologists than most of the folks in the over-emphasized areas.

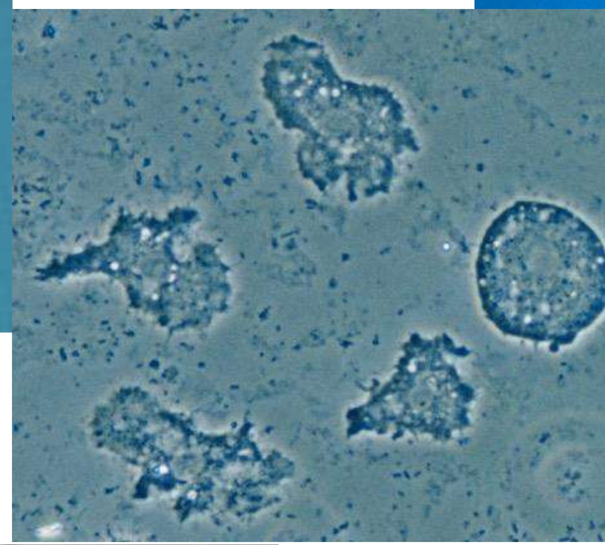
53 YEARS OF FORMAL EXPOSURE TO MYCETOZOANS WITH AN INAUSPICIOUS START IN 1967.

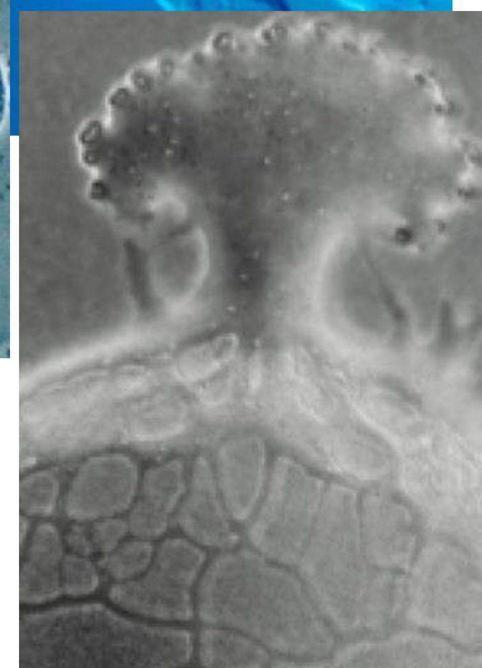




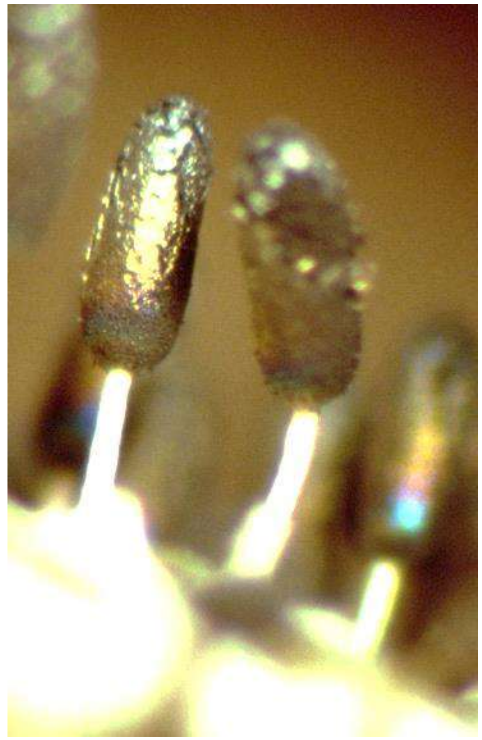
But not a totally inauspicious situation.

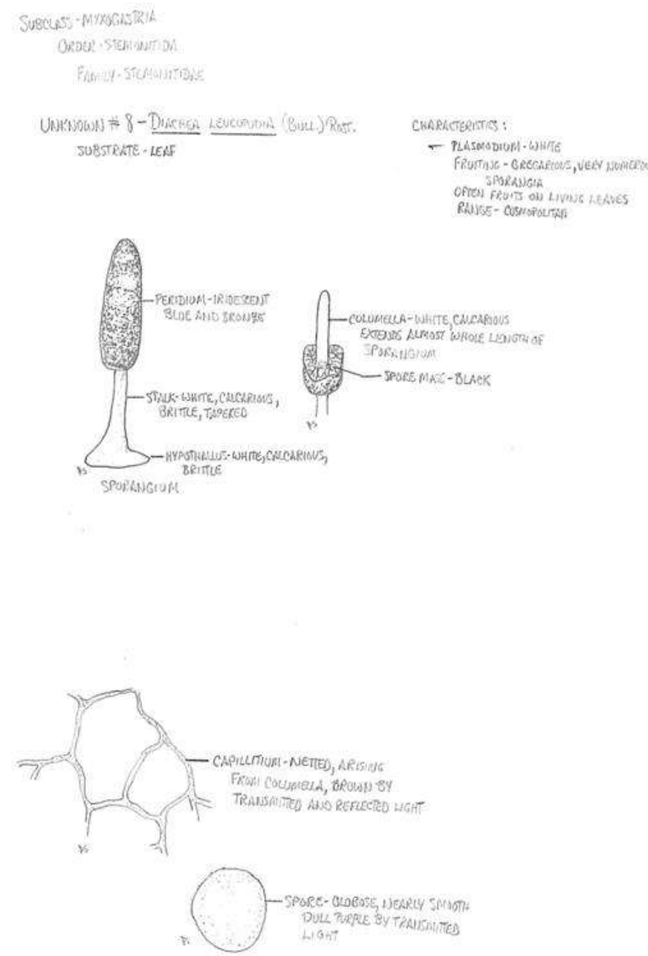


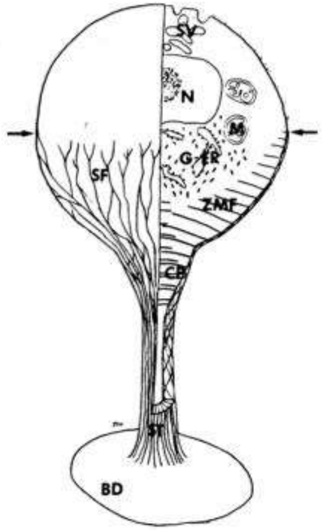


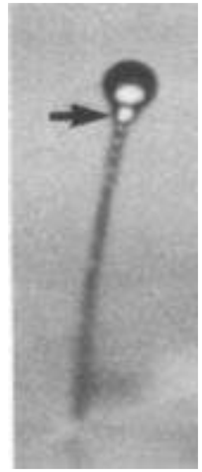


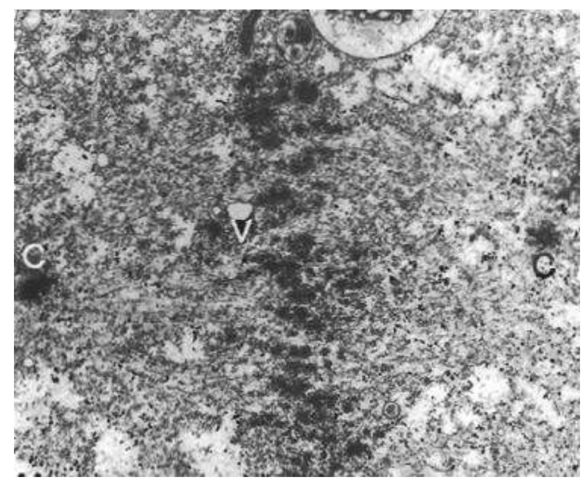
JUMP AHEAD SEVEN YEARS TO 1974.
I GOT AMBUSHED.






SV
N
M
G
ER
SF
ZMF
CR
ST
BD

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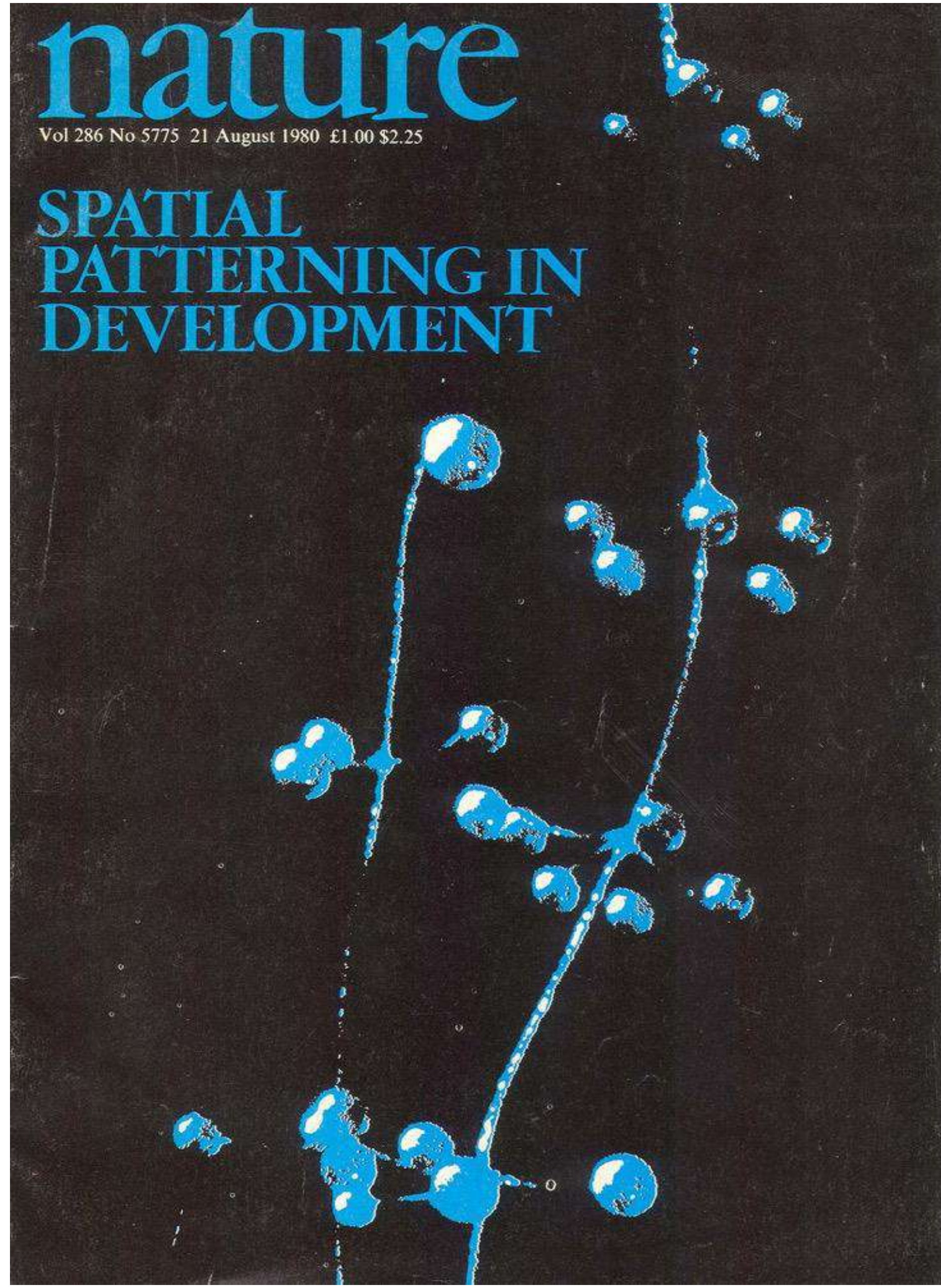
Ted Cox

John Bonner

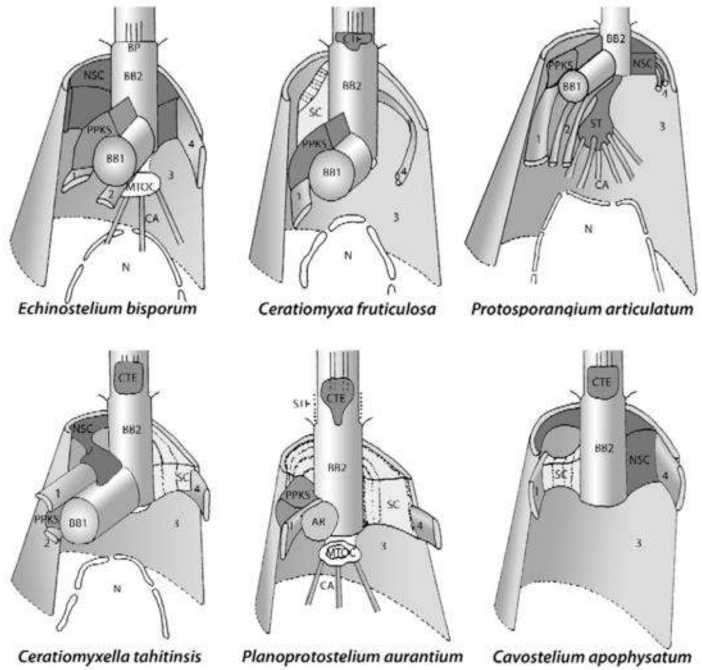


POST-DOC ON THE DARK SIDE TO BECOME A REAL SCIENTIST

Learning some context in the world

Karl Mattox

Ken Stewart

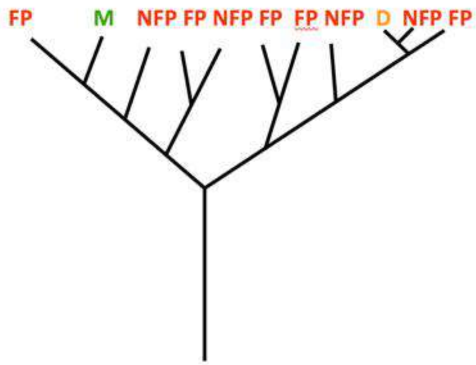


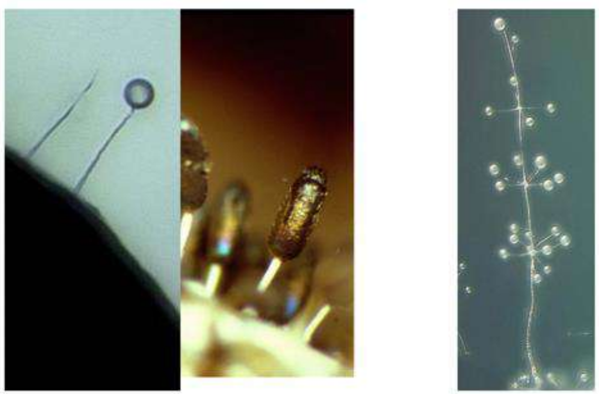
Matt Brown after Spiegel 1990

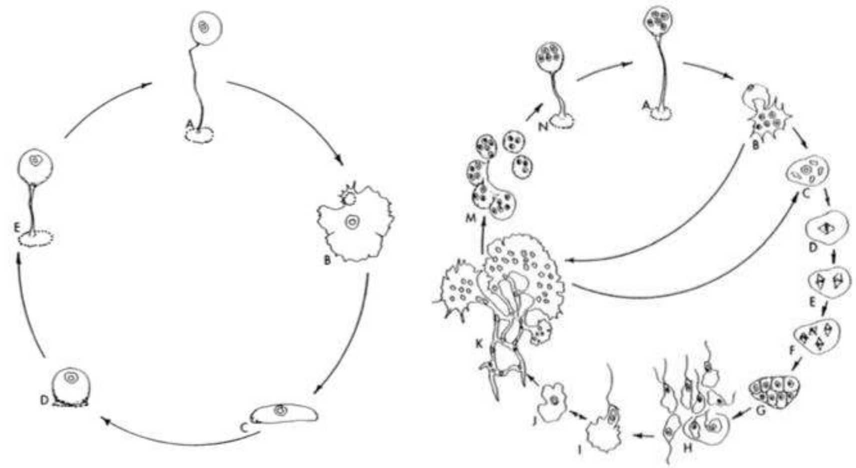
Martha Powell

Lots of Good Influences at Arkansas

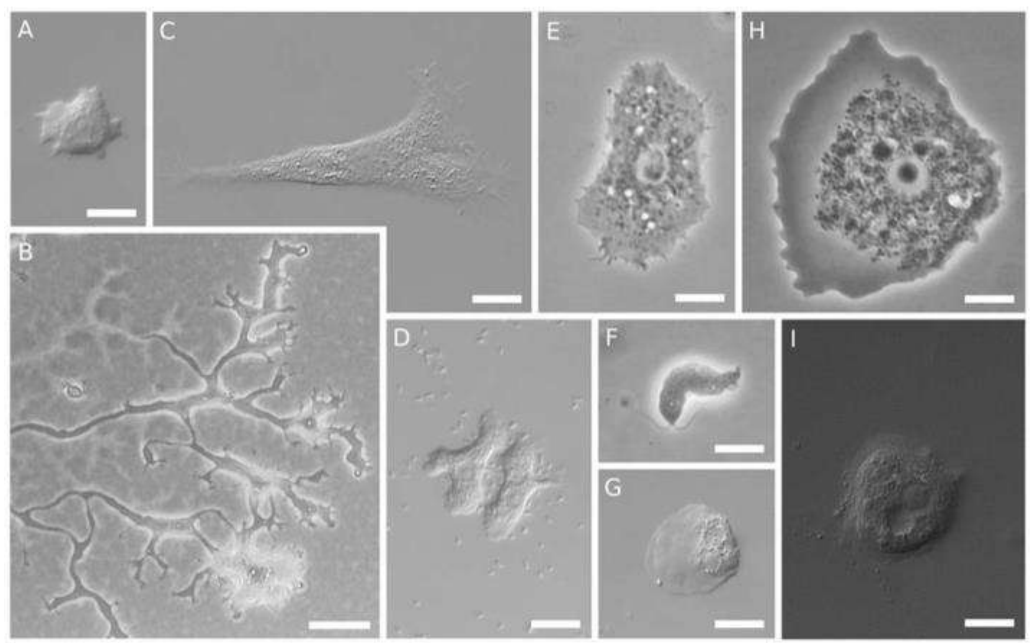
Eumycetozoa



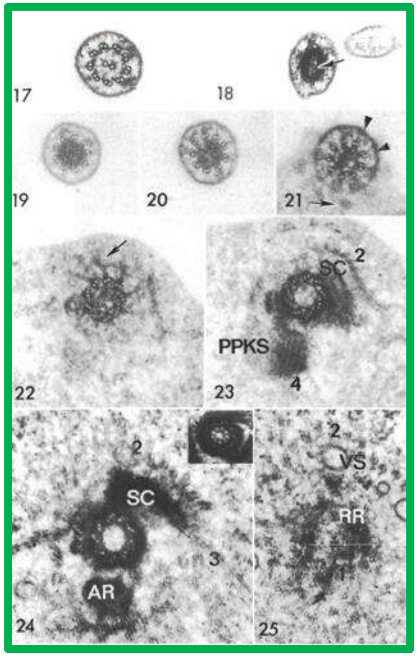


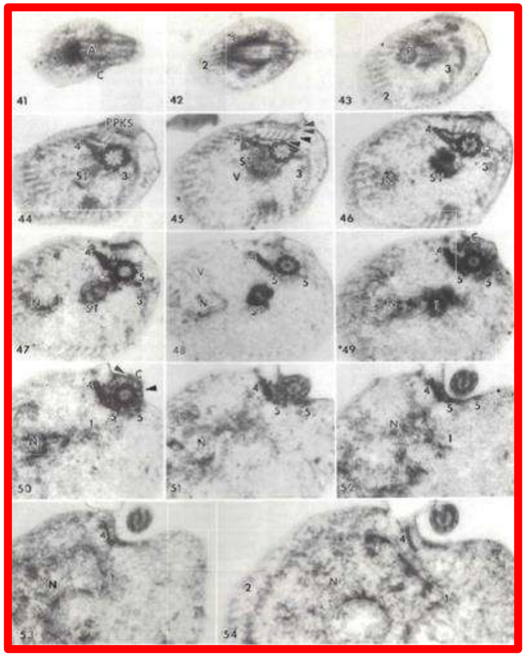


From: Spiegel et al. 2017



From: Shadwick et al. 2009





Spiegel 1982
Spiegel et al. 1986

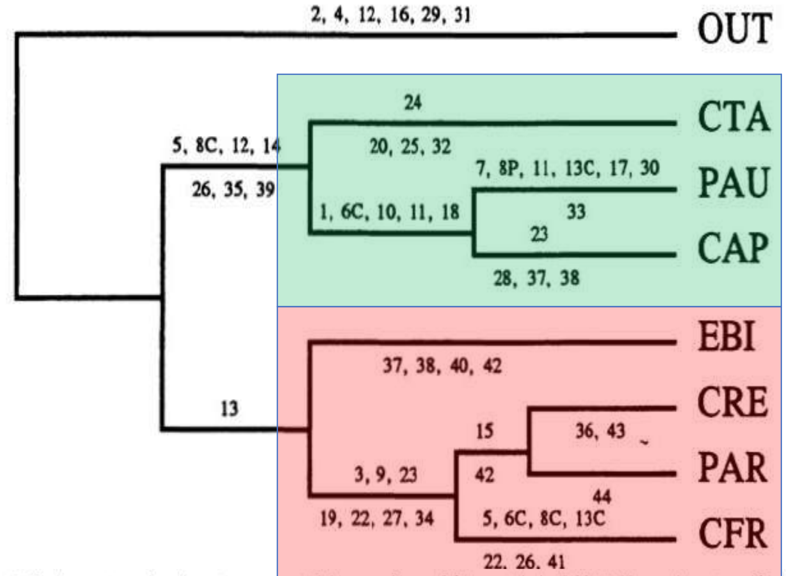


Fig. 2. Single most parsimonious tree generated from analyses of data matrix in Table 3. Numerals on top side of each line are character changes in the first analysis, those on bottom are those additional characters included in the second analysis. C = convergence, P = parallelism.

From Spiegel (1991)

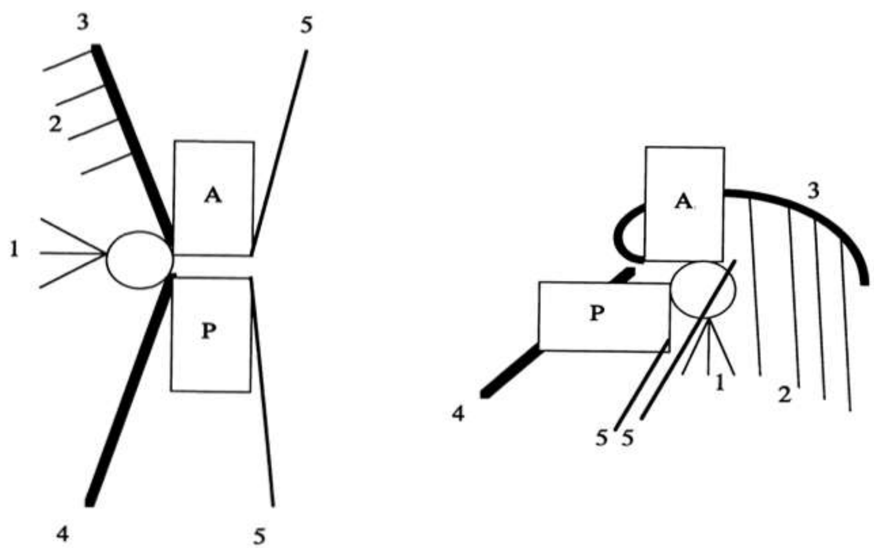
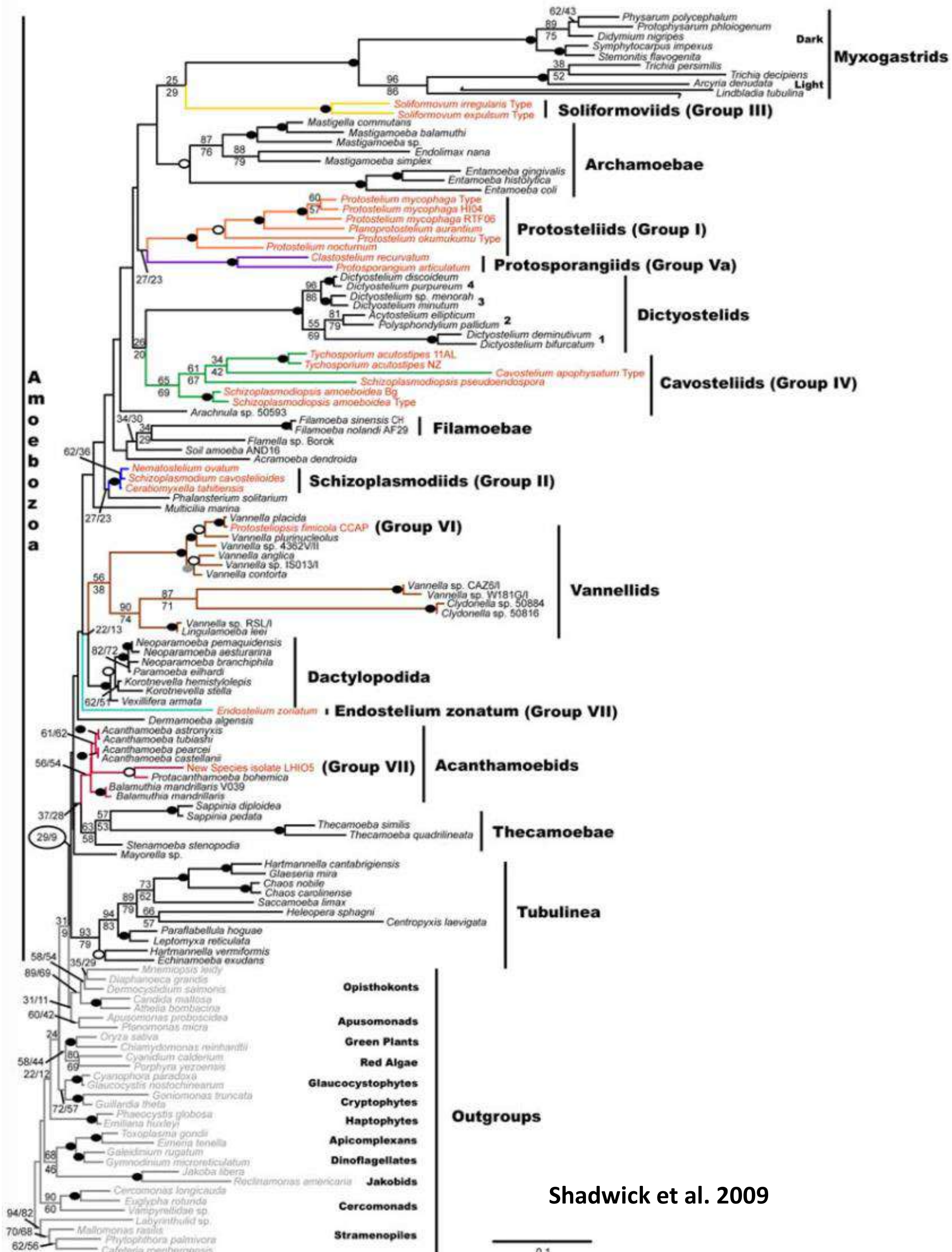


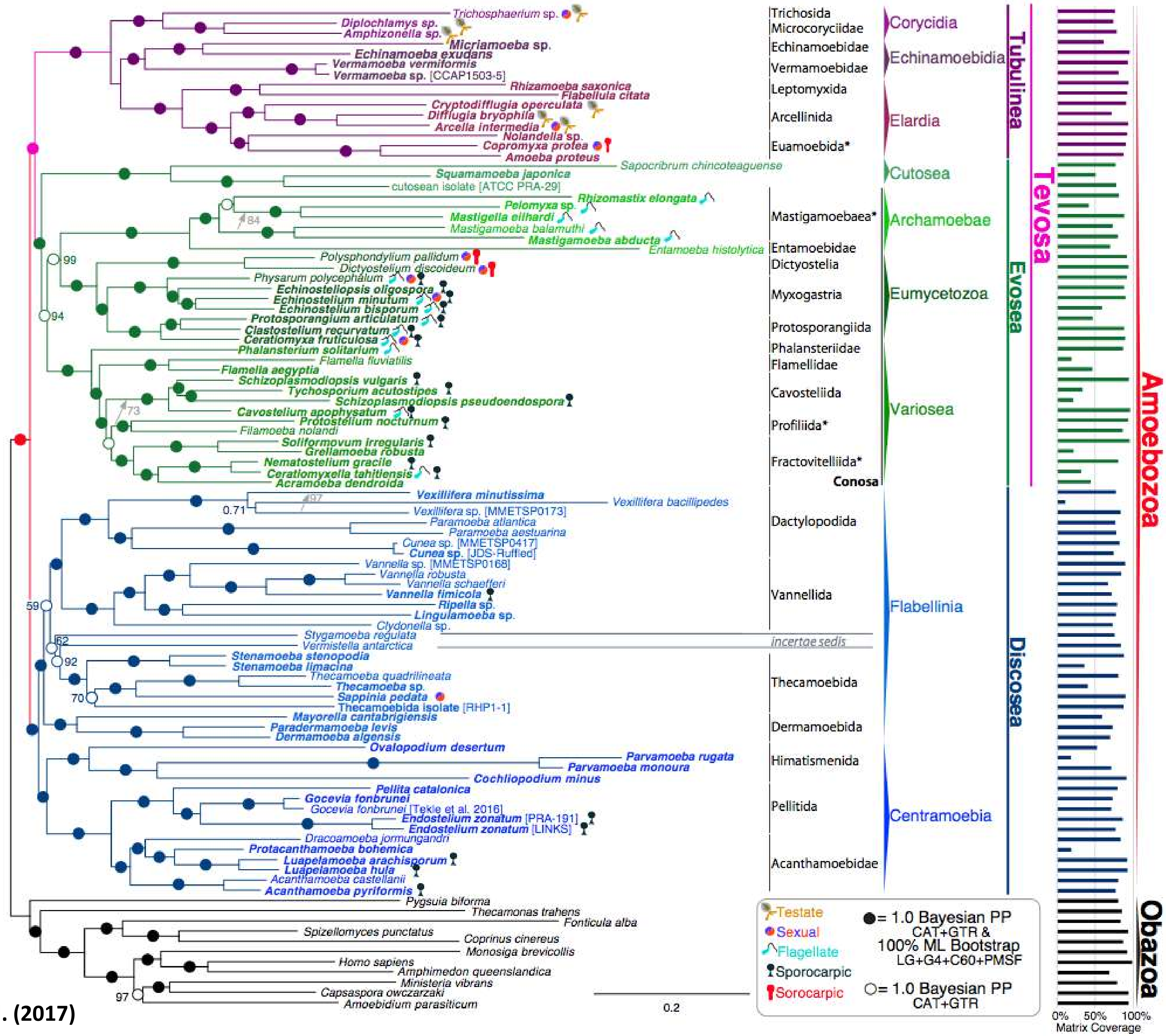
Fig. 1. Diagram of flagellar apparatuses of *Phytophthora* (left) and flagellated eumycetozoans (right) viewed from the ventral side. Abbreviations of roots are those for eumycetozoans (see Spiegel, 1981a, 1990) and are placed to show hypothesized homologies.

From Spiegel (1991)



Shadwick et al. 2009

2017 – 325 genes.



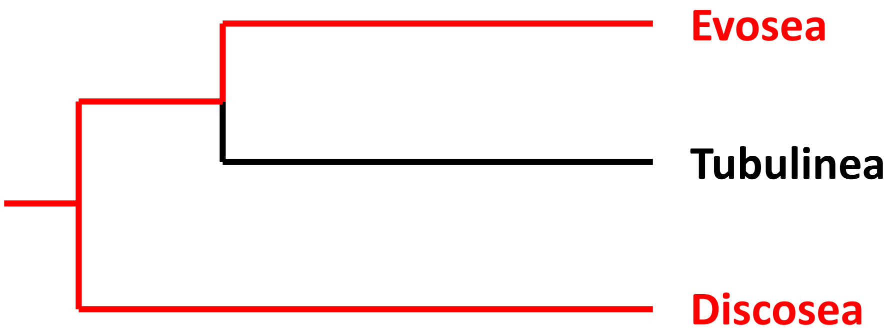
Kang et al. (2017)

UNFINISHED TASK NUMBER 1

SINCE EUMYCETOZOA (SENSU L.S. OLIVE) IS DEAD,

FIGURE OUT THE MACROEVOLUTIONAY PROCESSES THAT HAVE GIVEN US SPOROCARPIC MEMBERS OF AMOEBOZOA

Sporocarpic Fruiting – Unique to Amoebozoa

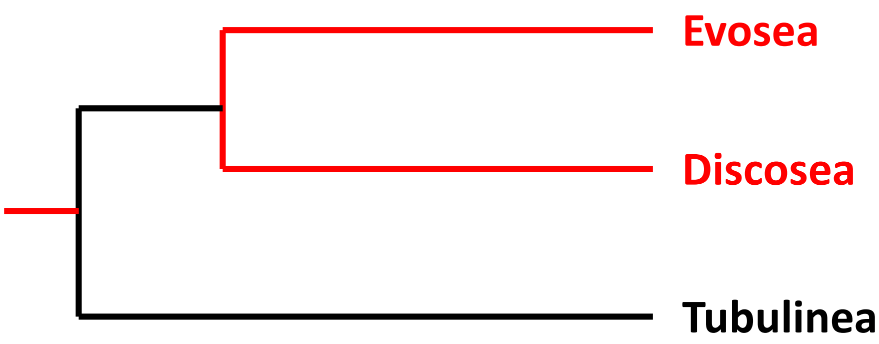


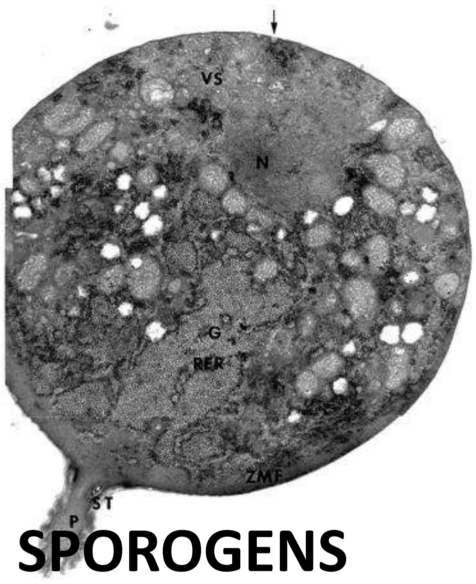
How many origins?

Depends on the final phylogeny

(Consider fruiting in the context of life repertoires)

Find out life repertoires (See below)

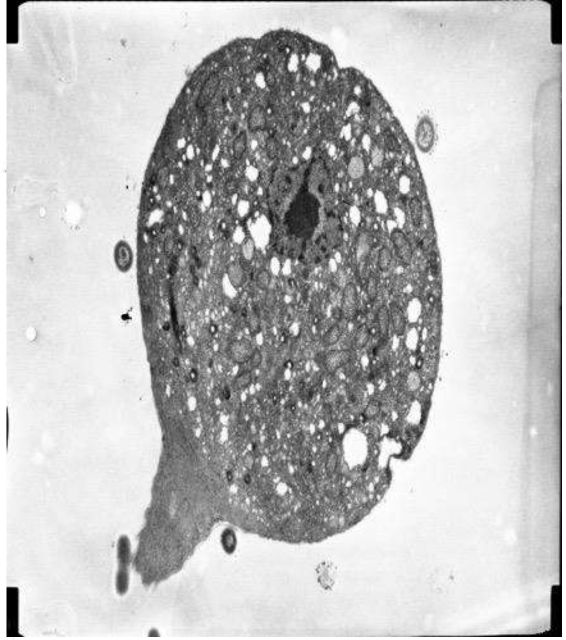




135

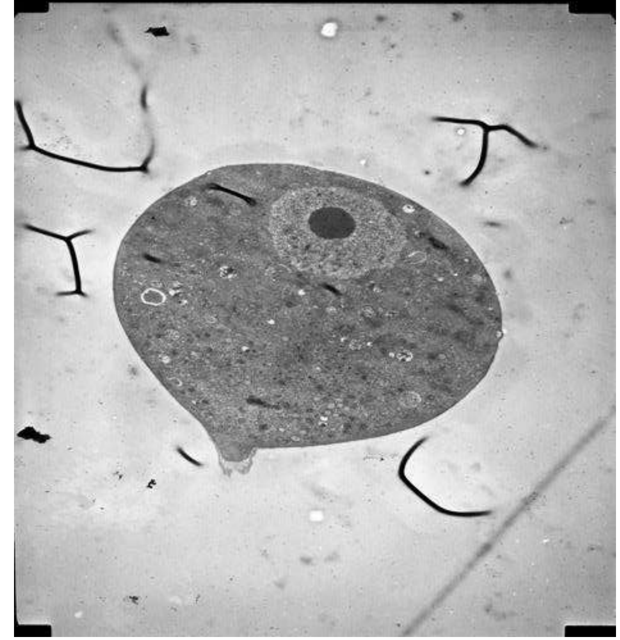
Spiegel 1978

Pau



Smith & Spiegel unpublished

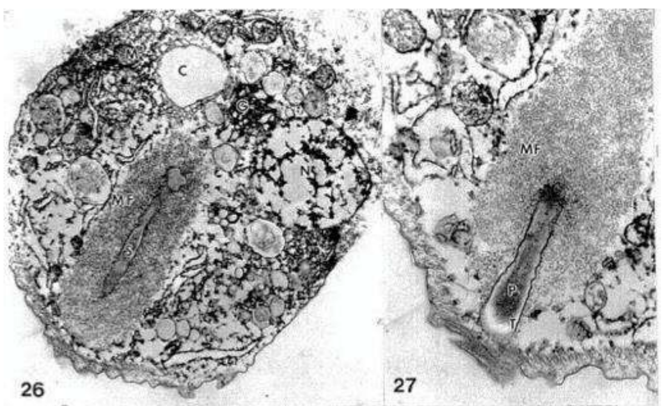
Cta

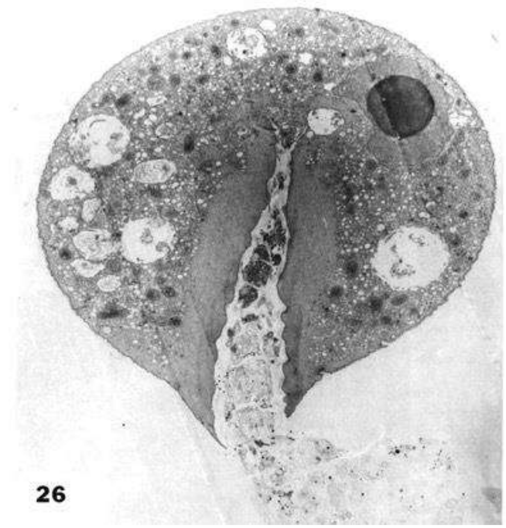


Spiegel unpublished

Par

Evosea





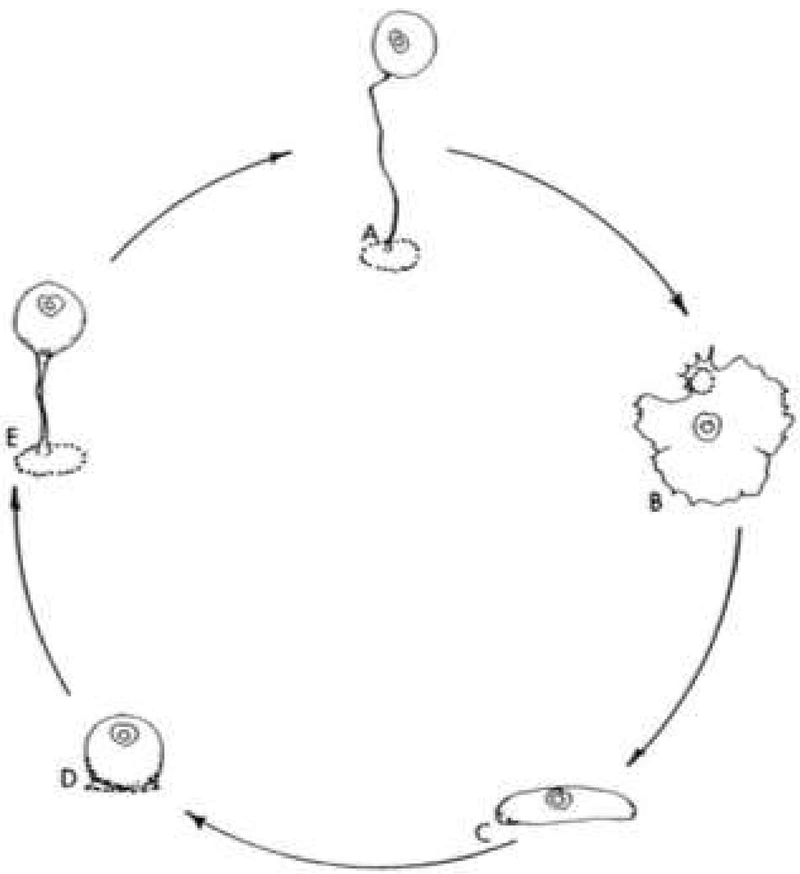
Discosea

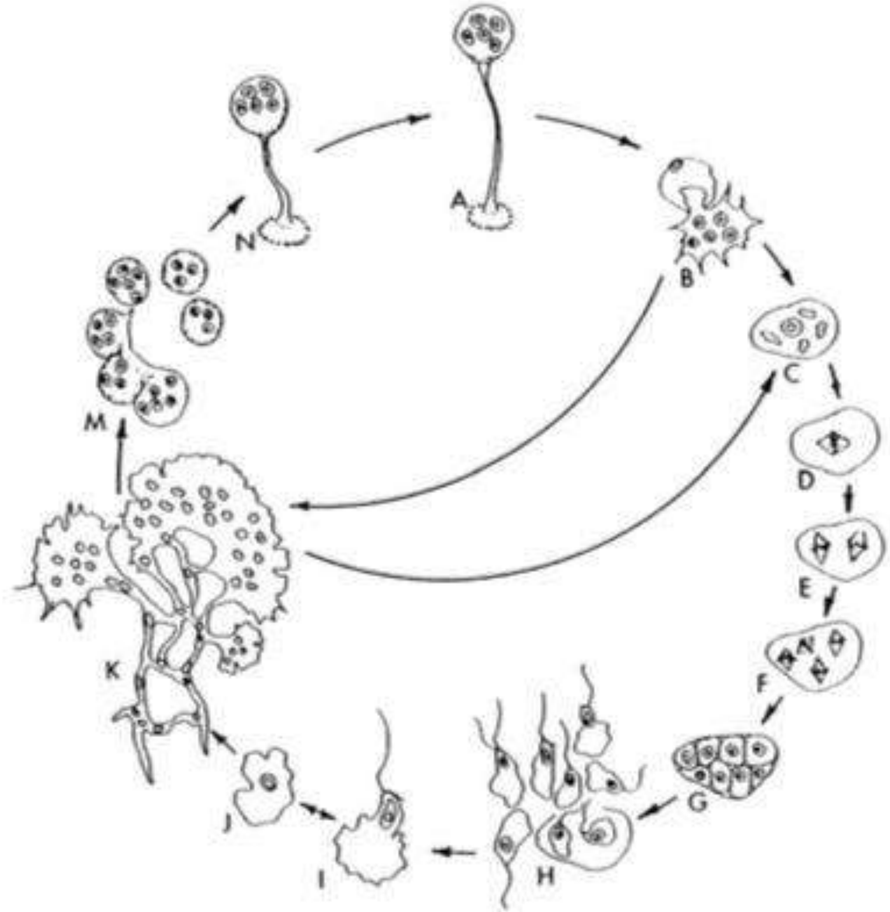
Spiegel & Feldman unpublished

Apy

Olive et al. 1984

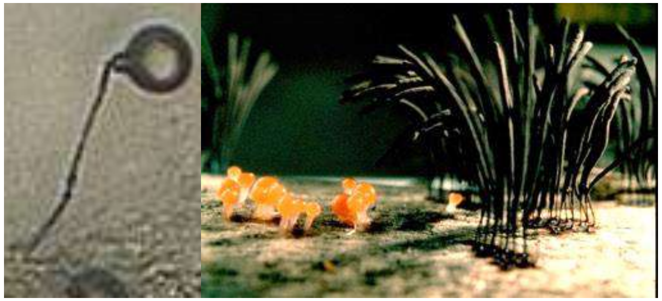
Ezo

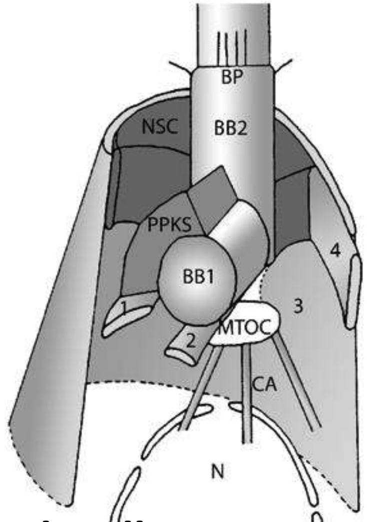




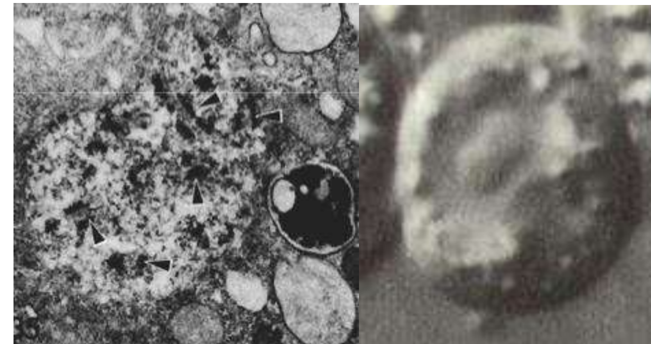
From: Spiegel et al. 2017

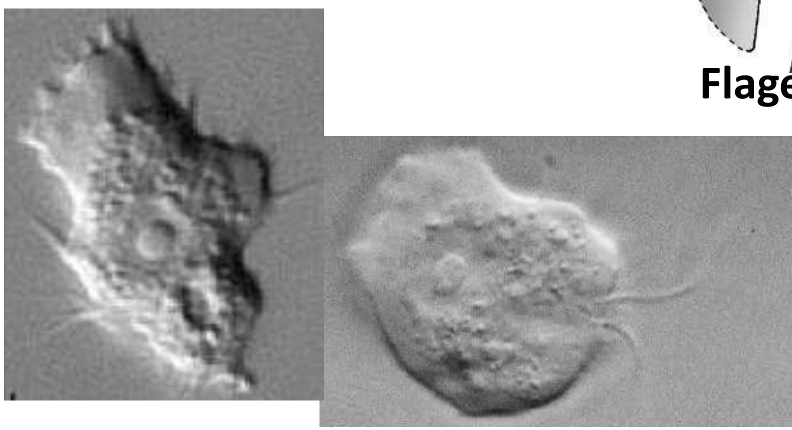
Consider Life Repertoires (aka, life cycles)

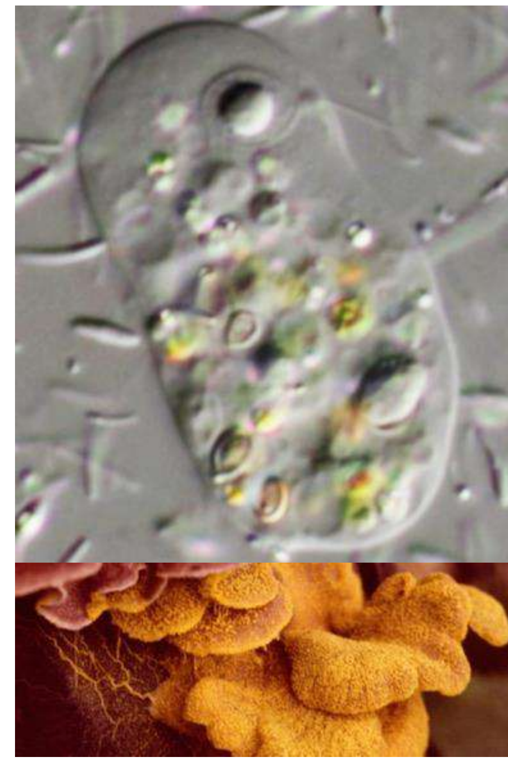

Sporocarpy



Flagellar apparatus

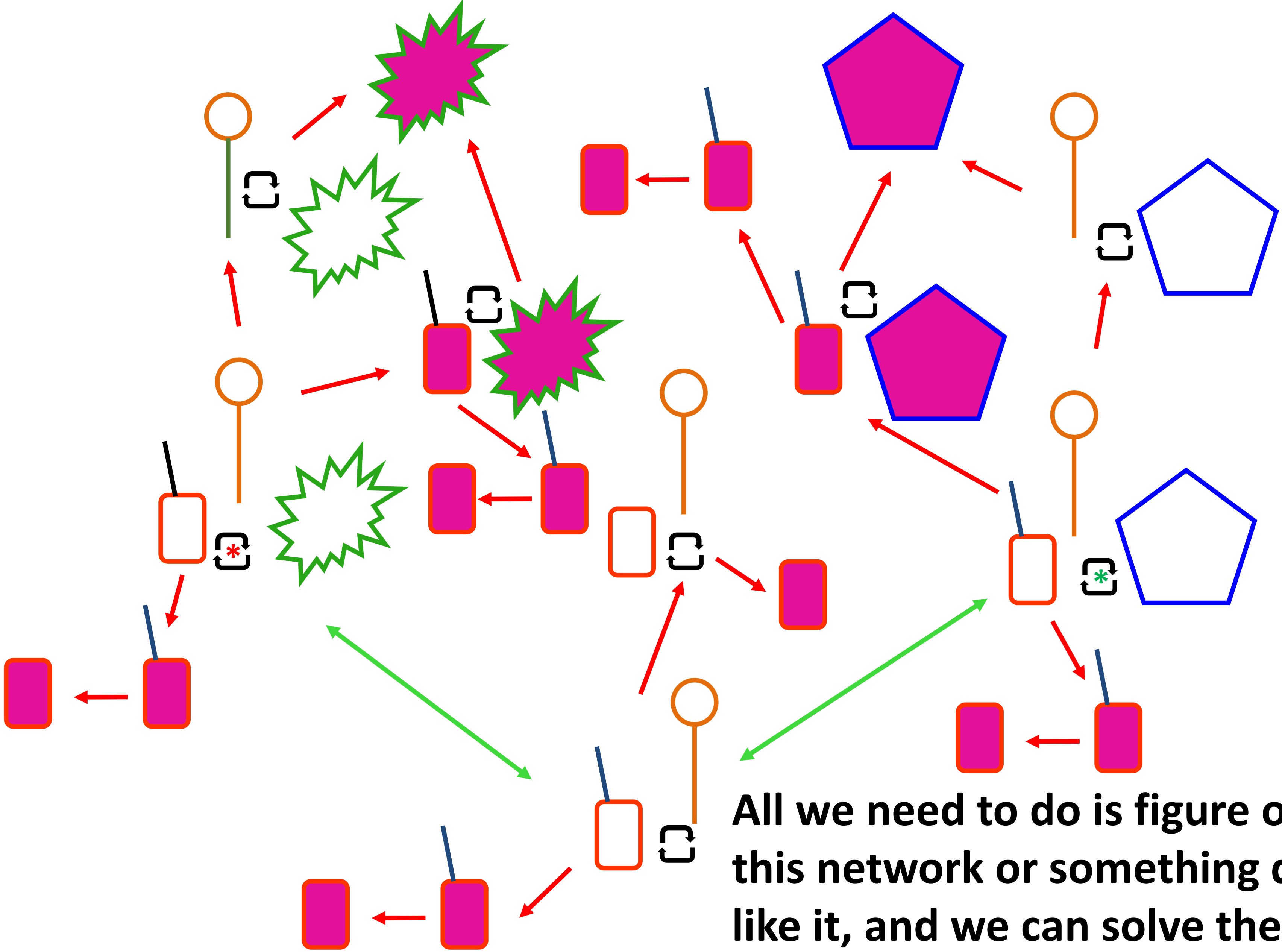

Sex


Flat amoeboid state


Tubular amoeboid state

Potential Characters of LAmCA Suggested by Kang et al. (2017)

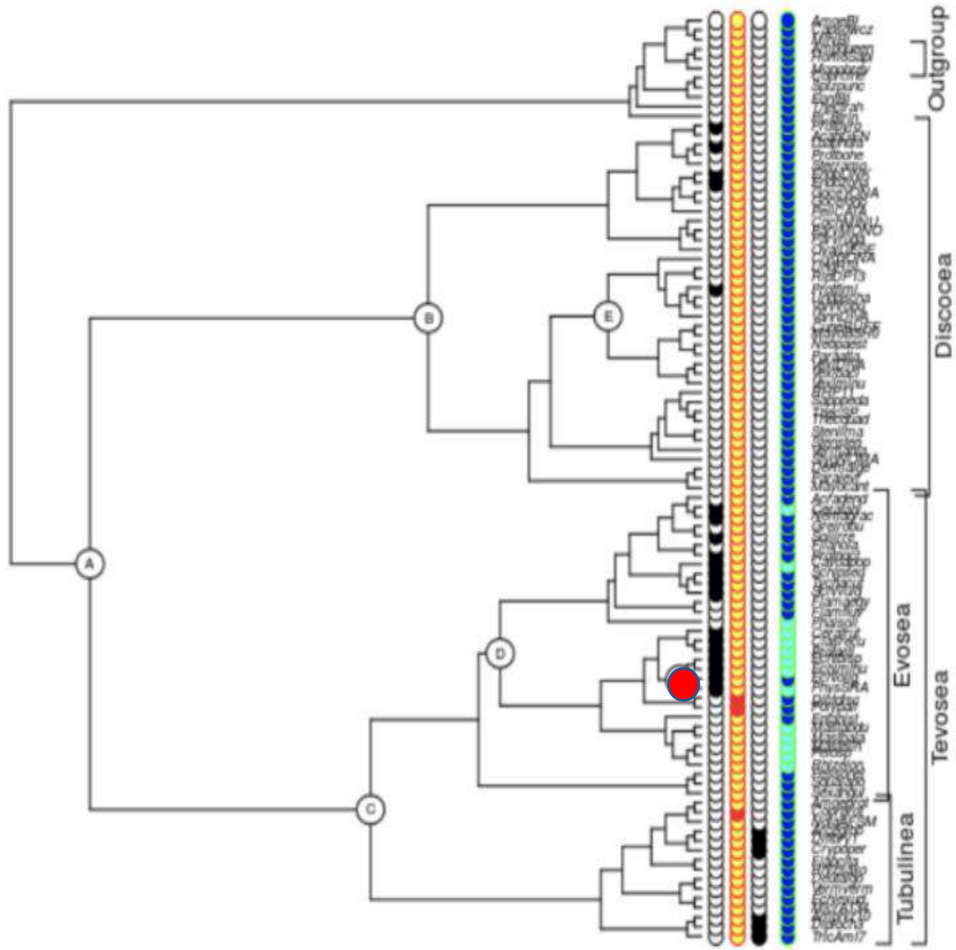

Cysts



All we need to do is figure out this network or something quite like it, and we can solve the macroevolutionary patterns of Amoebozoa as whole.

*Possible LAmCA candidates.

Are Whole Genome Duplications involved with Macroevolutionary Patterns?



Probably not

UNFINISHED TASK NUMBER 2

REVISE THE CLASSIFICATION OF MONOPHYLETIC, FRUITING GROUPS OF AMOEBOZOA.

REASONABLY WELL DONE FOR DICTYOSTELIDS

ON THE WAY FOR PROTOSTELOID GROUPS

FIX THE DAMN MYXOS!

MY OBSERVATIONS

THE LIGHT SPORED CLADE IS IN PRETTY GOOD SHAPE EXCEPT FOR THE TRICHIACEAE.

THE DARK SPORED CLADE IS A MESS.

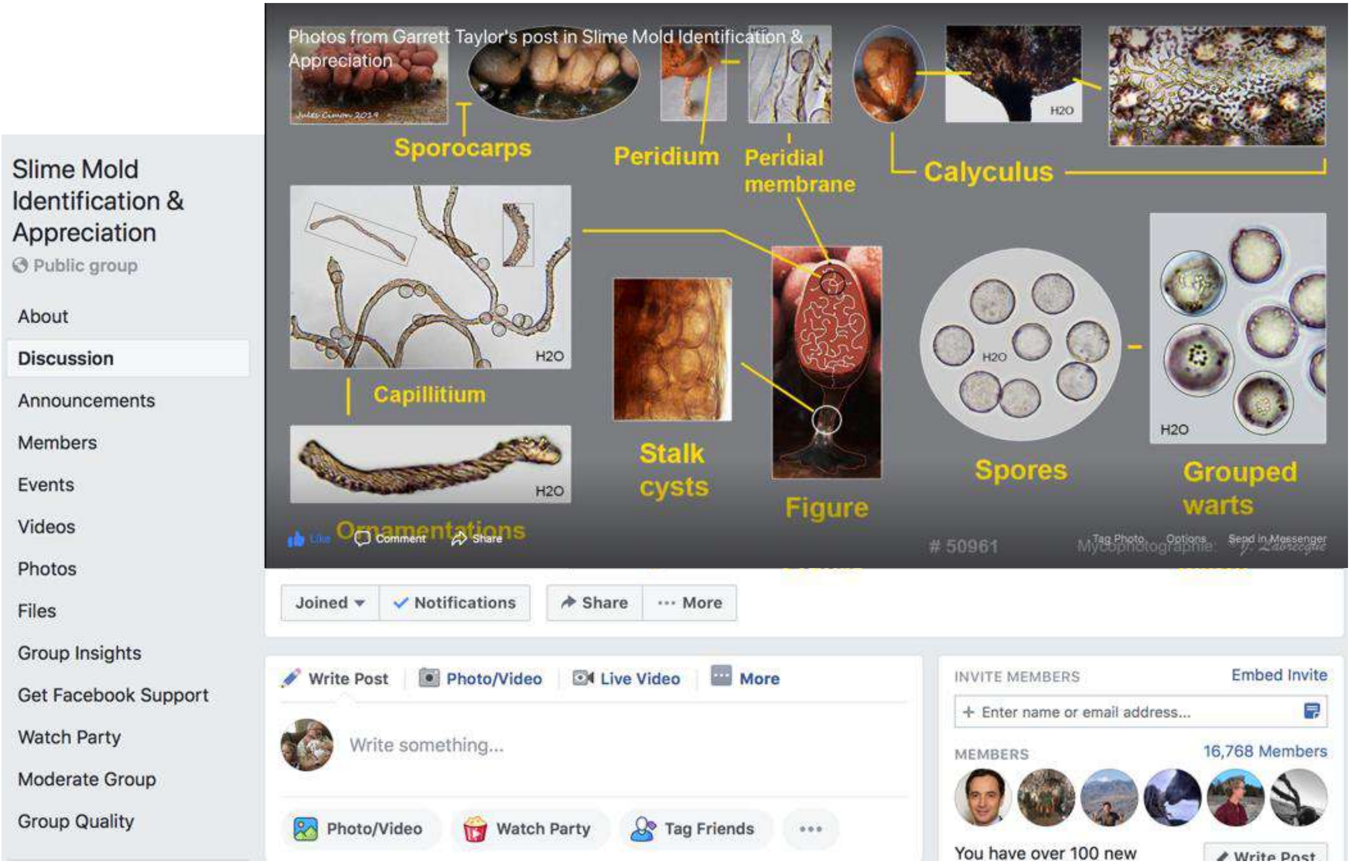
PARAPHYLETIC TAXA ABOUND ACCORDING TO MOLECULAR PHYLOGENIES.

A CLASSIFICATION IS AN HYPOTHESIS ABOUT WHAT WE KNOW NOW. HYPOTHESES CAN BE REVISED.

NEVER BUILD A CLASSIFICATION SOLELY FROM A SINGLE PHYLOGENY.

GET RID OF ALL PARAPHYLETIC TAXA YOU CAN.

Use Citizen Scientists!



https://www.facebook.com/groups/SlimeMold/2514056468854196/?comment_id=2514547362138440&notif_id=1582722027532311&notif_t=group_comment_reply

For both sets of unfinished tasks,

Use the breadth of biological techniques,
from very classic to mid-20^{th} Century
to state of the art to anything new that comes along.

Some possibilities:

DESCRIPTIVE DEVELOPMENT (DRAWINGS AND PHOTOS LM, TEM, SEM)

Spore Germination

Nuclear and Cell Division

Cell Types and Transitions –
Amoeba to Flagellate
Amoeboflagellate to Obligate Amoeba

Cyst Development and Germination

Plasmogamy and Karyogamy

Meiosis

Fruiting –
Prespore Cell
Stalk Elongation
Spore Maturation

PHYSICAL AND CHEMICAL TRAITS (CHEMISTRY AND X-RAY DIFFRACTION)

Spore Wall Composition

Cyst Wall Composition

Stalk Composition

MOLECULAR TRAITS

Genomes

Developmental Transcriptomes

TAXON SELECTION

Types, Types, Types…

At least have each genus Represented.

For troublesome groups (Read Myxos), Select Taxa from OTU's Discovered in Phylogenetic Studies.

Test The Validity of Named Varieties, Subspecies, etc. (Read *Ceratiomyxa fruticulosa*)

Many Thanks!

Universidad Autónoma de Tlaxcala

REAL JARDÍN BOTÁNICO

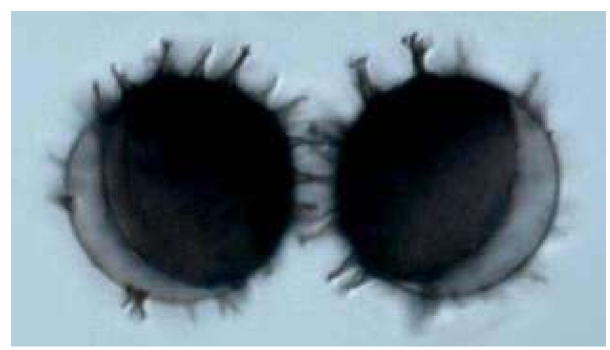
From La Malinche Volcano to Tierra del Fuego: Thirty years looking for myxos in Latin America

Arturo Estrada-Torres

Carlos Lado

Diana Wrigley de Basanta

ICSEM-10



















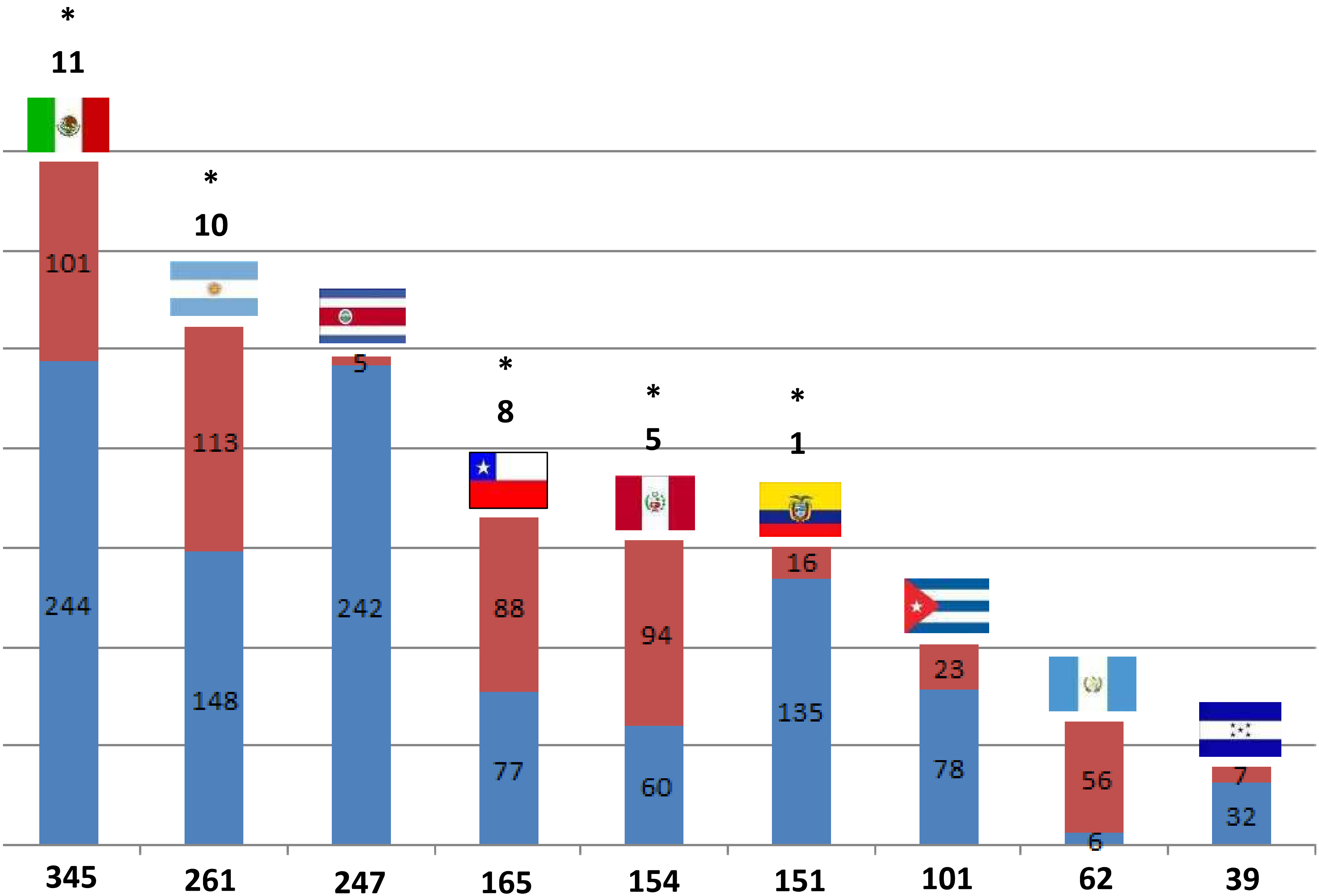












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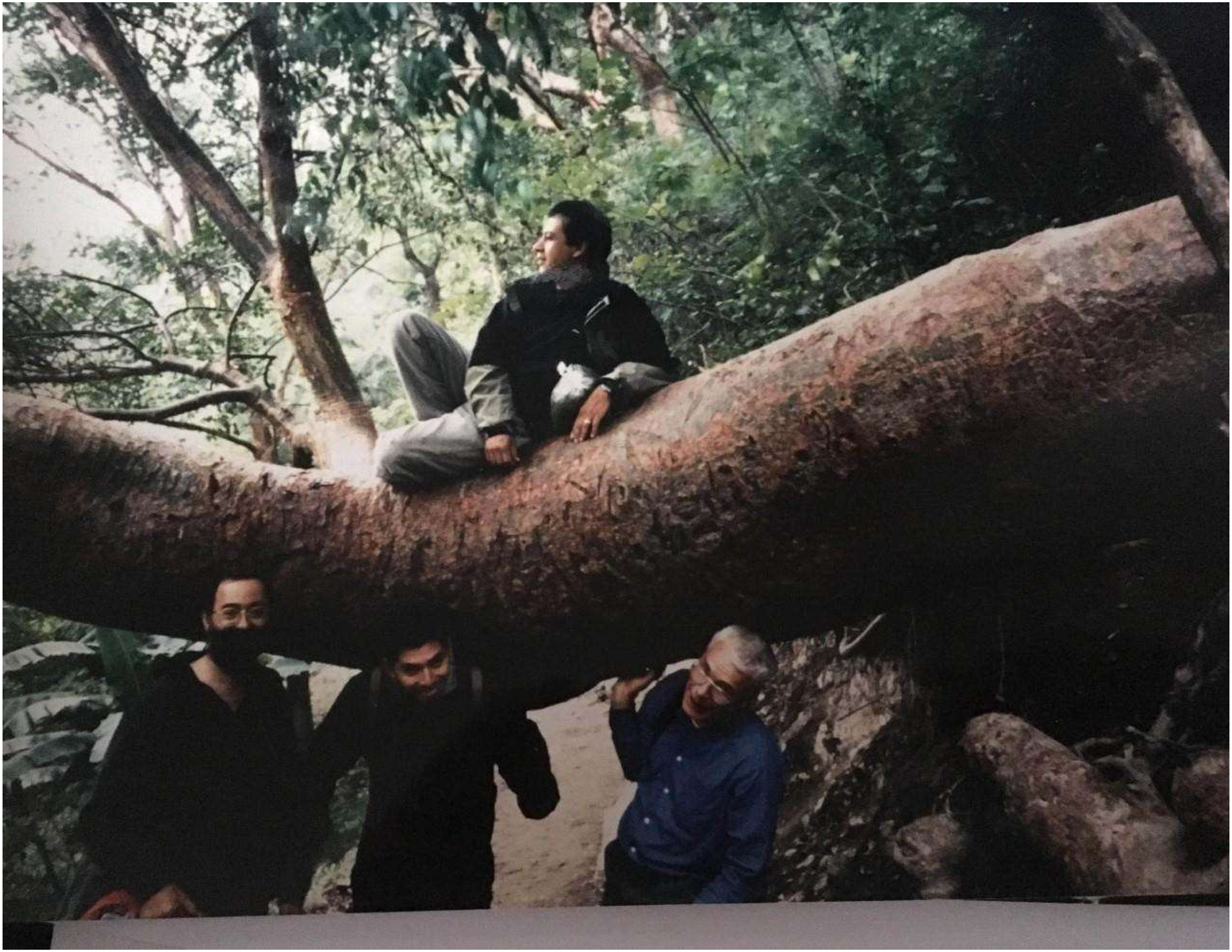



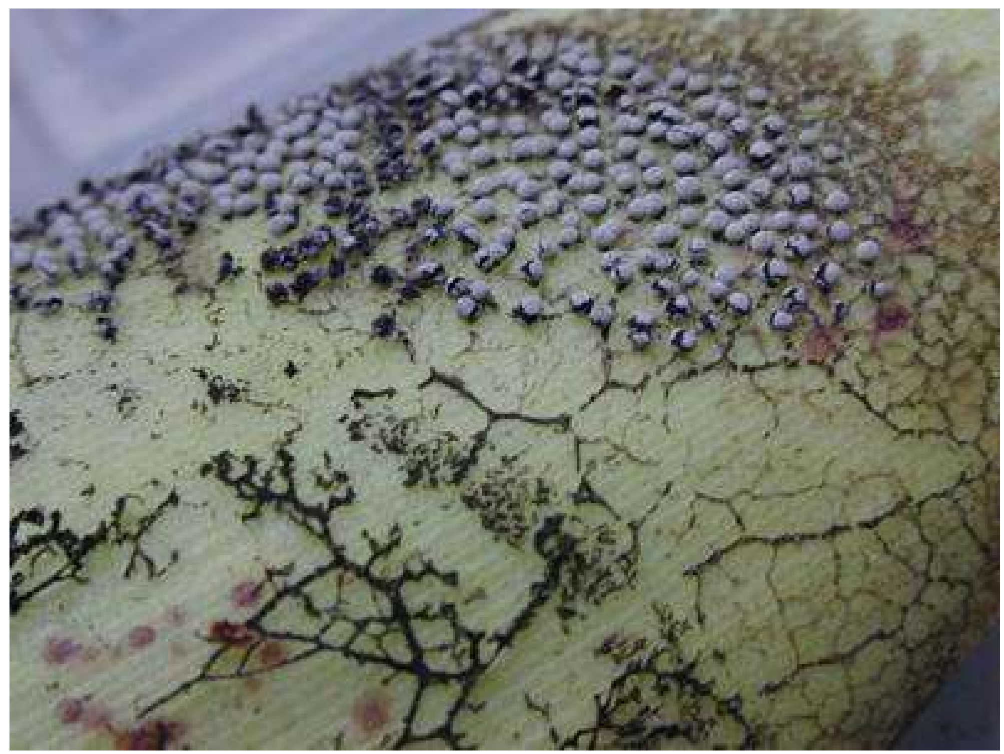

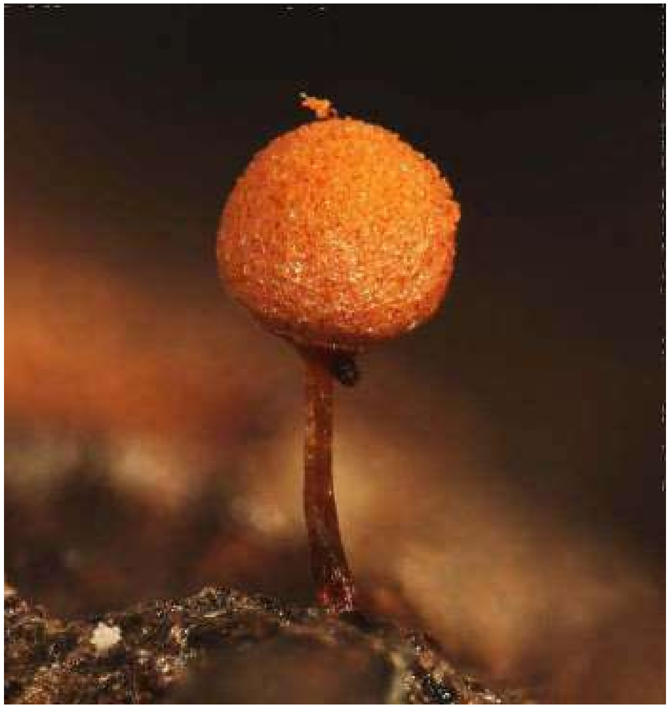


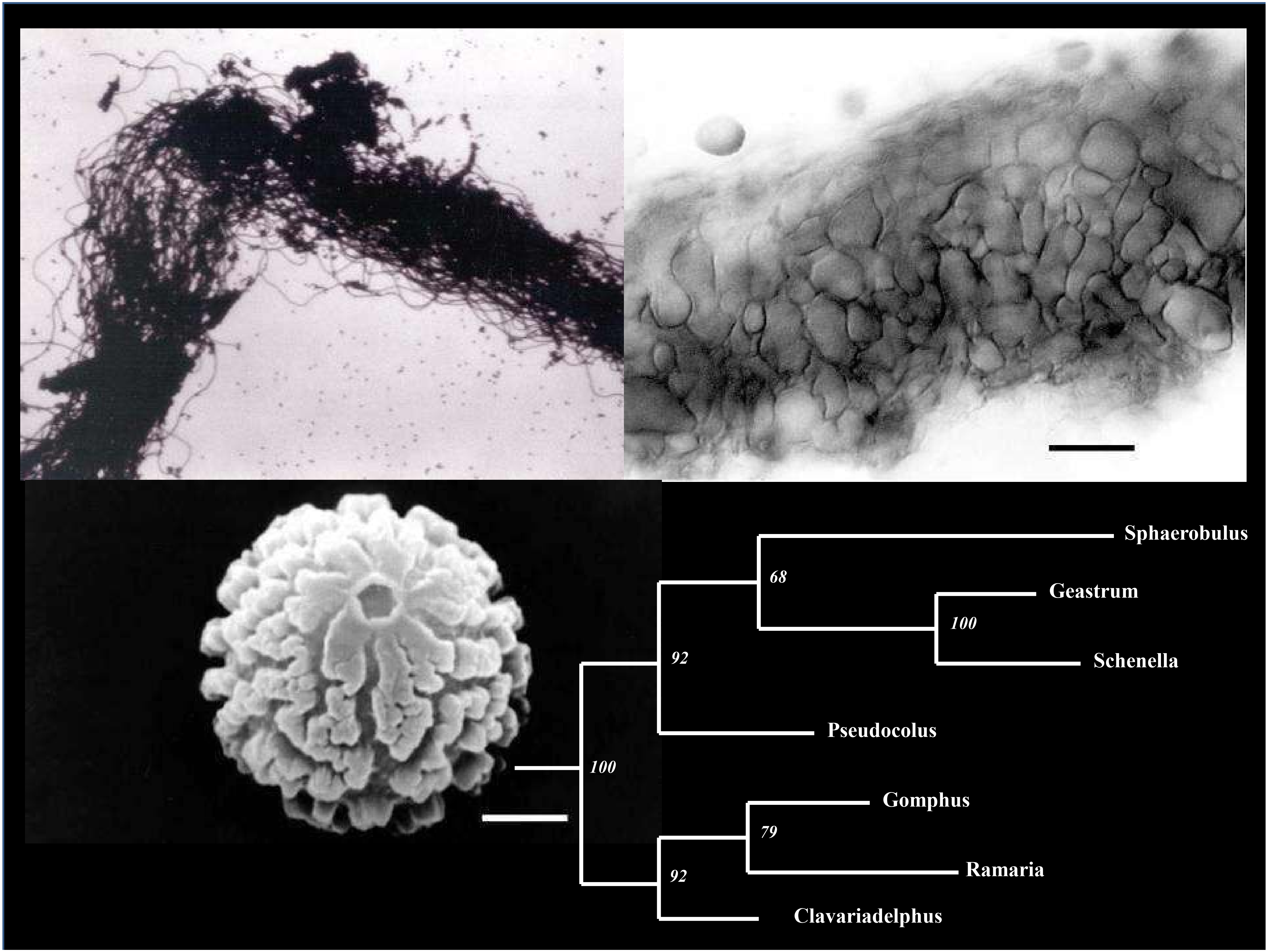
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Ramaria
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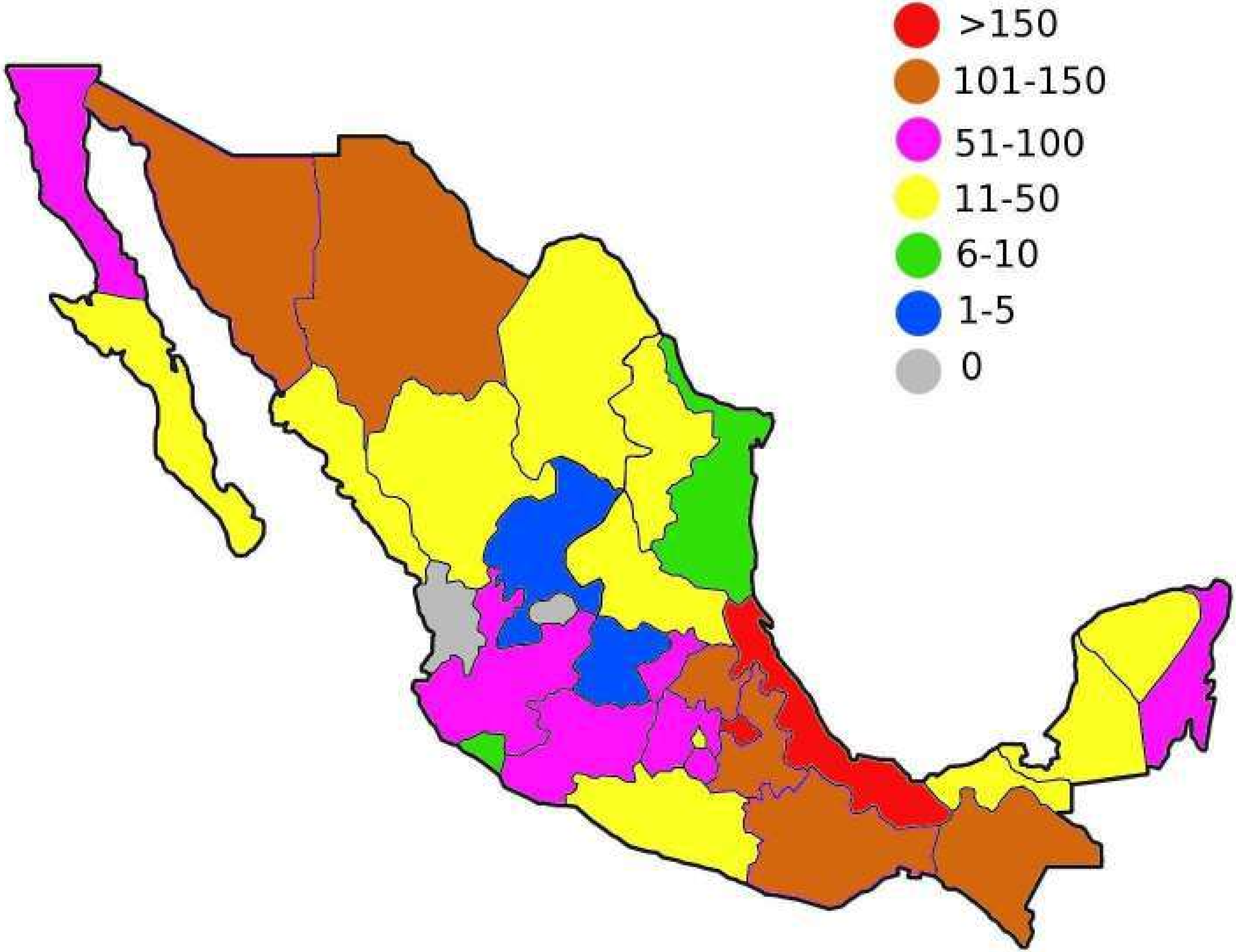
Clavariadelphus



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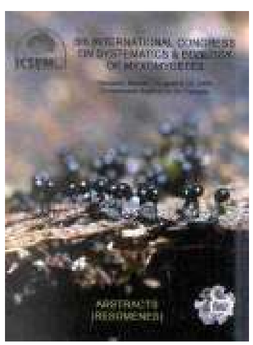
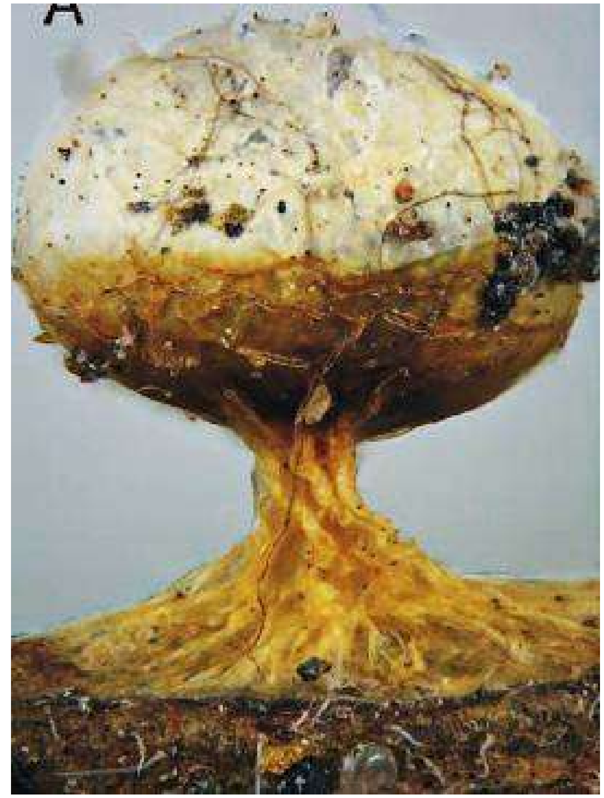
5th INTERNATIONAL CONGRESS ON SYSTEMATICS & ECOLOGY OF MYXOMYCETES

Tlaxcala, Mexico - August 8 -13, 2005



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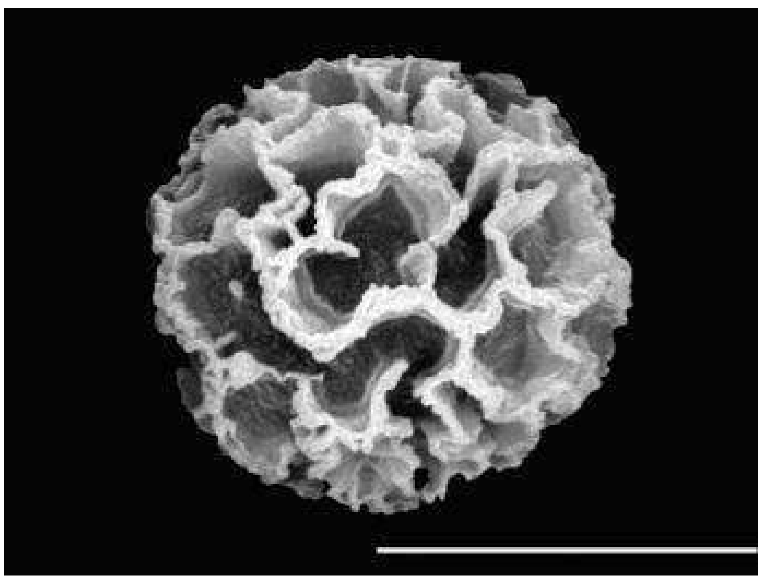
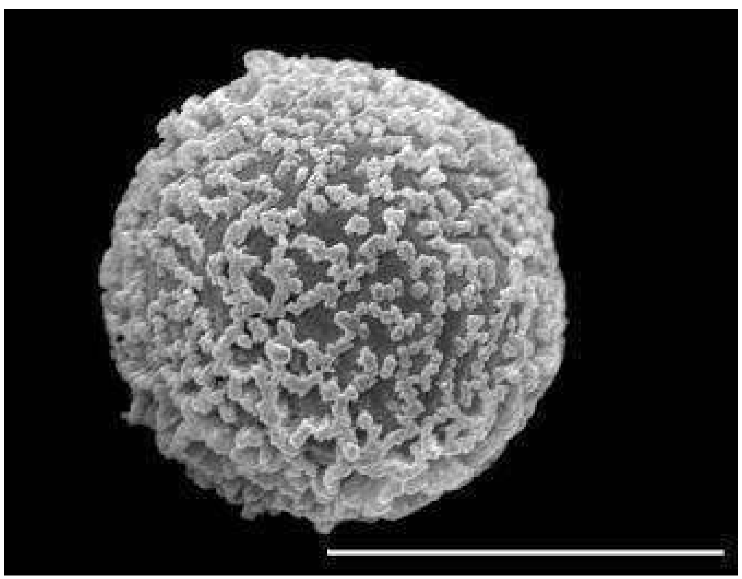
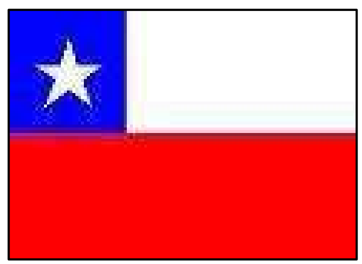
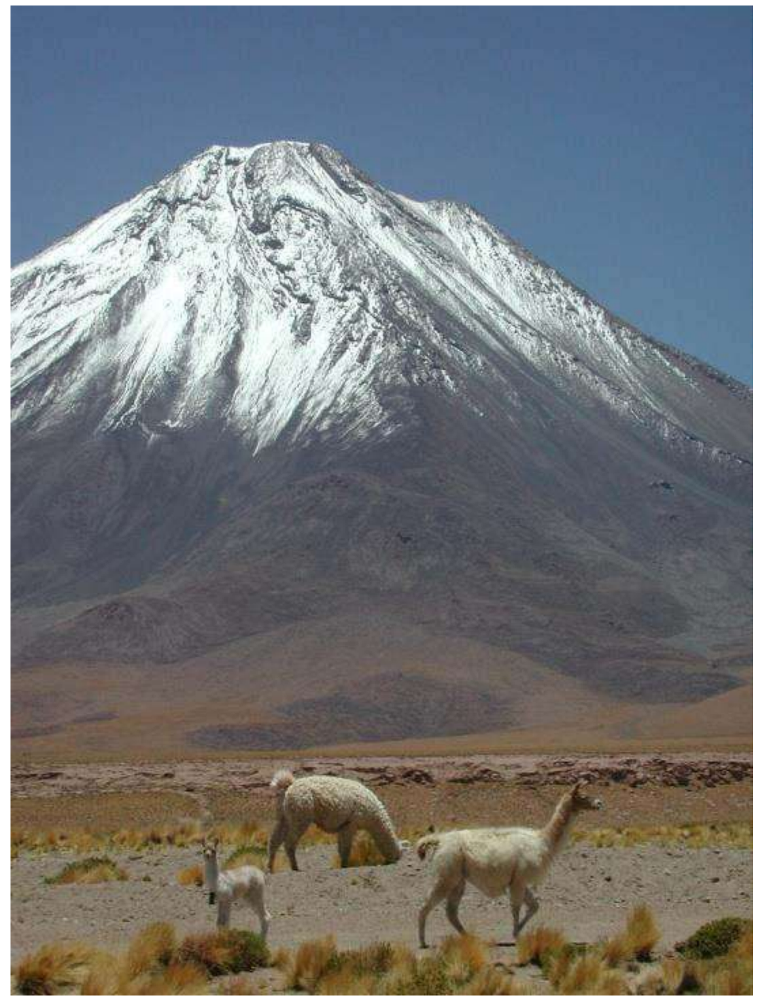




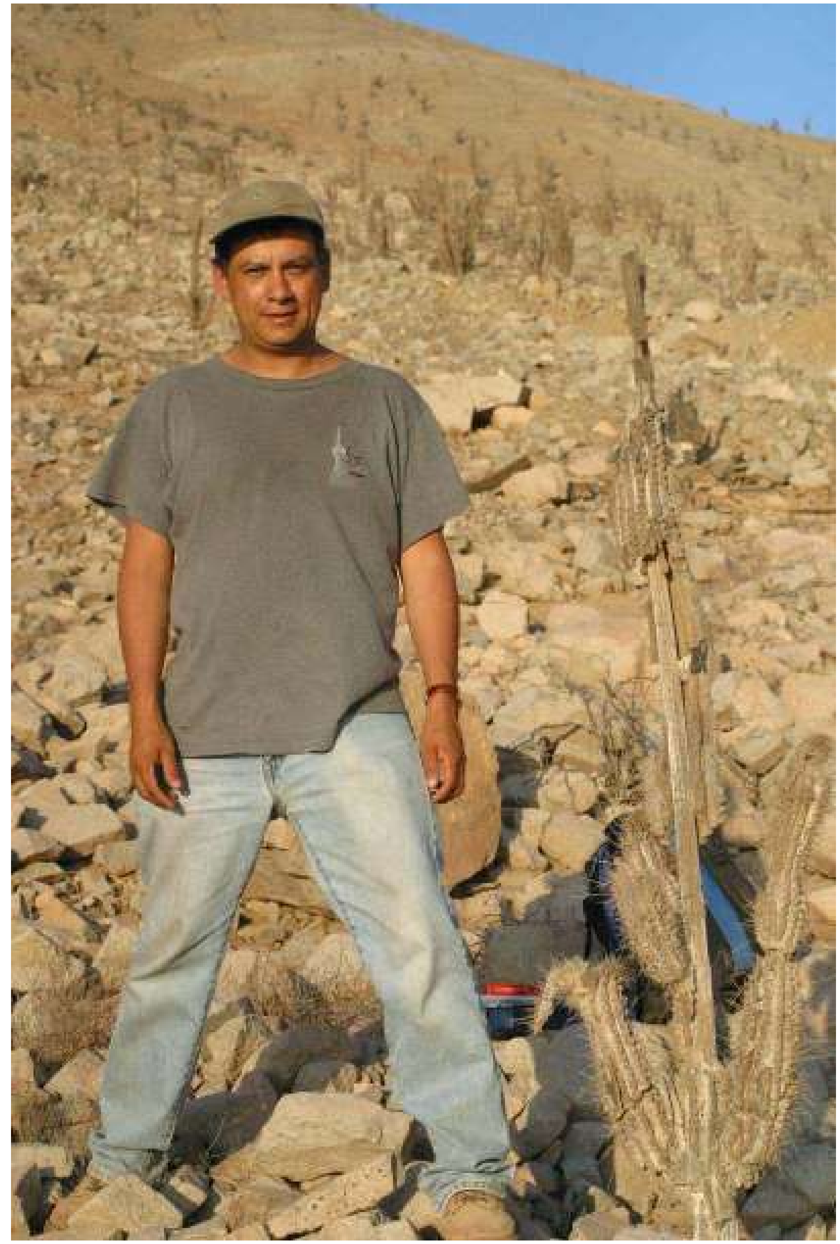




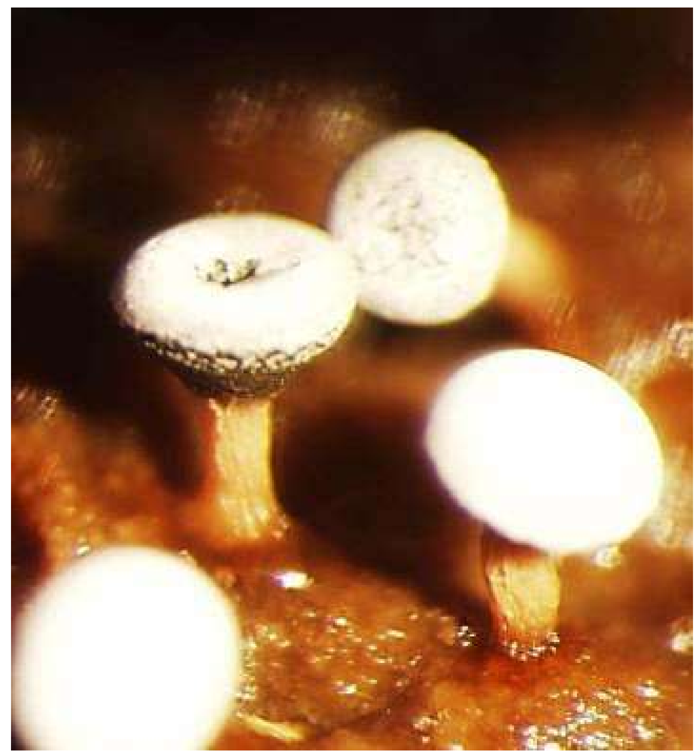


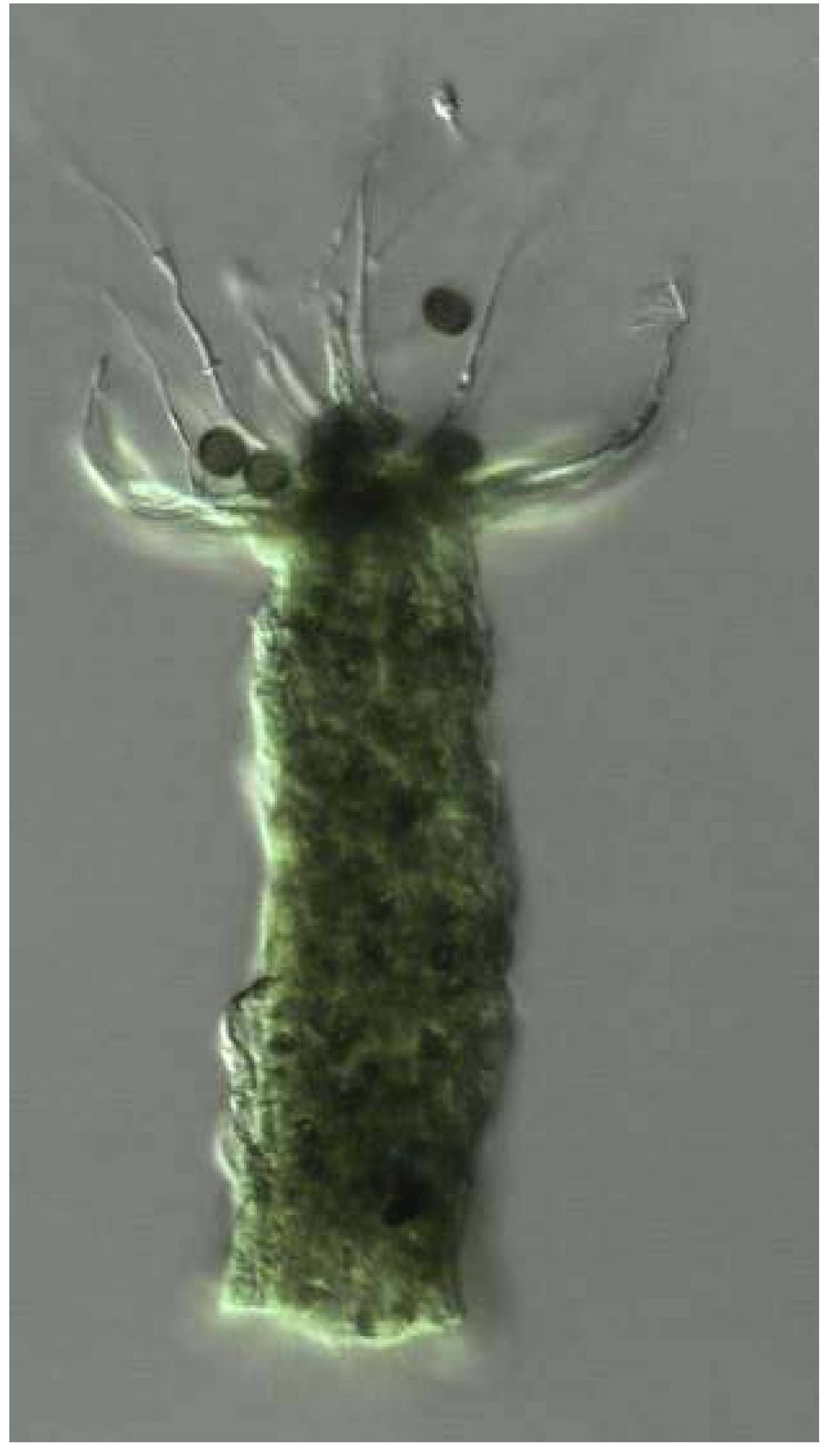









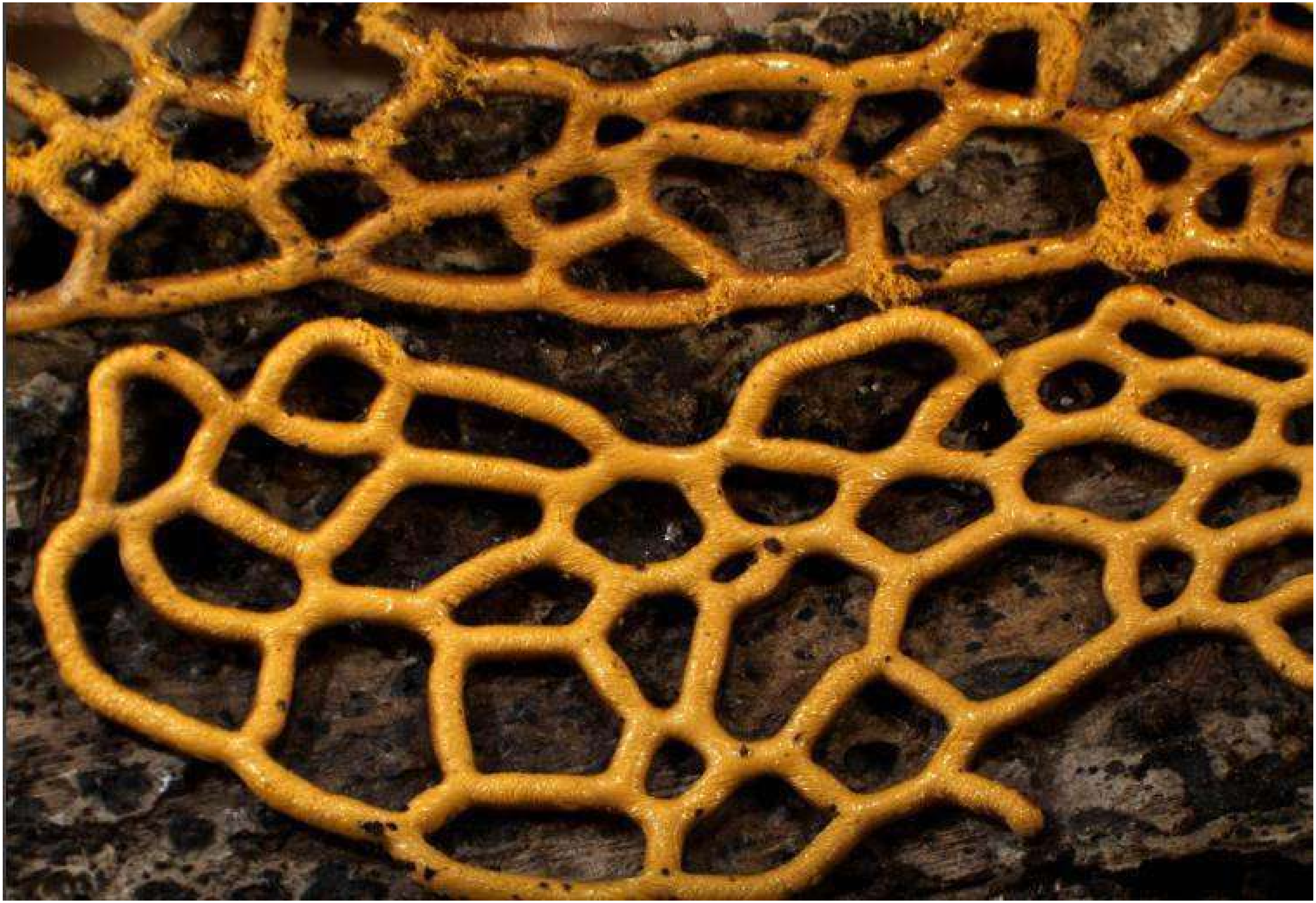



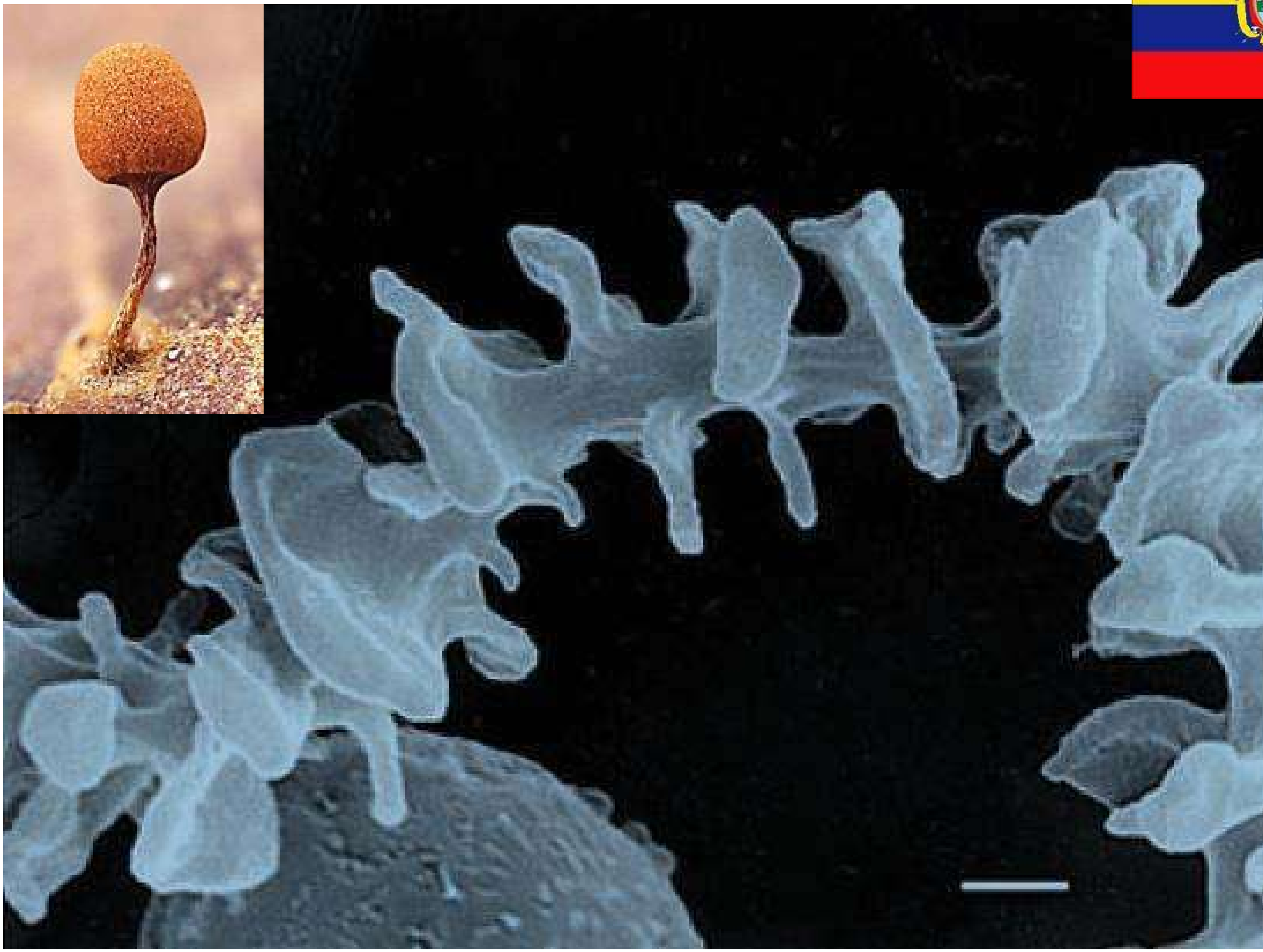


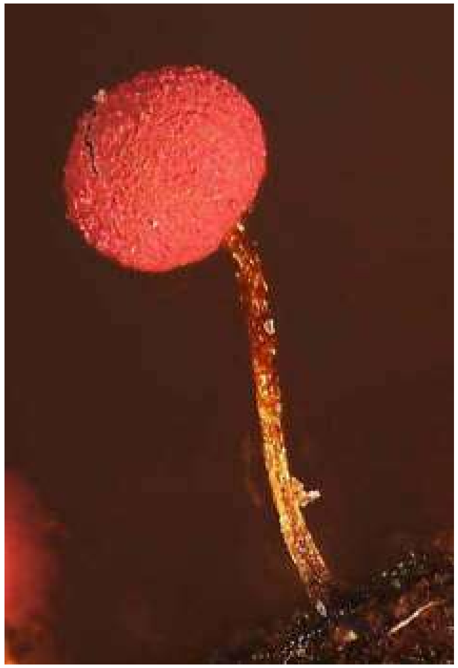



TOYOTA





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- Mayra Camino
- Asunción Cano
- Thomas W. Gaither
- Ricardo García Sandoval
- Dolores González
- Gastón Guzmán
- Laura Hernández-Cuevas
- Harold W. Keller
- Tatiana Krivomatz
- Carlos Lado
- John Landolt
- Dennis L. Miller
- David Mitchell
- Juan Mosquera
- Carlos Rojas
- Ana Ronikier
- Mercedes Rodríguez
- Martin Schnittler
- Steven L. Stephenson
- Diana Wrigley
- Víctor Águila Flores
- Enrique Altamirano
- Karina Carrillo
- Fret Cervantes
- Enrique Conde Cano
- Berenice Díaz
- Paola Díaz Canales
- Mirna Díaz Ramírez
- J. Alberto García Cortés
- Gema Galindo Flores
- Marisol García Sastré
- Alejandro Hernández Ortega
- José Eduardo Hok
- Dolores Martínez Bocaranda
- Rubén Montes Montiel
- Samuel Nolasco Garduño
- J. Martín Ramírez Ortega
- Mayra Reyes Luna
- Laura Teomitzi
- Adalid Varela García
- Nancy Vázquez
- Aline Velasco Ramírez

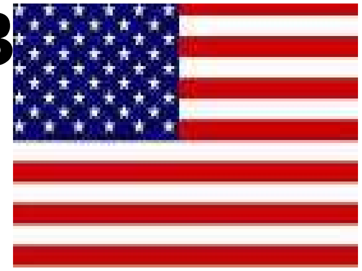
ICSEM

1

Chester (1993)

2

Madrid (1996)

3

Beltsville (1999)

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Meise (2002)

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Tlaxcala (2005)

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Yalta (2008)

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Recife (2011)

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Changchun (2014)

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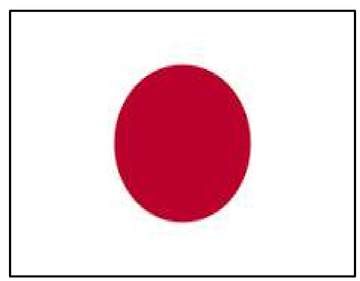

Tanabe (2017)

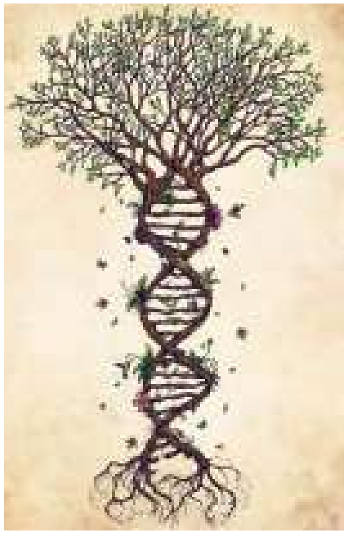
10

Turrialba (2020)

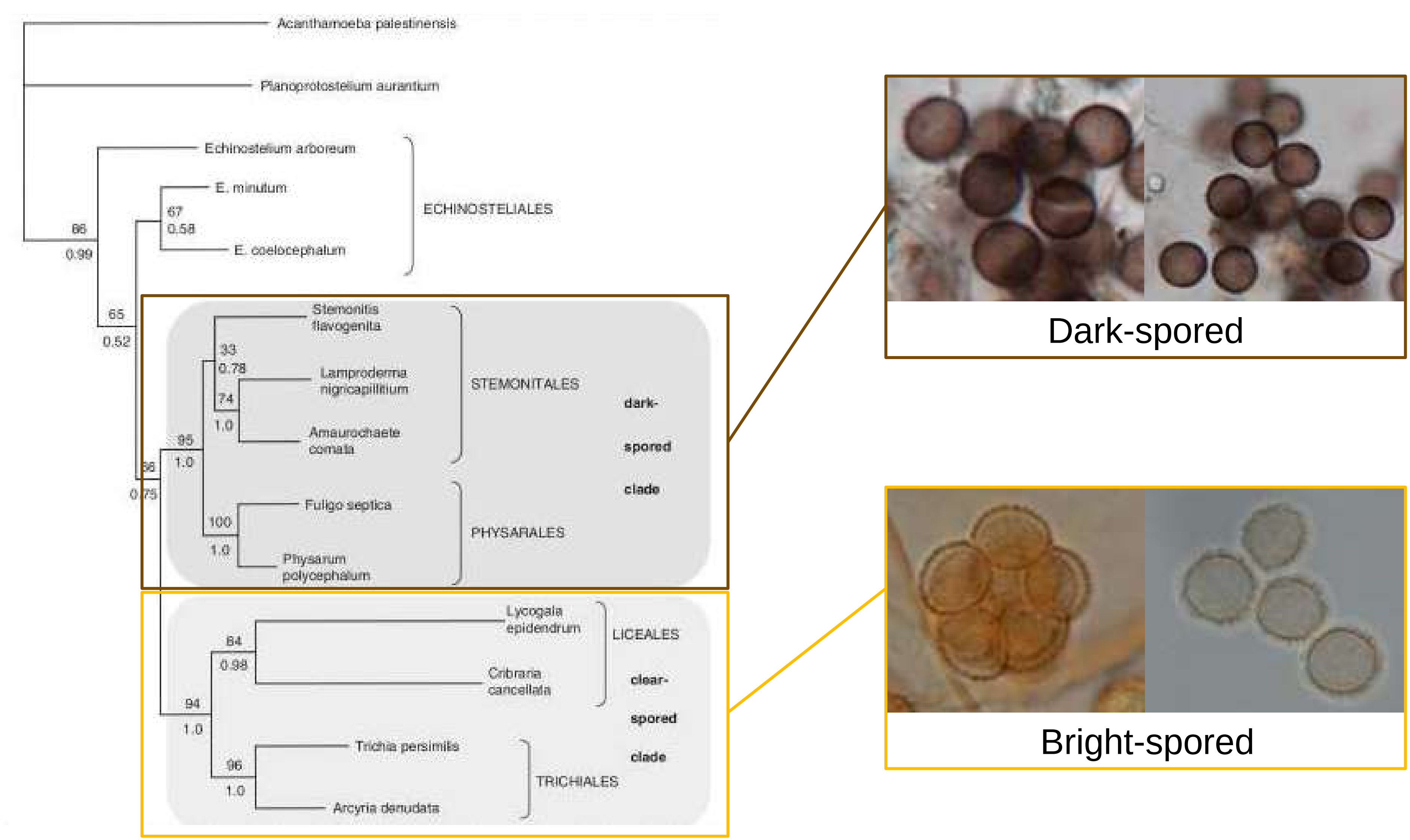
The evolutionary history of the order Trichiales in a new multi-gene phylogenetic framework

Iván García-Cunchillos[a,b], Juan Carlos Zamora[c], Martin Ryberg[d], Belén Estébanez[b], Carlos Lado[a]

[a] Real Jardín Botánico, CSIC.
[b] Facultad de Ciencias, Universidad Autónoma de Madrid
[c] Evolutions-museet, Uppsala Universitet
[d] Evolutionsbiologiskt centrum, Uppsala Universitet



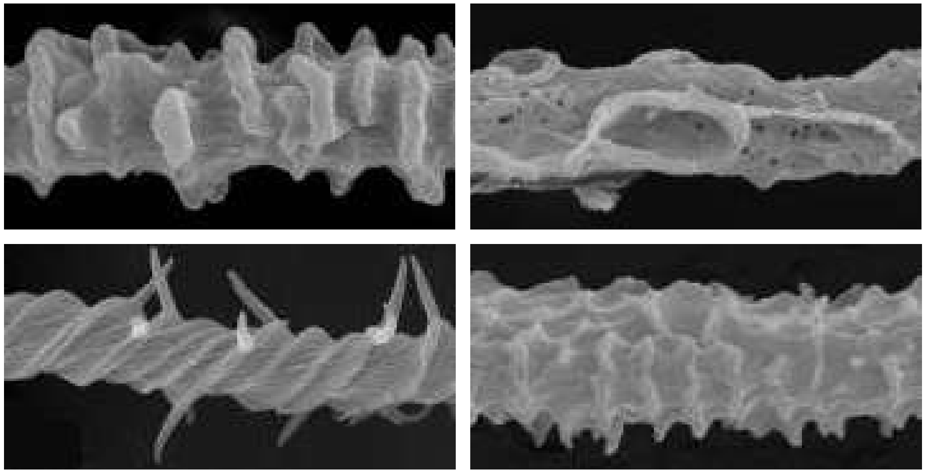
Bright-spored vs Dark-spored Myxomcyetes



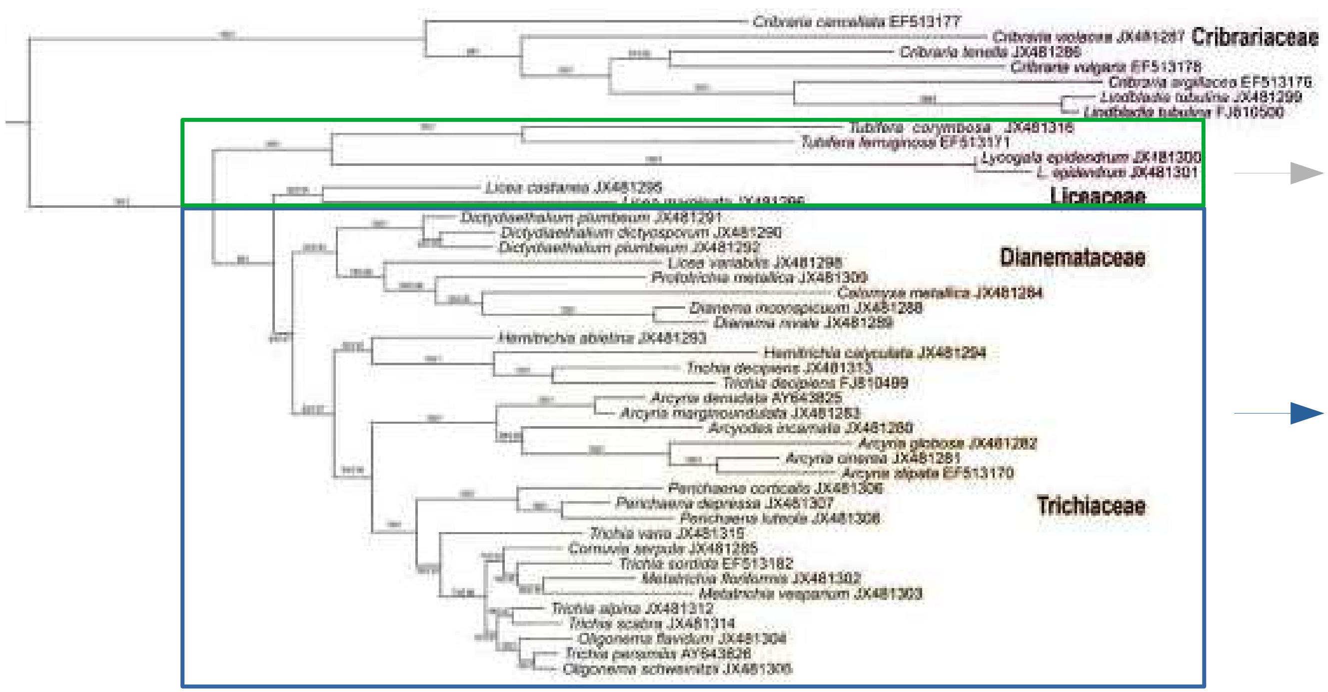
Fiore-Donno et al. (2005)

Order Trichiales. Capillitium

MYXOTROPIC



- Elastic capillitium
- Highly variable ornamentation
- Function: spore dispersion



→ Order Liceales

→ **Order Trichiales**

Leontyev et al. (2019)

Taxonomic diversity in the order Trichiales

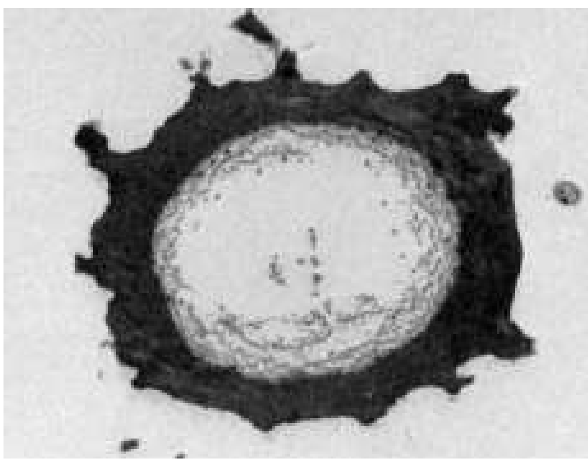
MYXOTROPIC

Family	Genera	Species
Dianemataceae	2	15
Arcyriaceae	5	87
Minakatellaceae	1	1
Trichiaceae	6	81
TOTAL	14	184

Solid capillitium

Hollow capillitium

Solid capillitium



Hollow capillitium

Taxonomic diversity in the order Trichiales

Family	Genera	Species
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Not spirals

Spirals

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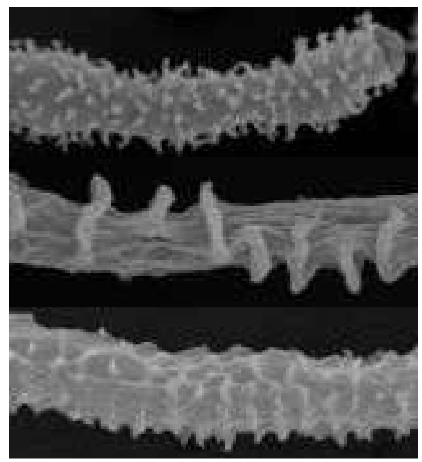
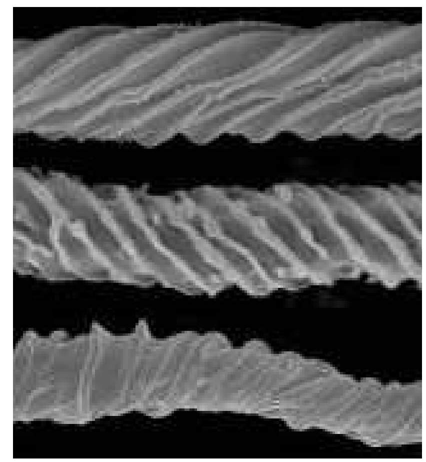


Not spirals



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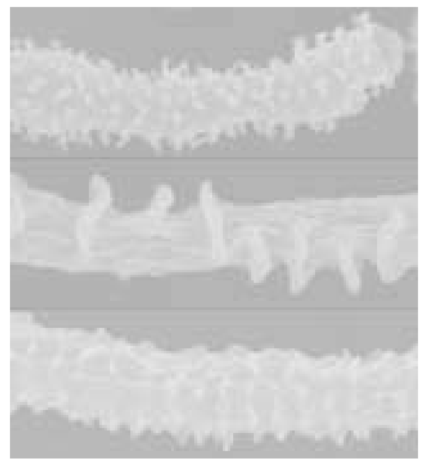

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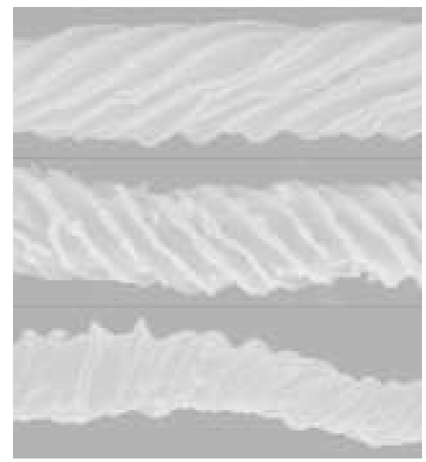

Spirals

? Characters shared with Arcyriaceae and Trichiaceae, uncertain position

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Taxonomic diversity in the order Trichiales

MYXOTROPIC

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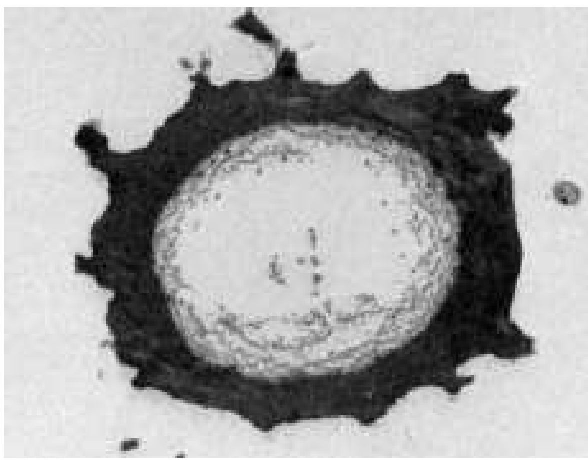
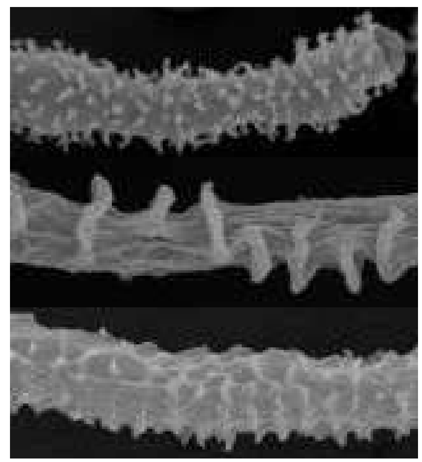

Hollow capillitium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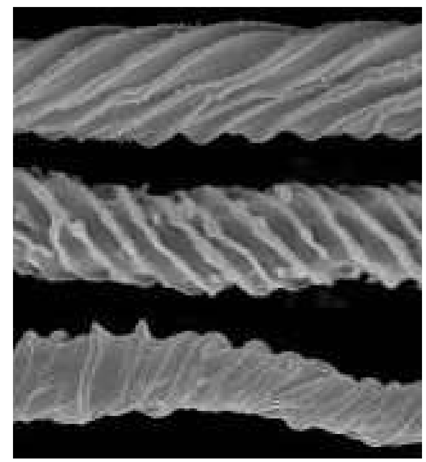
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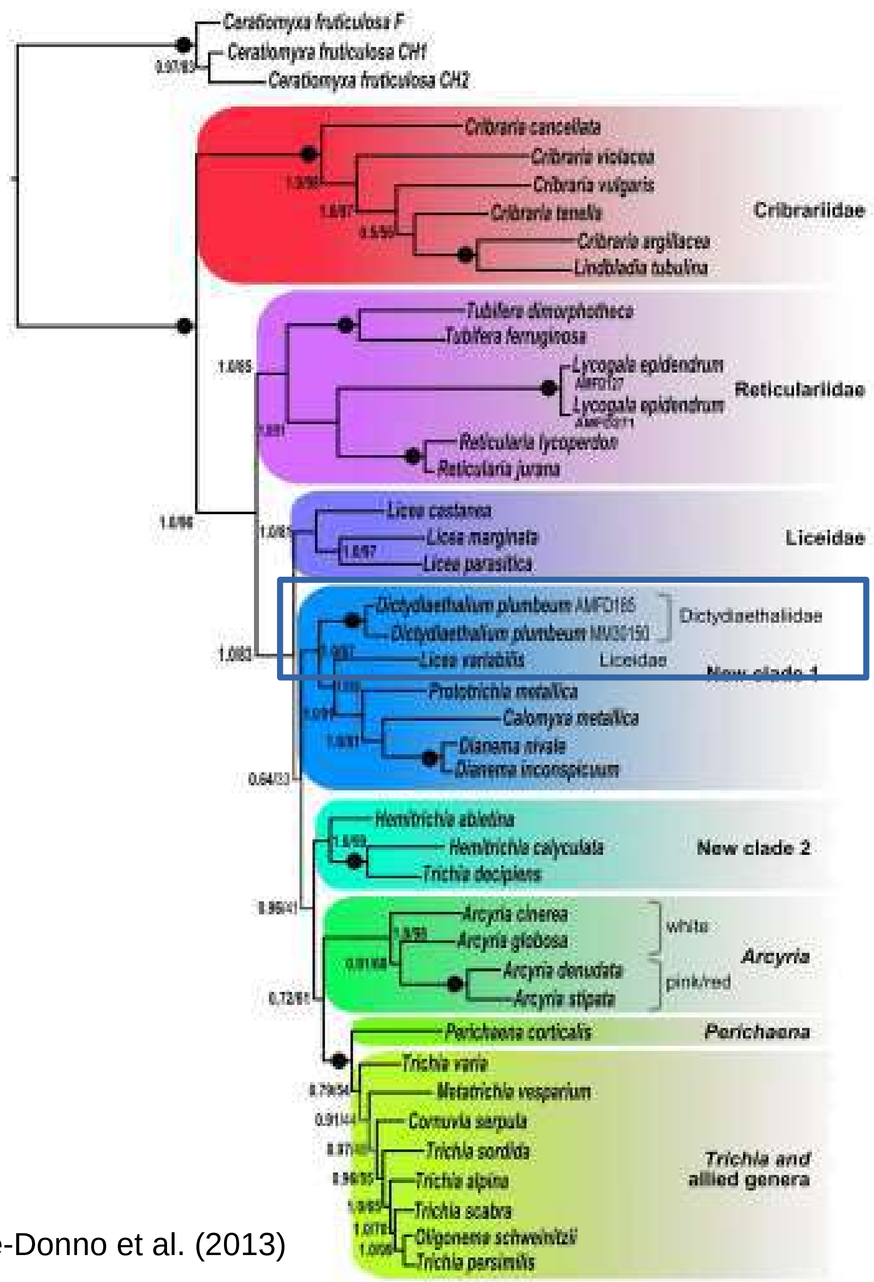
Phylogenetic background in the order Trichiales

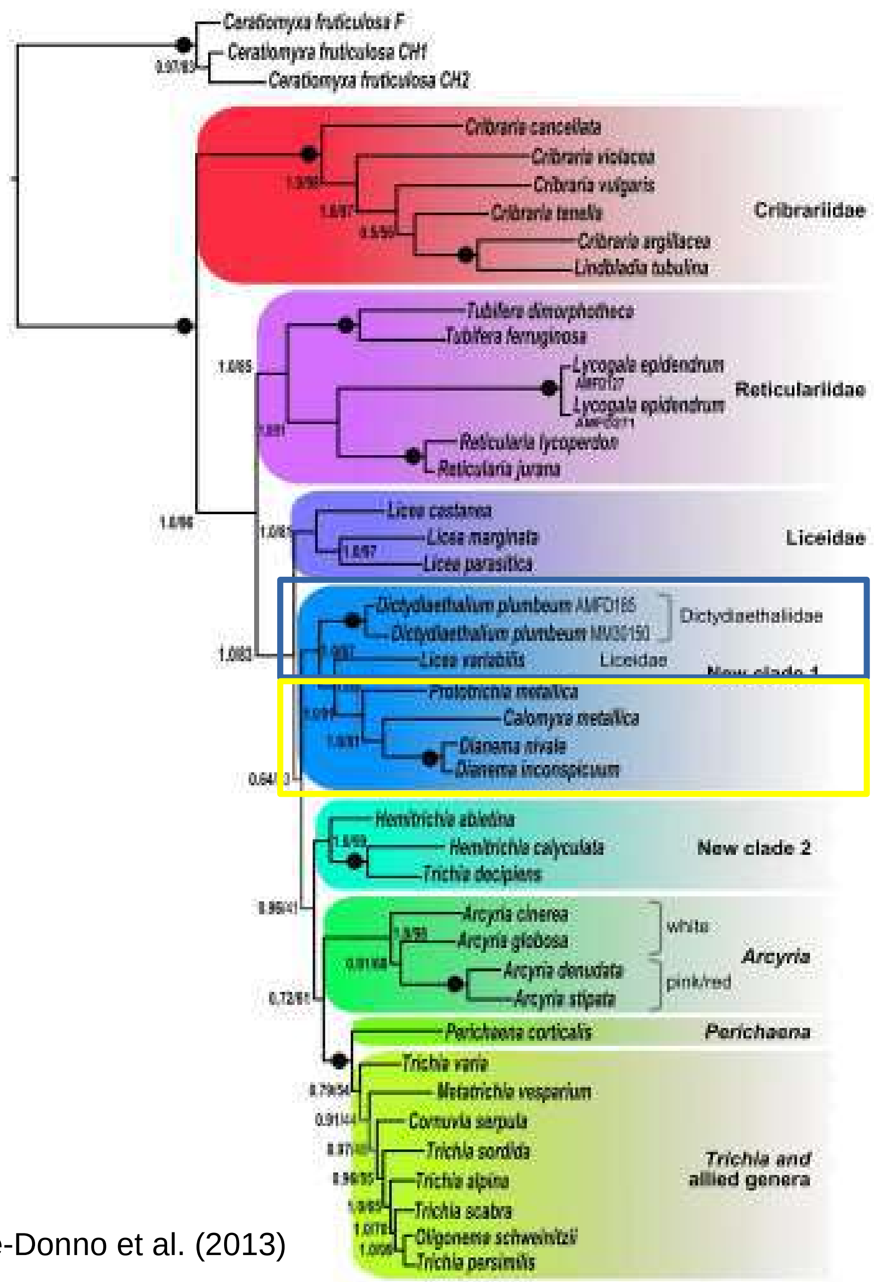
MYXOTROPIC



- Identity of the orders Trichiales and Liceales

Fiore-Donno et al. (2013)

Phylogenetic background in the order Trichiales

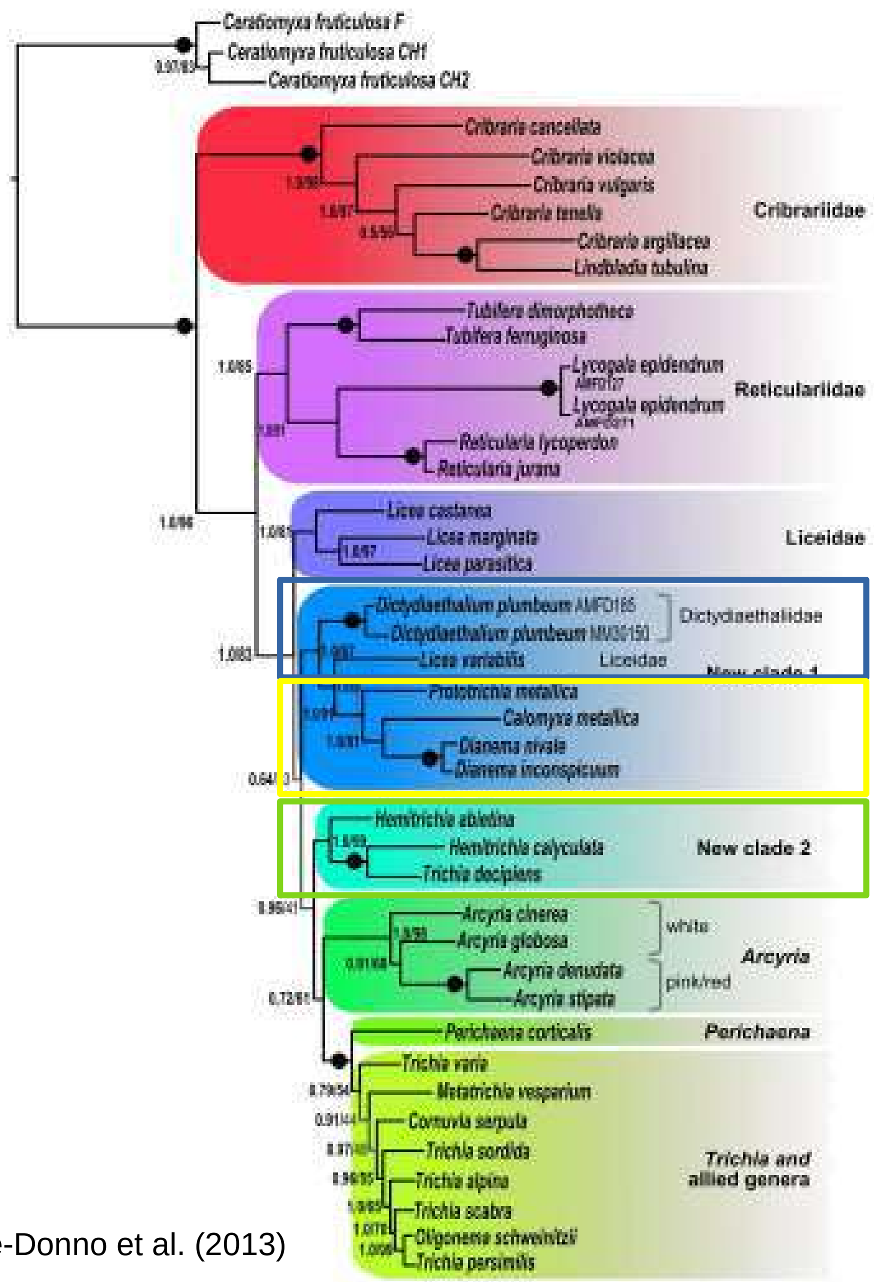


Fiore-Donno et al. (2013)

Identity of the orders Trichiales and Liceales

Position of *P. metallica*

Phylogenetic background in the order Trichiales



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- Identity of the orders Trichiales and Liceales
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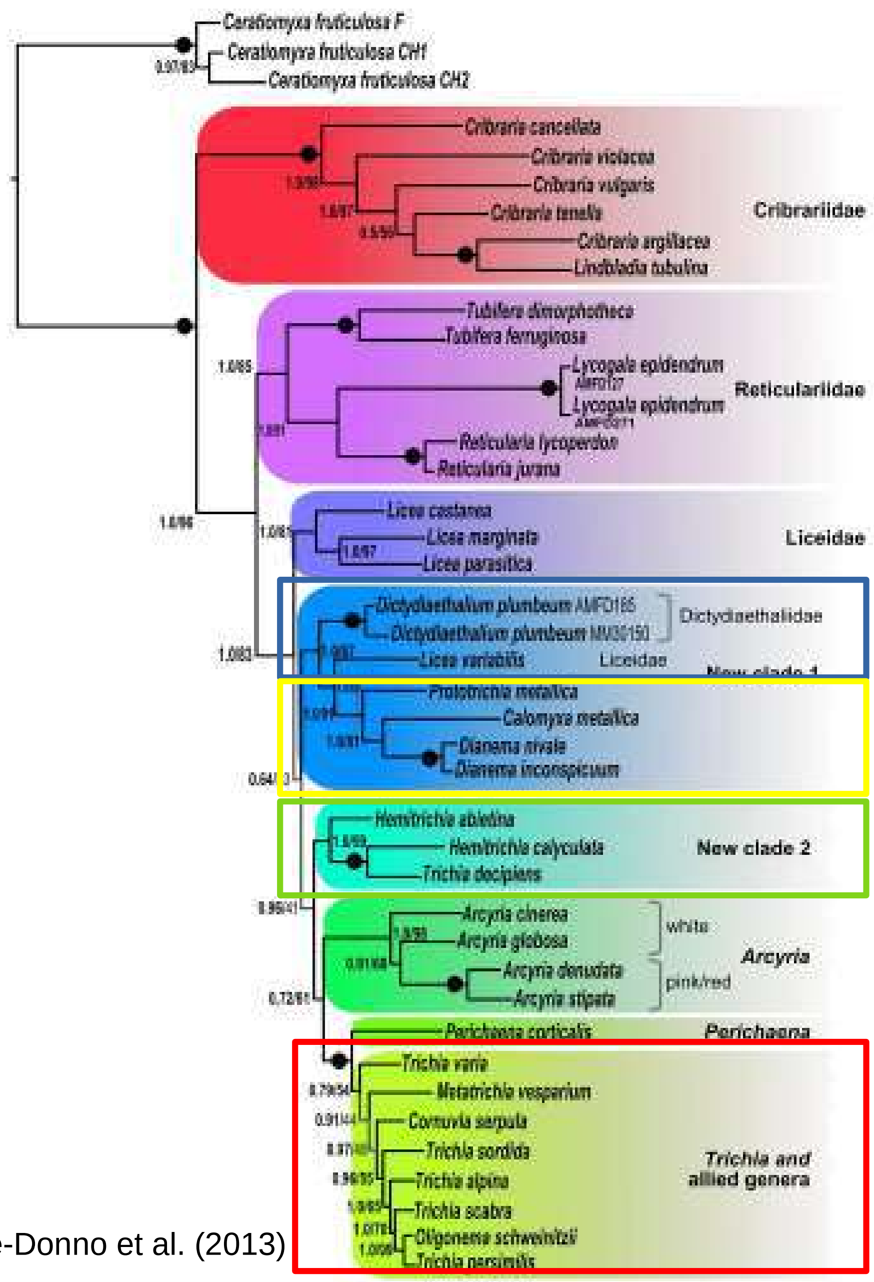
Phylogenetic background in the order Trichiales

MYXOTROPIC



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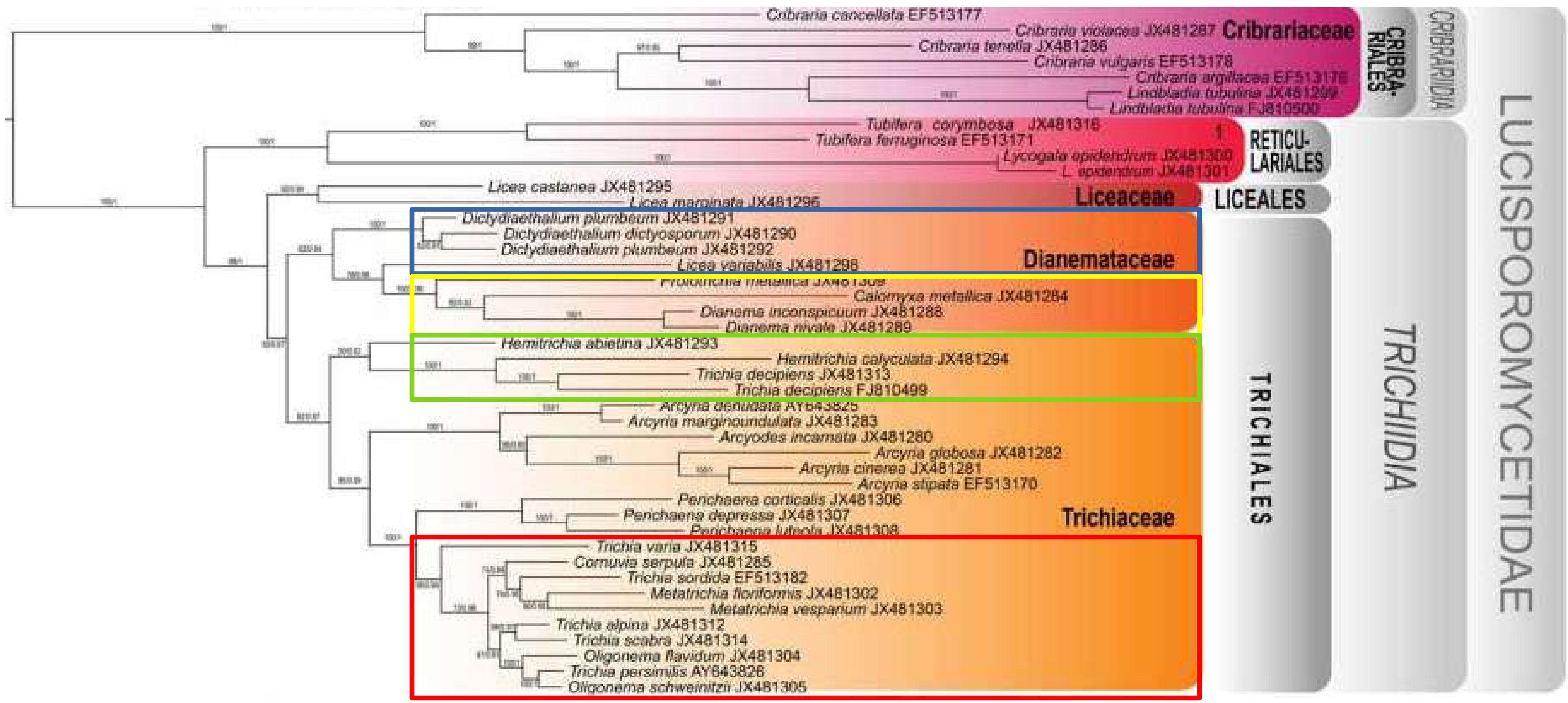
MYXOTROPIC



Leontyev et al. (2019)

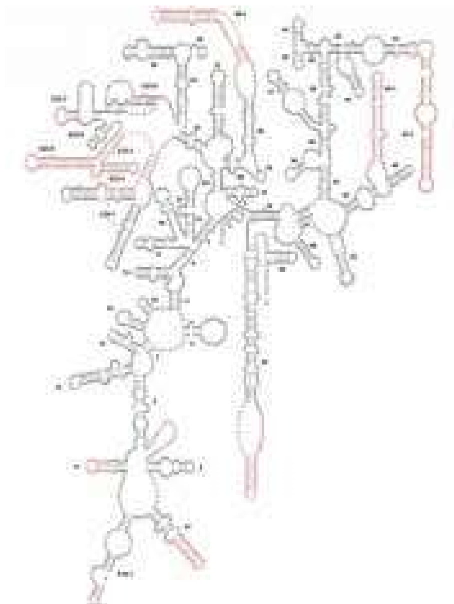
Objective

Deepen into the phylogenetic relationships of the species of the order Trichiales through:

- Increasing the taxa sampling in the phylogeny
- Covering the wide morphological variability of the order
- Exploring additional genetic regions

Phylogenetic approach

- 18SrDNA or Small Subunit ribosomal ribonucleic acid (SSU)



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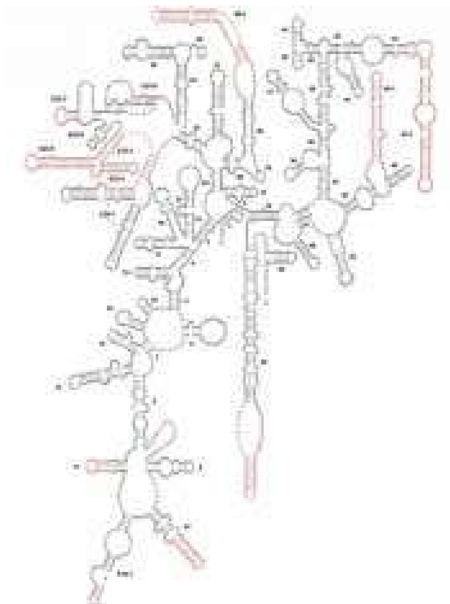
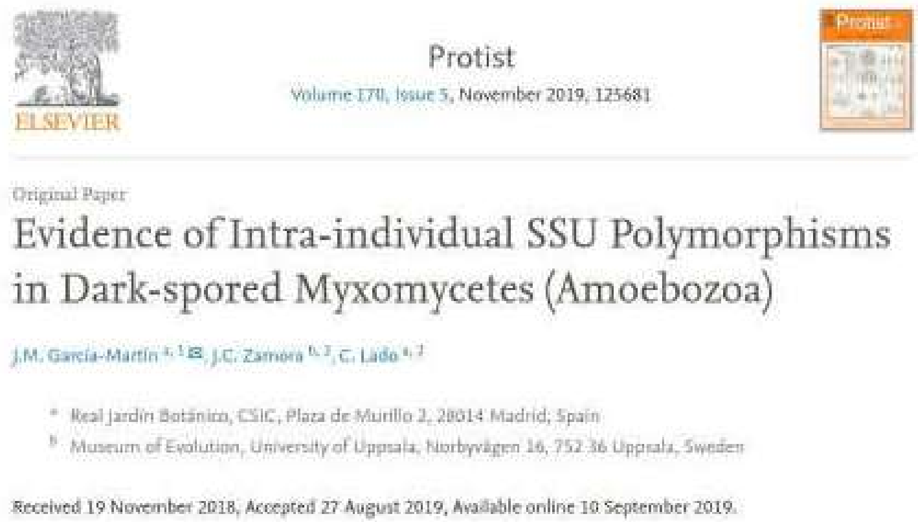



ELSEVIER

Protist
Volume 170, Issue 5, November 2019, 125681

Original Paper

Evidence of Intra-individual SSU Polymorphisms in Dark-spored Myxomycetes (Amoebozoa)

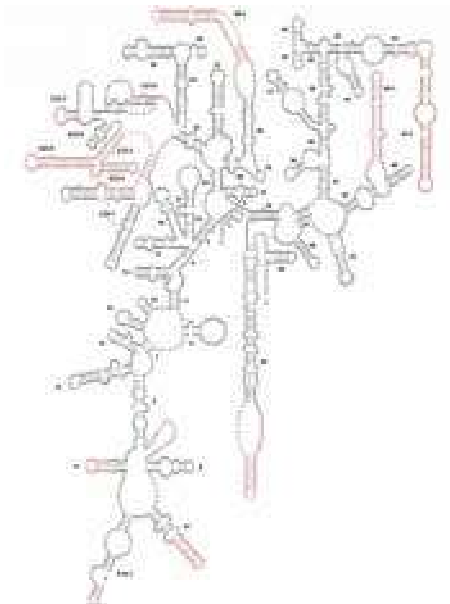
J.M. García-Martín [a, 1], J.C. Zamora [b, 2], C. Lado [a, 2]

[a] Real Jardín Botánico, CSIC, Plaza de Murillo 2, 28014 Madrid, Spain
[b] Museum of Evolution, University of Uppsala, Norbyvägen 16, 752 36 Uppsala, Sweden

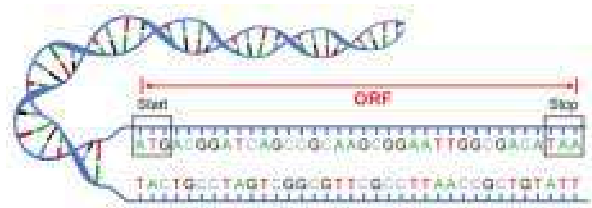
Received 19 November 2018, Accepted 27 August 2019, Available online 10 September 2019.

Phylogenetic approach

- 18SrDNA or Small Subunit ribosomal ribonucleic acid (SSU)



- Eukaryotic translation Elongation Factor 1 Alpha 1 (EF1-α)



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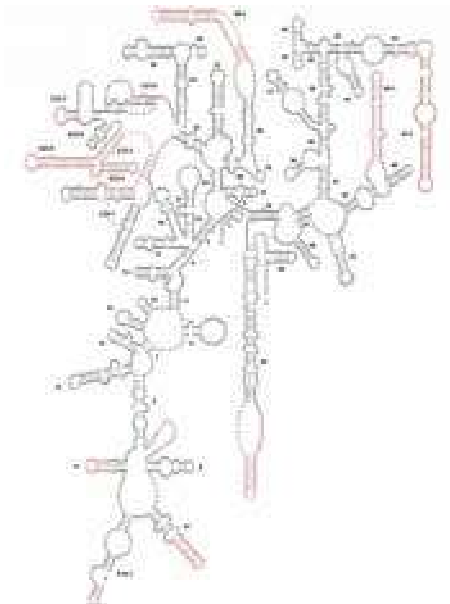

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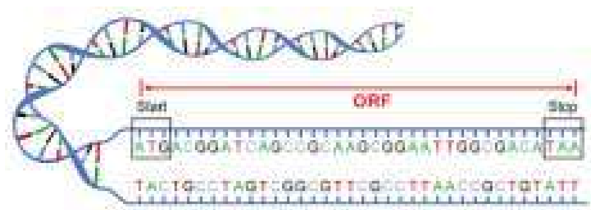
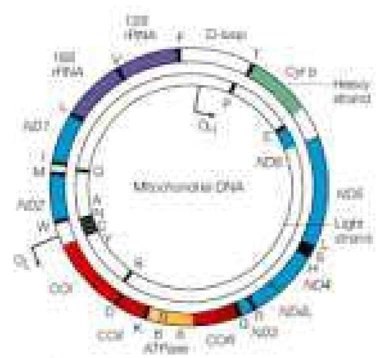
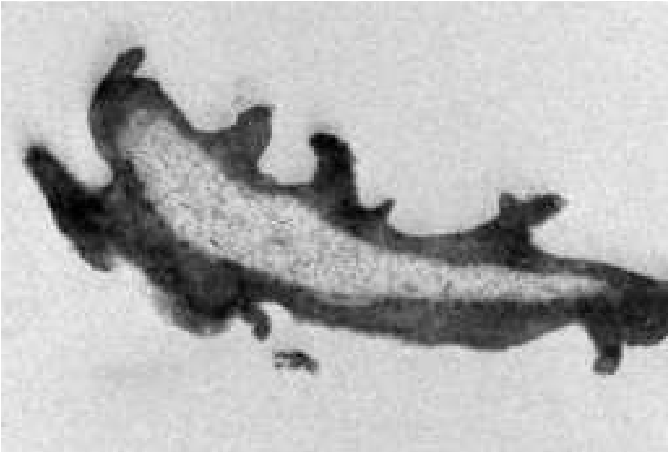


- Mitochondrial Small Subunit ribosomal ribonucleic acid (mt SSU)
- Cytochrome c Oxidase subunit I



Ultrastructural approaches

- Transmission Electron Microscopy (TEM)



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Ultrastructural approaches

MYXOTROPIC

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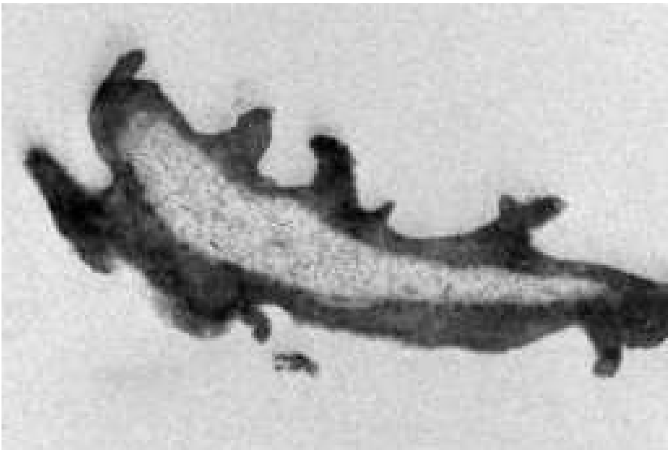
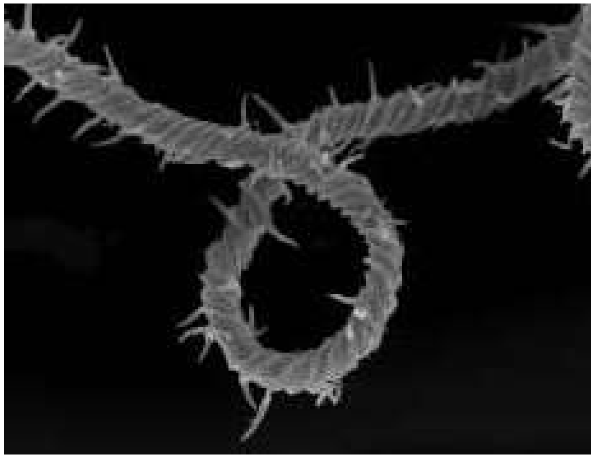


- Scanning Electron Microscopy (SEM)



Solid vs hollow capillitium?

Dianema

Prototrichia

ICSEM 10
Costa Rica

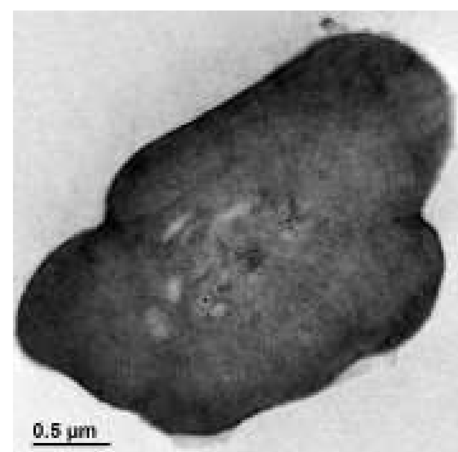
Solid vs hollow capillitium?

MYXOTROPIC

Dianema

Prototrichia

Capillitium
type A *



* García-Cunchillos
et al. In prerp.

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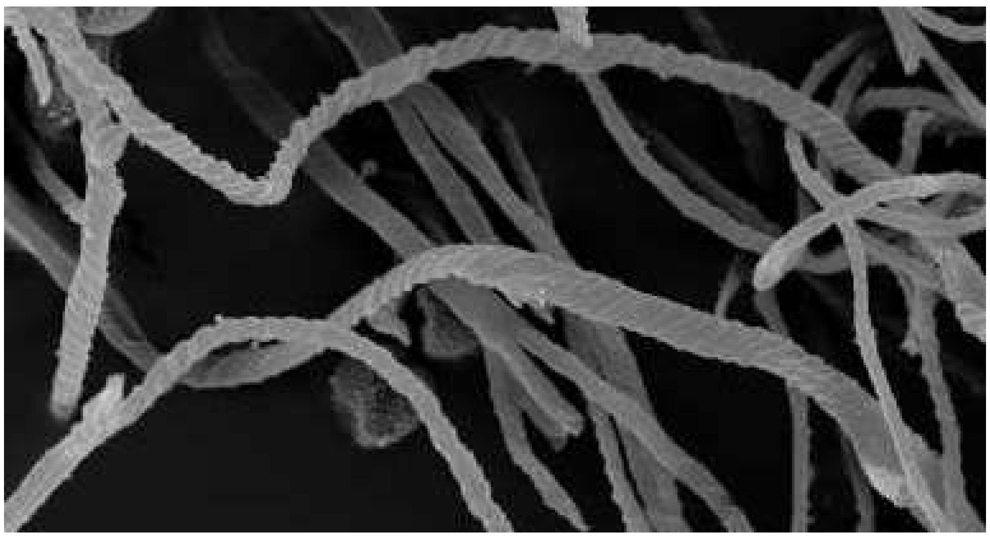

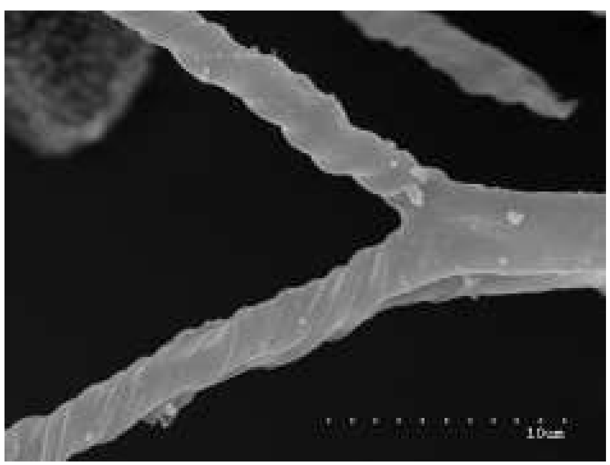

Prototrichia

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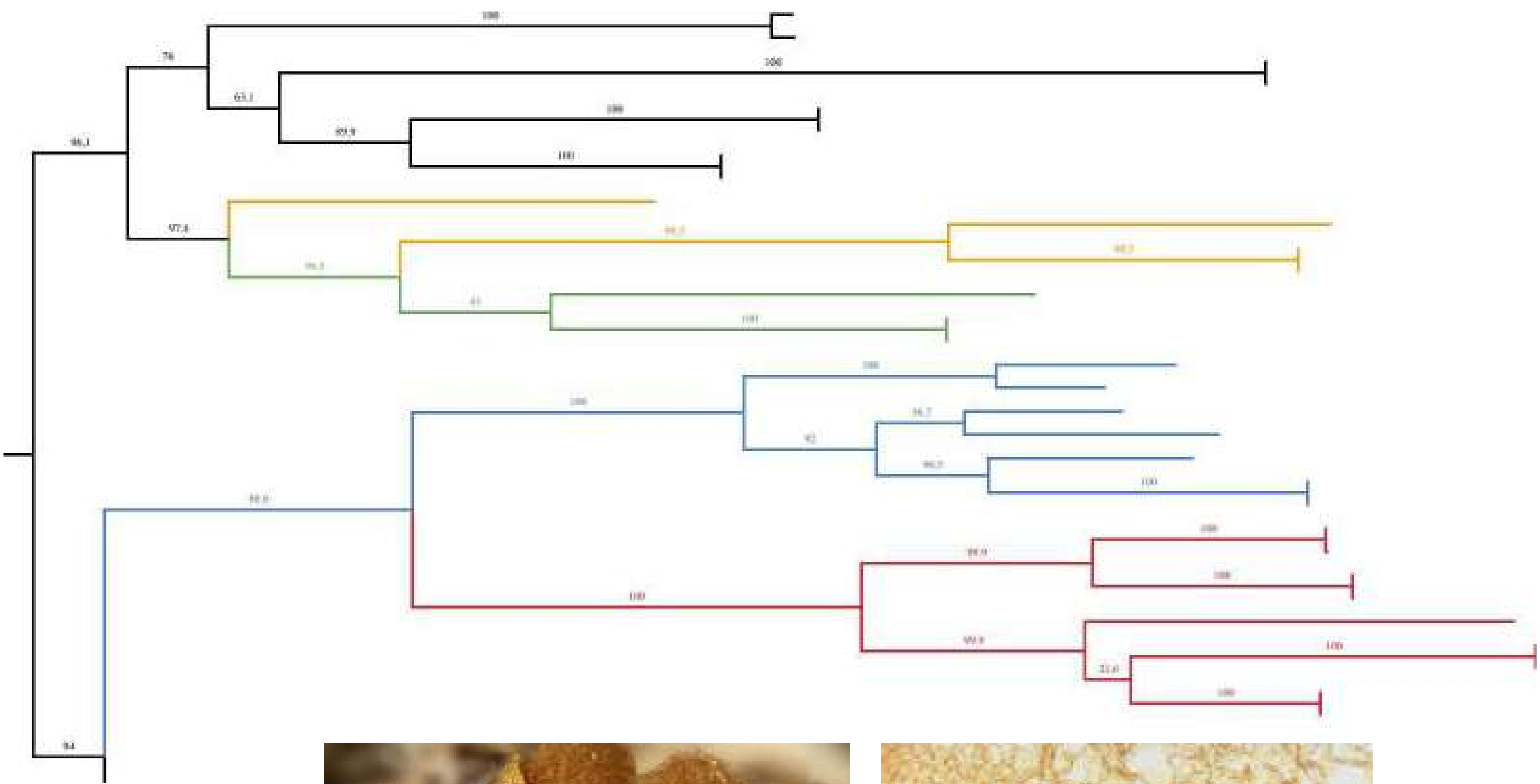
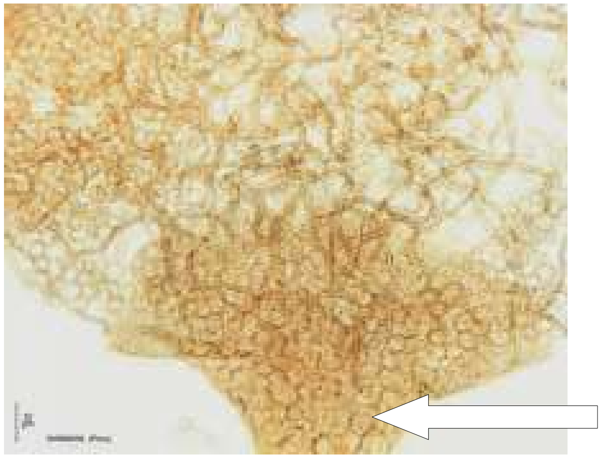
Spore-Like Cells (cysts)

MYXOTROPIC



— *Hemitrichia*

— *Trichia*



Stalk filled with spore-like cells or cysts

Spore-Like Cells or Cysts

MYXOTROPIC

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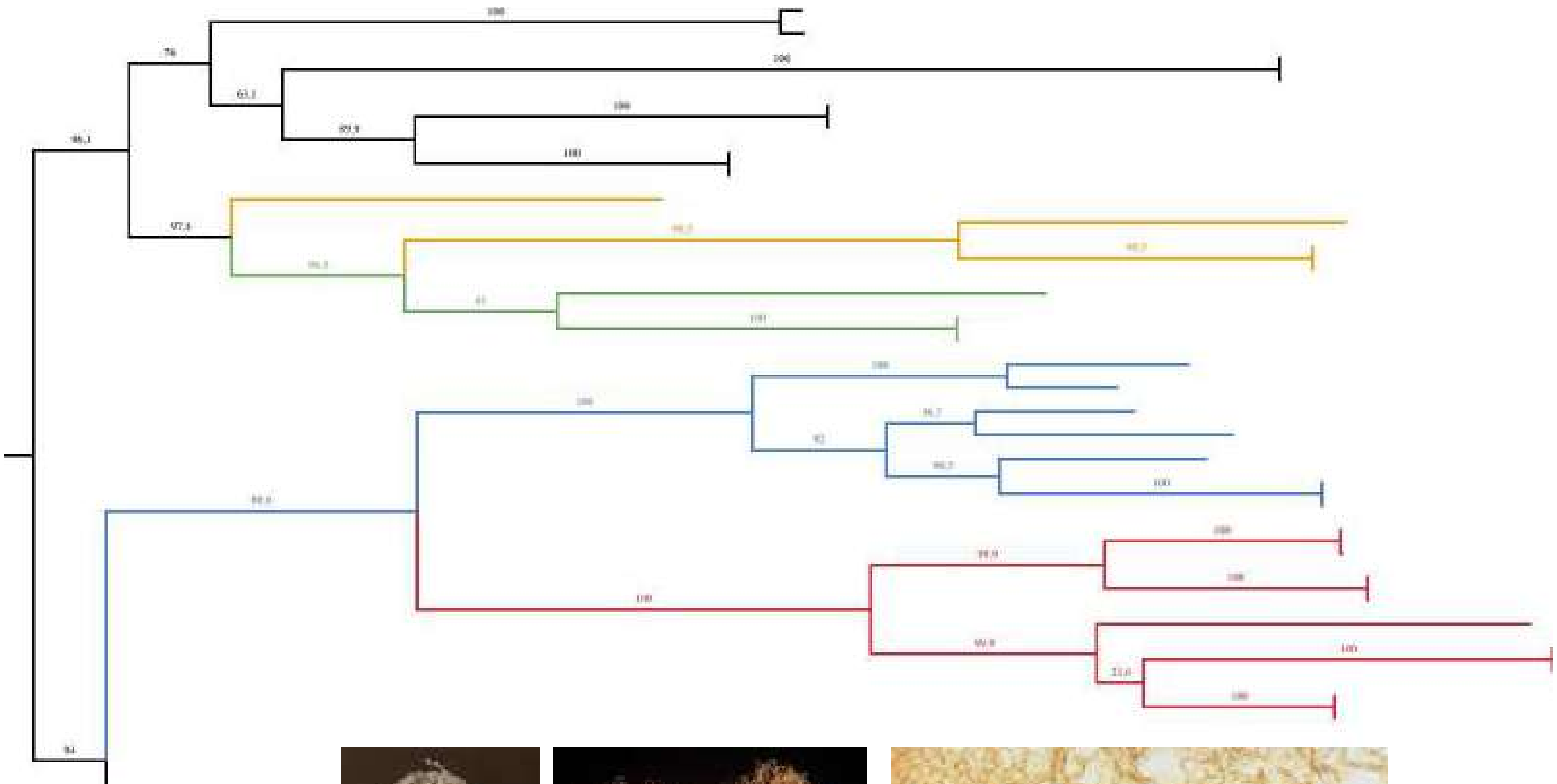
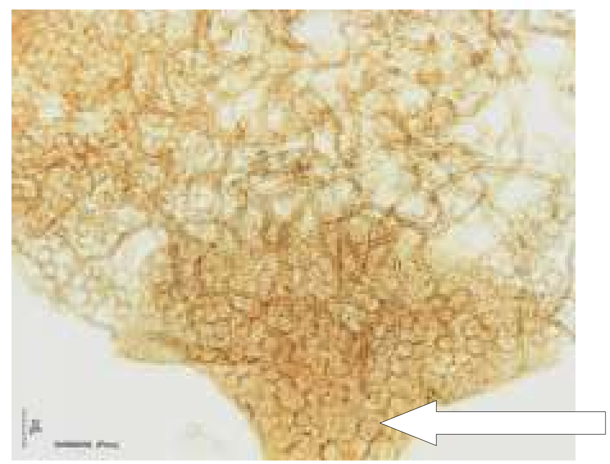


— *Hemitrichia*

— *Trichia*

— *Arcyria* (white)

— *Arcyria* (red)



Stalk filled with spore-like cells or cysts

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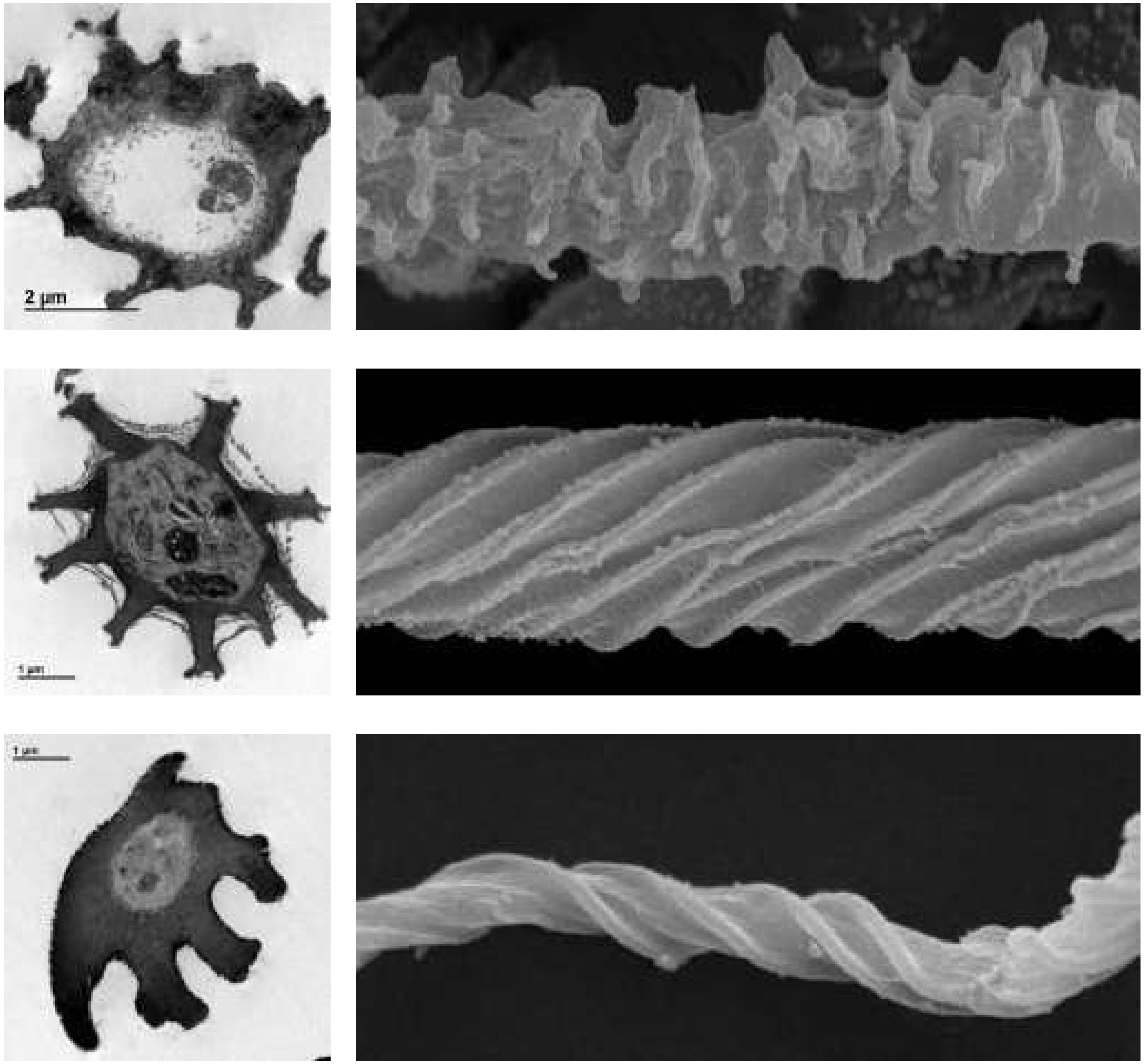
Spore-Like Cells or Cysts

MYXOTROPIC

Capillitium type B *



* García-Cunchillos et al. In prerp.

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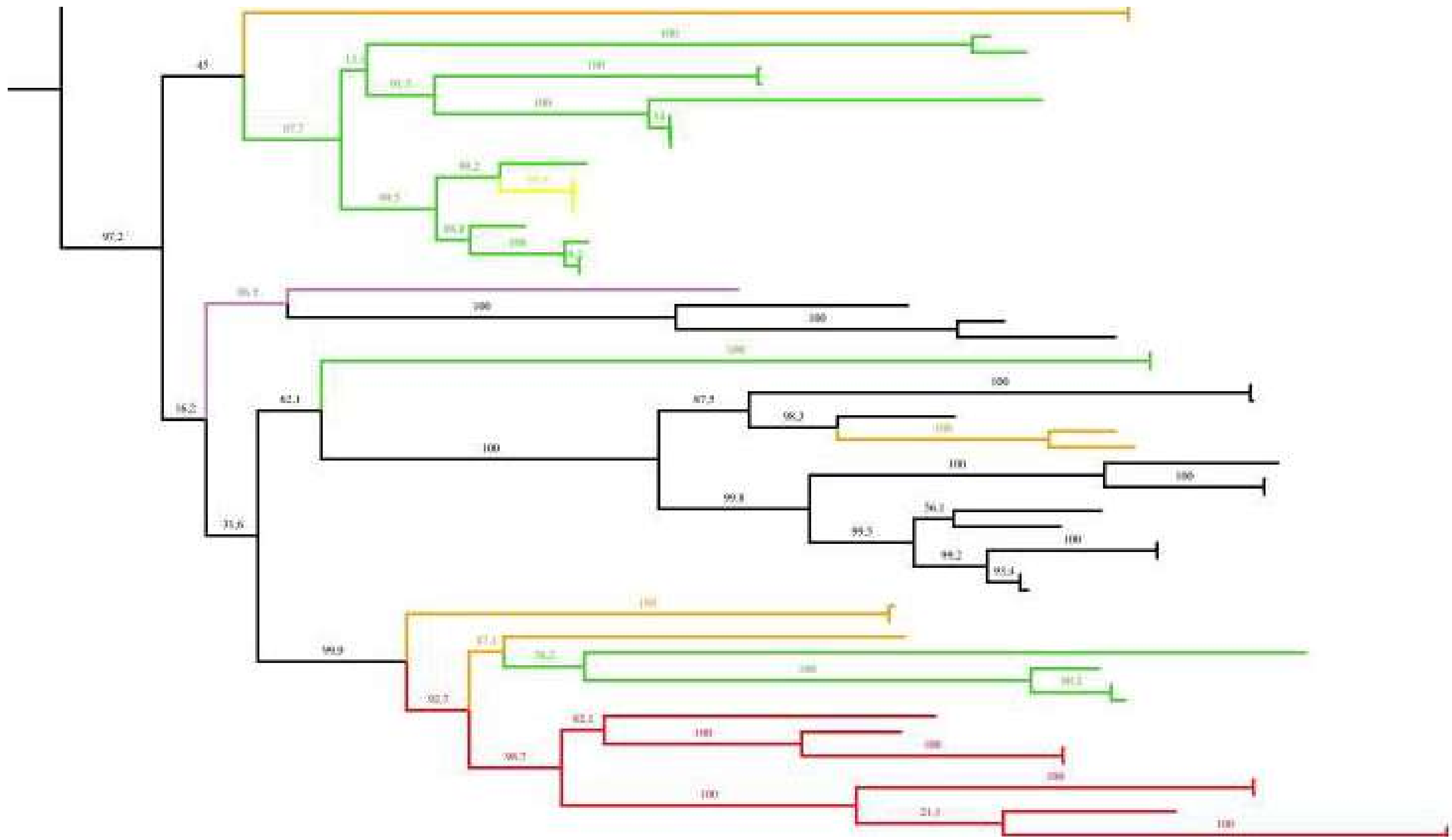
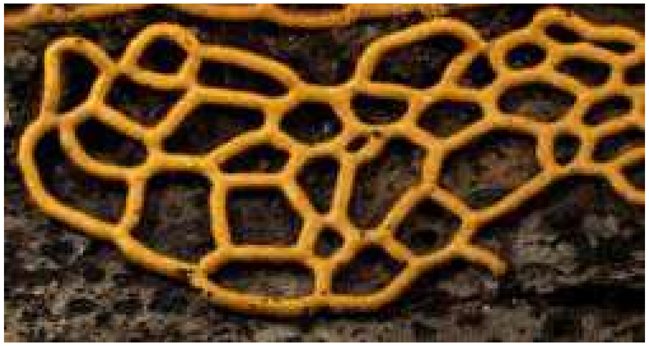
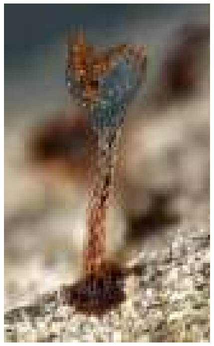
The family Trichiaceae

MYXOTROPIC

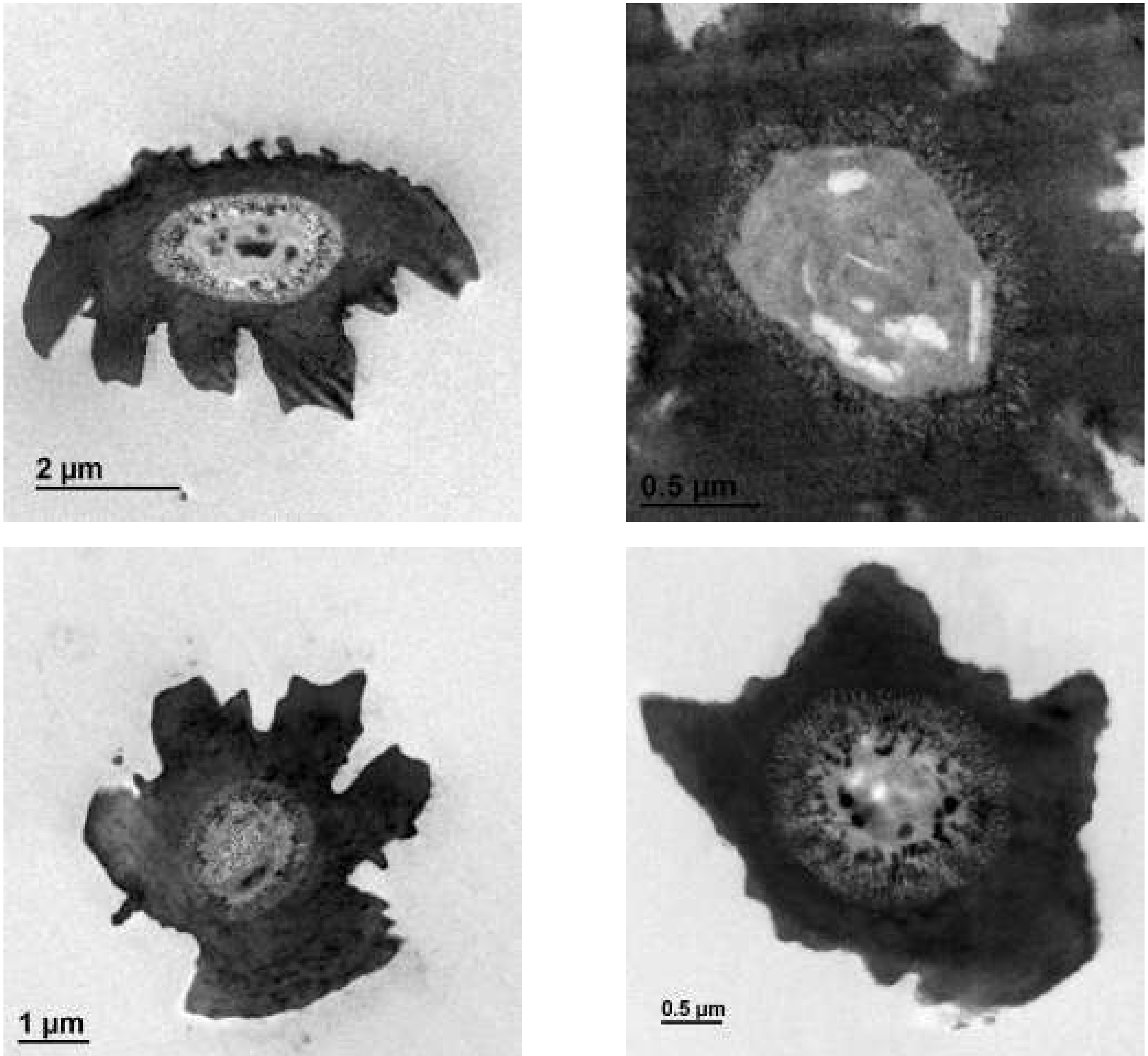






The family Trichiaceae

Capillitium type C *



* García-Cunchillos et al. In prerp.

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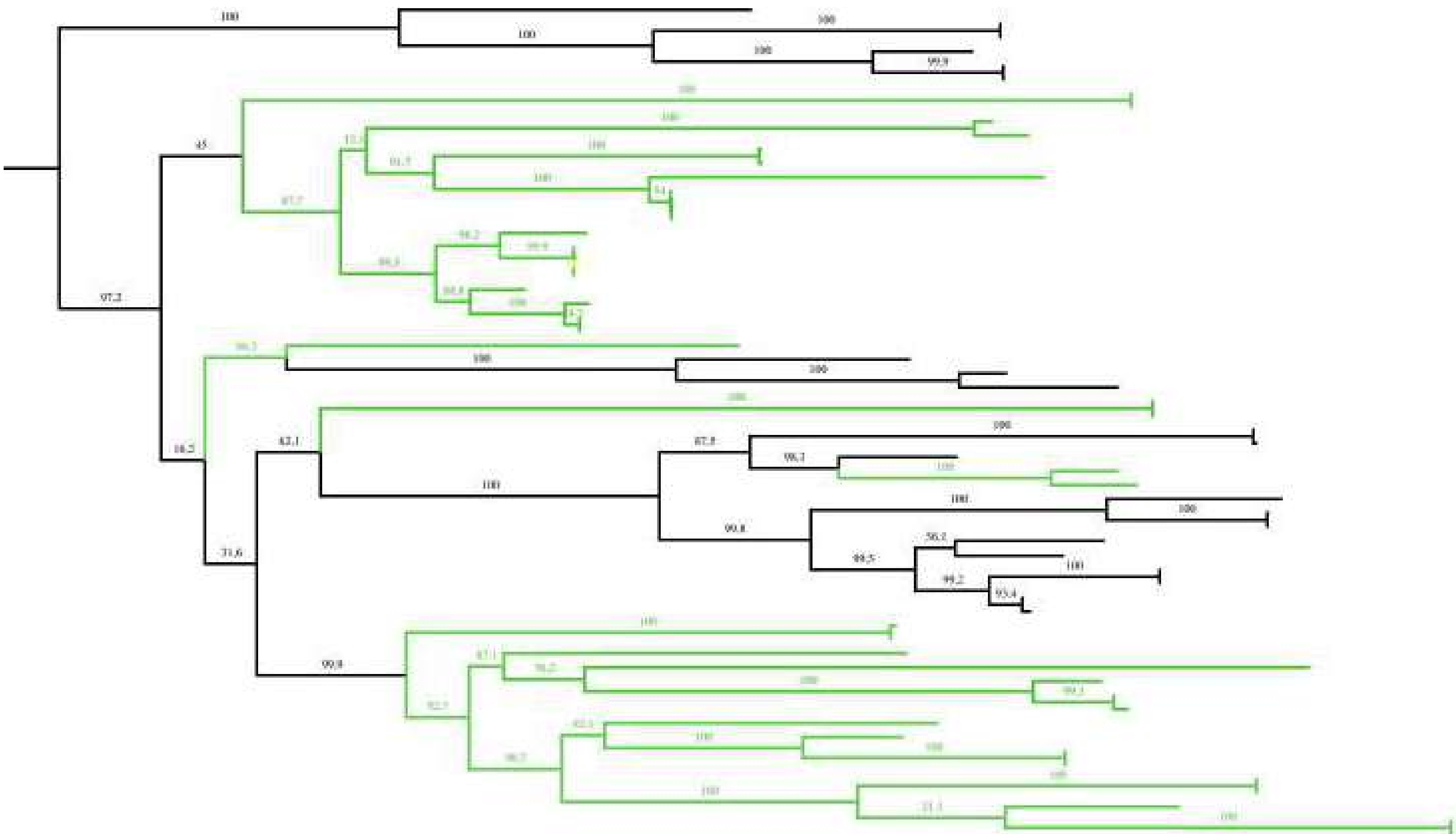
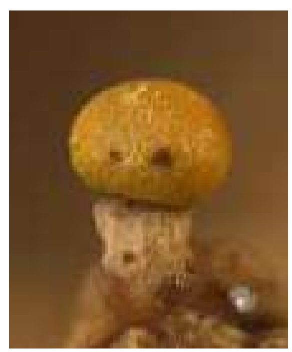
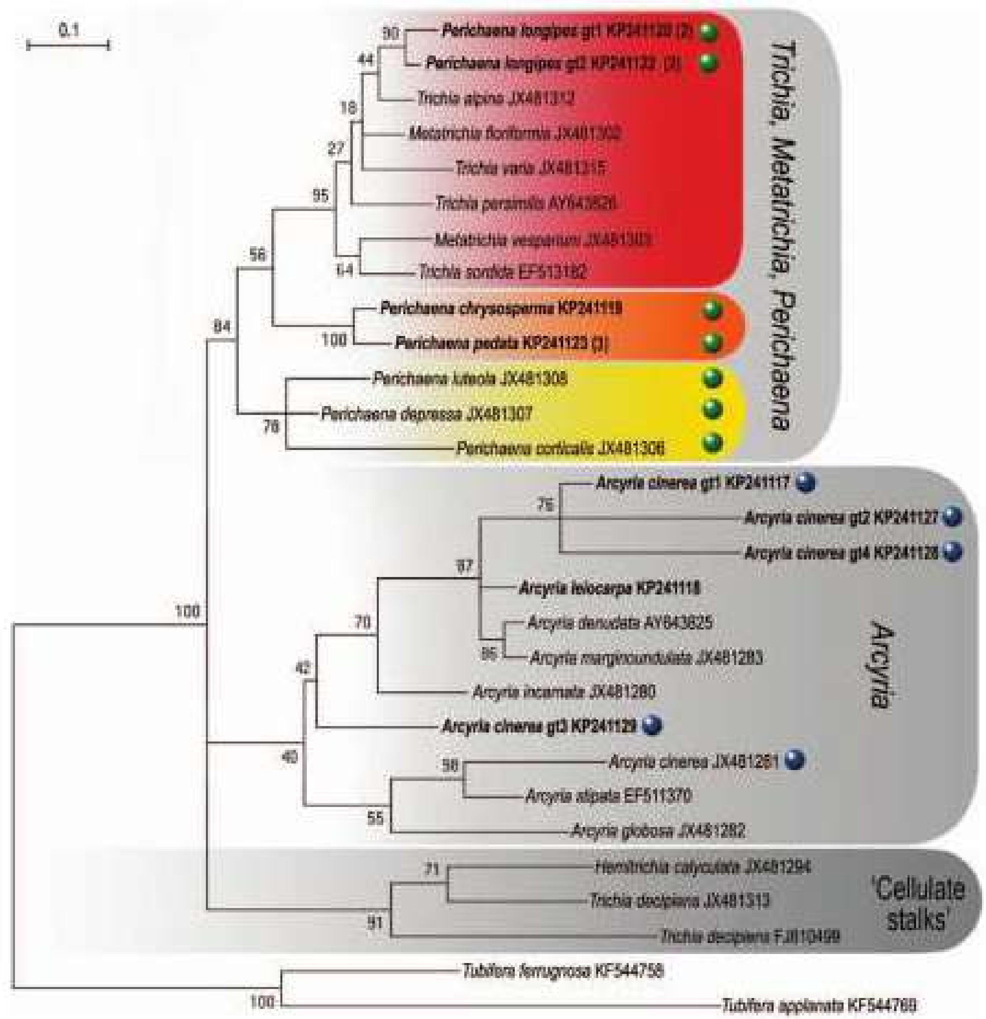
The genus *Perichaena*

MYXOTROPIC



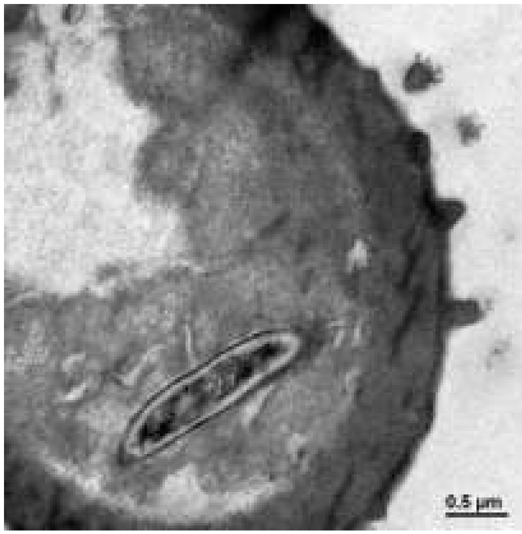


The genus *Perichaena*

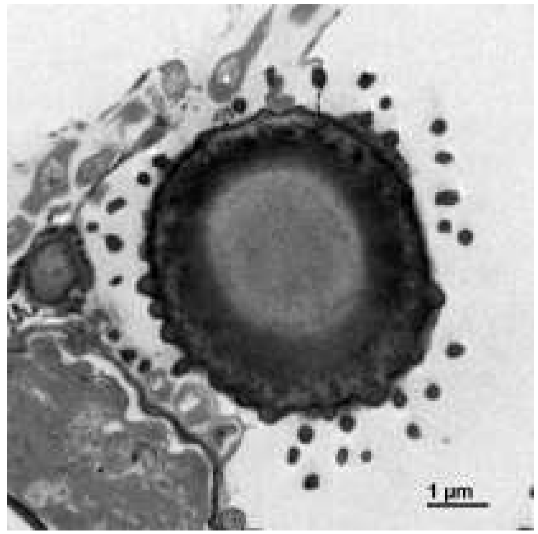


Walker et al. (2015)

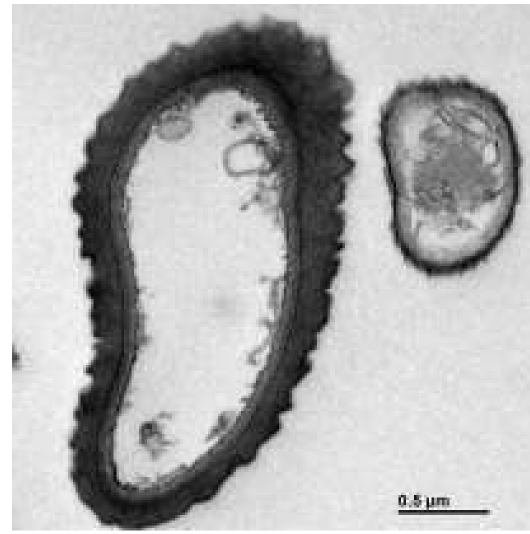
The genus *Perichaena*



Capillitium type A *

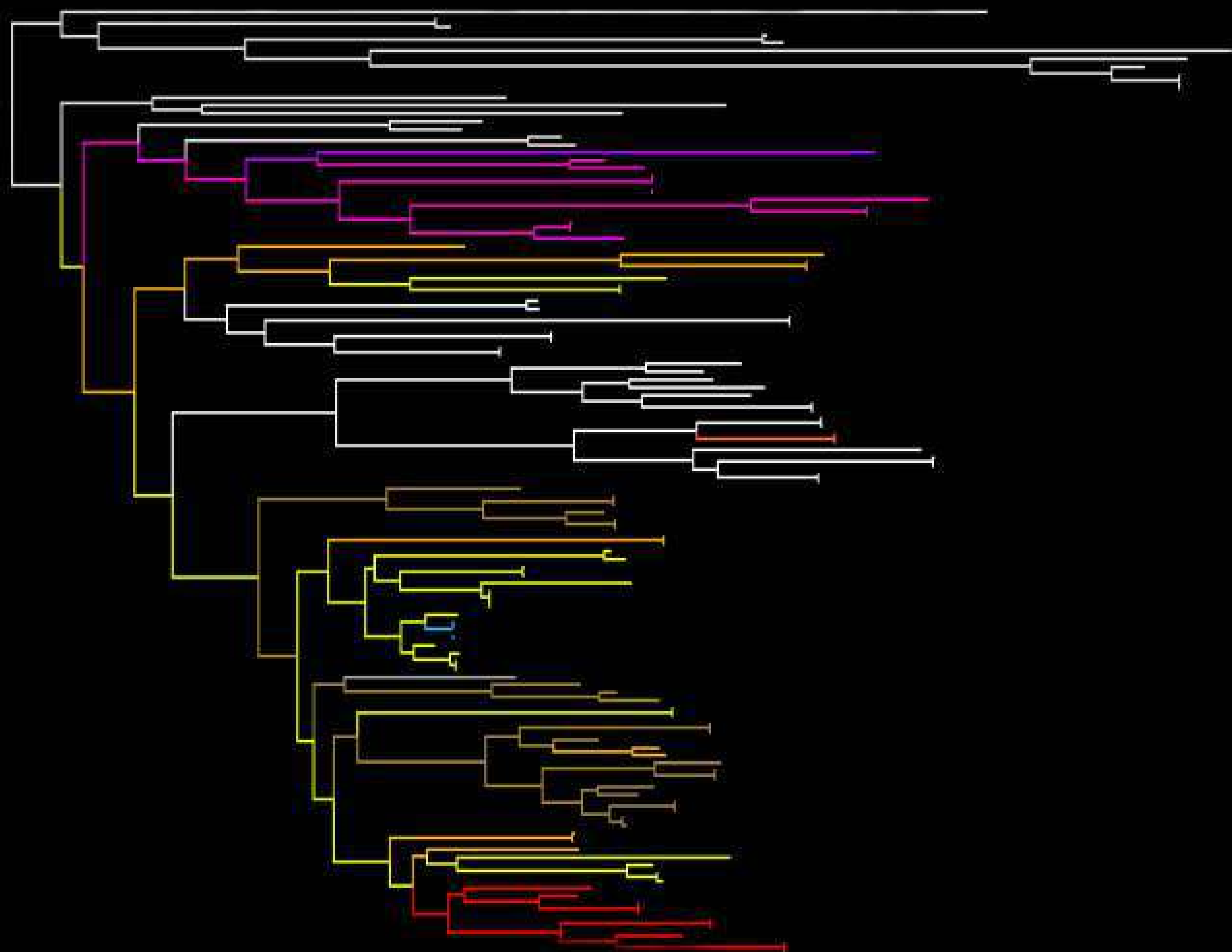


Capillitium type D *



Capillitium type E *

* García-Cunchillos et al. In prerp.



Take-home ideas

- Disagreements between morphological-based classifications vs phylogenetic reconstructions

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Take-home ideas

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- Polyphyly of most of the genera as currently described in the order Trichiales

Take-home ideas

MYXOTROPIC

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  - Spiral ornamentation of the capillitium
  - Capillitium net vs single tubules
  - Stalk vs sessile fructifications
- Polyphyly of most of the genera as currently described in the order Trichiales
- Future considerations:
  - Taxa sampling (cryptic diversity?)
  - Increasing the resolution of the phylogenies (i.e., genomics)

Acknowledgments

- Transmission Electron Microscopy:
  - Belén Estébanez Pérez
  - Francisco R. Urbano Olmos
  - Covadonga Aguado Ballano
- Scanning Electron Microscopy:
  - Yolanda Ruiz León
- Molecular systematics laboratory:
  - Joaquina María García-Martín
  - Emilio Cano Cabezas

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MINISTERIO DE CIENCIA, INNOVACIÓN Y UNIVERSIDADES

AGENCIA ESTATAL DE INVESTIGACIÓN

MYXOTROPIC

ISOP International Society of Protistologists

Scholarship funding: 2015 BES-2015-072763

Project funding: Myxotropic V (CGL 2018-52584P)

THANK YOU VERY MUCH!

Iván García-Cunchillos

igcun@rjb.csic.es

@Igarpaetus

How DNA metabarcoding changes our understanding of myxomycete ecology, diversity and distribution

Oleg Shchepin, Yuri Novozhilov, Ilya Prikhodko, Nadezhda Fedorova, Vladimir Gmoshinskiy, Martin Schnittler

Sporocarp-based diversity studies of myxomycetes

Field collecting + moist chamber cultures

- Virtually all studies
- Morphological species concept
- ~1000 morphospecies
- Some fruit rarely (or never?)
- No data about microscopic stages

Cryptic speciation problem

- Morphological traits in many cases are not able to resolve biospecies
- Multiple biospecies within morphospecies
- Biospecies of one morphospecies often seem to occupy different ecological niches and have different distribution ranges

-> **the morphospecies-based ecological studies heavily lack the resolution**

Molecule-based diversity studies

Sequencing of environmental DNA/RNA

- Few studies
- OTUs (Operational Taxonomic Units)
  - Can distinguish cryptic species with a proper similarity threshold
- Large hidden diversity
- No need for culturing
- No need for sporocarps
- Error-prone :(

DNA metabarcoding (amplicon metagenomics)

Community analysis based on:

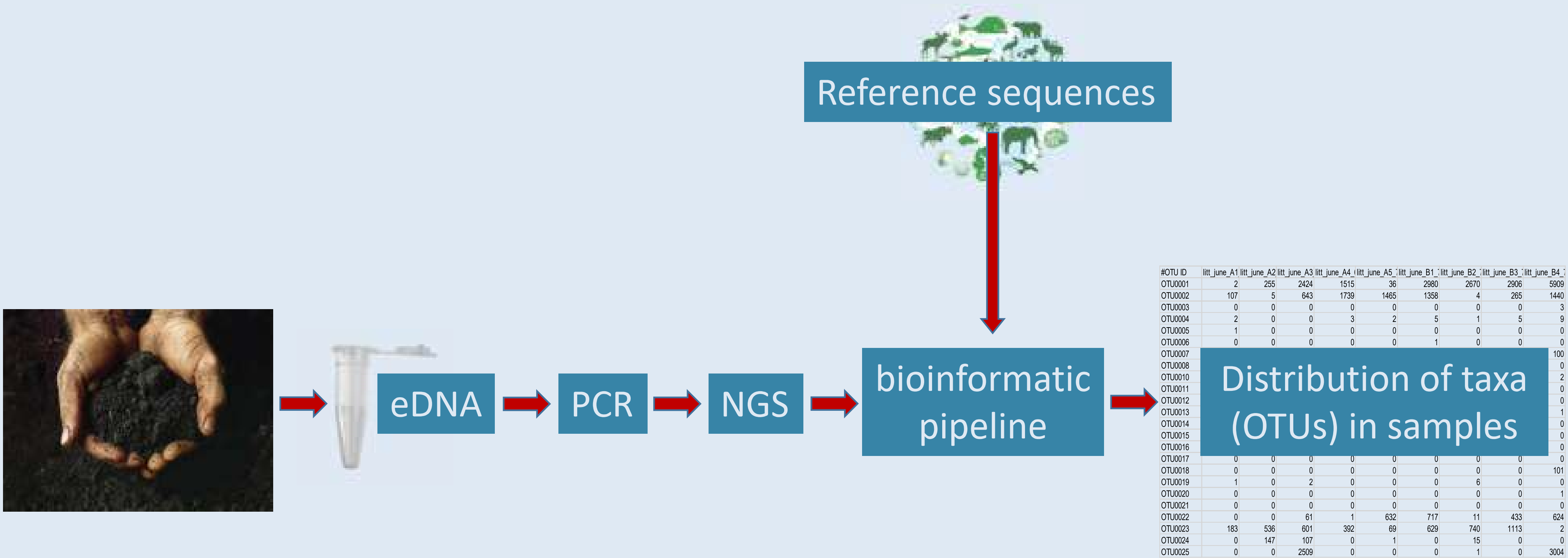
- **DNA barcoding**

  species identification with short universal DNA fragments (ITS, COI, 16S, 18S, …)

- **Next Generation Sequencing** (high throughput sequencing)

  parallel sequencing of millions of different nucleotide sequences (Illumina, PacBio, Oxford Nanopore, …)

Metabarcoding in one slide



Reference sequences

- **GenBank** data are very noisy
- Myxomycetes poorly represented in **SILVA** and **PR2**

Solution – create a curated collection of sequences

Online resource: https://dna.myxomycetes.org/

More details – in the talk **O5**

Published studies

Paper	Primers	Region	Habitat	Method	Threshold (%)	OTUs found
Fiore-Donno et al. 2016	S1/SR19Dark, S1/SF2Dark	Germany	Grassland soils	pyrosequencing	97.0	338
Borg Dahl et al. 2018a	S1/SU19R, S3bF/S31R	Northern Caucasus, Teberda Nature Reserve	Alpine soils	Illumina MiSeq	99.1	27
Borg Dahl et al. 2018b	S1/SU19R, S3bF/S31R	German Alps, Garmisch-Partenkirchen	Alpine soils	Illumina MiSeq	99.1	208
Shchepin et al. 2019	S3bF/S31R	Northwestern Russia, Nizhne-Svirskiy Nature Reserve	Ground litter and soil in boreal coniferous forest	Illumina MiSeq	99.1/98.0	187/101
Gao et al. 2019	S3bF/S31R	Central China, Baotianman Nature Reserve	Alpine soils	Illumina MiSeq	98.0	195

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Unpublished data, 229 amplicon libraries

Primers	Region	Habitat	Method	Threshold (%)	Amount of samples
S1/SU19R, S3bF/S31R	Russia, Kamchatka	Alpine soils	Illumina MiSeq	98.0	48
S1/SU19R, S3bF/S31R	Russia, Khibine Mts	Alpine soils	Illumina MiSeq	98.0	48
S1/SU19R, S3bF/S31R	Northwestern Russia, Bolshoy Berezoviy isl.	Lowland forest soil	Illumina MiSeq	98.0	30
S1/SU19R, S3bF/S31R	Northwestern Russia, Vaskelovo	Lowland forest soil	Illumina MiSeq	98.0	30
S1/SU19R, S3bF/S31R	Russia, Tver region, Central Forest Reserve	Lowland forest soil	Illumina MiSeq	98.0	30
S1/SU19R, S3bF/S31R	Antarctica, King George, Schirmacher Lake	Soil and mosses	Illumina MiSeq	98.0	8
S1/SU19R, S3bF/S31R	Germany, peat bogs	Living sphagnum mosses and peat cores	Illumina MiSeq	98.0	30
S1/SU19R, S3bF/S31R	Russia, Krasnoyarsk region	lakes and rivers	Illumina MiSeq	98.0	5 (of 46)

pilot samples

Taxonomic assignments

Study	OTUs assigned to species
Unpublished data*	198 / 582 (34%)
Garmisch-Partenkirchen	63 / 208 (30%)
Nizhne-Svirskiy Reserve*	28 / 101 (28%)
Baotianman Nature Reserve*	16 / 195 (**8%**)

* - assigned using the same reference data base

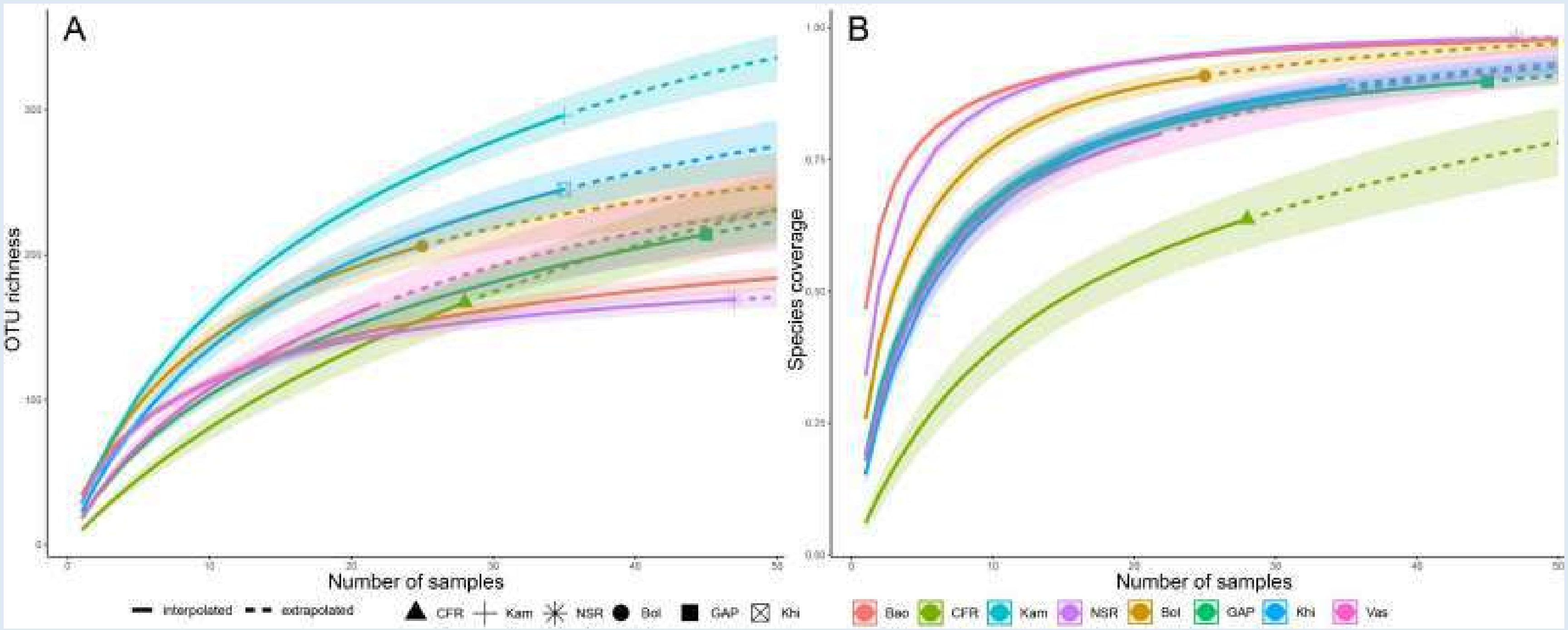
Datasets re-analyzed

- 374 samples
- VSEARCH-based pipeline
- 951 OTU (98% similarity threshold) of Columellomycetidae
- 244 OTUs (26%) assigned to species

Sample-based rarefaction curves

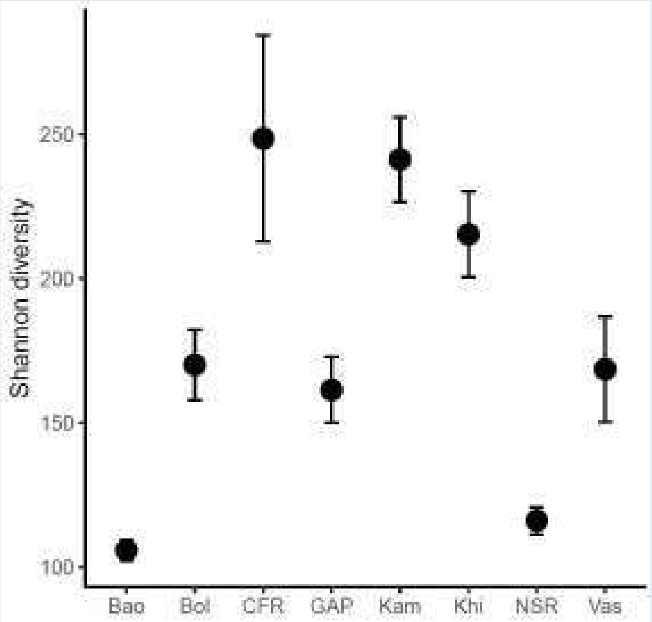
OTU richness

OTU coverage

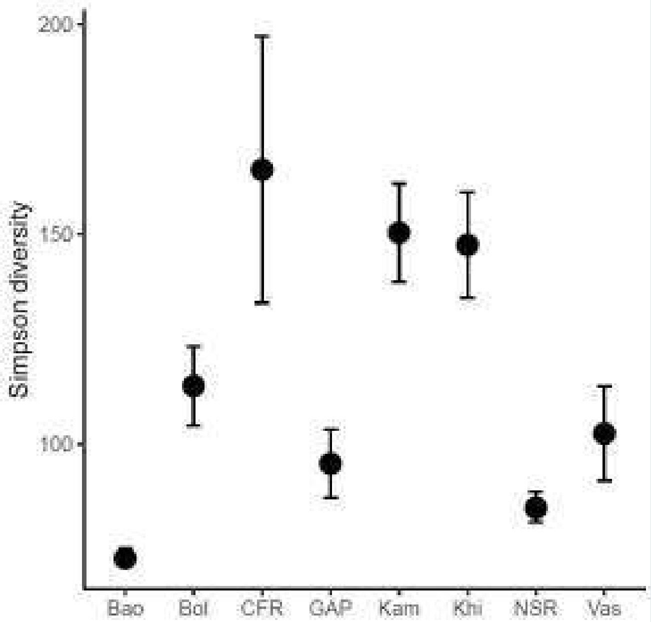


Sample-based rarefaction curves

Shannon diversity



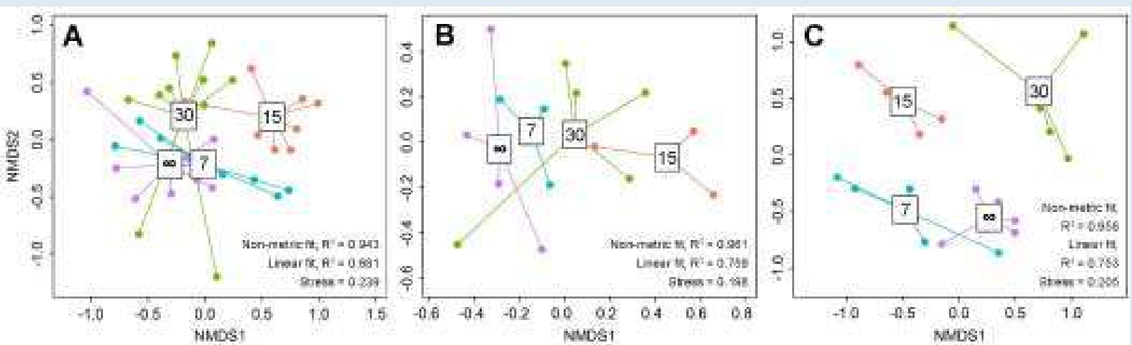
Simpson diversity



NMDS: Structured assemblages

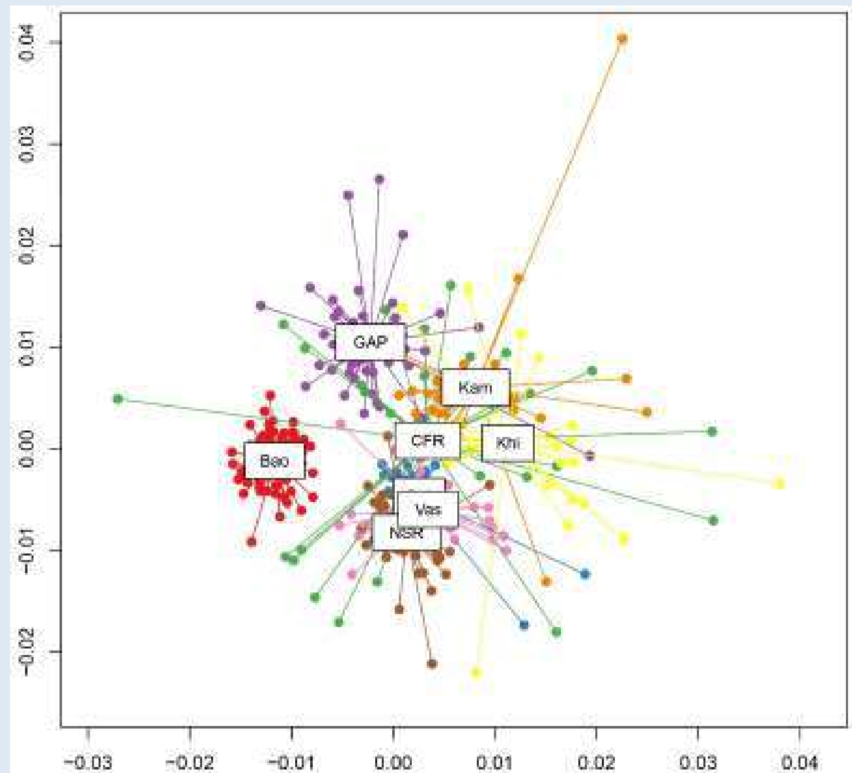
Small scale

Leaf litter samples from the four plots in NSR:
A – all samples, **B** – June, **C** – September.



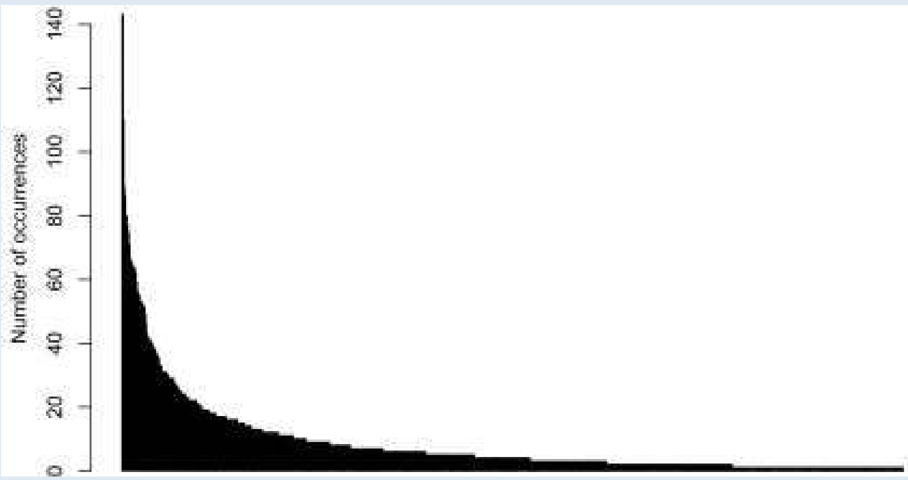
Large scale

Soil samples from the eight study regions



- Tropical forest (*Bao*) – distinctive community, lowest diversity
- This agrees with the trend of myxomycete diversity decreasing from boreal forests towards tropical forests (but more tropical samples needed to confirm this)
- The high OTU richness and high diversity on Kamchatka Peninsula agrees with our sporocarp-based observations (unpublished)

OTU frequency curve



- Few seemingly ubiquistic OTUs
- 80% of OTUs found only in one or two of the studied regions
- 2 OTUs (*Meriderma cribrarioides*) found in all surveys - extraordinary ecological plasticity!
- Of 25 OTUs occurring in at least six studied regions, 16 belong to nivicolous species, 12 of them – *Meriderma* spp.
- OTU 100% matching "*Hyperamoeba*" strain from bark of living trees in Germany found in 7 regions

Garmisch-Partenkirchen (GAP)

Photo source: www.choschiba.com

Collected: June 2016

German limestone Alps, mixed forest with *Fagus sylvatica*, *Abies alba* and *Picea abies* to open grasslands. Elev. 1200–1700 m a.s.l.

48 soil samples

59 / 201 OTUs (29%)

Comatricha rubens
Diachea subsessilis
Diacheopsis bulbillosa
Diderma alpinum
Diderma europaeum
Diderma fallax
Diderma meyerae
Diderma microcarpum
Diderma niveum
Didymium anellus
Didymium crustaceum
Didymium difforme
Didymium dubium
Didymium iridis
Didymium sp. 1
Fuligo septica
Lamproderma aeneum
Lamproderma album
Lamproderma arcyrioides
Lamproderma echinosporum
Lamproderma lycopodiicola
Lamproderma ovoideum
Lamproderma piriforme
Lamproderma retirugisporum
Lamproderma sauteri
Lamproderma scintillans
Lamproderma sp.
Leocarpus fragilis
Lepidoderma chailletii
Meriderma carestiae
Meriderma cribrarioides
Meriderma echinulatum
Meriderma spinulosporum
Physarum albescens
Physarum vernum
Stemonitis sp.

Nizhne-Svirskiy Reserve (NSR)

Collected: June and September 2015

From lowland coniferous forest with Pinus sylvestris. Elev. 1200-1700 m a.s.l.

48 leaf litter samples

28 / 101 OTUs (28%)

- Many nivicolous species
- Nivicolous present in majority of samples
- *D. europaeum, L. carpatiensis* ad int., *M. cribrarioides* and *Ph. albescens* never registered fruiting
- *C. oculatum* and *L. tigrinum* – unusual substrate

Colloderma oculatum
Comatricha fragilis
Diderma alpinum
Diderma europaeum
Diderma niveum
Didymium melanospermum
Didymium sp. 1
Lamproderma arcyrioides
Lamproderma sauteri
***Lamproderma carpatiensis* ad int.**
Leocarpus fragilis
Lepidoderma chailletii
Lepidoderma tigrinum
Meriderma cribrarioides
Meriderma echinulatum
Physarum albescens
Physarum globuliferum
Stemonitis sp.

Baotianman Nature Reserve (Bao)

Collected: April-October2016
Subtropical forests (Central China) with *Pinus* spp., *Quercus* spp., *Cyclobalanopsis glauca*, *Diospyros lotus*. Elev. 1200–1600 m a.s.l.
75 soil samples
16 / 195 OTUs (8%)

- 4 nivicolous myxomycetes – first records for China (contamination impossible: in that lab people never worked with them)
- Only *Craterium minutum* was recorded fruiting in the reserve
- 26 OTUs shared with GAP, 7 with NSR
- Again *Didymium* sp. 1: huge plasticity

Craterium minutum
Didymium anellus
Didymium flexuosum
Lamproderma arcyrioides
Lamproderma cristatum
Lamproderma piriforme
Lamproderma scintillans
Meriderma cribrarioides
Didymium sp. 1

Kamchatka (Kam)

Collected: June-July 2017
Elevational transect: *Betula* spp. forest – *Alnus* sp. thickets – alpine tundra. Elev. 1250–900 m a.s.l.
48 soil samples
92 / 222 OTUs (41%)

Comatricha rubens
Craterium leucocephalum
Diderma alpinum
Diderma europaeum
Diderma microcarpum
Diderma umbilicatum
Didymium anellus
Didymium difforme
Didymium melanospermum
Didymium verrucosporum
Fuligo septica
Lamproderma aeneum
Lamproderma album
Lamproderma arcyrioides
Lamproderma cristatum
Lamproderma echinosporum
Lamproderma muscorum
Lamproderma ovoideum
Lamproderma piriforme
Lamproderma pulveratum
Lamproderma retirugisporum
Lamproderma sauteri
Lamproderma scintillans
Lamproderma zonatum
Leocarpus fragilis
Lepidoderma alpestroides
Lepidoderma carestianum
Lepidoderma chailletii
Meriderma aggregatum
Meriderma cribrarioides
Meriderma echinulatum
Meriderma verrucosporum
Physarum albescens
Physarum alpestre
Physarum bivalve
Physarum contextum
Physarum melleum
Physarum nivale
Physarum rubiginosum
Stemonitis smithii

Kamchatka (Kam)

Collected: June-July 2017

Elevational transect: *Betula* spp. forest – *Alnus* sp. thickets – alpine tundra. Elev. 1250–900 m a.s.l.

48 soil samples

92 / 222 OTUs (41%)

rare tropical litter species

Comatricha rubens
Craterium leucocephalum
Diderma alpinum
Diderma europaeum
Diderma microcarpum
Diderma umbilicatum
Didymium anellus
Didymium difforme
Didymium melanospermum
Didymium verrucosporum
Fuligo septica
Lamproderma aeneum
Lamproderma album
Lamproderma arcyrioides
Lamproderma cristatum
Lamproderma echinosporum
Lamproderma muscorum
Lamproderma ovoideum
Lamproderma piriforme
Lamproderma pulveratum
Lamproderma retirugisporum
Lamproderma sauteri
Lamproderma scintillans
Lamproderma zonatum
Leocarpus fragilis
Lepidoderma alpestroides
Lepidoderma carestianum
Lepidoderma chailletii
Meriderma aggregatum
Meriderma cribrarioides
Meriderma echinulatum
Meriderma verrucosporum
Physarum albescens
Physarum alpestre
Physarum bivalve
Physarum contextum
Physarum melleum
Physarum nivale
Physarum rubiginosum
Stemonitis smithii

Kamchatka (Kam)

Collected: June-July 2017
Elevational transect: *Betula* spp. forest – *Alnus* sp. thickets – alpine tundra. Elev. 1250–900 m a.s.l.
48 soil samples
92 / 222 OTUs (41%)

Field collection 2019:
Physarum hongkongense !

rare tropical litter species

Comatricha rubens
Craterium leucocephalum
Diderma alpinum
Diderma europaeum
Diderma microcarpum
Diderma umbilicatum
Didymium anellus
Didymium difforme
Didymium melanospermum
Didymium verrucosporum
Fuligo septica
Lamproderma aeneum
Lamproderma album
Lamproderma arcyrioides
Lamproderma cristatum
Lamproderma echinosporum
Lamproderma muscorum
Lamproderma ovoideum
Lamproderma piriforme
Lamproderma pulveratum
Lamproderma retirugisporum
Lamproderma sauteri
Lamproderma scintillans
Lamproderma zonatum
Leocarpus fragilis
Lepidoderma alpestroides
Lepidoderma carestianum
Lepidoderma chailletii
Meriderma aggregatum
Meriderma cribrarioides
Meriderma echinulatum
Meriderma verrucosporum
Physarum albescens
Physarum alpestre
Physarum bivalve
Physarum contextum
Physarum melleum
Physarum nivale
Physarum rubiginosum
Stemonitis smithii

Khibine Mts (Khi)

Collected: June-July 2018
Elevational transect: *Picea abies* forest – crooked birch belt – alpine tundra. Elev. 500–750 m a.s.l.
48 soil samples
93 / 171 OTUs (54%)

Colloderma oculatum
Diderma alpinum
Diderma fallax
Diderma europaeum
Diderma microcarpum
Diderma niveum
Diderma umbilicatum
Didymium dubium
Fuligo leviderma
Lamproderma aeneum
Lamproderma arcyrioides
Lamproderma cacographicum
Lamproderma cristatum
Lamproderma ovoideum
Lamproderma pulveratum
Lamproderma sauteri
Lamproderma sp.
Lamproderma splendidissimum
Lamproderma zonatum
Leocarpus fragilis
Lepidoderma alpestroides
Lepidoderma carestianum
Lepidoderma chailletii
Lepidoderma tigrinum
Meriderma aggregatum
Meriderma cribrarioides
Meriderma echinulatum
Meriderma fuscatum
Meriderma spinulosporum
Meriderma verrucosporum
Physarum albescens
Physarum alpestre
Physarum leucophaeum
Physarum notabile

Central Forest Reserve (CFR)

Collected: September 2018
Lowland *Picea abies* forest.
30 soil samples
49 / 143 OTUs (34%)

Diderma alpinum
Diderma fallax
Diderma europaeum
Diderma meyerae
Diderma microcarpum
Diderma niveum
Didymium anellus
Lamproderma arcyrioides
Lamproderma cristatum
Lamproderma ovoideum
Lamproderma scintillans
Lamproderma zonatum
Leocarpus fragilis
Lepidoderma alpestroides
Lepidoderma chailletii
Meriderma carestiae
Meriderma cribrarioides
Meriderma echinulatum
Meriderma spinulosporum
Meriderma verrucosporum
Physarum alpestre
Physarum contextum

Photo credits: www.zapoved.net

Vaskelovo (Vas)

Collected: September 2017

Lowland *Pinus sylvestris* and *Picea abies* forest.

30 soil samples

47 / 113 OTUs (41%)

Diderma europaeum
Diderma fallax
Diderma microcarpum
Diderma testaceum
Diderma umbilicatum
Didymium clavus
Didymium melanospermum
Fuligo leviderma
Lamproderma arcyrioides
Lamproderma cristatum
Lamproderma ovoideum
Lamproderma pulveratum
Leocarpus fragilis
Lepidoderma carestianum
Lepidoderma chailletii
Lepidoderma tigrinum
Meriderma cribrarioides
Meriderma echinulatum
Physarum album
Physarum bivalve

Bolshoy Berezovy Island (Bol)

Collected: September 2017
Lowland *Pinus sylvestris* forest.
30 soil samples
38 / 130 OTUs (29%)

Diderma niveum
Didymium melanospermum
Lamproderma arcyrioides
Lamproderma cristatum
Lamproderma pulveratum
Leocarpus fragilis
Lepidoderma chailletii
Lepidoderma tigrinum
Meriderma cribrarioides
Meriderma echinulatum
Physarum albescens
Physarum album

Photo credits: zwezet.livejournal.com

Living Sphagnum from German peat bogs

Received from Paul Lamkowski in 2018
24 moss samples
3 / 12 OTUs (25%)

Didymium sp. 1
Lamproderma ovoideum
Didymium anellus

The most abundant OTU: 95% similar to *Leocarpus fragilis*

The rest – unknown Didymiaceae and Stemonitidaceae

Living Sphagnum from German peat bogs

Received from Paul Lamkowski in 2018
24 moss samples
3 / 12 OTUs (25%)

Didymium sp. 1 again this OTU – very widespread

Lamproderma ovoideum
Didymium anellus
known to love wet environments

The most abundant OTU: 95% similar to *Leocarpus fragilis*
known to love acidic substrates

The rest – unknown Didymiaceae and Stemonitidaceae

Peat cores from OPTIMOOR project

Sampled in September 2017
6 peat core samples
3 / 11 OTUs (27%)

Stemonitis flavogenita
Didymium anellus Found in both peat bog datasets

The most abundant OTU: *Didymium* sp.

The rest – unknown Didymiaceae

Antarctic mosses

Scratched from rocks in 2018
King George Island and
Schirmacher Lake Plateau
8 samples
7 / 14 OTUs (50%)

Diderma alpinum
Lamproderma arcyrioides
Lamproderma ovoideum
Leocarpus fragilis
Lepidoderma chailletii

The rest – unknown Physaraceae and Didymiaceae

Water samples

Plancton samples filtered from undersurface water from lakes and rivers around Krasnoyarsk in September 2018
46 samples, sequenced only 5
15 / 31 OTUs (48%)

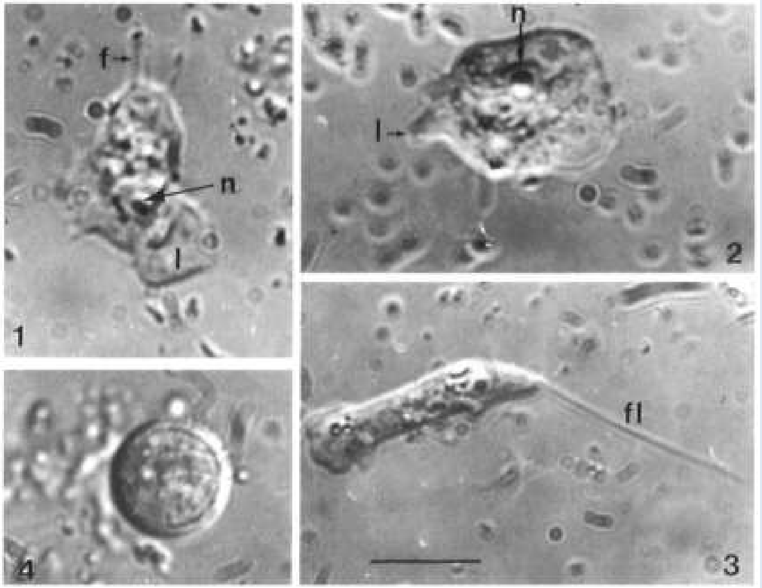
- 18 OTUs (58%) found only in water samples
- Almost no intersections between samples
- Myxoflagellates?
- Nivicolous species adapted to live underwater (melting snow; evidence from culture experiments)

Diderma fallax
Diderma montanum
Lamproderma arcyrioides
Lamproderma ovoideum
Lamproderma sauteri
Lepidoderma chailletii
Meriderma echinulatum
Meriderma spinulosporum
Physarum albescens
Physarum album
Physarum melleum

The rest – unknown Physaraceae and Didymiaceae

Hyperamoeba Alexeieff, 1923

- Several species of free-living aerobic amoebae
- Three stages: **amoeba**, **flagellated cell** and **cyst**
- Maintained in culture collections for a long time
- Formation of plasmodia and fruiting never observed

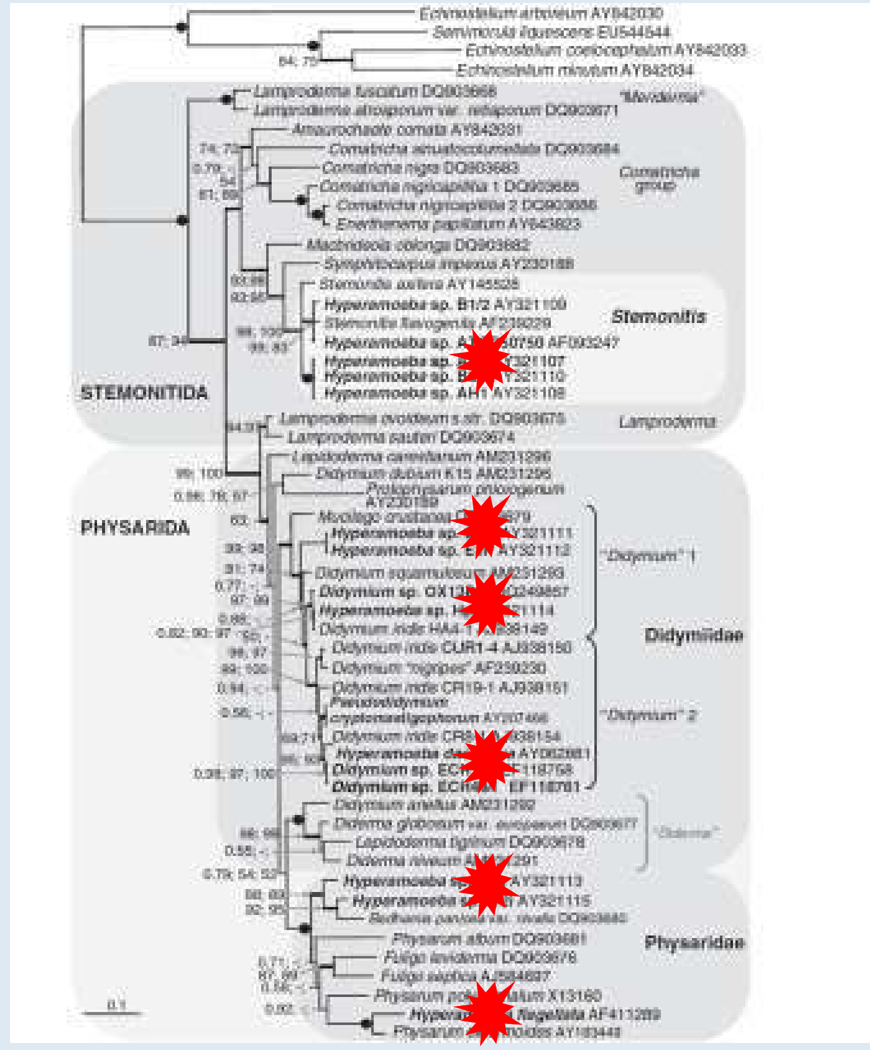


Karpov & Mylnikov 1997

Phylogenetic position

18S rDNA (Fiore-Donno et al. 2010):

- ‘*Hyperamoeba*‘ is a polyphyletic genus within Myxomycetes
- Their sequences are closely related, but not identical to different myxomycete species
- If ‘*Hyperamoeba*‘ strains really **never** fruit, then this loss of traits happened multiple times in evolution of myxomycetes



"Hyperamoeba" was isolated from:

[places where nobody would ever search for myxomycetes]

- clinical samples of human feces
- empty beer bottles
- physiotherapy baths
- under the ice of a frozen lake
- drinking water treatment plants
- coelomic cavity of sea urchins
- gills of freshwater fishes

Dykova et al. 2007, Karpov & Mylnikov 1997, Walochnick et al. 2004, Zaman & Adoutte 1999

Two ideas

1. Myxomycete ecology studies should deal more with the microscopic stages, not only fructifications

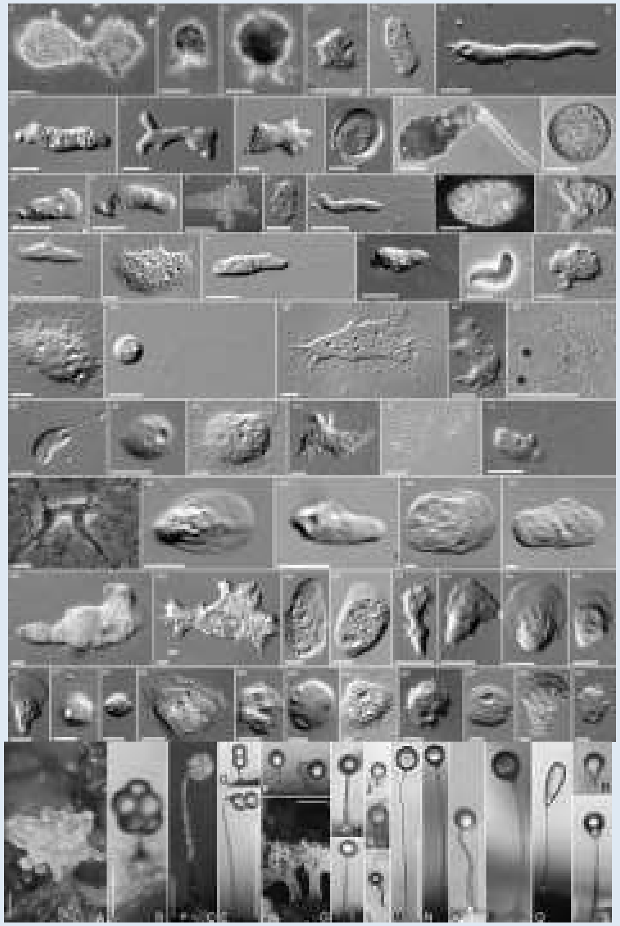
2. Do some of the myxos even fruit?

Reductive evolution in Amoebozoa

Loss of characters is one of the major trends (Kang et al. 2017, Mol Biol Evol 34(9): 2258-2270)

The hypothetic **Last Common Ancestor of Amoebozoa** supposedly had all these traits:

✓Sporocarpy
✓Flagellar apparatus
✓Sex
✓Flat amoeboid cell
✓Tubular amoeboid cell
✓Encystment



From Kang et al. 2017

Based on the slides of Prof. F. Spiegel

Reductive evolution in Amoebozoa

Pelomyxa palustris (Mastigamoebaea):

- ✓~~Sporocarpy~~
- ✓Flagellar apparatus
- ✓Sex (?)
- ✓~~Flat amoeboid cell~~
- ✓Tubular amoeboid cell
- ✓Encystment

Based on the slides of Prof. F. Spiegel

Reductive evolution in Amoebozoa

Acanthamoeba pyriformis (Acanthamoebidae):

- ✓Sporocarpy
- ~~✓Flagellar apparatus~~
- ~~✓Sex~~
- ✓Flat amoeboid cell
- ~~✓Tubular amoeboid cell~~
- ✓Encystment

Based on the slides of Prof. F. Spiegel

Reductive evolution in Amoebozoa

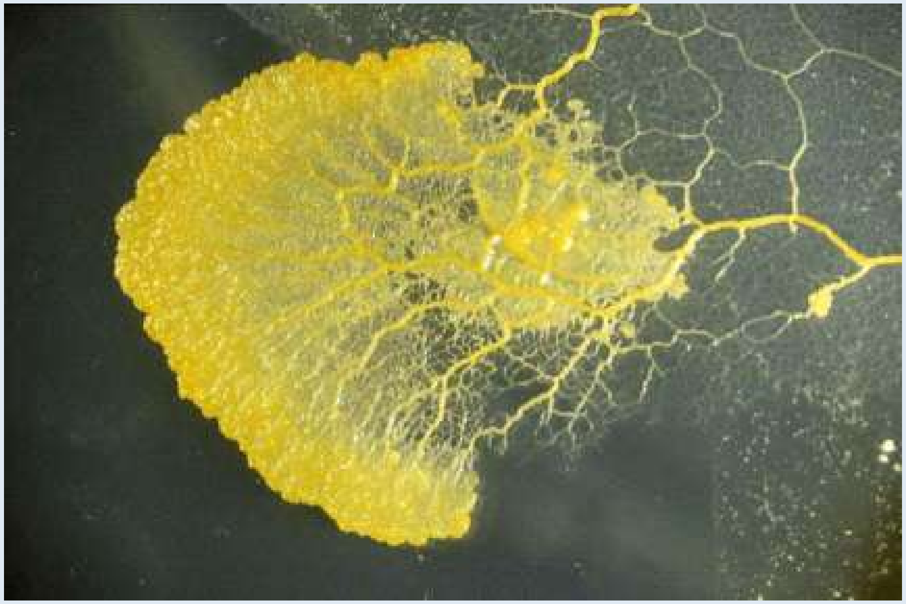
Amoeba proteus (Euamoebida)

- ✓~~Sporocarpy~~
- ✓~~Flagellar apparatus~~
- ✓~~Sex~~
- ✓~~Flat amoeboid cell~~
- ✓Tubular amoeboid cell
- ✓~~Encystment~~

Based on the slides of Prof. F. Spiegel

Reductive evolution in Amoebozoa

Physarum polycephalum:



- ✓Sporocarpy
- ✓Flagellar apparatus
- ✓Sex
- ✓Flat amoeboid cell
- ✓Tubular amoeboid cell
- ✓Encystment

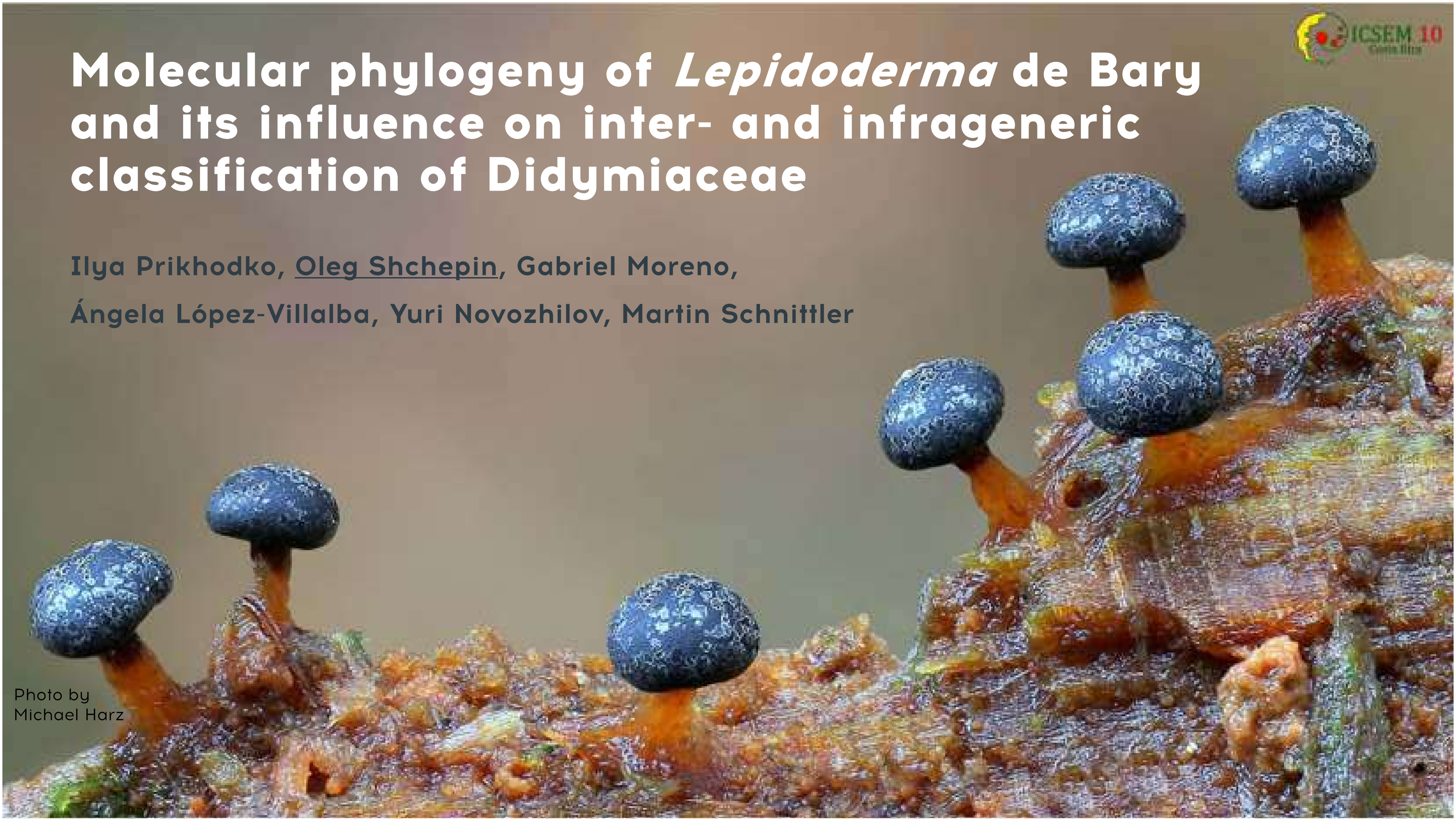
But maybe some lineages of myxomycetes followed this reduction trend and lost some traits? E.g. "*Hyperamoeba*" isolates

Based on the slides of Prof. F. Spiegel

Generalizing it all…

- Myxomycete assemblages are structured both at a large and small geographical scale.
- A few OTUs have extremely wide distribution and the majority of OTUs are restricted to certain regions. Endemicity?
- Typical nivicolous species were found to be a significant part of myxomycete assemblages in all eight studied regions, including subtropical forest.
- An expanded dataset (coming soon) including more areas in Europe and in Southeast Asia will show if myxomycete diversity decreases towards tropics.
- Ecological studies of myxomycetes always targeted only the tip of the iceberg. Ecology and distribution of their trophic stages is still to be investigated, but it is already clear that we should expect many surprises.
- Speculation: there might be a polyphyletic pool of species that are widespread and never or extremely rarely form plasmodia and fruiting bodies – this could be an example of evolution via loss of characters that is characteristic for other groups of Amoebozoa.


Thank you for your attention!



Molecular phylogeny of *Lepidoderma* de Bary and its influence on inter- and infrageneric classification of Didymiaceae

Ilya Prikhodko, Oleg Shchepin, Gabriel Moreno,

Ángela López-Villalba, Yuri Novozhilov, Martin Schnittler

Photo by
Michael Harz

Ilya S. Prikhodko

PhD project

Komarov Botanical Institute RAS

St. Petersburg, Russia

Lab. of Systematics and Geography of Fungi

Lepidoderma de Bary ex Rostaf.

- *L. alpestroides* Mar. Mey. & Poulain
- *L. carestianum* (Rabenh.) Rostaf.
- *L. chailletii* Rostaf.
- *L. crassipes* Flatau, Massner & Schirmer
- *L. cristatosporum* G. Moreno, López-Villalba, S.L. Stephenson & A. Castillo
- *L. crustaceum* Kowalski
- *L. echinosporum* G. Moreno, López-Villalba & S.L. Stephenson
- *L. granuliferum* (W. Phillips) R.E. Fr.
- *L. neoperforatum* Kuhnt
- *L. nevadense* G. Moreno, A. Sánchez, Mar. Mey., López-Villaba & A. Castillo
- *L. perforatum* Mar. Mey. & Poulain
- *L. peyerimhoffii* Maire & Pinoy
- *L. stipitatum* Flatau
- *L. tigrinum* (Schrad.) Rostaf.
- *L. trevelyanii* (Grev.) Poulain & Mar. Mey.

15 species considered valid

in Lado (2005-2020)

www.nomen.eumycetozoa.com

Lepidoderma de Bary ex Rostaf.

- *L. alpestroides* Mar. Mey. & Poulain
- *L. carestianum* (Rabenh.) Rostaf.
- *L. chailletii* Rostaf.
- *L. crassipes* Flatau, Massner & Schirmer — Non-nivicolous
- *L. cristatosporum* G. Moreno, López-Villalba, S.L. Stephenson & A. Castillo
- *L. crustaceum* Kowalski
- *L. echinosporum* G. Moreno, López-Villalba & S.L. Stephenson
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- *L. peyerimhoffii* Maire & Pinoy
- *L. stipitatum* Flatau — Non-nivicolous
- *L. tigrinum* (Schrad.) Rostaf. — Non-nivicolous
- *L. trevelyanii* (Grev.) Poulain & Mar. Mey. — Non-nivicolous

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- *L. trevelyanii* (Grev.) Poulain & Mar. Mey.

Illustration of *Didymium tigrinum* Schrad. (1797) and photo of *L. tigrinum* from LE (BIN RAS)

Lepidoderma de Bary ex Rostaf.

- *L. tigrinum* (Schrad.) Rostaf.
  ≡ Didymium tigrinum Schrad., Nov. gen. p. 28, t. 6, f. 2,3 (1797)

1873 – the genus *Lepidoderma* erected by Rostafinski in Fuckel, Jahrb. Nassauischen Vereins Naturk. 27-28:73

Didymium tigrinum -> *L. tigrinum*

Crystalline scales as a main trait

Photo by Heinz Spath

«Sporangia sessile or stalked, sometimes with a single wall, covered with very large scales, consisting of a small number of highly calcified bodies» - translation from *Sluzowce monogr.* 187 (1874)

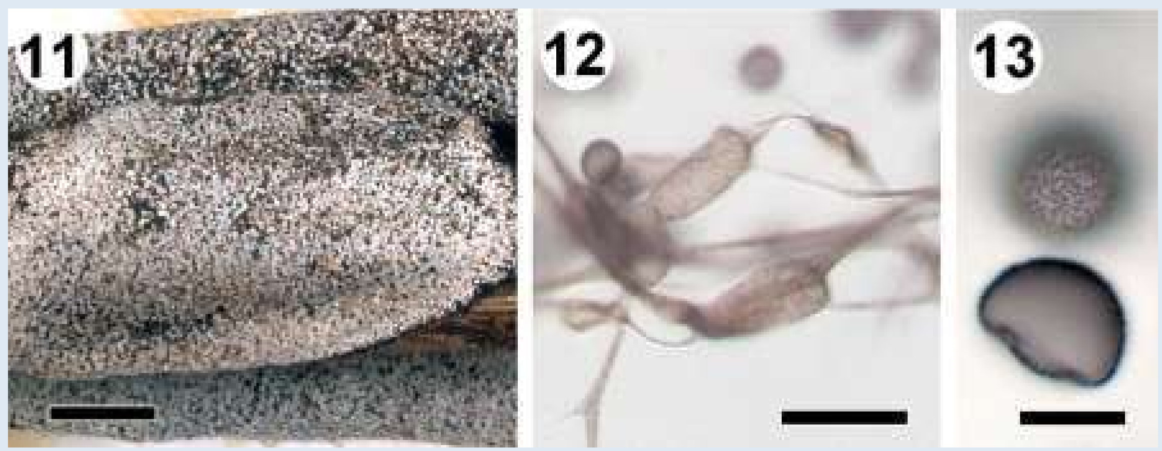
Lepidoderma de Bary ex Rostaf.

- *L. tigrinum* (Schrad.) Rostaf.
  ≡ Didymium tigrinum Schrad., Nov. gen. p. 28, t. 6, f. 2,3 (1797)
- *L. carestianum* (Rabenh.) Rostaf.
  ≡ Reticularia carestiana Rabenh., Fung. Eur. exs. No. 436 (1862)
- *L. chailletii* Rostaf.

1874 – Rostafinski, two new species:

1) *Reticularia carestiana* -> *L. carestianum*

- Elongated plasmodiocarps, rarely branched
- Filamentous and anastomosed capillitium with lime nodules
- Lime scales white to slightly yellow



From Shchepin et al. (2016)

Lepidoderma de Bary ex Rostaf.

- *L. tigrinum* (Schrad.) Rostaf.
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- *L. carestianum* (Rabenh.) Rostaf.
  ≡ Reticularia carestiana Rabenh., Fung. Eur. exs. No. 436 (1862)
- *L. chailletii* Rostaf.

1874 – Rostafinski, two new species:

2) *L. chailletii*

«Sporangia hemispherical, broad base … , black and purple, covered with numerous pelvic-ochreous outgrowths [scales?] … Capillitium with dark purple fillaments thickening, forms networks, spores dark purple, spiky, from 10.8 to 12.5 µm.» - translation from Sluzowce monogr. 189 (1874)

From Moreno et al. (2018)

Lepidoderma chailletii Rostaf.

- *L. tigrinum* (Schrad.) Rostaf.
  ≡ Didymium tigrinum Schrad., Nov. gen. p. 28, t. 6, f. 2,3 (1797)
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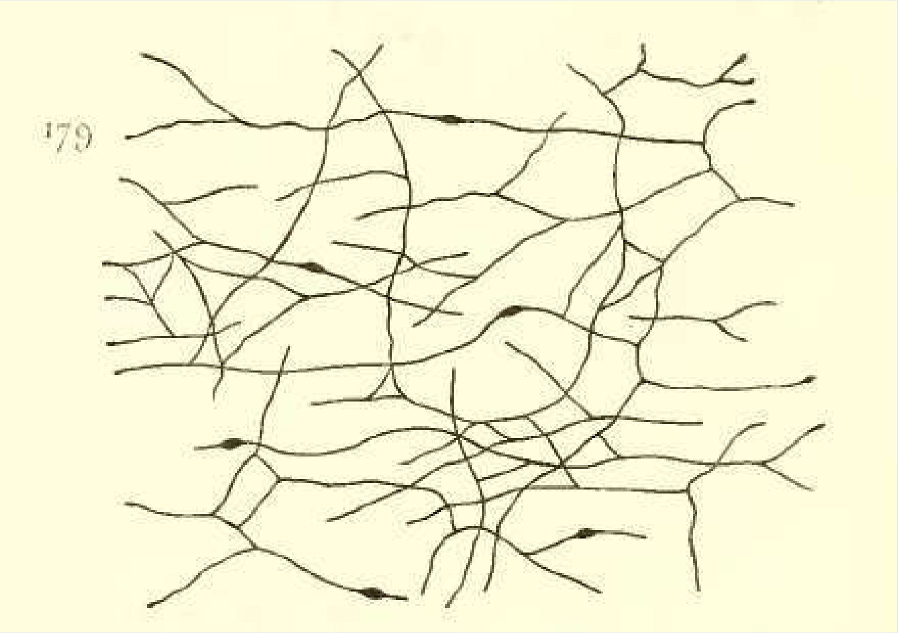
  ≡ Reticularia carestiana Rabenh., Fung. Eur. exs. No. 436 (1862)
- *L. chailletii* Rostaf.



The only illustration on *Lepidoderma chailletii* Rostaf.: Schematic picture of capillitium from Sluzowce monogr., t. 10, f. 179 (1874)

Lepidoderma chailletii Rostaf.

- *L. tigrinum* (Schrad.) Rostaf.
  - ≡ Didymium tigrinum Schrad., Nov. gen. p. 28, t. 6, f. 2,3 (1797)
- *L. carestianum* (Rabenh.) Rostaf.
  - ≡ Reticularia carestiana Rabenh., Fung. Eur. exs. No. 436 (1862)
- *L. chailletii* Rostaf.

91. *L. Chailletii, Rfski. L. Chailleta.* — Zarodnie półkuliste, szeroką nasadą do podłoża lub leżni przyrosłe, czarno-fioletowe, pokryte licznemi perłowo-ochrowatemi wypukliakami. Podsada maleńka, ochrowa. Włośnia o włóknach ciemno-fioletowych gęstą sieć tworzących, zarodniki ciemno-fioletowe, kolczaste, od 10,8 do 12,5 m. m. wielkie.

Opis. — Już to na delikatnej błoneczkowatej leżni, już też wprost na podłożu siedzą gromadnie liczne półkuliste, mocno wypukłe zarodnie. Barwa ich ciemna upstrzona licznemi błyszczącemi wypuklinkami perłowo-ochrowatéj barwy. Po wypróżnieniu zarodników i włośni ścianka ich jest przeświecająca brudno-ochrowa, podobnie jak dolna, maleńka podsada.

Ścianka zarodni jest błoną tęgą, ochrowo zabarwioną, w licznych miejscach soczewkowato rozdwojoną. W rozdwojeniach tych leżą skupienia krystaliczne wapna. Skupienia te tworzą nieregularne bryłki. W jedném rozdwojeniu błony leży albo tylko jedna taka bryłka, albo też bywa ich więcéj, do czterech zrośniętych pomiędzy sobą. Każda bryłka składa się z igłowatych, promieniście koło jednego punktu zbitych kryształków; po odwapnieniu pozostaje nieco istoty ostrojowéj. Podsada podzielona jest błonkowatemi wyrostkami i włóknami na liczne fałszywe komory powypełniane bryłkami krystalicznych skupień wapna. Włośnia składa się z cienkich włókien, często rozwidlających się, licznemi odnogami w zbitą sieć połączonych.

Znajdowanie się. — Gatunek ten widziałem po raz pierwszy w zbiorach Kunzego w muzeum lipskiém, przesłane ze Szwajcaryi przez Chailleta pod nazwą «Stemonitis chalybaea». Późniéj odkryłem go w zbiorach praskiego muzeum. Okazy te były zbierane w hrabstwie Hauenstein przez Opiza.

Rostafinski cited two specimens from different locations collected by different people

«This species was first seen in Kunze's collections at the Leipzig Museum, sent from Switzerland by Chaillet under the name «Stemonitis chalybæa». Later I will discover it (the species) in the collection of the Prague museum. These specimens were collected in Hauenstein County by Opiz.» - translation from Sluzowce monogr. 189 (1874)

Lepidoderma de Bary ex Rostaf.

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- ***L. chailletii*** Rostaf.
  = Lepidoderma carestianum var. chailletii (Rostaf.) G. Lister, in Lister, Monogr. mycetozoa, ed. 2, 140 (1911)
- ***L. granuliferum*** (W. Phillips) R.E. Fr., Ark. Bot. 6(7):3 (1906)
  ≡ Didymium granuliferum W. Phillips, Grevillea 5:114 (1877)
  = Lepidoderma carestianum var. granuliferum (W. Phillips) G. Lister, in Lister, Monogr. mycetozoa, ed. 2, 140 (1911)

Lister (1911): *Lepidoderma carestianum* var. *chailletii*

Lister (1925): separate species

Fries (1906): *Didymium granuliferum* -> *L. granuliferum*

Lister (1911) and Hagelstein (1944): *Lepidoderma carestianum* var. *granuliferum*

Macbride and Martin (1934), Martin (1949) recognized all 4 species

Kowalski's monograph, 1971

- *L. tigrinum* (Schrad.) Rostaf.
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- *L. crustaceum* Kowalski, Mycologia 59(1): 167 (1967)
- *L. aggregatum* Kowalski, Mycologia 63(3): 511 (1971)
- *L. didermoides* Kowalski, Mycologia 63(3): 503 (1971)

L. chailletii synonymized with *L. carestianum*

Three new species

Lepidoderma crustaceum Kowalski

- *L. tigrinum* (Schrad.) Rostaf.
  ≡ Didymium tigrinum Schrad., Nov. gen. p. 28, t. 6, f. 2,3 (1797)
- *L. carestianum* (Rabenh.) Rostaf.
  ≡ Reticularia carestiana Rabenh., Fung. Eur. exs. No. 436 (1862)

  = Lepidoderma chailletii Rostaf.
- *L. granuliferum* (W. Phillips) R.E. Fr., Ark. Bot. 6(7):3 (1906)
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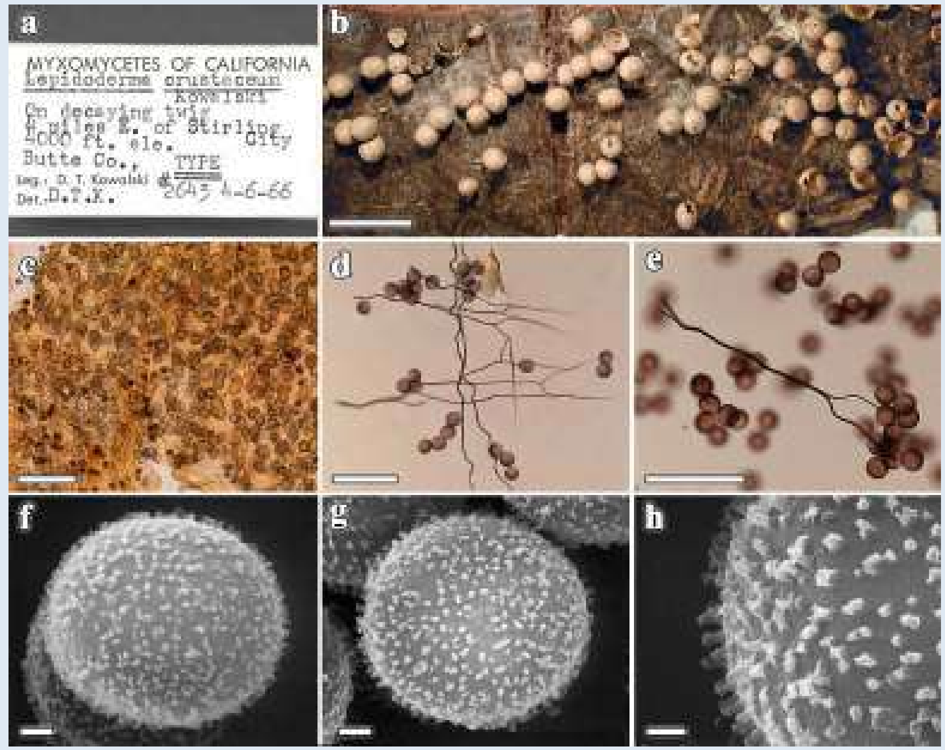
  = Lepidoderma carestianum var. granuliferum (W. Phillips) G. Lister, in Lister, Monogr. mycetozoa, ed. 2, 140 (1911)
- *L. crustaceum* Kowalski, Mycologia 59(1): 167 (1967)
- *L. aggregatum* Kowalski, Mycologia 63(3): 511 (1971)
- *L. didermoides* Kowalski, Mycologia 63(3): 503 (1971)

Short stalk, pale violaceous-brown sporocarps, separated or in small groups, double peridium with lime scales forming a continuous layer



Photos of type specimen from Moreno et al. (2018)

Lepidoderma aggregatum Kowalski

- *L. tigrinum* (Schrad.) Rostaf.
  ≡ Didymium tigrinum Schrad., Nov. gen. p. 28, t. 6, f. 2,3 (1797)
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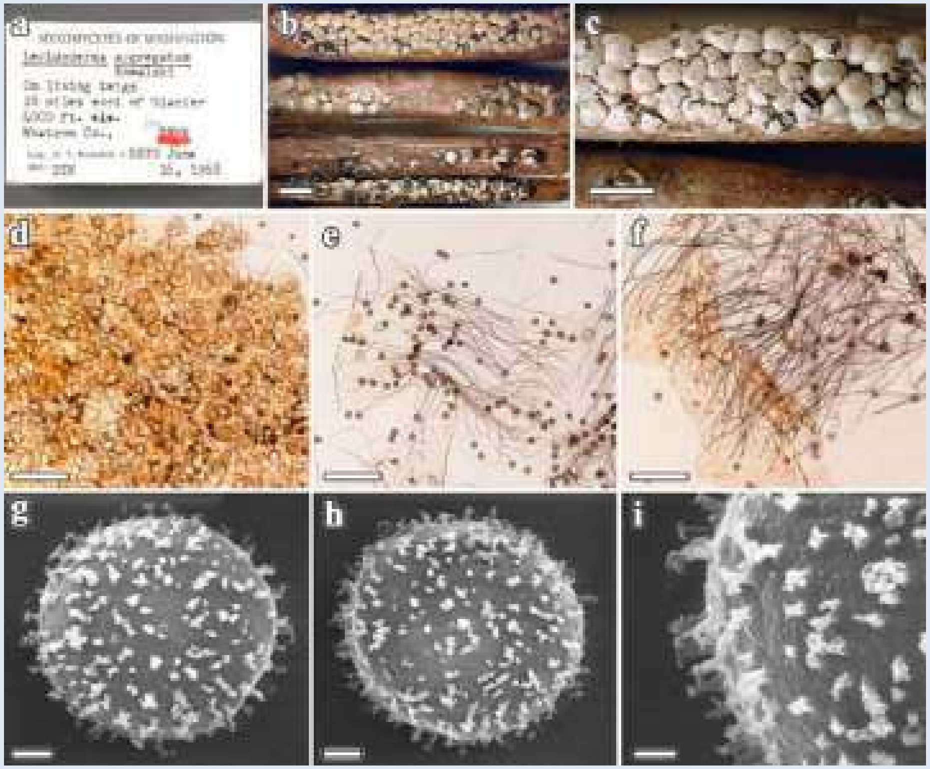
- *L. aggregatum* Kowalski, Mycologia 63(3): 511 (1971)
- *L. didermoides* Kowalski, Mycologia 63(3): 503 (1971)

Aggregated sporocarps, sessile, pulviniform to applanate, lime scales forming a whitish crust.
In Lado (2005-2020) – synonym of *L. chailletii*



Photos of type specimen from Moreno et al. (2018)

Lepidoderma didermoides Kowalski

- *L. tigrinum* (Schrad.) Rostaf.
  ≡ Didymium tigrinum Schrad., Nov. gen. p. 28, t. 6, f. 2,3 (1797)
- *L. carestianum* (Rabenh.) Rostaf.
  ≡ Reticularia carestiana Rabenh., Fung. Eur. exs. No. 436 (1862)
  = Lepidoderma chailletii Rostaf.
- *L. granuliferum* (W. Phillips) R.E. Fr., Ark. Bot. 6(7):3 (1906)
  ≡ Didymium granuliferum W. Phillips, Grevillea 5:114 (1877)
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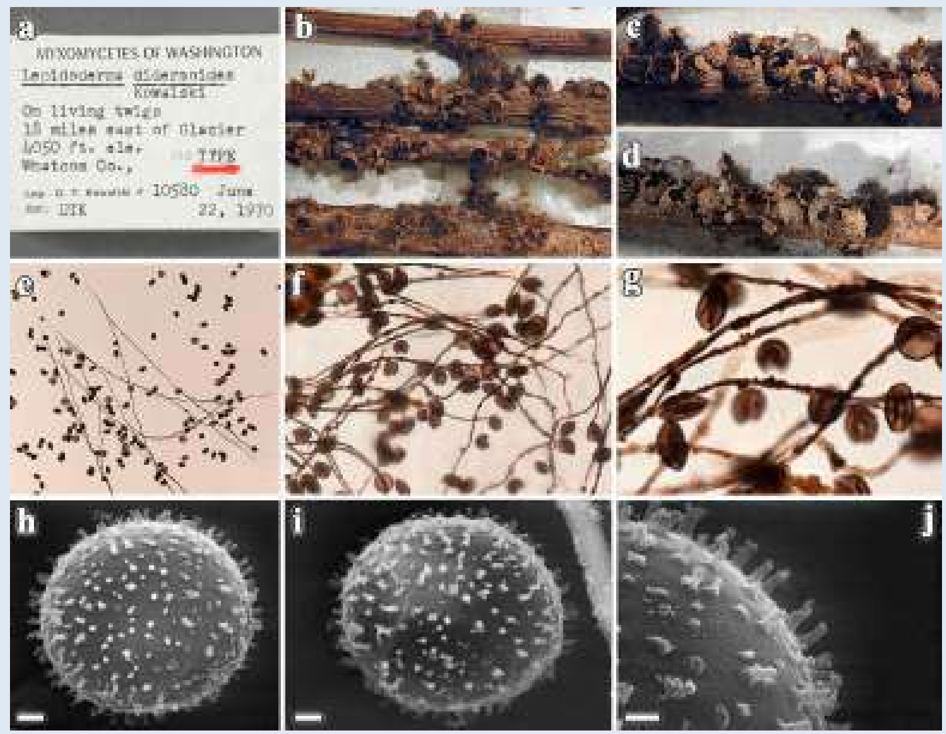
- *L. crustaceum* Kowalski, Mycologia 59(1): 167 (1967)
- *L. aggregatum* Kowalski, Mycologia 63(3): 511 (1971)
- *L. didermoides* Kowalski, Mycologia 63(3): 503 (1971)

Aggregated sporocarps, sessile, pulviniform to applanate, lime scales forming a whitish crust. **Moreno et al. (2018) synonymized with *L. chailletii***



Photos of type specimen from Moreno et al. (2018)

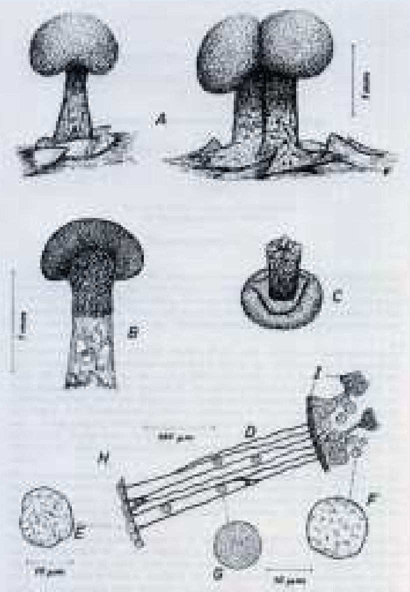
Other species

- *L. peyerimhoffii* Maire & Pinoy, in Maire, Patouillard & Pinoy, Bull. Soc.Hist. Nat. Afrique N. 17(1):40 (1926)
- *L. stipitatum* Flatau, Beitr. Kenntn. Pilze Mitteleurop. 1:193 (1984)
- *L. crassipes* Flatau, Massner & Schirmer, Z. Mykol. 53(1):146 (1987)
- *L. alpestroides* Mar. Mey. & Poulain, in Poulain, Meyer & Bozonnet, Bull. Mycol. Bot. Dauphiné-Savoie 165:9 (2002)
- *L. perforatum* Mar. Mey. & Poulain, in Poulain, Meyer & Bozonnet, Bull. Mycol. Bot. Dauphiné-Savoie 165:6 (2002)
- *L. trevelyanii* (Grev.) Poulain & Mar. Mey., in Poulain, Meyer & Bozonnet, Bull. Mycol. Bot. Dauphiné-Savoie 165:10 (2002)
- *L. echinosporum* G. Moreno, López-Villalba & S.L. Stephenson, in Crous et al., Persoonia 37:231 (2016)
- *L. neoperforatum* Kuhnt, Ber. Bayer. Bot. Ges. 87:99 (2017)
- *L. cristatosporum* G. Moreno, López-Villalba, S.L. Stephenson & A. Castillo, Mycoscience 59(5):387 (2018)
- *L. nevadense* G. Moreno, A. Sánchez, Mar. Mey., López-Villaba & A. Castillo, Bol. Soc. Micol. Madrid 42:67 (2018)

L. tigrinum resemblance group

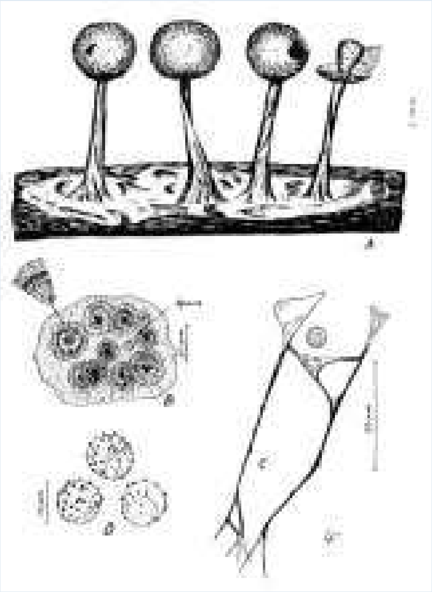
Stalked sporocarps, non-nivicolous

- *L. tigrinum* (Schrad.) Rostaf.



L. crassipes Flatau, Massner & Schirmer

From Flatau, Massner & Schirmer (1987)

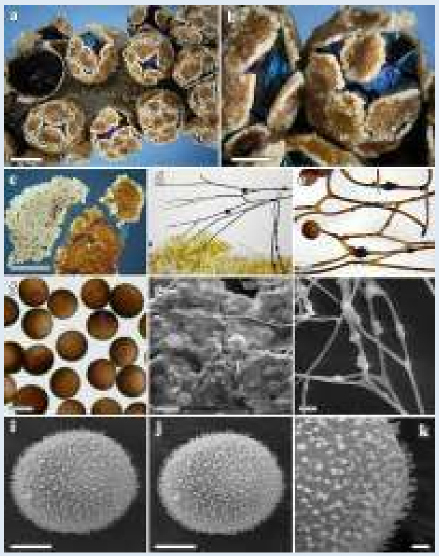


L. stipitatum Flatau

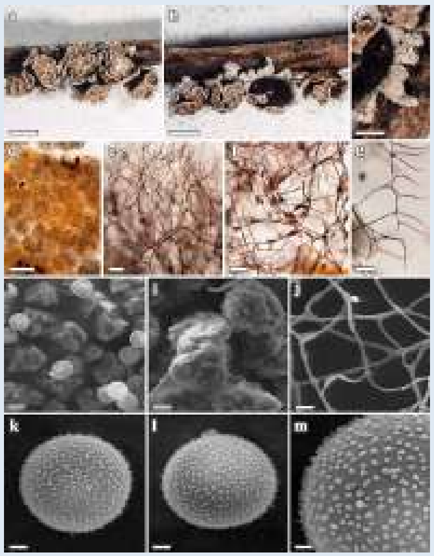
From Flatau (1984)

L. peyerimhoffii resemblance group

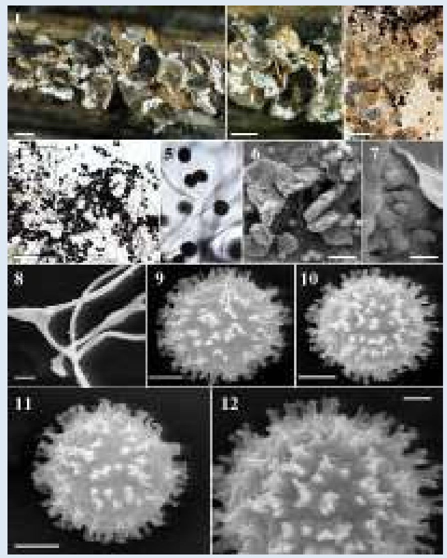
Sessile sporocarps with peridial plates, mostly nivicolous



L. peyerimhoffii Maire & Pinoy

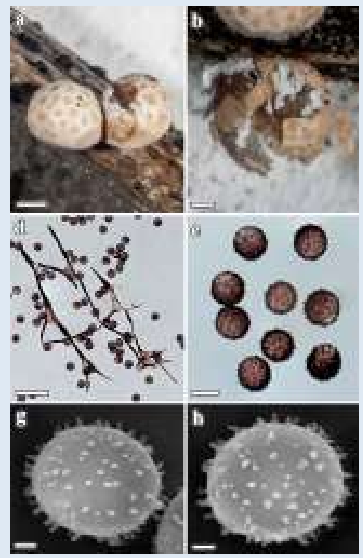


L. nevadense G. Moreno, A. Sánchez, Mar. Mey., López-Villaba & A. Castillo
Holotype



L. echinosporum G. Moreno, López-Villalba & S.L. Stephenson

Holotype



Diderma fallax (Rostaf.) E. Sheld.

L. trevelyanii (Grev.) Poulain & Mar. Mey.

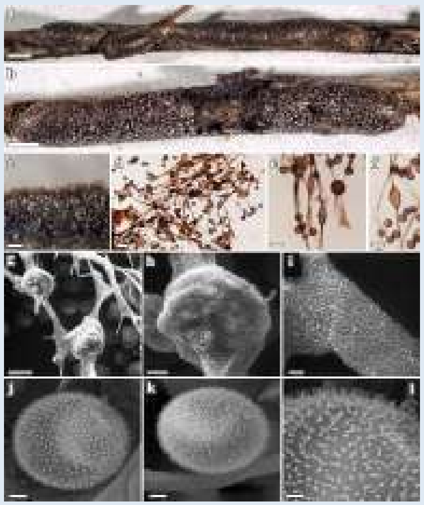
L. crustaceum ?

L. cristatosporum ?

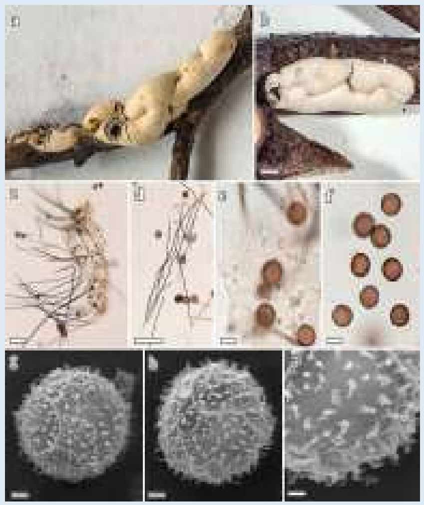
Plates from Moreno et al. (2018)

Plasmodiocarpic group

Plasmodiocarps, nivicolous

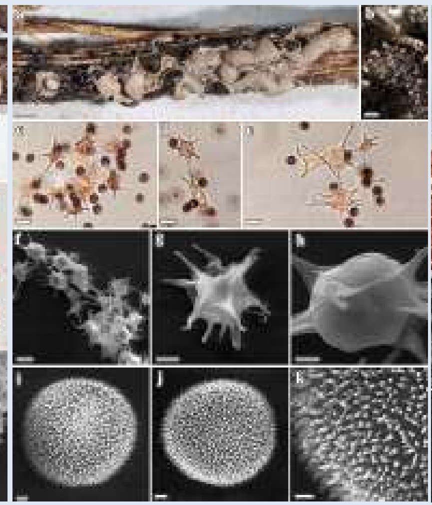


L. carestianum (Rabenh.) Rostaf.



L. alpestroides Mar. Mey. & Poulain

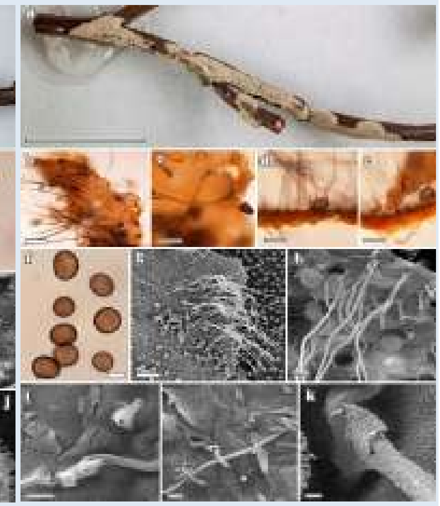
isotype



L. granuliferum (W. Phillips) R.E. Fr.

L. neoperforatum Kuhnt

isotype

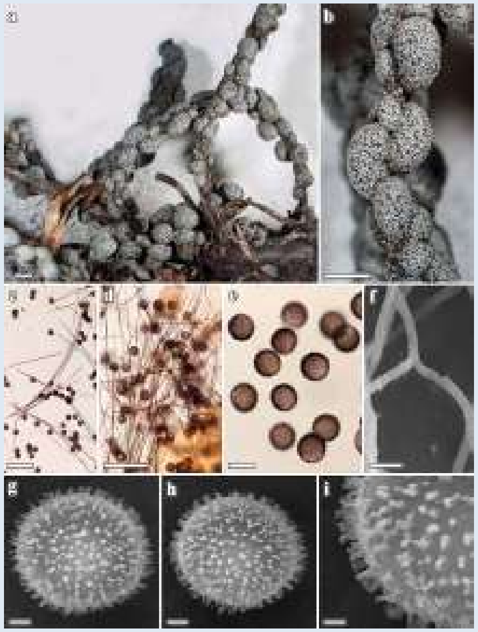


L. perforatum Mar. Mey. & Poulain

Plates from Moreno et al. (2018)

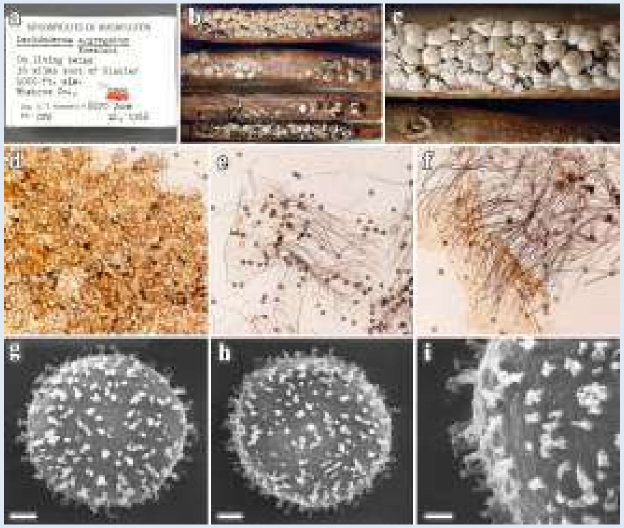
L. chailletii resemblance group

Sessile sporocarps, irregular dehiscence, nivicolous

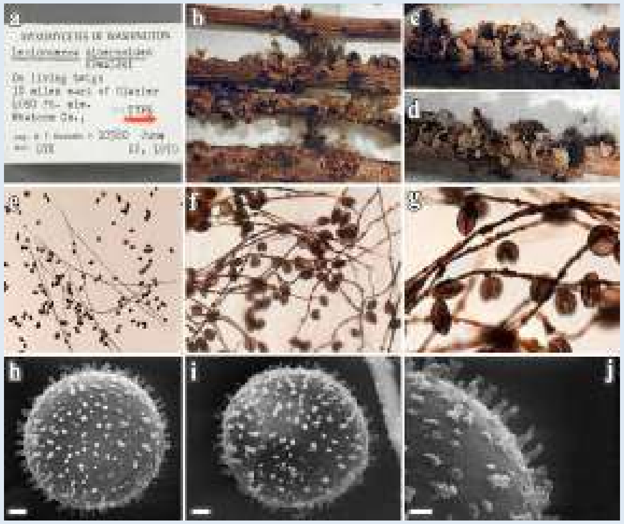


L. chailletii Rostaf.

Not accepted in Lado (2005-2020)



L. aggregatum Kowalski holotype



L. didermoides Kowalski holotype

Plates from Moreno et al. (2018)

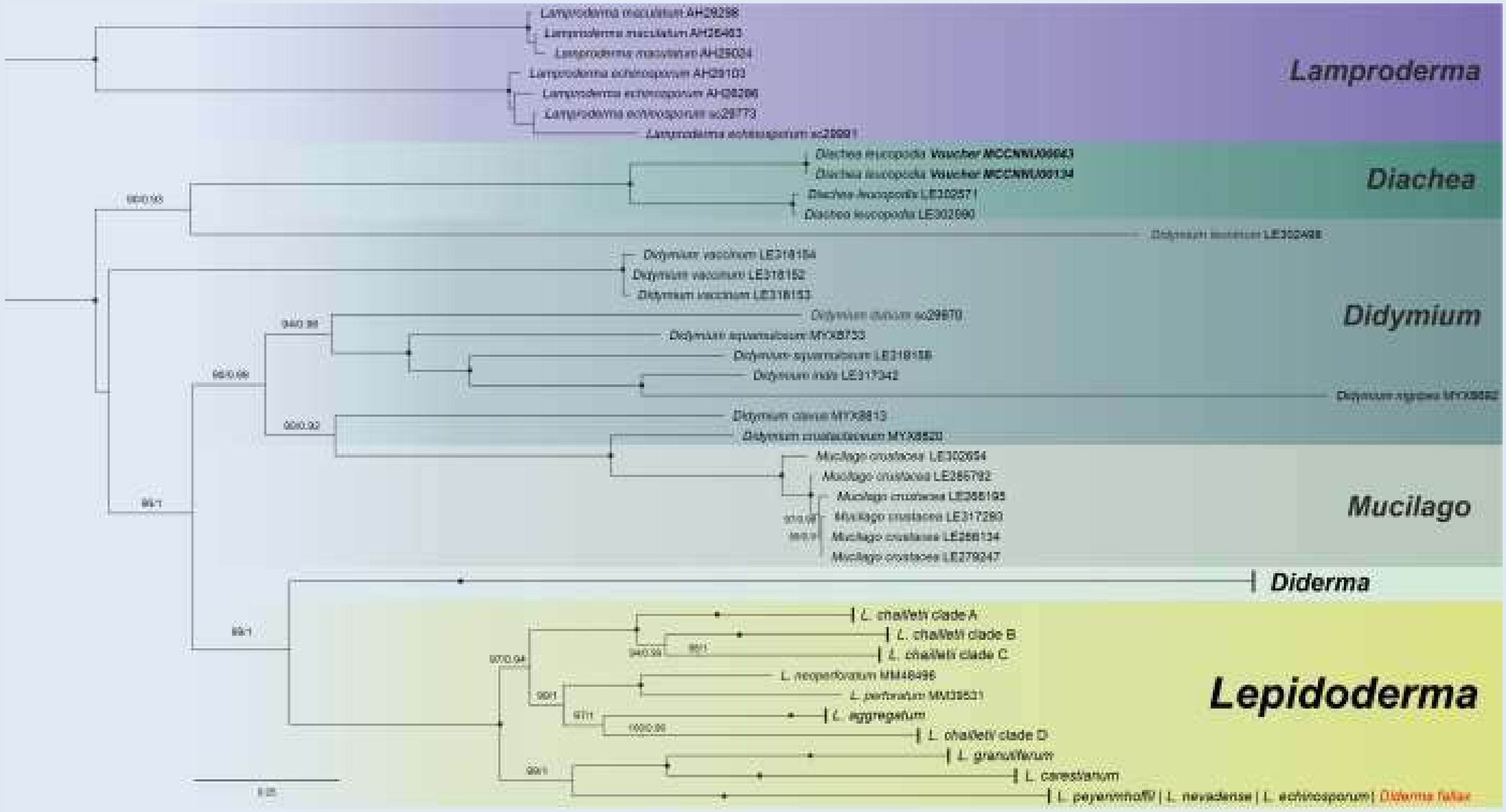
Molecular approach

10 species sequenced for 18S rRNA and COI genes (partial)

- *L. aggregatum* Kowalski
- *L. alpestroides* Mar. Mey. & Poulain
- *L. carestianum* (Rabenh.) Rostaf.
- *L. chailletii* Rostaf.
- *L. crassipes* Flatau, Massner & Schirmer
- *L. cristatosporum* G. Moreno, López-Villalba, S.L. Stephenson & A. Castillo
- *L. crustaceum* Kowalski
- * *L. echinosporum* G. Moreno, López-Villalba & S.L. Stephenson
- *L. granuliferum* (W. Phillips) R.E. Fr.
- *L. neoperforatum* Kuhnt
- * *L. nevadense* G. Moreno, A. Sánchez, Mar. Mey., López-Villaba & A. Castillo
- * *L. perforatum* Mar. Mey. & Poulain
- *L. peyerimhoffii* Maire & Pinoy
- *L. stipitatum* Flatau
- *L. tigrinum* (Schrad.) Rostaf.
- *L. trevelyanii* (Grev.) Poulain & Mar. Mey.

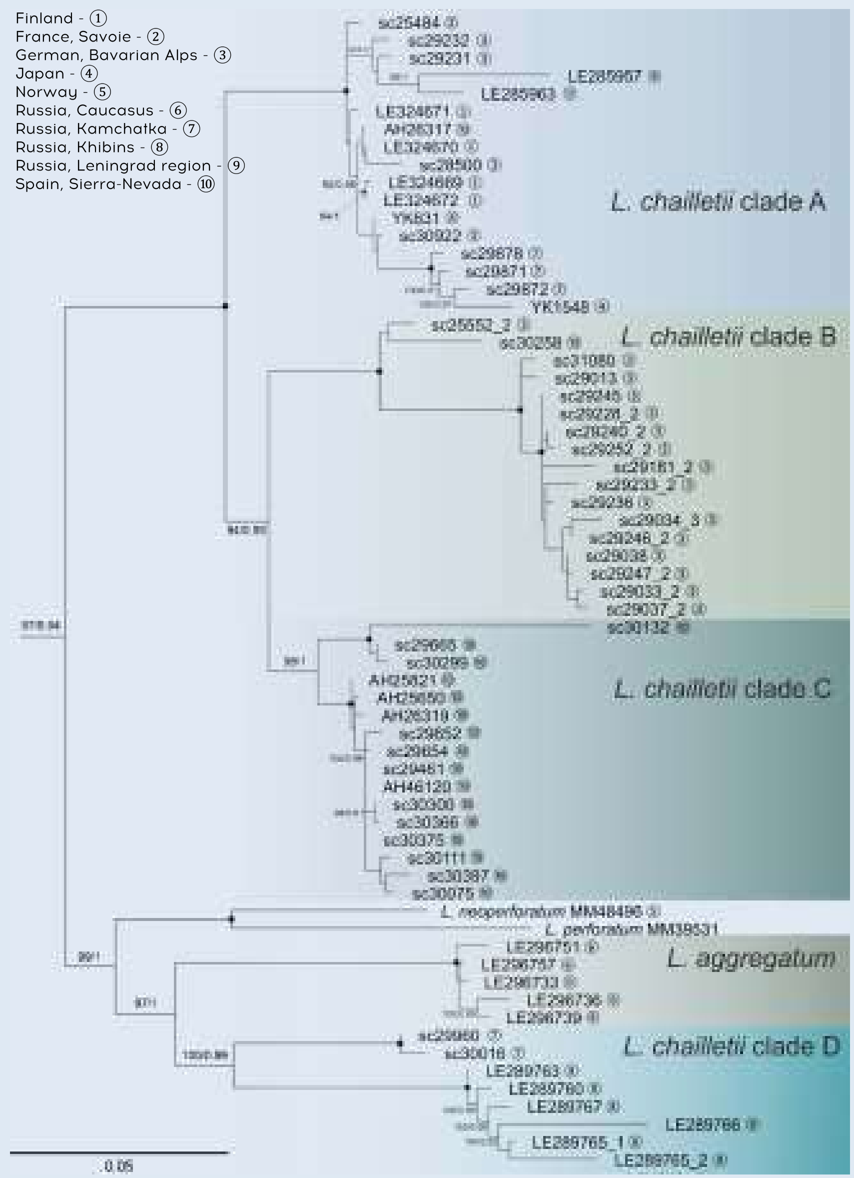
* – including type material (red)

* – including authentic material (black)



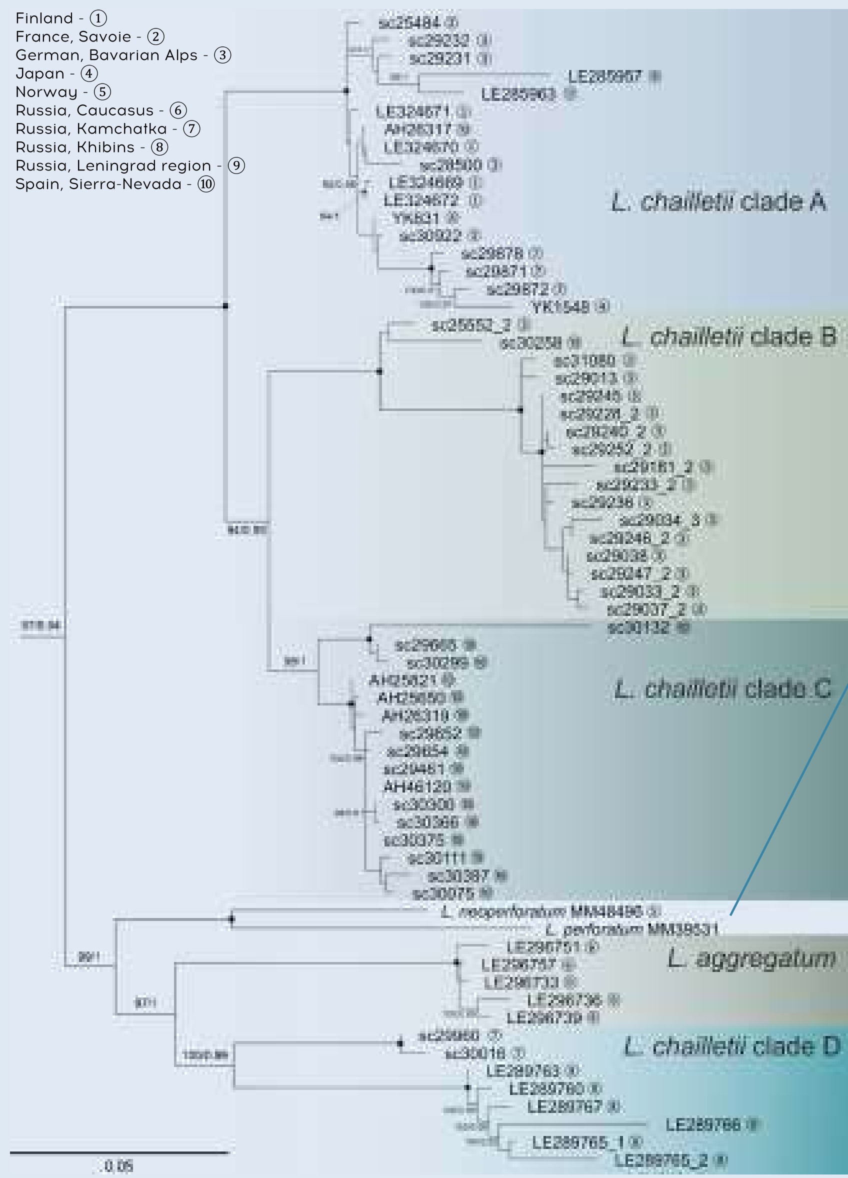
Two-gene phylogenetic tree of Didymiaceae obtained by Maximum Likelihood analysis of 189 taxa and 1471 aligned positions (COI partition - 849 bp; 18S partition - 622 bp). The tree is rooted with *Lamproderma*. Genebank sequences are in ***italic bold***.
Supports are shown for ultrafast bootstrap replicates/Bayesian posterior probabilities ≥ 90/0.9; black dots - maximum support in both analyses

IQTree 1.6.12 (local machine): TIM2+F+I+G4 (COI), SYM+I+G4 (18S), 1000 ultrafast boostrap
MrBayes 3.2.6 (CIPRES Science Gateway): GTR+invgamma, MCMC ngen=20000000, samplefreq=1000, burninfrac=0.25, nchains=6, nruns=4



Lepidoderma clade 1

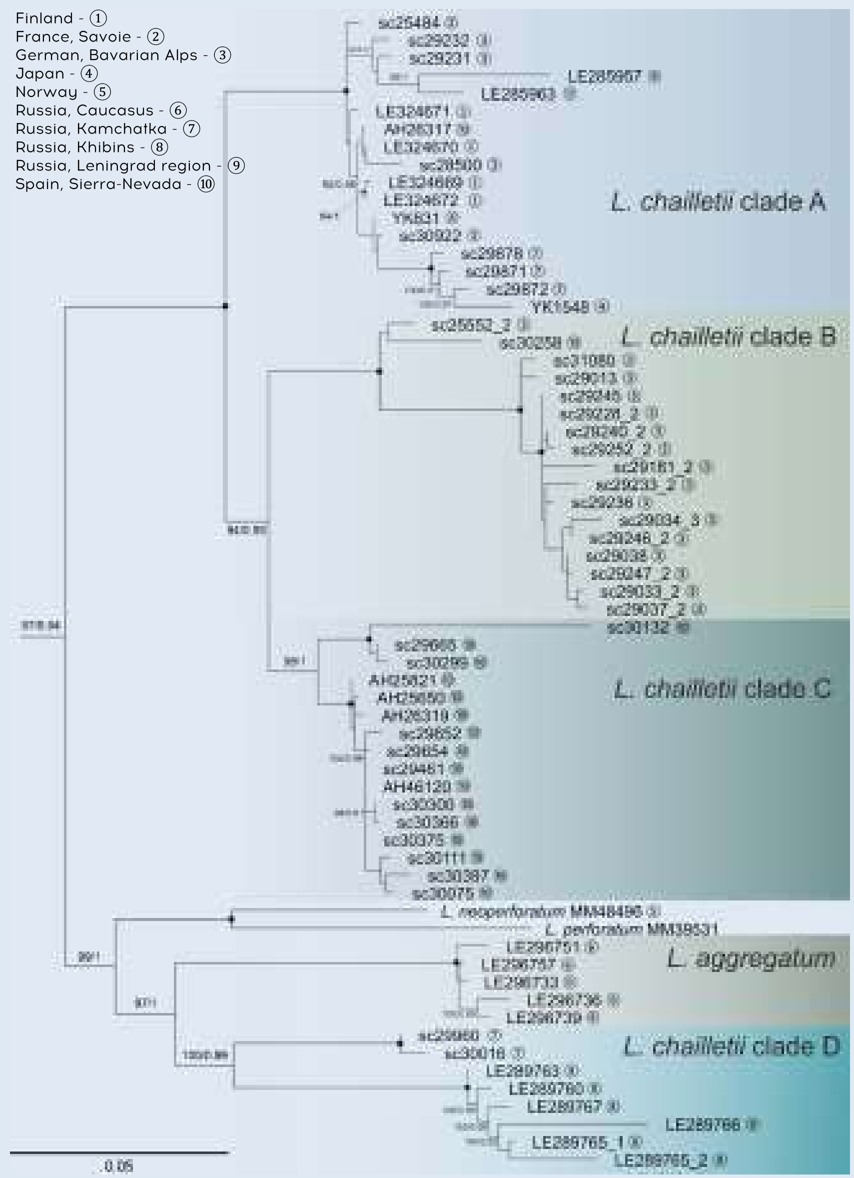
- *L. aggregatum* Kowalski — Seems to be a separate species. Specimens from US – the same?



***Lepidoderma* clade 1**

- *L. aggregatum* Kowalski — Seems to be a separate species. Specimens from US – the same?
- *L. neoperforatum* Kuhnt
- *L. perforatum* Mar. Mey. & Poulain

Seem to be well-separated, but only two specimens sequenced



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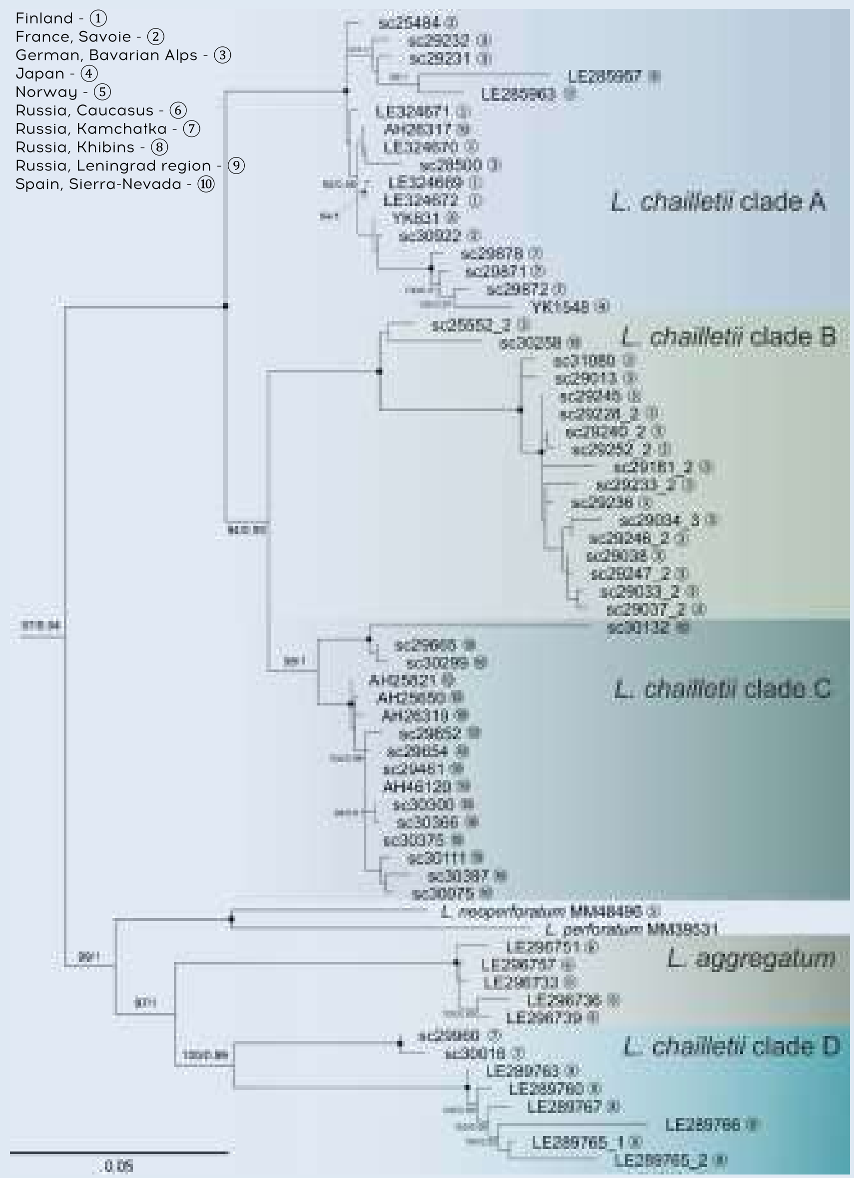
Seem to be well-separated, but only two specimens sequenced

- *L. chailletii* Rostaf. - **polyphyletic**



Lepidoderma clade 1

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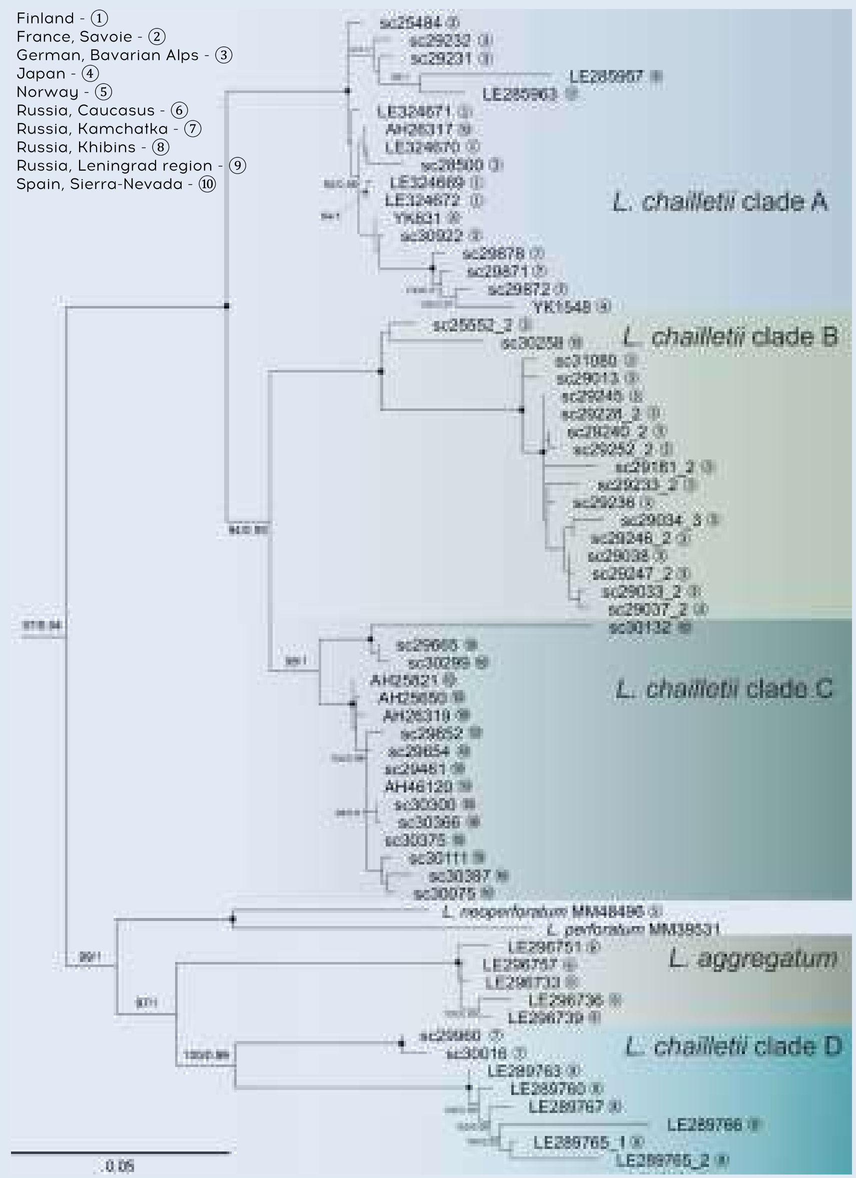
- *L. neoperforatum* Kuhnt
- *L. perforatum* Mar. Mey. & Poulain — (*L. neoperforatum* and *L. perforatum*:) Seem to be well-separated, but only two specimens sequenced
- *L. chailletii* Rostaf. - **polyphyletic**
  - Clade A – **throughout Eurasia**



***Lepidoderma* clade 1**

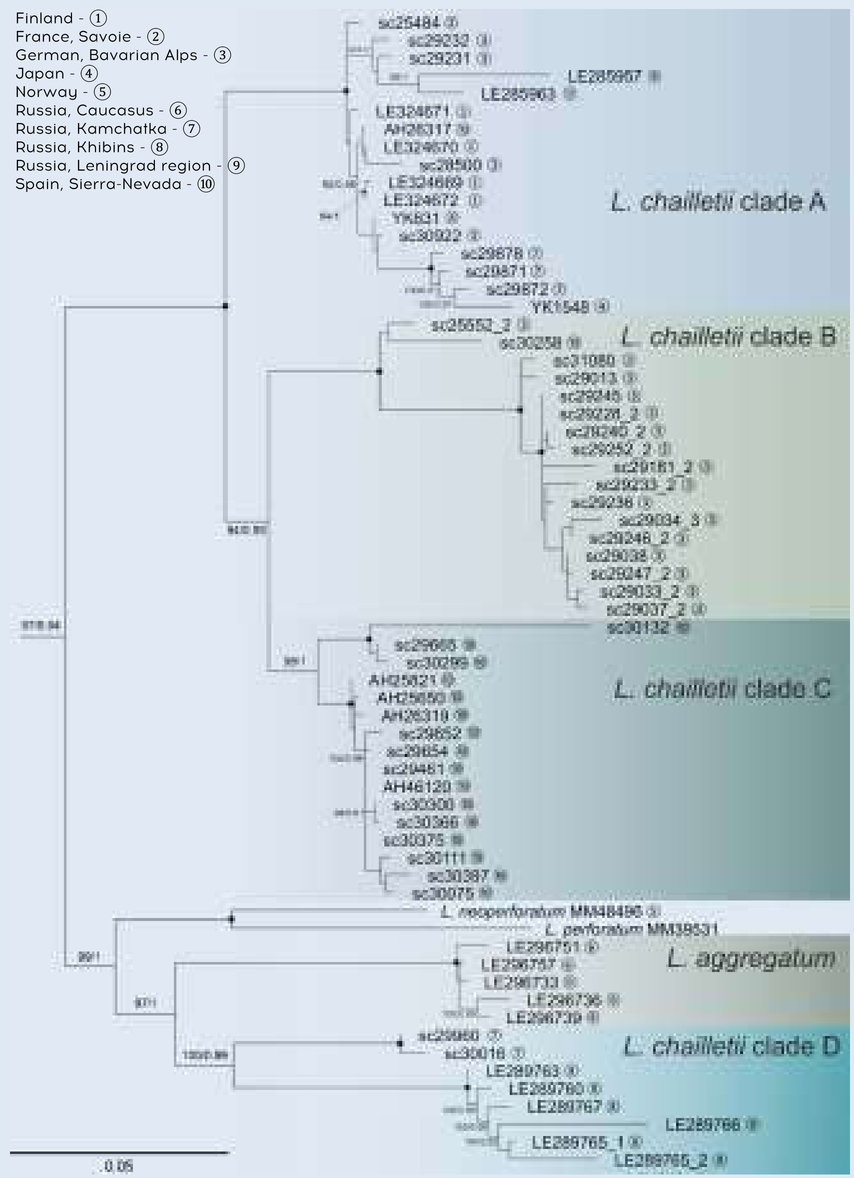
- *L. aggregatum* Kowalski

Seems to be a separate species. Specimens from US – the same?

- *L. neoperforatum* Kuhnt
- *L. perforatum* Mar. Mey. & Poulain

Seem to be well-separated, but only two specimens sequenced

- *L. chailletii* Rostaf. - **polyphyletic**
  - Clade A – **throughout Eurasia**
  - Clade B – **Bavarian Alps, two from French Alps and Sierra Nevada (Spain)**



Lepidoderma clade 1

- *L. aggregatum* Kowalski — Seems to be a separate species. Specimens from US – the same?
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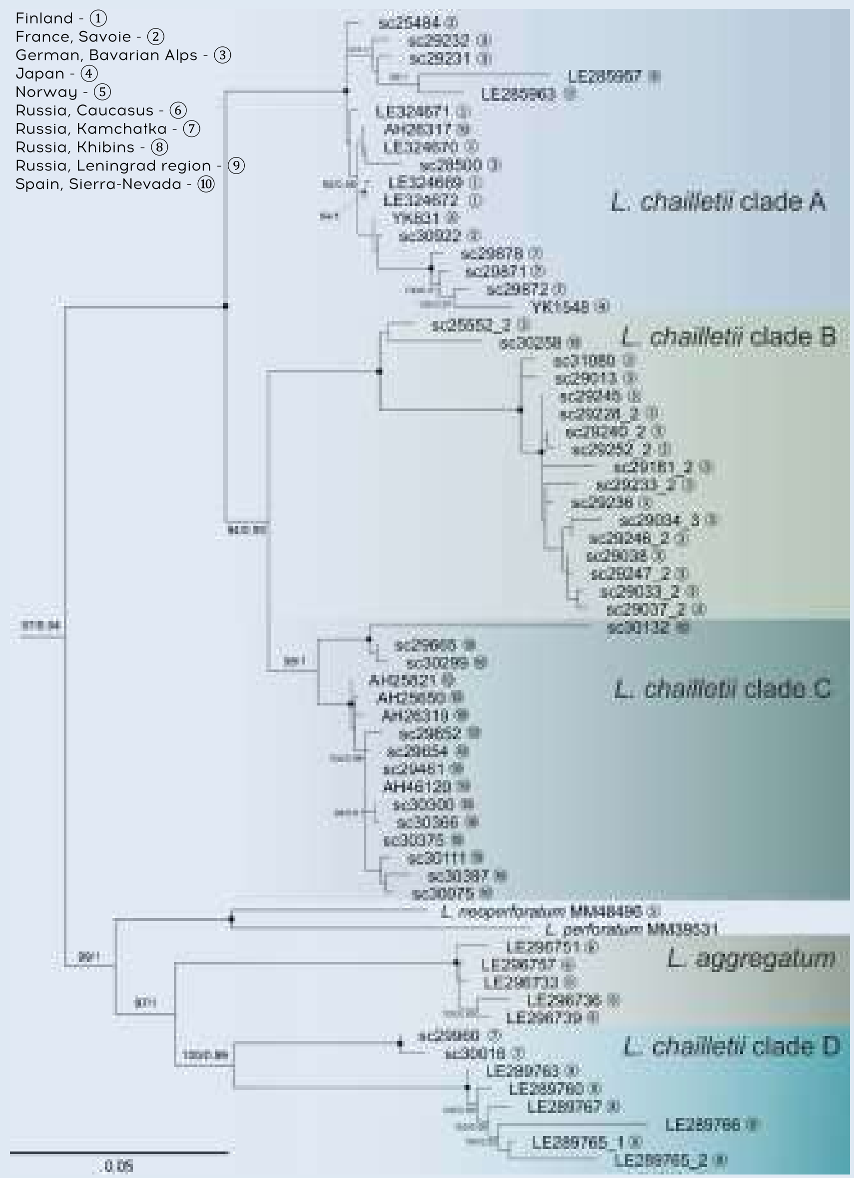

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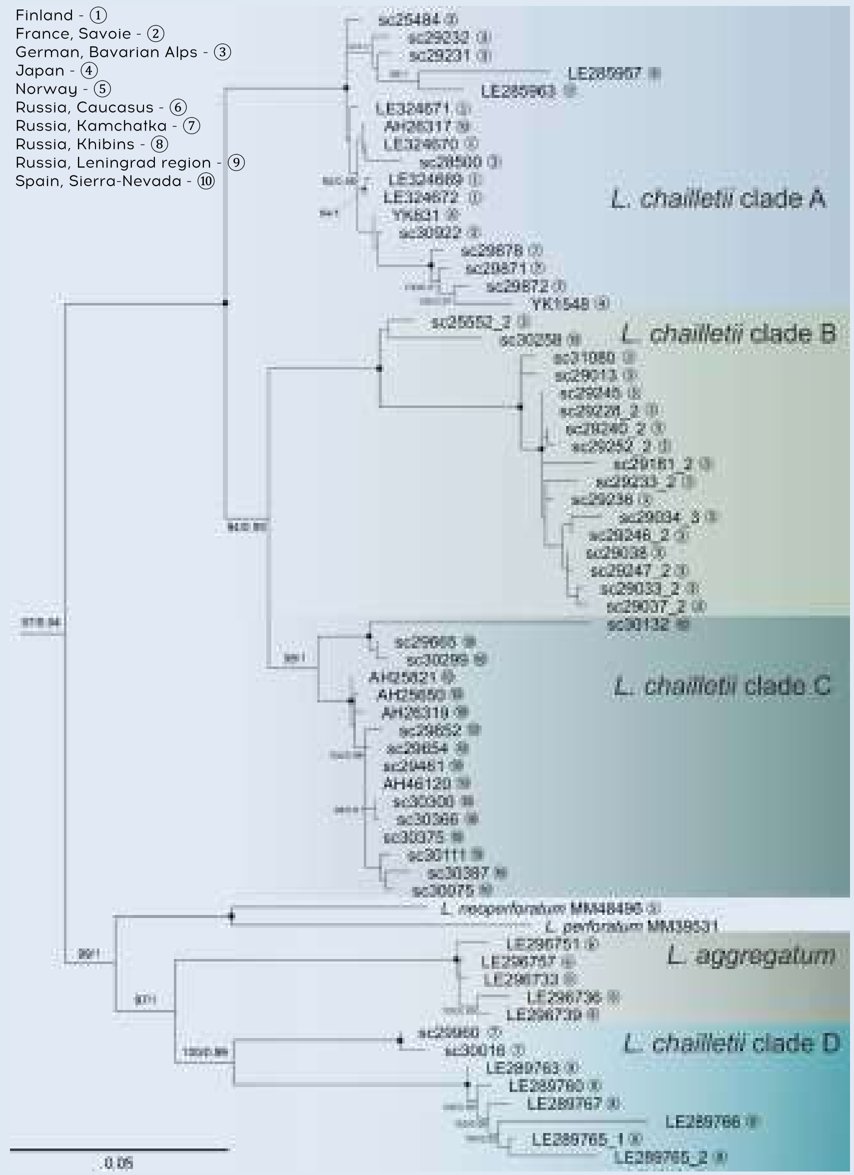

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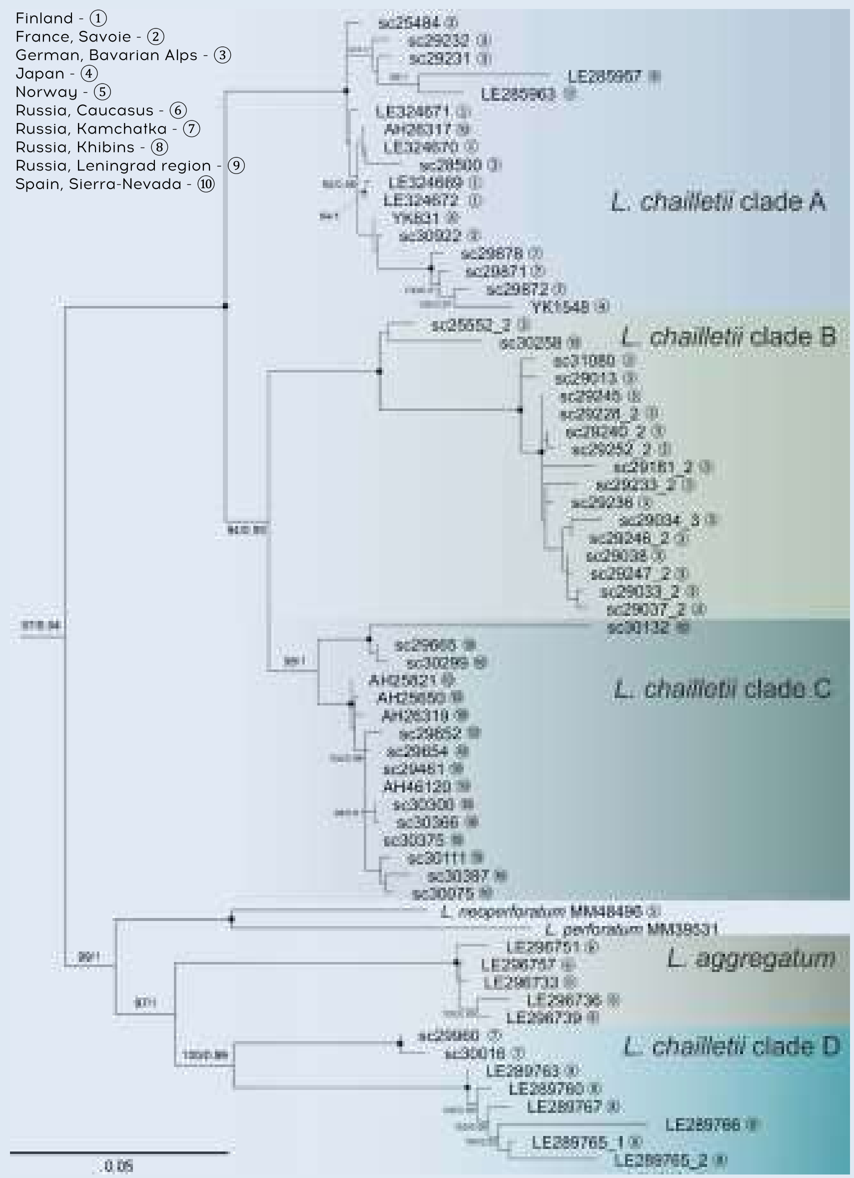
Can any of them be *L. didermoides*?



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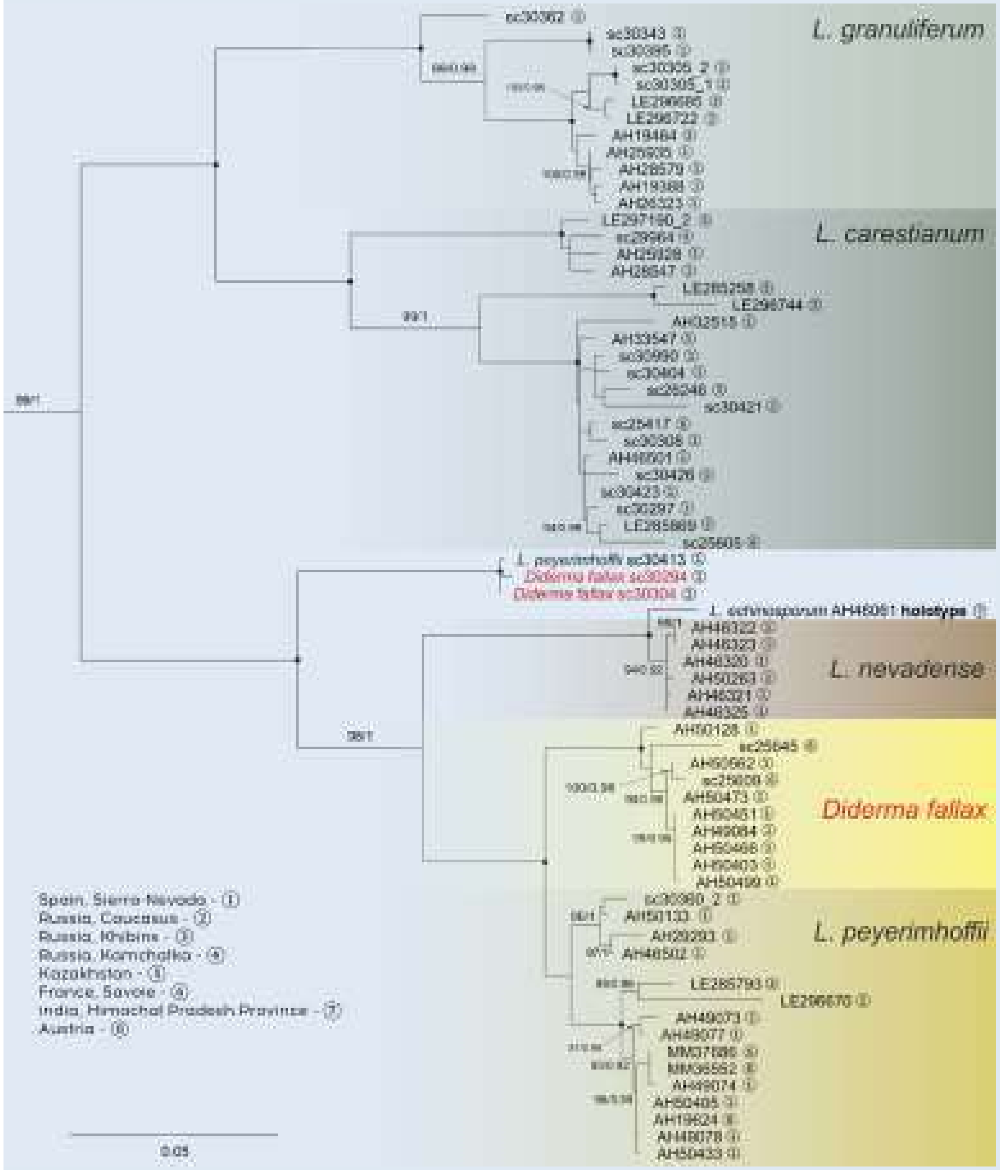
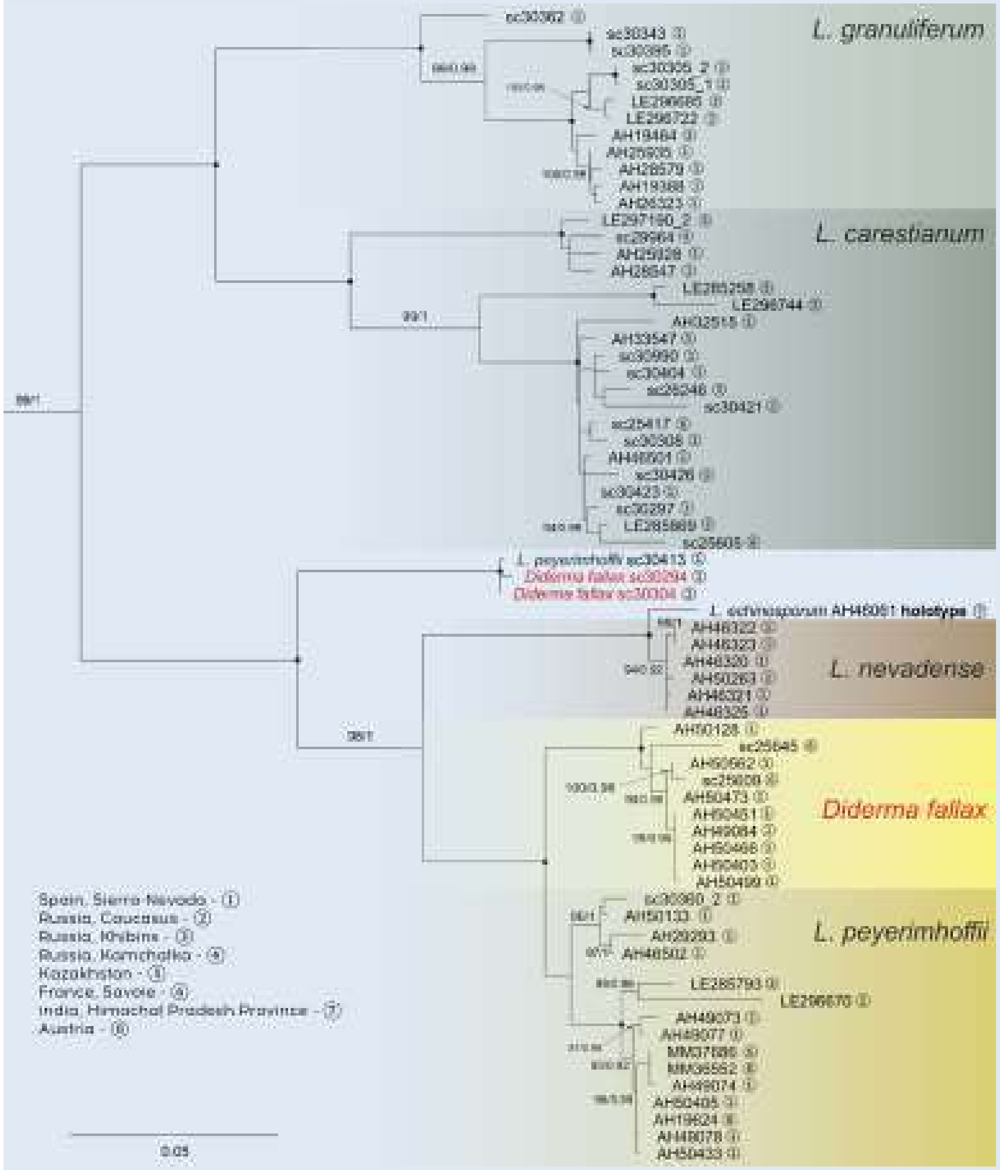
  Can any of them be *L. didermoides*?

L. alpestroides not sequenced, but 18S sequences from GenBank fell into *L. aggregatum* clade

Lepidoderma clade 2



- *L. granuliferum* (W. Phillips) R.E. Fr.



Lepidoderma clade 2

- *L. granuliferum* (W. Phillips) R.E. Fr.
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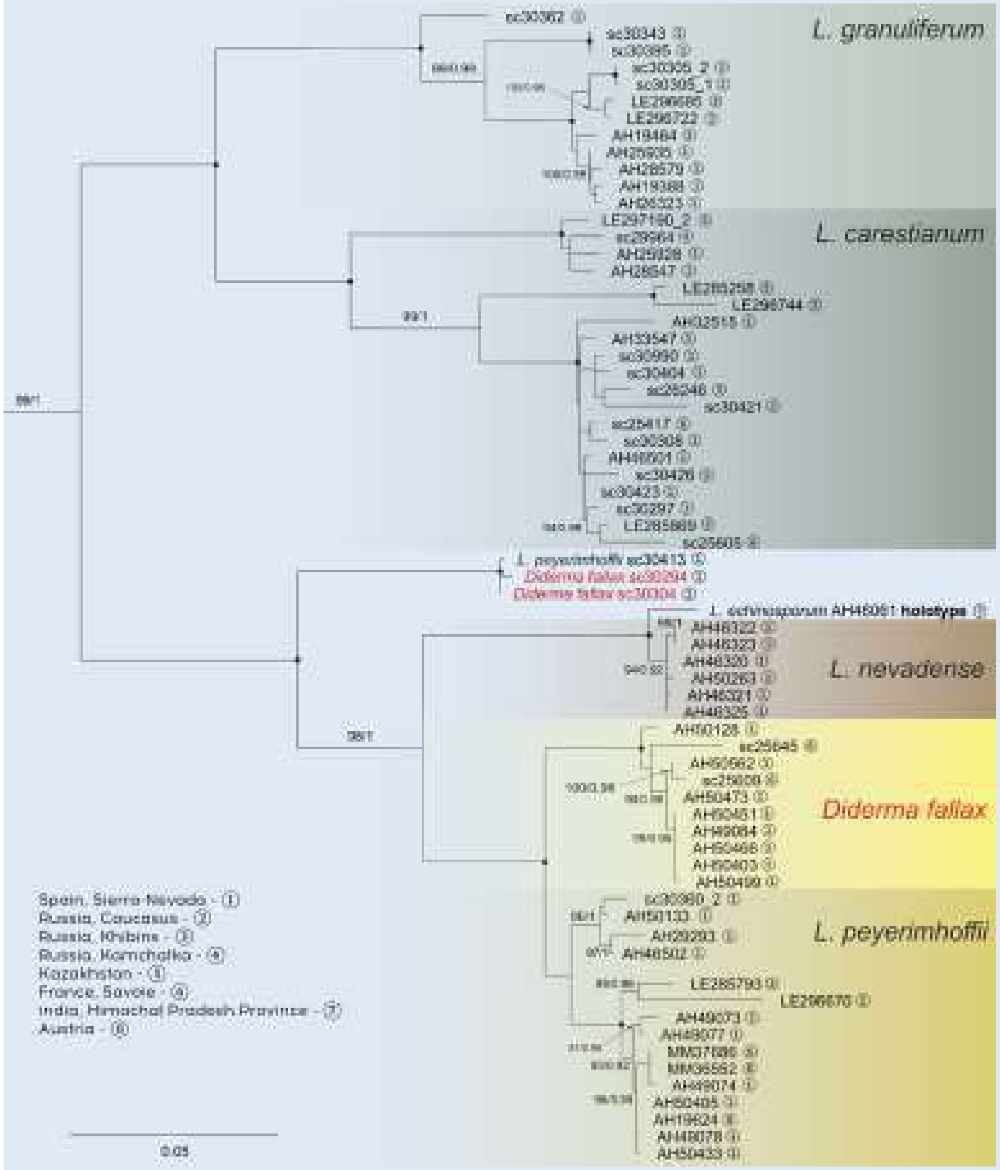

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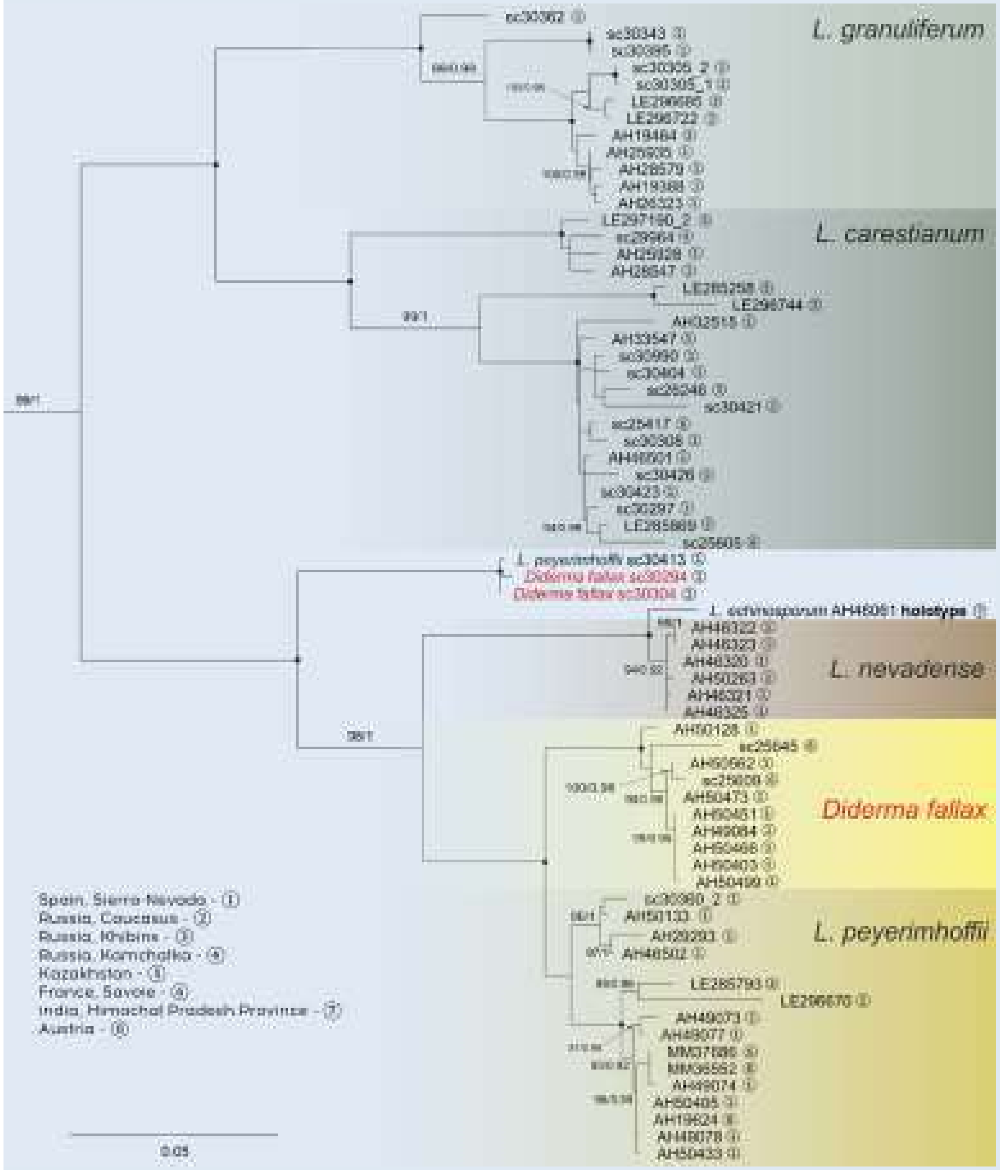

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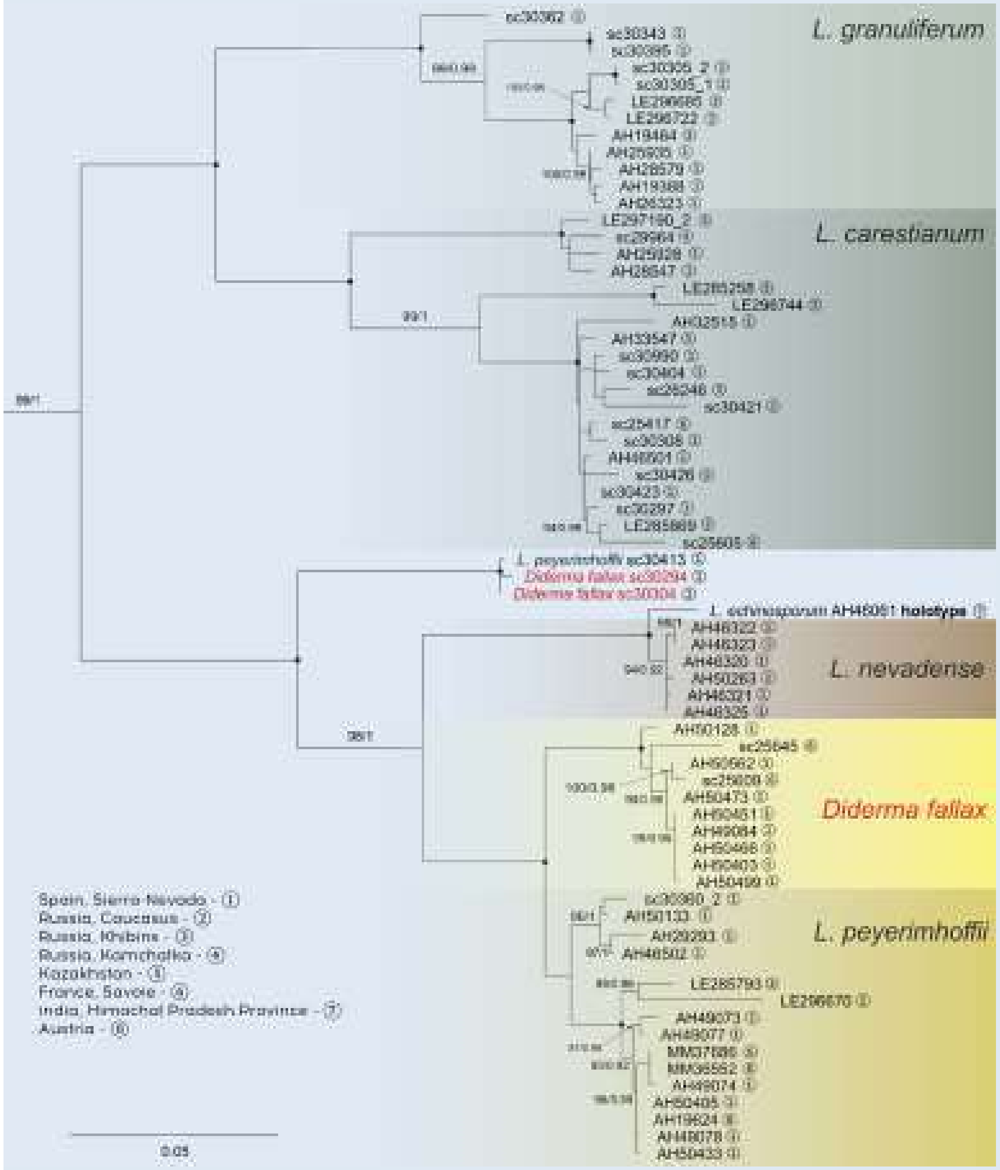

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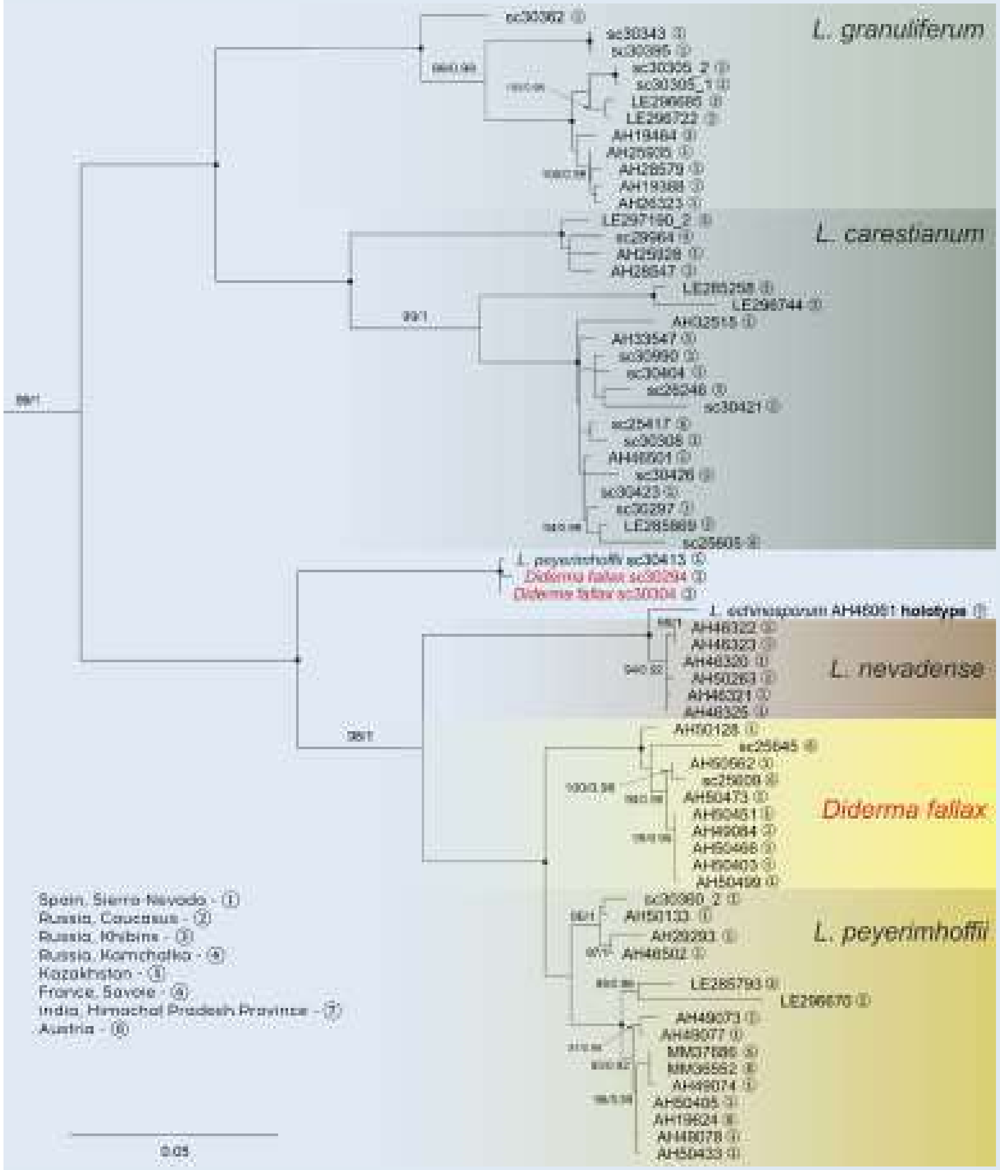
- *L. peyerimhoffii* Maire & Pinoy



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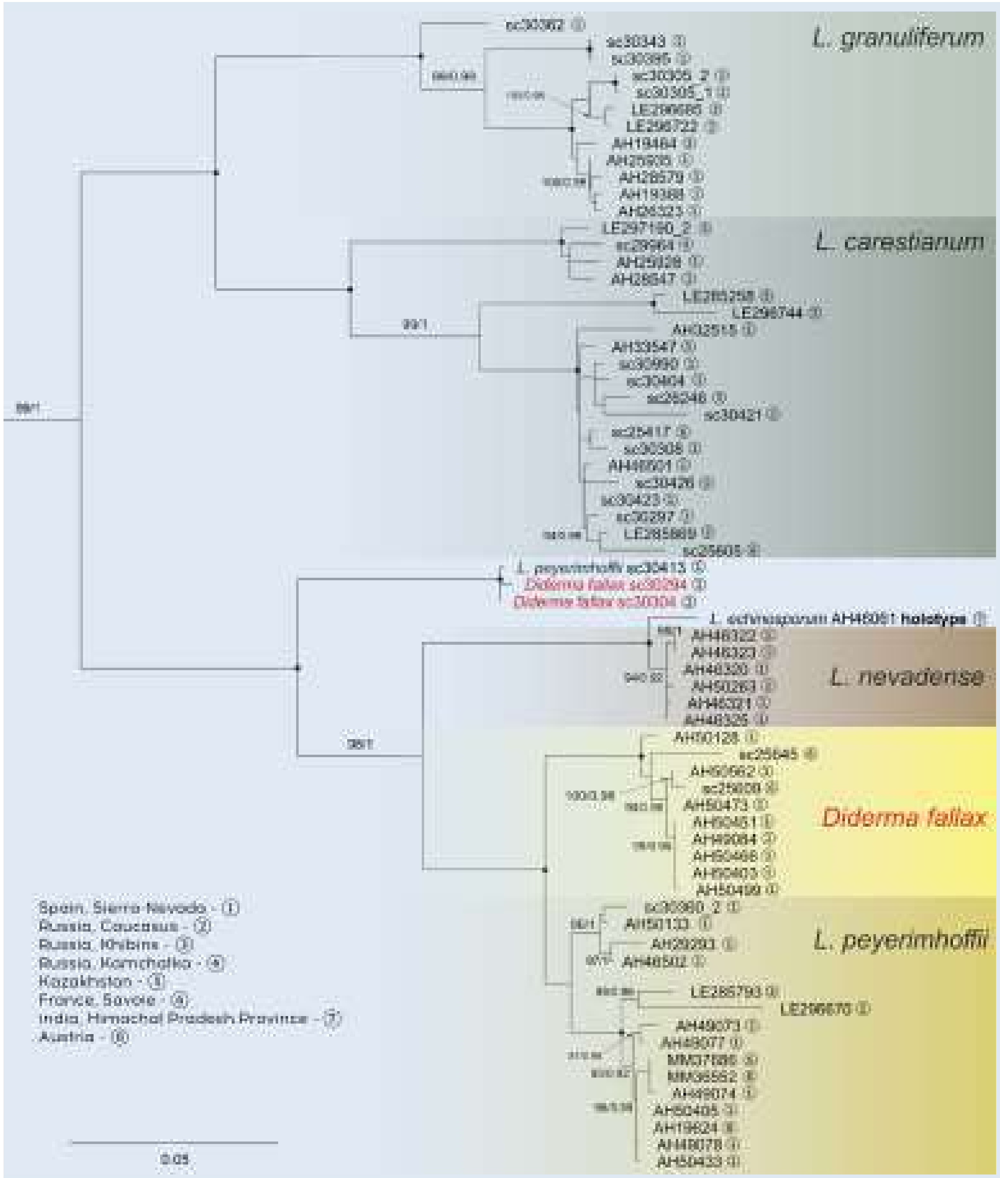
- *L. peyerimhoffii* Maire & Pinoy
- *Diderma fallax* (Rostaf.) E. Sheld.



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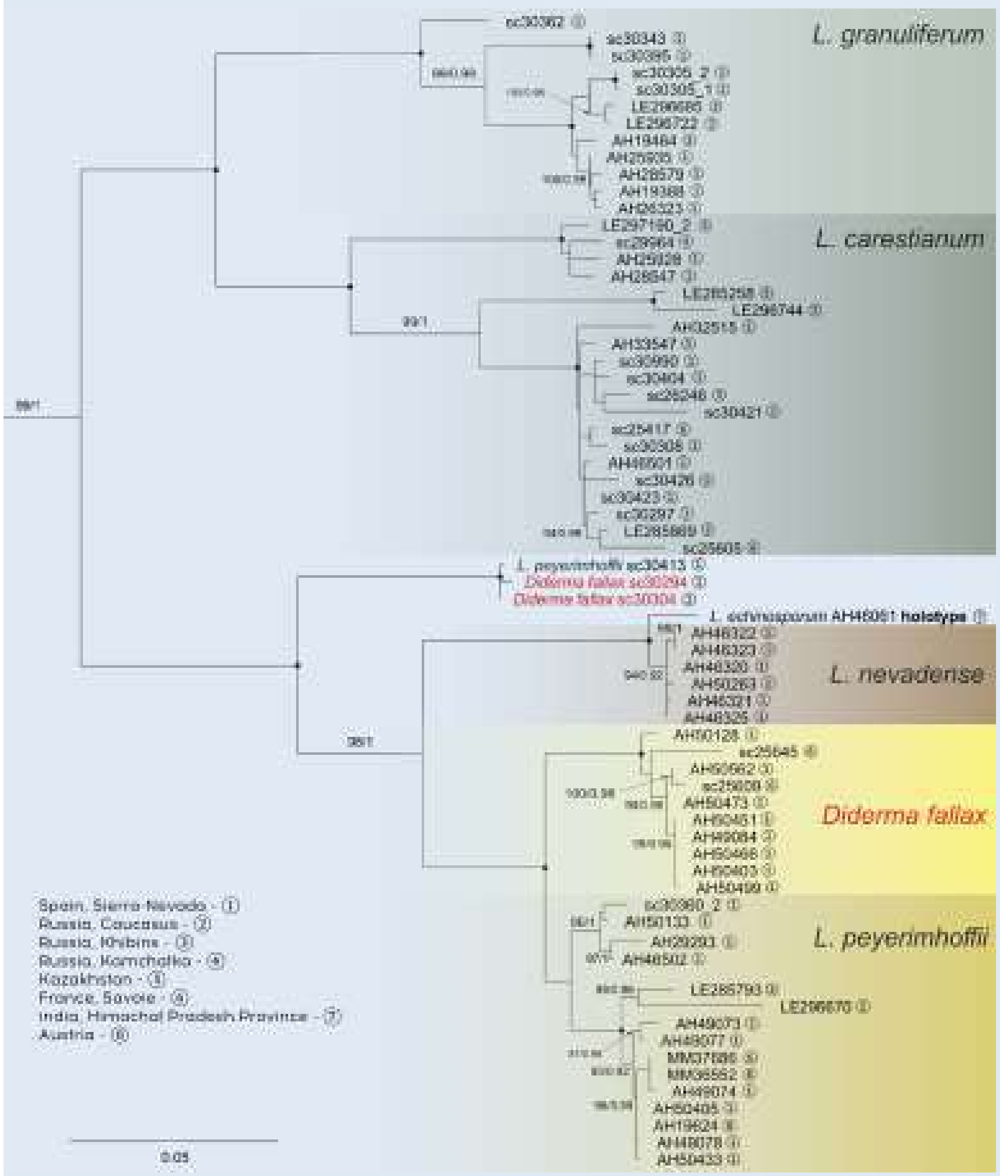
L. crustaceum not sequenced, but 18S sequence from GenBank belonged to *L. fallax-peyerimhoffii* clade (Shchepin et al., 2016)



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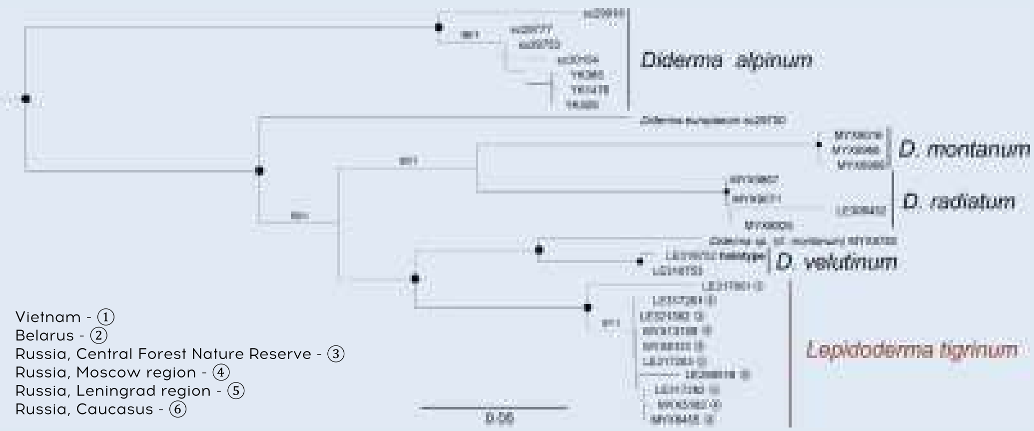
? *L. cristatosporum*, *L. trevelyanii* ?

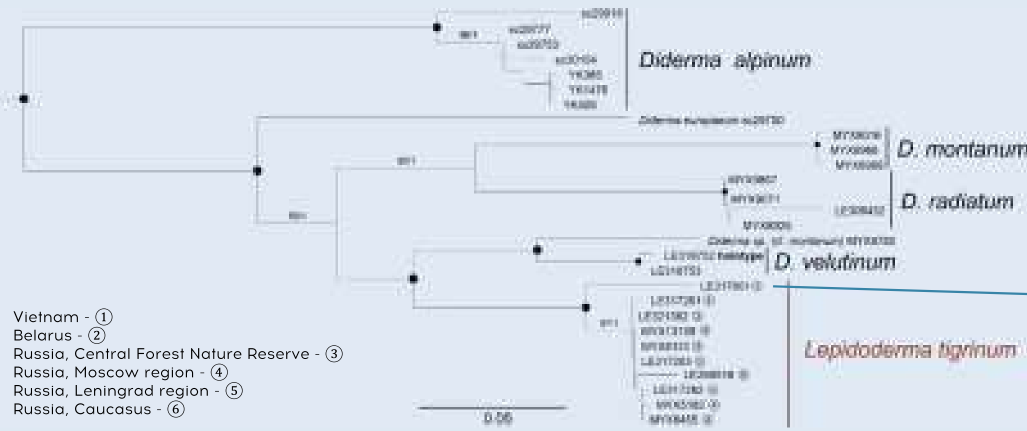
Diderma clade

- *L. tigrinum* (Schrad.) Rostaf.

Clearly belongs to *Diderma*



Diderma clade



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Diderma clade

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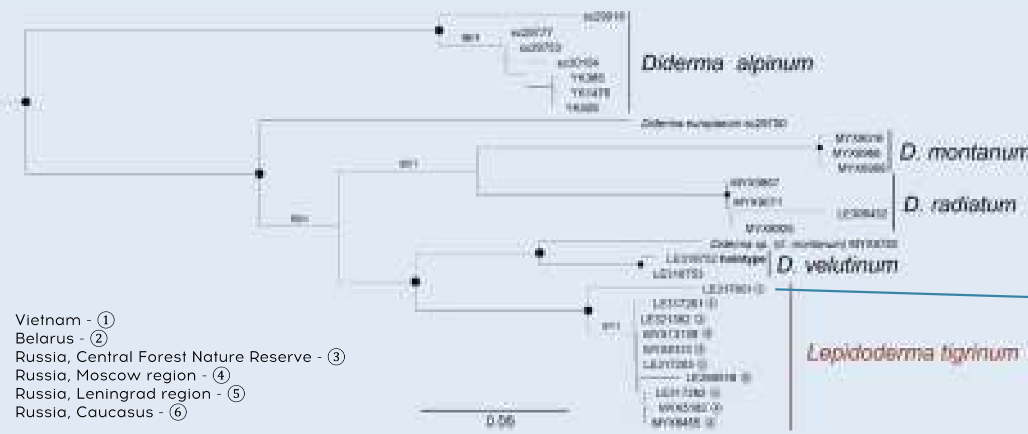


? *L. crassipes, L. stipitatum* **?**

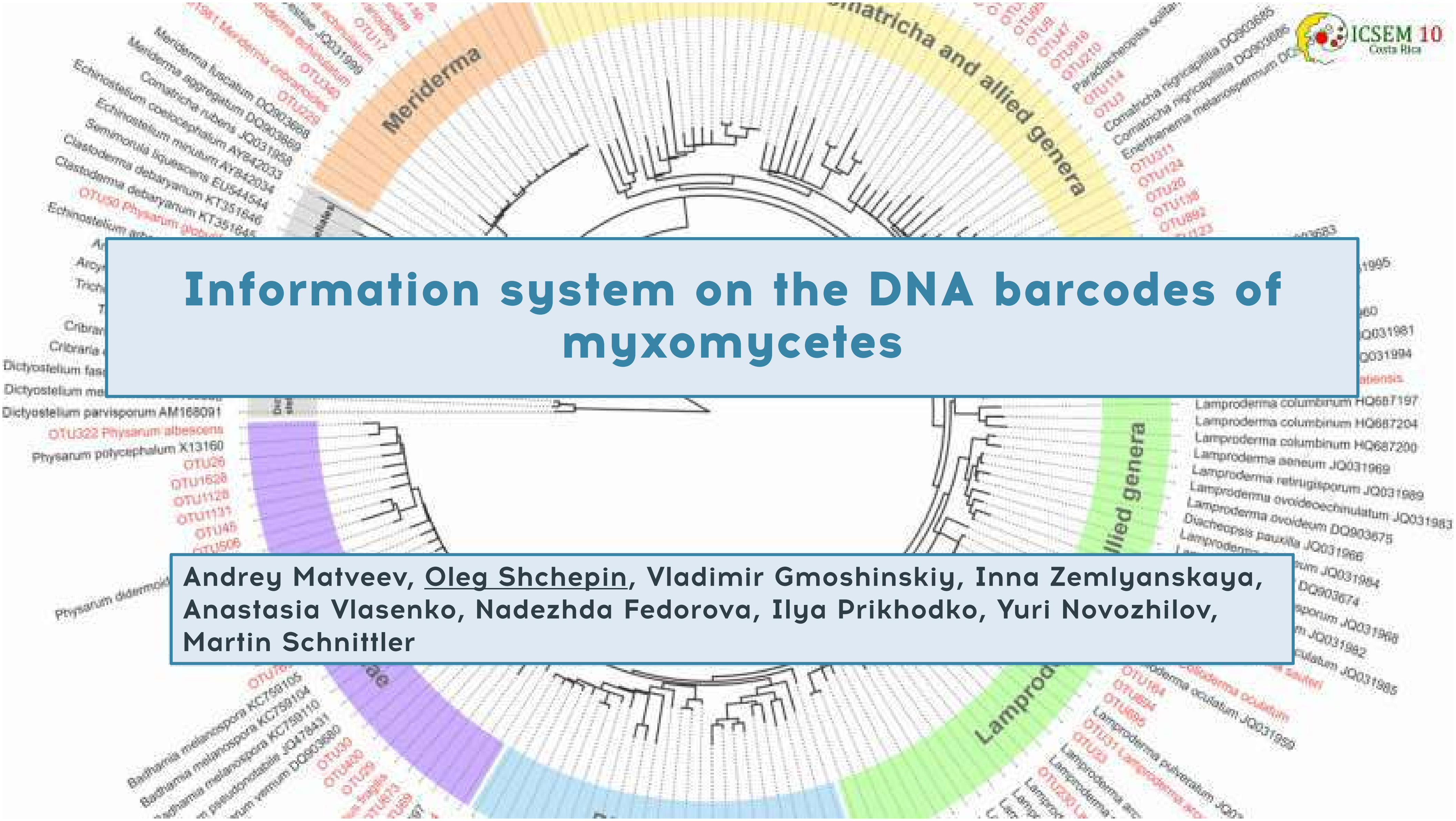
Conclusions and outlook

- All 10 investigated species of *Lepidoderma* seem to represent separate species
- *Lepidoderma* species with peridial plates form a monophyletic group
- *Lepidoderma* species with plasmodiocarps occur in both major clades of the genus
- ***L. chailletii*** is polyphyletic and probably represents four species
- ***L. chailletii* clade C** has a limited distribution and can be separated morphologically
- ***Lepidoderma tigrinum*** should be combined to ***Diderma***
- Name conservation proposal for ***Lepidoderma***?
- If yes, ***Diderma fallax*** should be combined to ***Lepidoderma***

For all of this, type material needs to be sequenced!


Thank you for your attention!

ICSEM 10
Costa Rica



Information system on the DNA barcodes of myxomycetes

Andrey Matveev, Oleg Shchepin, Vladimir Gmoshinskiy, Inna Zemlyanskaya, Anastasia Vlasenko, Nadezhda Fedorova, Ilya Prikhodko, Yuri Novozhilov, Martin Schnittler

DNA barcoding

- Species identification method
- Routine plants, metazoans, prokaryotes, fungi, many protists
- Myxomycetes:
  - Too few species sequenced
  - No curated database for the group exists

The idea

- DNA barcodes (mostly 18S rRNA gene, but also EF1A, COI, …?)
- Sequences linked to herbarium specimens
- Morphological determination confirmed based on sequence similarity and phylogenetic analysis
- Determination history preserved
- Whenever possible, accompanied by:
  - Collection data (coordinates, altitude, locality description, who and when collected…)
  - Photos (LM and SEM)
  - Raw sequence chromatograms

This includes:

- Review all published sequences
- Add newly obtained sequences

Participating organizations

Russian Foundation for Basic Research, project 18-04-01232 A

Komarov Botanical Institute RAS

Moscow State University

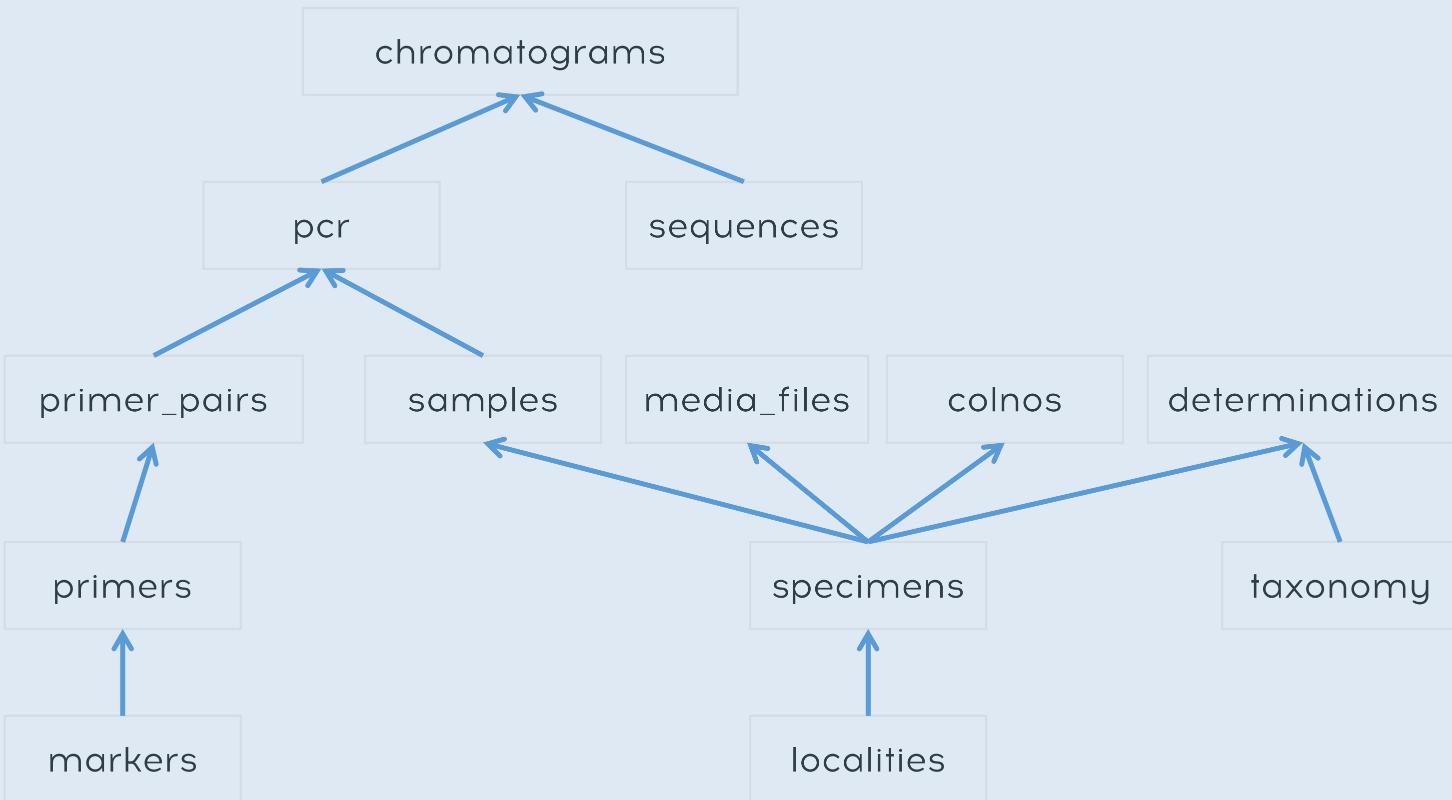
Institute of Botany and Landscape Ecology, University of Greifswald

German Research Council (DFG: SCHN1080/2-1, RTG 2010)

Collections being sequenced

- **LE** (myxological herbarium of the Komarov Botanical Institute, Russia)
- **MYX** (myxomycete herbarium of the Mycology and Algology department, Faculty of Biology, Moscow State University, Russia)
- Private myxomycete collection of Prof. Martin Schnittler (Greifswald University, Germany)
- Private myxomycete collection of Marianne Meyer (France)
- **AH** (mycological herbarium of the University of Alcala de Henares, Spain)
- Private myxomycete collection of Dr. Anastasia Vlasenko (Main Siberian Botanical Garden of the Siberian branch of RAS, Russia)
- Private myxomycete collection of Dr. Inna Zemlyanskaya (Volgograd State Medical University, Russia)

Database structure



Web application: dna.myxomycetes.org

MyxoSequences   Main   Sequences   Log in

MyxoSeq: Information system on the DNA barcodes of myxomycetes

An online resource for quality-checked nucleotide sequences of myxomycetes linked to herbarium specimens of fruit bodies (sporocarps) with reliable taxonomic determination and accompanied with metadata (photographs of morphological structures of reference specimens, sequence chromatograms, specimen collection data etc.). The aim of MyxoSeq is to provide a curated collection of reference sequences, with the first part of 18S rRNA gene accepted as the main DNA barcode for the group, which can be used for taxonomic annotation of the specimens of sporocarps, living cultures and environmental sequences. Taxonomic annotation of sequences is checked based on specimen morphology, position in molecular phylogeny and similarity to other sequences.

Participating organizations:

Komarov Botanical Institute, Russian Academy of Sciences, Saint Petersburg, Russia

Lomonosov Moscow State University, Russia

Central Siberian Botanical Garden of the Siberian Branch of the Russian Academy of Sciences, Novosibirsk, Russia

Institute of Botany and Landscape Ecology, Greifswald University, Germany

Acknowledgements

This information system was created under the project "DNA barcoding of myxomycetes (Myxomycetes = Myxogastria) and analysis of their hidden diversity based on herbarium collections and metagenomic data" (18-04-01232 A) funded by the Russian Foundation of Basic Research, and in framework of two programs of the Komarov Botanical Institute: "Taxonomic diversity, ecology and physiological and biochemical features of fungi and fungus-like protists of Vietnam" (AAAA-A19-119080990059-1) and "Biodiversity, ecology, structural and functional features of fungi and fungus-like protists" (AAAA-A19-119020890079-6). Additional support was provided by the "RESPONSE" project of the German Research Council (DFG: SCHN1080/2-1, RTG 2010).

We are grateful to all researchers who provided specimens of sporocarps of myxomycetes for DNA extraction and sequencing.

Web application: dna.myxomycetes.org

Contacts

Administrator: Oleg Shchepin, e-mail: OShchepin@binran.ru

Developer: Andrey Matveev, e-mail: AMatveev@binran.ru

INSTITUTUM BOTANICUM KOMAROVIANUM

1755 LOMONOSOV MOSCOW STATE UNIVERSITY

ЦЕНТРАЛЬНЫЙ СИБИРСКИЙ БОТАНИЧЕСКИЙ САД СО РАН

UNIVERSITÄT GREIFSWALD
Wissen lockt. Seit 1456

RFBR RUSSIAN FOUNDATION FOR BASIC RESEARCH

reSPOnse

Contents overview

MyxoSequences   Main   Sequences   Log in

	ID	Collection No.	Marker	Sequence quality	Reference	Length	Variant	Genus	Species epithet	Cf.	Primers pair nam
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	1480	LE305889	SSU	Excellent	Yes	564		Didymium	dubium	—	S1 / SU19R (56.0)
	1479	LE305886	SSU	Excellent	Yes	564		Didymium	dubium	—	S1 / SU19R (56.0)
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	457	LE305805	COI	Excellent	Yes	609		Lepidoderma	carestianum	—	COIF1 / COIR1 (50.…
	456	LE305765	EF1A	Readable	Yes	759		Lepidoderma	carestianum	—	PB1F / PB1R (65.4)
	455	LE305798	EF1A	Readable	Yes	759		Lepidoderma	carestianum	—	PB1F / PB1R (65.4)
	454	LE305805	EF1A	Readable	Yes	759		Lepidoderma	carestianum	—	PB1F / PB1R (65.4)
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	441	LE306464	SSU	Excellent	Yes	563		Diderma	umbilicatum	—	S1 / SU19R (56.0)
	440	LE306452	SSU	Excellent	Yes	577		Diderma	radiatum	—	S1 / SU19R (56.0)
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SORT

FILTER

SLICE

SPECIMEN CARD

PREVIEW

MAP

EXPORT FASTA

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Contents overview

MyxoSequences Main Sequences

Survey	Country	Province	Region	City	Elev.	Longitude	Latitude	C. p.	Remark	Genbank ID
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Contents overview

MyxoSequences | Main | Sequences

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hchepin	2017-11-23	Oleg Shche...	2017-11-23	2017-12-23	Oleg Shchepin	2020-01-22	Oleg Shchepin	2020-01-23	Oleg Shche...
hchepin	2017-07-24	Oleg Shche...	2017-11-19	2017-11-24	Oleg Shchepin	2020-01-22	Oleg Shchepin	2020-01-23	Oleg Shche...
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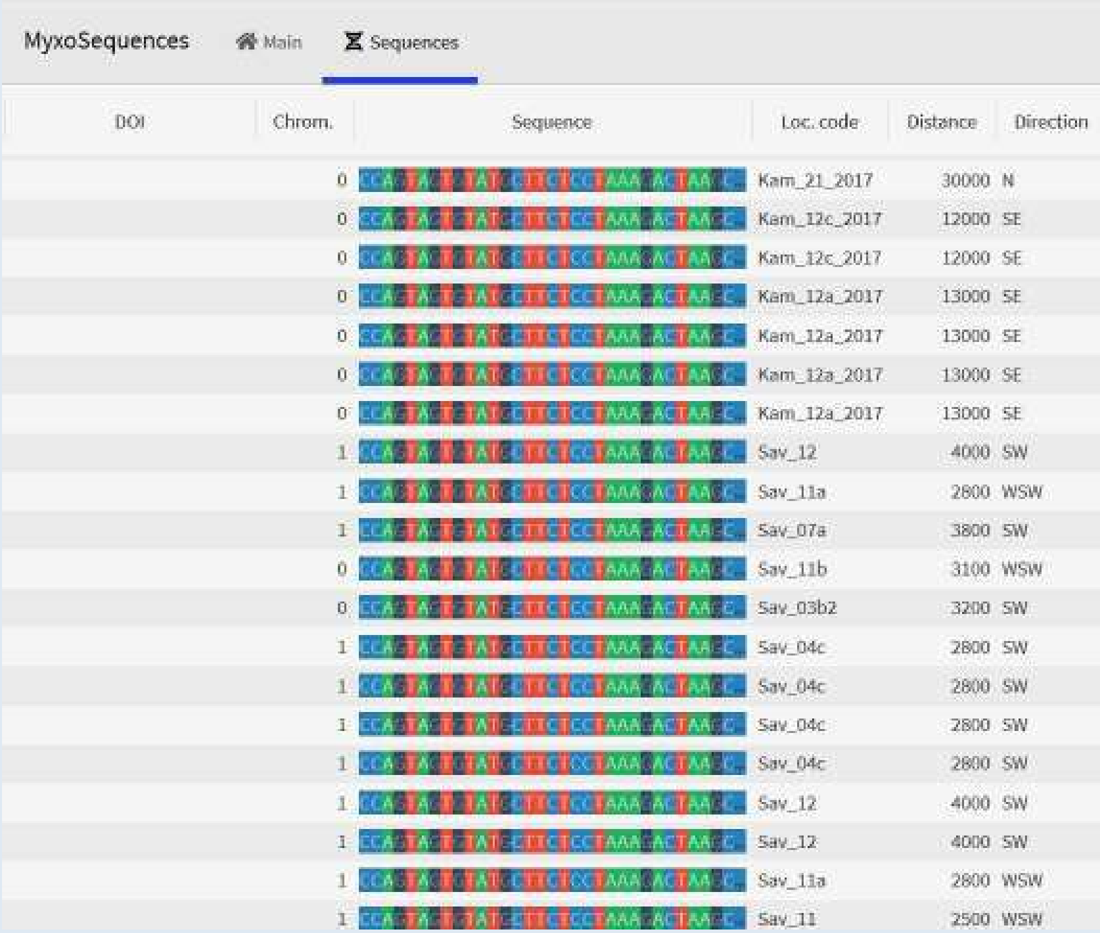
hchepin	2018-06-18	Oleg Shche...	2018-07-23	2018-07-26	Oleg Shchepin	2019-12-29	Oleg Shchepin	2019-12-29	Oleg Shche...
hchepin	2018-06-18	Oleg Shche...	2018-07-23	2018-07-26	Oleg Shchepin	2019-12-29	Oleg Shchepin	2019-12-29	Oleg Shche...
hchepin	2018-06-18	Oleg Shche...	2018-07-23	2018-07-26	Oleg Shchepin	2019-12-29	Oleg Shchepin	2019-12-29	Oleg Shche...
hchepin	2018-06-18	Oleg Shche...	2018-07-23	2018-07-26	Oleg Shchepin	2019-12-29	Oleg Shchepin	2019-12-29	Oleg Shche...
hchepin	2018-06-18	Oleg Shche...	2018-07-23	2018-07-26	Oleg Shchepin	2019-12-29	Oleg Shchepin	2019-12-29	Oleg Shche...
hchepin	2018-06-18	Oleg Shche...	2018-07-23	2018-07-26	Oleg Shchepin	2019-12-29	Oleg Shchepin	2019-12-29	Oleg Shche...
hchepin	2018-07-18	Oleg Shche...	2018-07-30	2018-08-07	Oleg Shchepin	2019-12-29	Oleg Shchepin	2019-12-29	Oleg Shche...
hchepin	2018-07-18	Oleg Shche...	2018-07-30	2018-08-07	Oleg Shchepin	2019-12-29	Oleg Shchepin	2019-12-29	Oleg Shche...

Contents overview



DOI	Chrom.	Sequence	Loc. code	Distance	Direction
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	0	[illegible]	Kam_12c_2017	12000	SE
	0	[illegible]	Kam_12a_2017	13000	SE
	0	[illegible]	Kam_12a_2017	13000	SE
	0	[illegible]	Kam_12a_2017	13000	SE
	0	[illegible]	Kam_12a_2017	13000	SE
	1	[illegible]	Sav_12	4000	SW
	1	[illegible]	Sav_11a	2800	WSW
	1	[illegible]	Sav_07a	3800	SW
	0	[illegible]	Sav_11b	3100	WSW
	0	[illegible]	Sav_03b2	3200	SW
	1	[illegible]	Sav_04c	2800	SW
	1	[illegible]	Sav_04c	2800	SW
	1	[illegible]	Sav_04c	2800	SW
	1	[illegible]	Sav_04c	2800	SW
	1	[illegible]	Sav_12	4000	SW
	1	[illegible]	Sav_12	4000	SW
	1	[illegible]	Sav_11a	2800	WSW
	1	[illegible]	Sav_11	2500	WSW

Contents overview

MyxoSequences   Main   Sequences

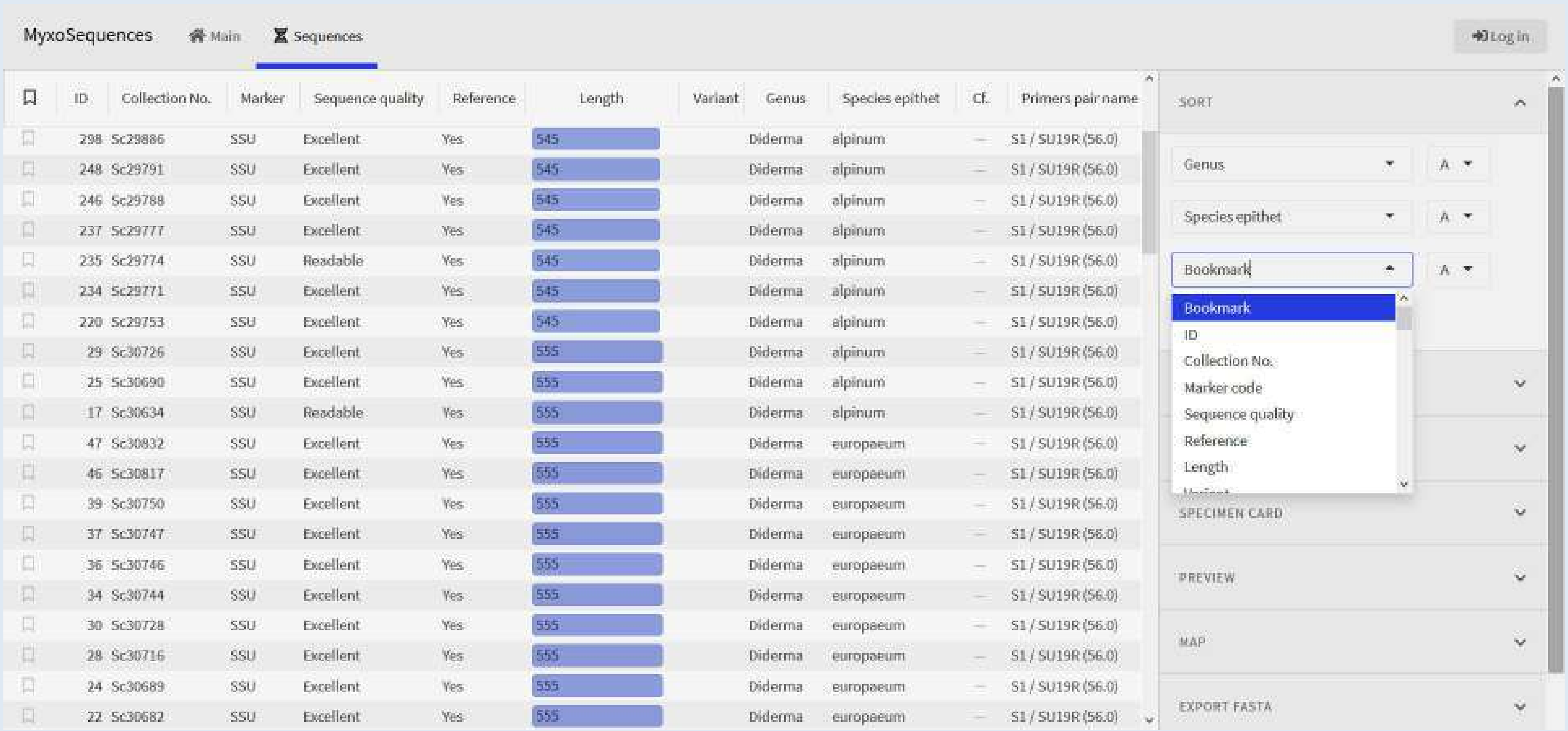
Loc. code	Distance	Direction	Toponym	Habitat	Loc. desc.
Kam_12c_2017	12000	SE	Esso	alpine tundra with dense Duschekia thickets…	ca. 3 km SSW of Mt. Duigeren-Olengende
Kam_12a_2017	13000	SE	Esso	alpine tundra at shallow SE-exp. slopes, oth…	ca. 3 km SSW of Mt. Duigeren-Olengende
Kam_12a_2017	13000	SE	Esso	alpine tundra at shallow SE-exp. slopes, oth…	ca. 3 km SSW of Mt. Duigeren-Olengende
Kam_12a_2017	13000	SE	Esso	alpine tundra at shallow SE-exp. slopes, oth…	ca. 3 km SSW of Mt. Duigeren-Olengende
Kam_12a_2017	13000	SE	Esso	alpine tundra at shallow SE-exp. slopes, oth…	ca. 3 km SSW of Mt. Duigeren-Olengende
Sav_12	4000	SW	Rognaix	clearings in spruce forest under a powerline	SE-exp. slope, western side of the valley, trai…
Sav_11a	2800	WSW	Rognaix	spruce-maple forest, 2nd little side valley, n…	ESE-exp. slopes 900 m SW settlement "Mons…
Sav_07a	3800	SW	Rognaix	open alpine meadows with some Acer ps.pla…	S-exp. slope, western side of the valley, over …
Sav_11b	3100	WSW	Rognaix	spruce-maple forest, 3nd little side valley, n…	ESE-exp. slopes 1 km SW settlement "Monsl…
Sav_03b2	3200	SW	Rognaix	spruce forest with clearings above shelters (…	W-exp slope under a powerline, ca. 650 m N…
Sav_04c	2800	SW	Rognaix	clearings with young forest, mainly birch, ab…	N-exp slope, damaged spruce forest above a…
Sav_04c	2800	SW	Rognaix	clearings with young forest, mainly birch, ab…	N-exp slope, damaged spruce forest above a…
Sav_04c	2800	SW	Rognaix	clearings with young forest, mainly birch, ab…	N-exp slope, damaged spruce forest above a…
Sav_04c	2800	SW	Rognaix	clearings with young forest, mainly birch, ab…	N-exp slope, damaged spruce forest above a…
Sav_12	4000	SW	Rognaix	clearings in spruce forest under a powerline	SE-exp. slope, western side of the valley, trai…
Sav_12	4000	SW	Rognaix	clearings in spruce forest under a powerline	SE-exp. slope, western side of the valley, trai…
Sav_11a	2800	WSW	Rognaix	spruce-maple forest, 2nd little side valley, n…	ESE-exp. slopes 900 m SW settlement "Mons…
Sav_11	2500	WSW	Rognaix	spruce-maple forest, little side valley, near h…	SE-exp. slopes 600 m SW settlement "Monsl…
Sav_10	5500	WSW	Bonneval	alpine meadows, clearings with tree groups …	S-exp. slope, road from Chapelle Celliers, ca.…
Sav_02	3000	NNE	Moutiers	mixed spruce-pine forest	S-exp. slope at "Doucy" above village Haute…

Contents overview

MyxoSequences   Main   Sequences

Loc. code	Distance	Direction	Toponym	Habitat	Loc. desc.
Kam_12c_2017	12000	SE	Esso	alpine tundra with dense Duschekia thickets…	ca. 3 km SSW of Mt. Duigeren-Olengende
Kam_12a_2017	13000	SE	Esso	alpine tundra at shallow SE-exp. slopes, oth…	ca. 3 km SSW of Mt. Duigeren-Olengende
Kam_12a_2017	13000	SE	Esso	alpine tundra at shallow SE-exp. slopes, oth…	ca. 3 km SSW of Mt. Duigeren-Olengende
Kam_12a_2017	13000	SE	Esso	alpine tundra at shallow SE-exp. slopes, oth…	ca. 3 km SSW of Mt. Duigeren-Olengende
Kam_12a_2017	13000	SE	Esso	alpine tundra at shallow SE-exp. slopes, oth…	ca. 3 km SSW of Mt. Duigeren-Olengende
Sav_12	4000	SW	Rognaix	clearings in spruce forest under a powerline	SE-exp. slope, western side of the valley, trai…
Sav_11a	2800	WSW	Rognaix	spruce-maple forest, 2nd little side valley, n…	ESE-exp. slopes 900 m SW settlement "Mons…
Sav_07a	3800	SW	Rognaix	open alpine meadows with some Acer ps.pla…	S-exp. slope, western side of the valley, over …
Sav_11b	3100	WSW	Rognaix	spruce-maple forest, 3nd little side valley, n…	ESE-exp. slopes 1 km SW settlement "Monsl…
Sav_03b2	3200	SW	Rognaix	spruce forest with clearings above shelters (…	W-exp slope under a powerline, ca. 650 m N…
Sav_04c	2800	SW	Rognaix	clearings with young forest, mainly birch, ab…	N-exp slope, damaged spruce forest above a…
Sav_04c	2800	SW	Rognaix	clearings with young forest, mainly birch, ab…	N-exp slope, damaged spruce forest above a…
Sav_04c	2800	SW	Rognaix	clearings with young forest, mainly birch, ab…	N-exp slope, damaged spruce forest above a…
Sav_04c	2800	SW	Rognaix	clearings with young forest, mainly birch, ab…	N-exp slope, damaged spruce forest above a…
Sav_12	4000	SW	Rognaix	clearings in spruce forest under a powerline	SE-exp. slope, western side of the valley, trai…
Sav_12	4000	SW	Rognaix	clearings in spruce forest under a powerline	SE-exp. slope, western side of the valley, trai…
Sav_11a	2800	WSW	Rognaix	spruce-maple forest, 2nd little side valley, n…	ESE-exp. slopes 900 m SW settlement "Mons…
Sav_11	2500	WSW	Rognaix	spruce-maple forest, little side valley, near h…	SE-exp. slopes 600 m SW settlement "Monsl…
Sav_10	5500	WSW	Bonneval	alpine meadows, clearings with tree groups …	S-exp. slope, road from Chapelle Celliers, ca.…
Sav_02	3000	NNE	Moutiers	mixed spruce-pine forest	S-exp. slope at "Doucy" above village Haute…

Side panel: sorting



Side panel: filtering

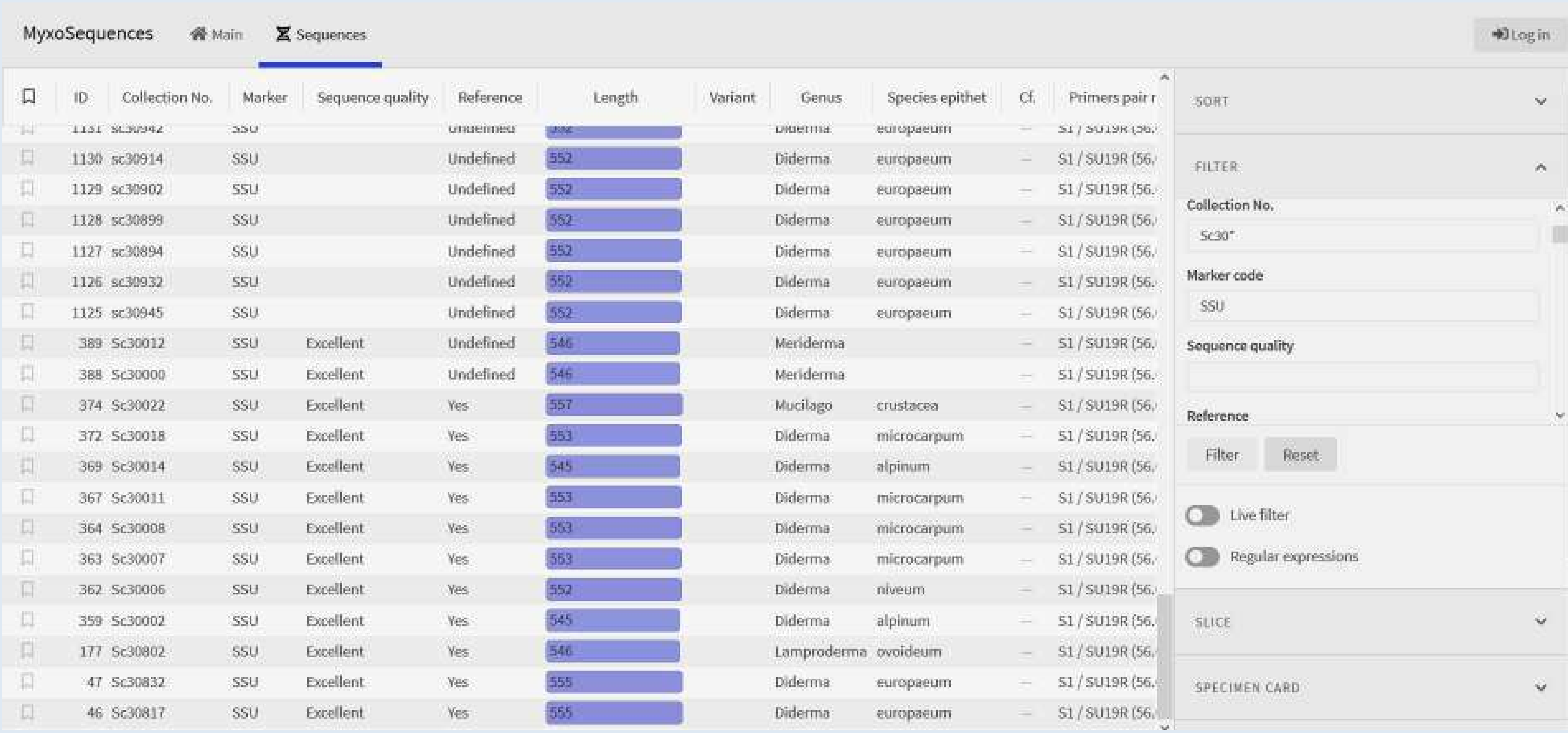
Glob pattern system works by default
https://en.wikipedia.org/wiki/Glob_(programming)

Wildcards: «*», «?», «[», «]».

It is easy:
? means any symbol (exactly one);
***** means any number of any symbols;
Symbols inside **[]** mean any one of the symbols listed inside.

Examples:
p[iy]riformis will find p**i**riformis and p**y**riformis
Sc1234? will find Sc12341, Sc12342, Sc12349 etc.
Sc* will find anything that starts with Sc

Side panel: filtering



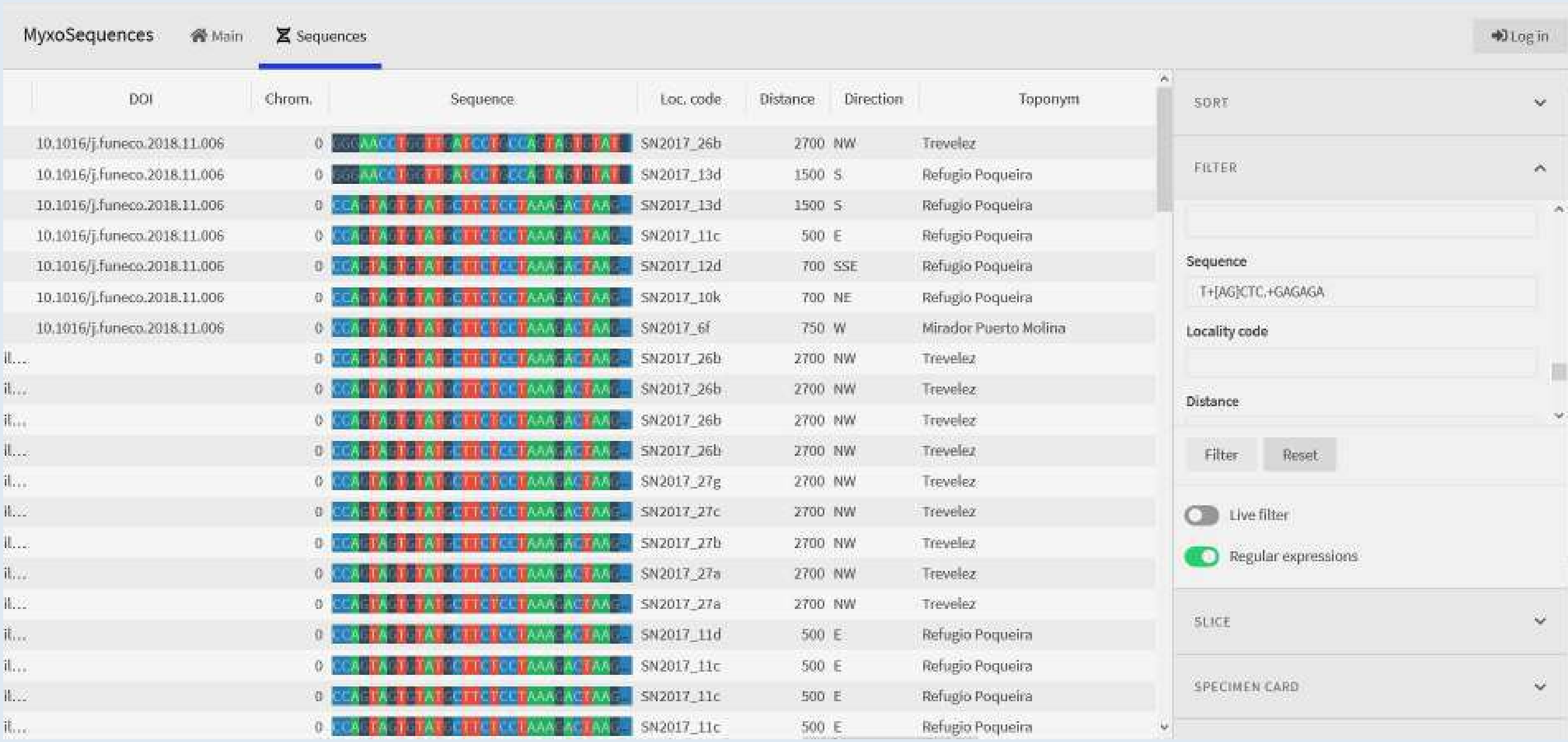
	ID	Collection No.	Marker	Sequence quality	Reference	Length	Variant	Genus	Species epithet	Cf.	Primers pair r
	1131	sc30942	SSU		Undefined	552		Diderma	europaeum	—	S1 / SU19R (56.
	1130	sc30914	SSU		Undefined	552		Diderma	europaeum	—	S1 / SU19R (56.
	1129	sc30902	SSU		Undefined	552		Diderma	europaeum	—	S1 / SU19R (56.
	1128	sc30899	SSU		Undefined	552		Diderma	europaeum	—	S1 / SU19R (56.
	1127	sc30894	SSU		Undefined	552		Diderma	europaeum	—	S1 / SU19R (56.
	1126	sc30932	SSU		Undefined	552		Diderma	europaeum	—	S1 / SU19R (56.
	1125	sc30945	SSU		Undefined	552		Diderma	europaeum	—	S1 / SU19R (56.
	389	Sc30012	SSU	Excellent	Undefined	546		Meriderma		—	S1 / SU19R (56.
	388	Sc30000	SSU	Excellent	Undefined	546		Meriderma		—	S1 / SU19R (56.
	374	Sc30022	SSU	Excellent	Yes	557		Mucilago	crustacea	—	S1 / SU19R (56.
	372	Sc30018	SSU	Excellent	Yes	553		Diderma	microcarpum	—	S1 / SU19R (56.
	369	Sc30014	SSU	Excellent	Yes	545		Diderma	alpinum	—	S1 / SU19R (56.
	367	Sc30011	SSU	Excellent	Yes	553		Diderma	microcarpum	—	S1 / SU19R (56.
	364	Sc30008	SSU	Excellent	Yes	553		Diderma	microcarpum	—	S1 / SU19R (56.
	363	Sc30007	SSU	Excellent	Yes	553		Diderma	microcarpum	—	S1 / SU19R (56.
	362	Sc30006	SSU	Excellent	Yes	552		Diderma	niveum	—	S1 / SU19R (56.
	359	Sc30002	SSU	Excellent	Yes	545		Diderma	alpinum	—	S1 / SU19R (56.
	177	Sc30802	SSU	Excellent	Yes	546		Lamproderma	ovoideum	—	S1 / SU19R (56.
	47	Sc30832	SSU	Excellent	Yes	555		Diderma	europaeum	—	S1 / SU19R (56.
	46	Sc30817	SSU	Excellent	Yes	555		Diderma	europaeum	—	S1 / SU19R (56.

Side panel: filtering

You can activate **regular expressions** – more powerful pattern system

. – any non-empty symbol
+ – previous symbol should appear at least once
***** – any number of previous symbol including zero
? – previous symbol should appear zero or one time
{n} – previous symbol should appear exactly n times
^ - beginning of the line
\n – end of the line
\w – any letter
\d – any digit
\t – tabulation
[] – same meaning as in Glob
…etc.

Side panel: filtering

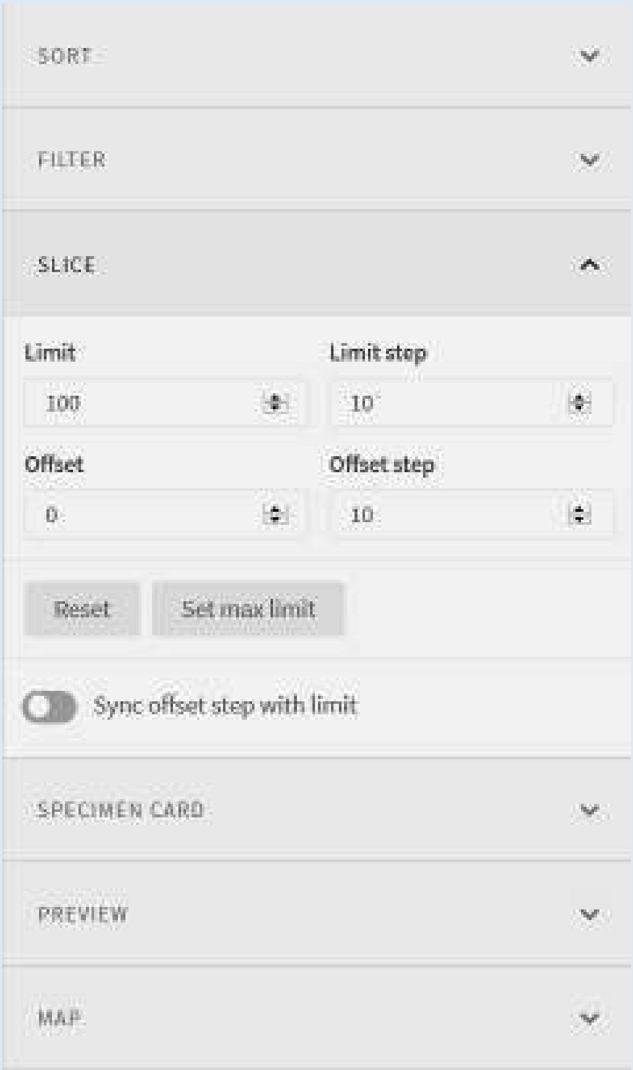


Side panel: navigation ("Slice")

Right now not so user-friendly, but we are working on changing it…

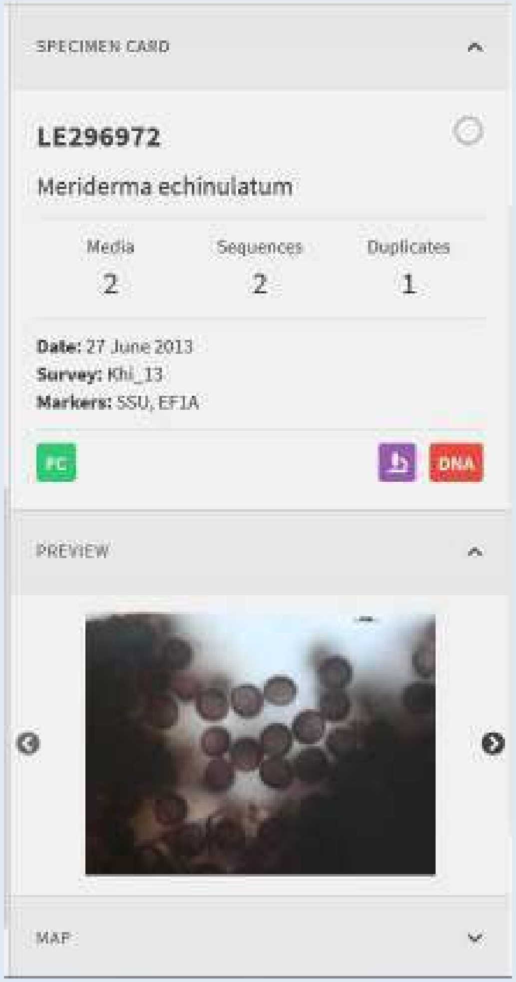
- By default – only 100 records shown at a time. Change **Limit** to see more.

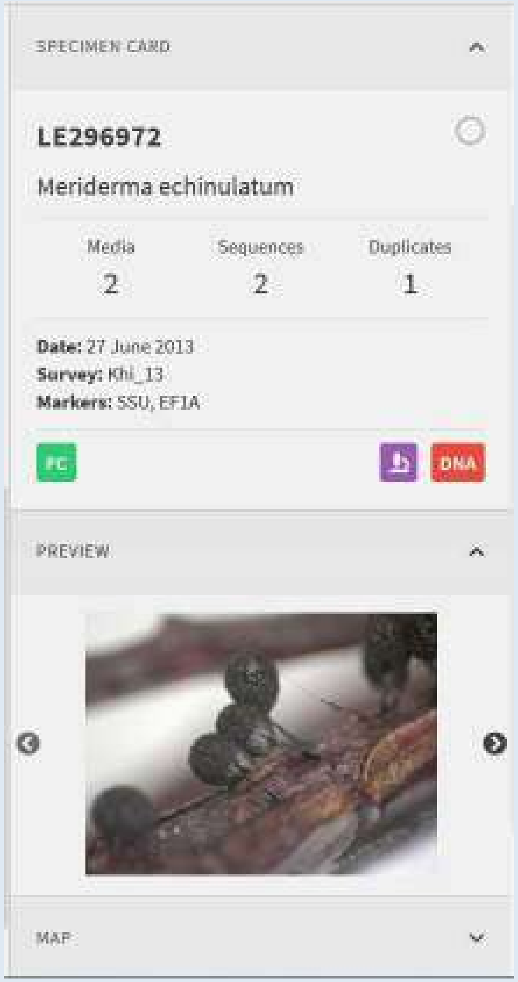
- Choose **Offset step** (e.g. 100), click up or down in **Offset** field – and you will navigate through the records seeing the next or previous 100 records.



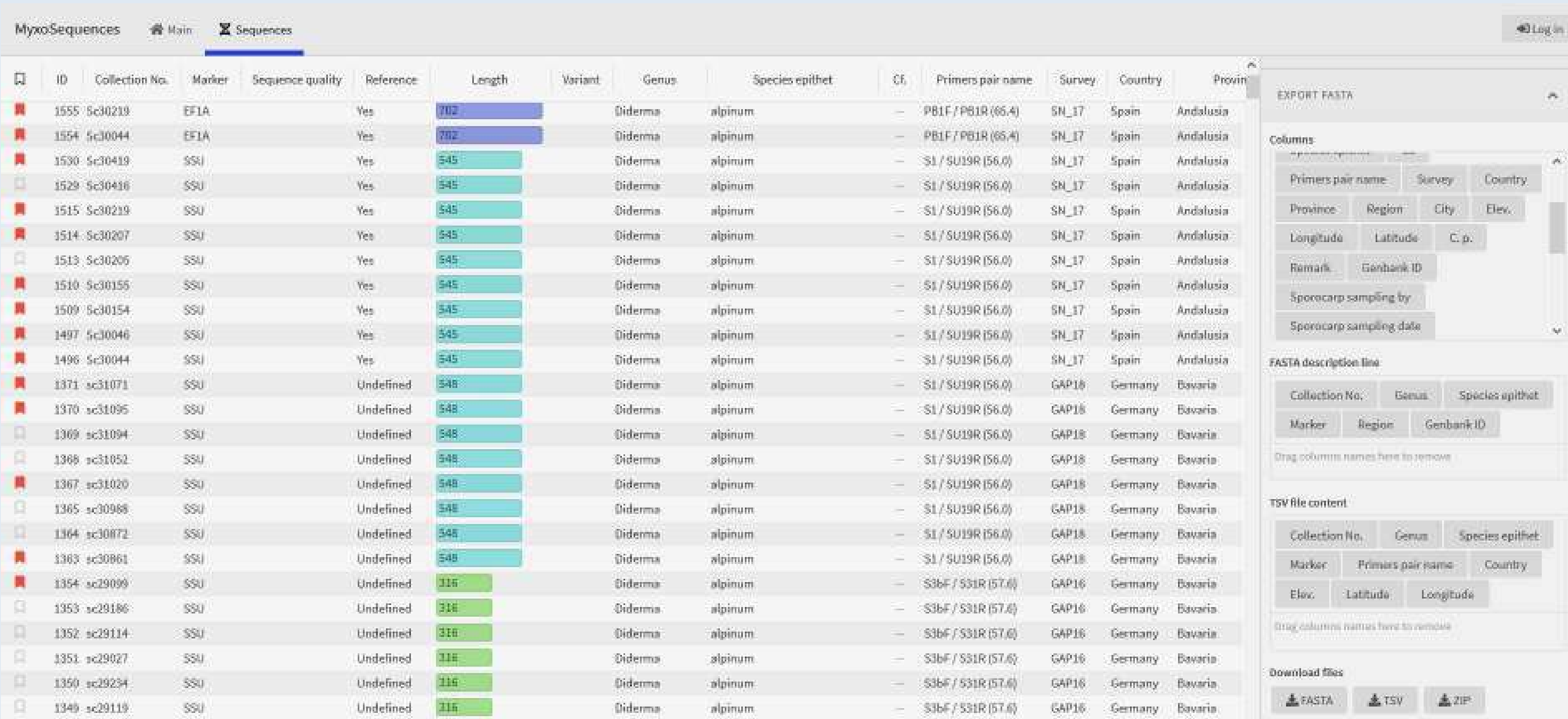
Side panel: map

Side panel: specimen card and image preview



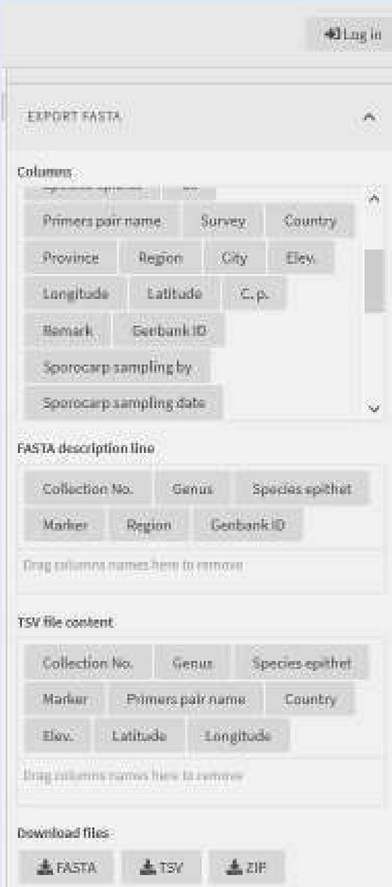


Side panel: export



ID	Collection No.	Marker	Sequence quality	Reference	Length	Variant	Genus	Species epithet	Cf.	Primers pair name	Survey	Country	Provin
1555	Sc30219	EF1A		Yes	702		Diderma	alpinum	—	PB1F / PB1R (65.4)	SN_17	Spain	Andalusia
1554	Sc30044	EF1A		Yes	702		Diderma	alpinum	—	PB1F / PB1R (65.4)	SN_17	Spain	Andalusia
1530	Sc30419	SSU		Yes	545		Diderma	alpinum	—	S1 / SU19R (56.0)	SN_17	Spain	Andalusia
1529	Sc30416	SSU		Yes	545		Diderma	alpinum	—	S1 / SU19R (56.0)	SN_17	Spain	Andalusia
1515	Sc30219	SSU		Yes	545		Diderma	alpinum	—	S1 / SU19R (56.0)	SN_17	Spain	Andalusia
1514	Sc30207	SSU		Yes	545		Diderma	alpinum	—	S1 / SU19R (56.0)	SN_17	Spain	Andalusia
1513	Sc30206	SSU		Yes	545		Diderma	alpinum	—	S1 / SU19R (56.0)	SN_17	Spain	Andalusia
1510	Sc30155	SSU		Yes	545		Diderma	alpinum	—	S1 / SU19R (56.0)	SN_17	Spain	Andalusia
1509	Sc30154	SSU		Yes	545		Diderma	alpinum	—	S1 / SU19R (56.0)	SN_17	Spain	Andalusia
1497	Sc30046	SSU		Yes	545		Diderma	alpinum	—	S1 / SU19R (56.0)	SN_17	Spain	Andalusia
1496	Sc30044	SSU		Yes	545		Diderma	alpinum	—	S1 / SU19R (56.0)	SN_17	Spain	Andalusia
1371	sc31071	SSU		Undefined	548		Diderma	alpinum	—	S1 / SU19R (56.0)	GAP18	Germany	Bavaria
1370	sc31095	SSU		Undefined	548		Diderma	alpinum	—	S1 / SU19R (56.0)	GAP18	Germany	Bavaria
1369	sc31094	SSU		Undefined	548		Diderma	alpinum	—	S1 / SU19R (56.0)	GAP18	Germany	Bavaria
1368	sc31052	SSU		Undefined	548		Diderma	alpinum	—	S1 / SU19R (56.0)	GAP18	Germany	Bavaria
1367	sc31020	SSU		Undefined	548		Diderma	alpinum	—	S1 / SU19R (56.0)	GAP18	Germany	Bavaria
1365	sc30988	SSU		Undefined	548		Diderma	alpinum	—	S1 / SU19R (56.0)	GAP18	Germany	Bavaria
1364	sc30872	SSU		Undefined	548		Diderma	alpinum	—	S1 / SU19R (56.0)	GAP18	Germany	Bavaria
1363	sc30861	SSU		Undefined	548		Diderma	alpinum	—	S1 / SU19R (56.0)	GAP18	Germany	Bavaria
1354	sc29099	SSU		Undefined	316		Diderma	alpinum	—	S3bF / S31R (57.6)	GAP16	Germany	Bavaria
1353	sc29186	SSU		Undefined	316		Diderma	alpinum	—	S3bF / S31R (57.6)	GAP16	Germany	Bavaria
1352	sc29114	SSU		Undefined	316		Diderma	alpinum	—	S3bF / S31R (57.6)	GAP16	Germany	Bavaria
1351	sc29027	SSU		Undefined	316		Diderma	alpinum	—	S3bF / S31R (57.6)	GAP16	Germany	Bavaria
1350	sc29234	SSU		Undefined	316		Diderma	alpinum	—	S3bF / S31R (57.6)	GAP16	Germany	Bavaria
1349	sc29119	SSU		Undefined	316		Diderma	alpinum	—	S3bF / S31R (57.6)	GAP16	Germany	Bavaria

Side panel: export

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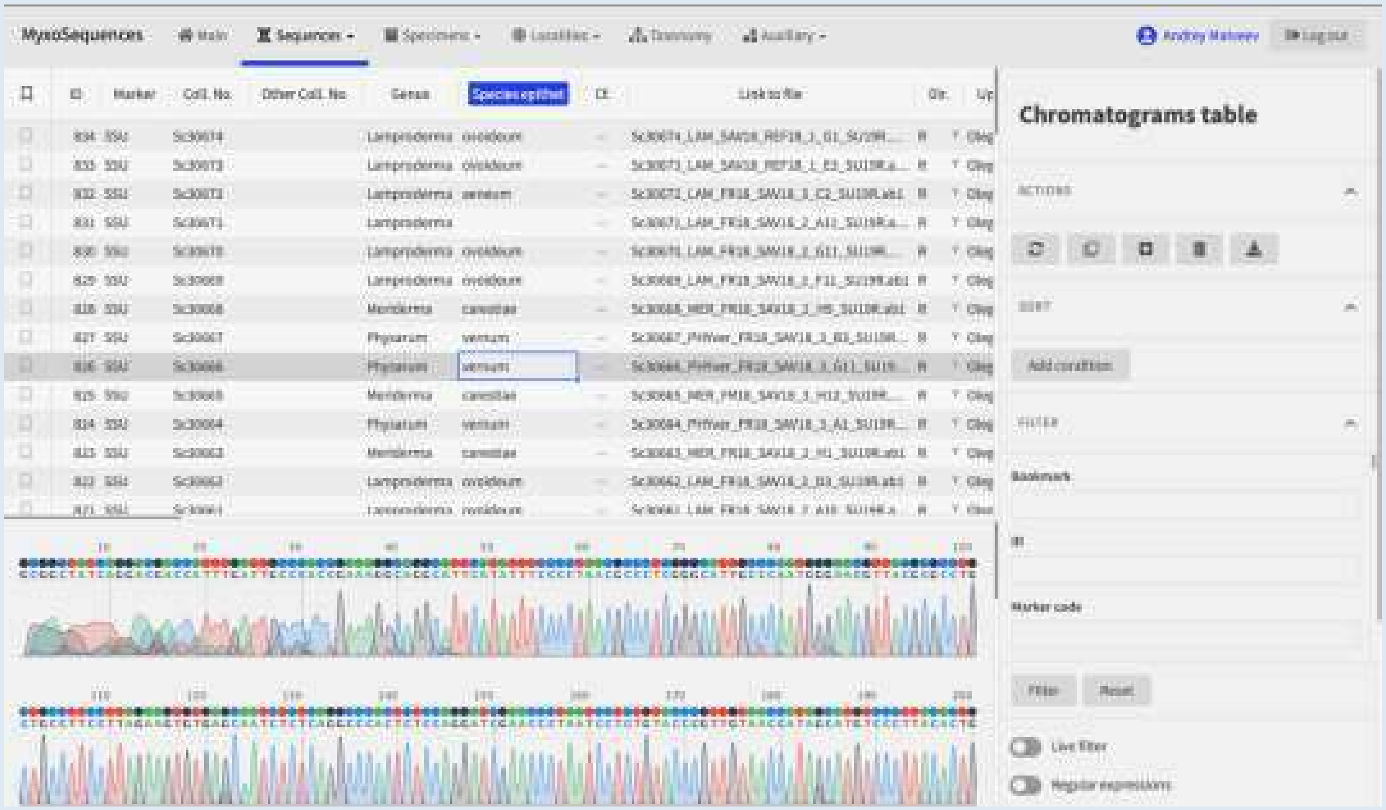
sc30044 Diderma alpinum EF1A Sierra Nevada MN596920          GTTACGACGAAATCGTGAAGGAGACTTCATCTTTCGTTAAGAA
sc30419 Diderma alpinum SSU Sierra Nevada MN595497           CCAGTAGTGTATGCTTCTCCTAAAGACTAAGCCATGCATGCCT
sc30219 Diderma alpinum SSU Sierra Nevada MN595482           CCAGTAGTGTATGCTTCTCCTAAAGACTAAGCCATGCATGCCT
sc30207 Diderma alpinum SSU Sierra Nevada MN595481           CCAGTAGTGTATGCTTCTCCTAAAGACTAAGCCATGCATGCCT
sc30155 Diderma alpinum SSU Sierra Nevada MN595477           CCAGTAGTGTATGCTTCTCCTAAAGACTAAGCCATGCATGCCT
sc30154 Diderma alpinum SSU Sierra Nevada MN595476           CCAGTAGTGTATGCTTCTCCTAAAGACTAAGCCATGCATGCCT
sc30046 Diderma alpinum SSU Sierra Nevada MN595464           CCAGTAGTGTATGCTTCTCCTAAAGACTAAGCCATGCATGCCT
sc30044 Diderma alpinum SSU Sierra Nevada MN595463           CCAGTAGTGTATGCTTCTCCTAAAGACTAAGCCATGCATGCCT
sc31071 Diderma alpinum SSU Wettersteingebirge MN595595      CTGCCAGTAGTGTATGCTTCTCCTAAAGACTAAGCCATGCATG
sc31095 Diderma alpinum SSU Wettersteingebirge MN595605      CTGCCAGTAGTGTATGCTTCTCCTAAAGACTAAGCCATGCATG
sc31020 Diderma alpinum SSU Wettersteingebirge MN595584      CTGCCAGTAGTGTATGCTTCTCCTAAAGACTAAGCCATGCATG
sc30861 Diderma alpinum SSU Wettersteingebirge MN595548      CTGCCAGTAGTGTATGCTTCTCCTAAAGACTAAGCCATGCATG
sc29099_Diderma_alpinum_SSU_Wettersteingebirge_MN595332      TCTGAATCTGCGAACGGCTCCGCAAACCAGTTGTAAACTATAG
```

main_colno	genus	spec_epithet	code	pair_name	country	elev	lat	lon
sc30219	Diderma	alpinum	EF1A	PB1F / PB1R (65.4)	Spain	2459	37.026306	-3.323194
sc30044	Diderma	alpinum	EF1A	PB1F / PB1R (65.4)	Spain	2420	37.022472	-3.322278
sc30419	Diderma	alpinum	SSU	S1 / SU19R (56.0)	Spain	2400	37.006861	-3.293361
sc30219	Diderma	alpinum	SSU	S1 / SU19R (56.0)	Spain	2459	37.026306	-3.323194
sc30207	Diderma	alpinum	SSU	S1 / SU19R (56.0)	Spain	2459	37.026306	-3.323194
sc30155	Diderma	alpinum	SSU	S1 / SU19R (56.0)	Spain	2171	36.999472	-3.328611
sc30154	Diderma	alpinum	SSU	S1 / SU19R (56.0)	Spain	2296	37.000944	-3.324611
sc30046	Diderma	alpinum	SSU	S1 / SU19R (56.0)	Spain	2420	37.022472	-3.322278
sc30044	Diderma	alpinum	SSU	S1 / SU19R (56.0)	Spain	2420	37.022472	-3.322278
sc31071	Diderma	alpinum	SSU	S1 / SU19R (56.0)	Germany	1682	47.452400	11.080300
sc31095	Diderma	alpinum	SSU	S1 / SU19R (56.0)	Germany	1577	47.454500	11.079600
sc31020	Diderma	alpinum	SSU	S1 / SU19R (56.0)	Germany	1871	47.443600	11.056800
sc30861	Diderma	alpinum	SSU	S1 / SU19R (56.0)	Germany	1467	47.456600	11.078300
sc29099	Diderma	alpinum	SSU	S3bF / S31R (57.6)	Germany	1650	47.446083	11.062778

Side panel: chromatogram preview and export

Not yet available for the end users



dna.myxomycetes.org

- Main functions are working
- Still some bugs appear
- Ca. 10% of the existing data (at best) are uploaded – this is an ongoing work
- Fully functional online system will be announced with a publication


Thank you for your attention!

Automated image analysis in determining the spore size of dark-spored myxomycetes

Jan Woyzichovski [a], Oleg Shchepin [a, b], Nikki H.A. Dagamac [a], Yuri K. Novozhilov [b], Martin Schnittler [a]

[a] General Botany and Plant Systematics, Institute of Botany and Landscape Ecology, University Greifswald, Soldmannstr. 15, Greifswald 17487, Germany

[b] Laboratory of Systematics and Geography of Fungi, Komarov Botanical Institute of the Russian Academy of Sciences, Prof. Popov Str. 2, St. Petersburg 197376, Russia

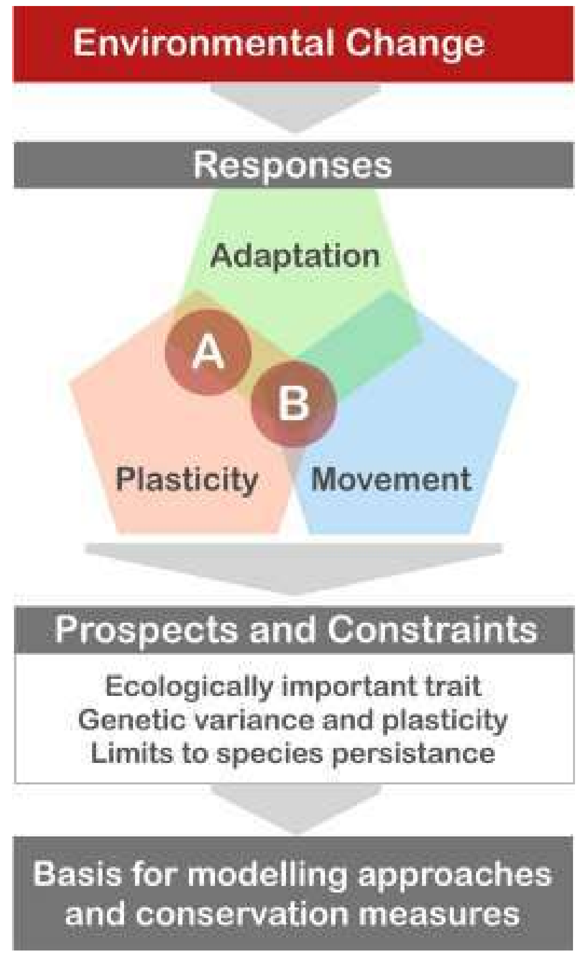
Gefördert durch DFG Deutsche Forschungsgemeinschaft

What is RESPONSE?

…Research Training Group (RTG 2010) "Biological RESPONSEs to Novel and Changing Environments"

…focuses on the plastic and genetic capacities for in situ responses (A) and on the factors limiting or facilitating dispersal to new habitats (B).

The RTG aims at deepening our understanding of the limits to population persistence, enabling more accurate predictions regarding the fate of populations under changing conditions.



Dispersal in myxomycetes?

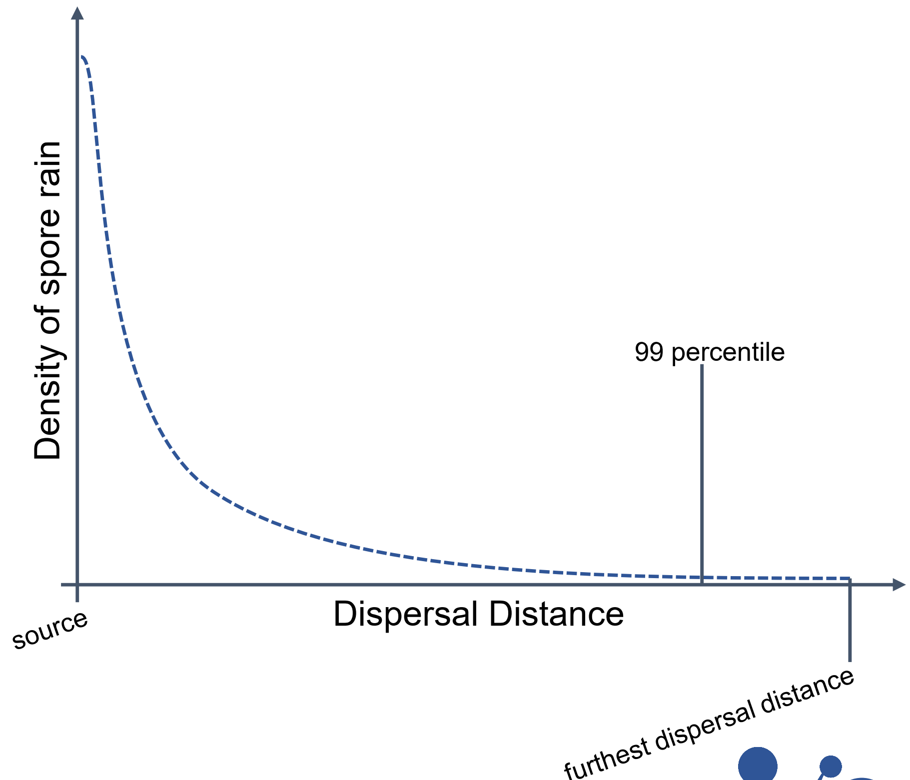
Short distance: - motility
- splitting up: diploid myxoamoeba and plasmodium

Long distance: - airborne spores
- hitchhiking

Success is determined by range and establishment efficiency

Spore size:
trade-off between dispersal range → smaller spores
and
establishment success → larger spores with more resources

Spore numbers *(nivicolous)* produced (dispersal efficiency)
0.8-1.2 Mio per sporocarp
10-1,000 sporocarps per colony



Dispersal in myxomycetes?

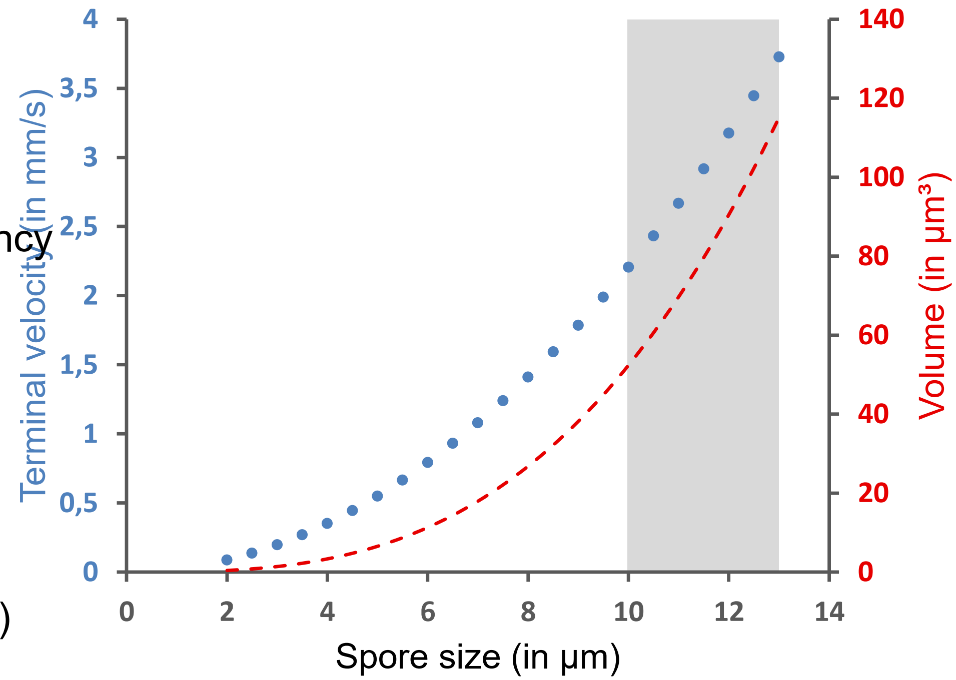
Short distance: - motility
- splitting up: diploid myxoamoeba and plasmodium

Long distance: - airborne spores
- hitchhiking

Success is determined by range and establishment efficiency

Spore size:
trade-off between dispersal range → smaller spores
and
establishment success → larger spores with more resources

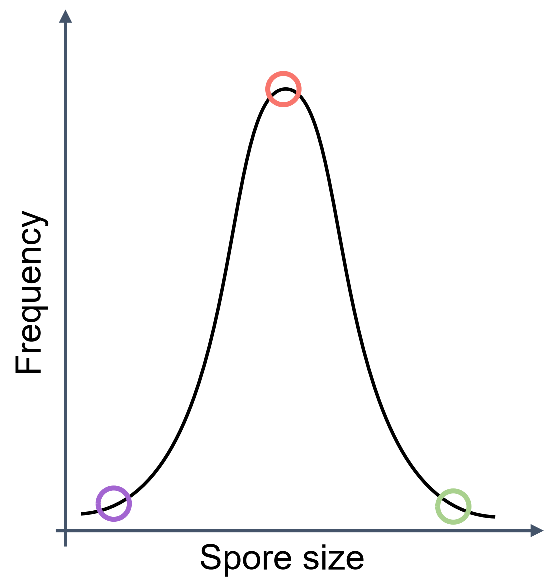
Spore numbers *(nivicolous)* produced (dispersal efficiency)
0.8-1.2 Mio per sporocarp
10-1,000 sporocarps per colony

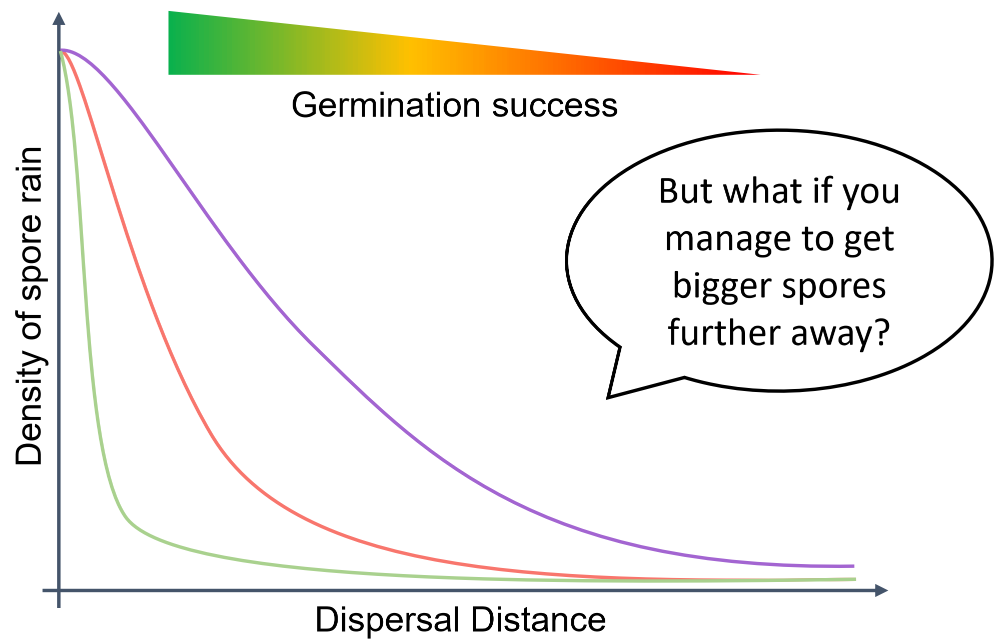


How would adaptation look like?

<u>Cooperation with Oleg Shchepin:</u>
Genetic investigation into *Ph. albescens* suggest at least 8 ribogroups

Different spore diameter / features depending on environment factors and genes

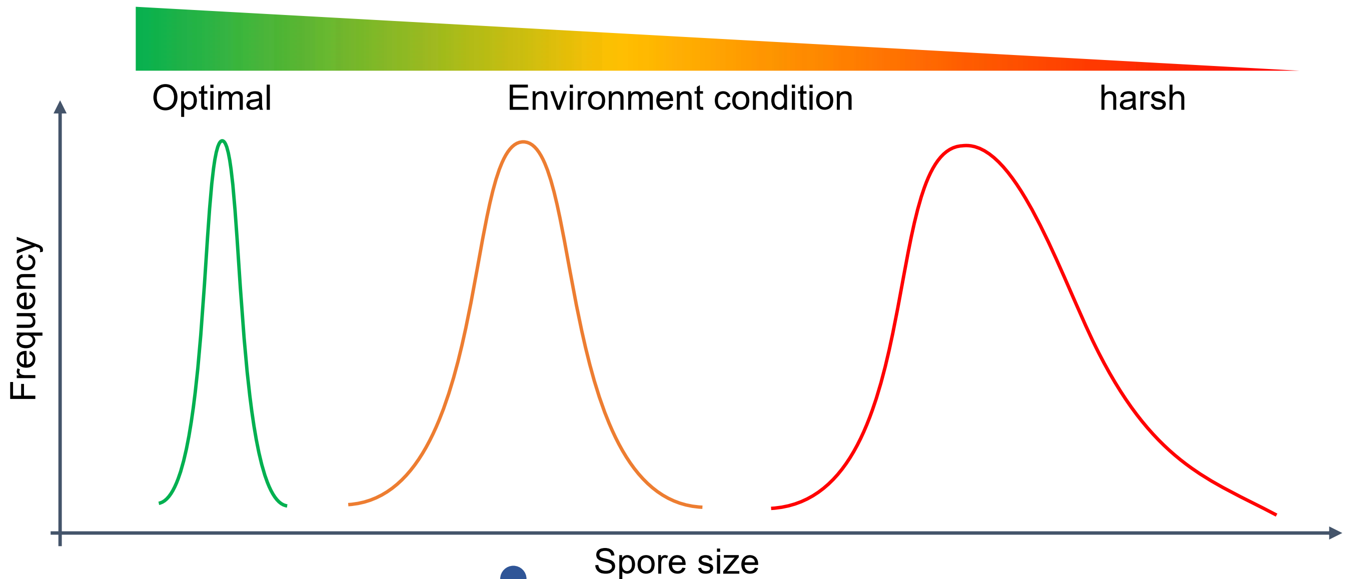




How would adaptation look like?

How many should we count and why so many?

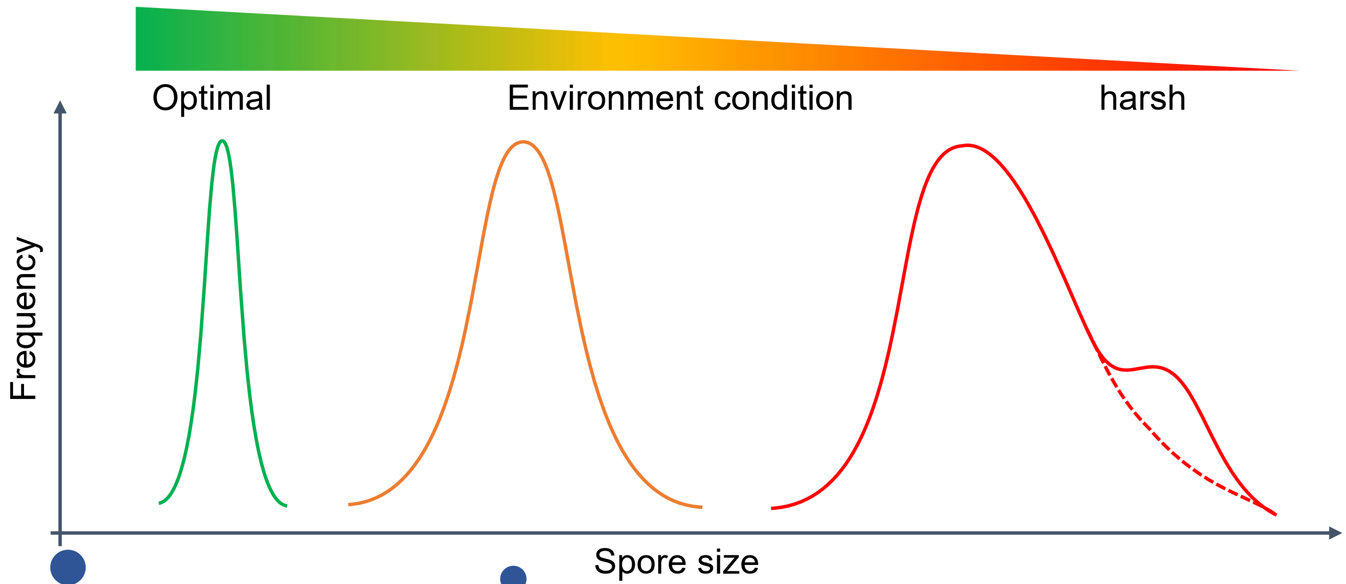
- Full count of one sporocarp ➡ total amount depends on resources
- Ratio between macro and "normal-sized" spores ➡ proxy for disturbed development



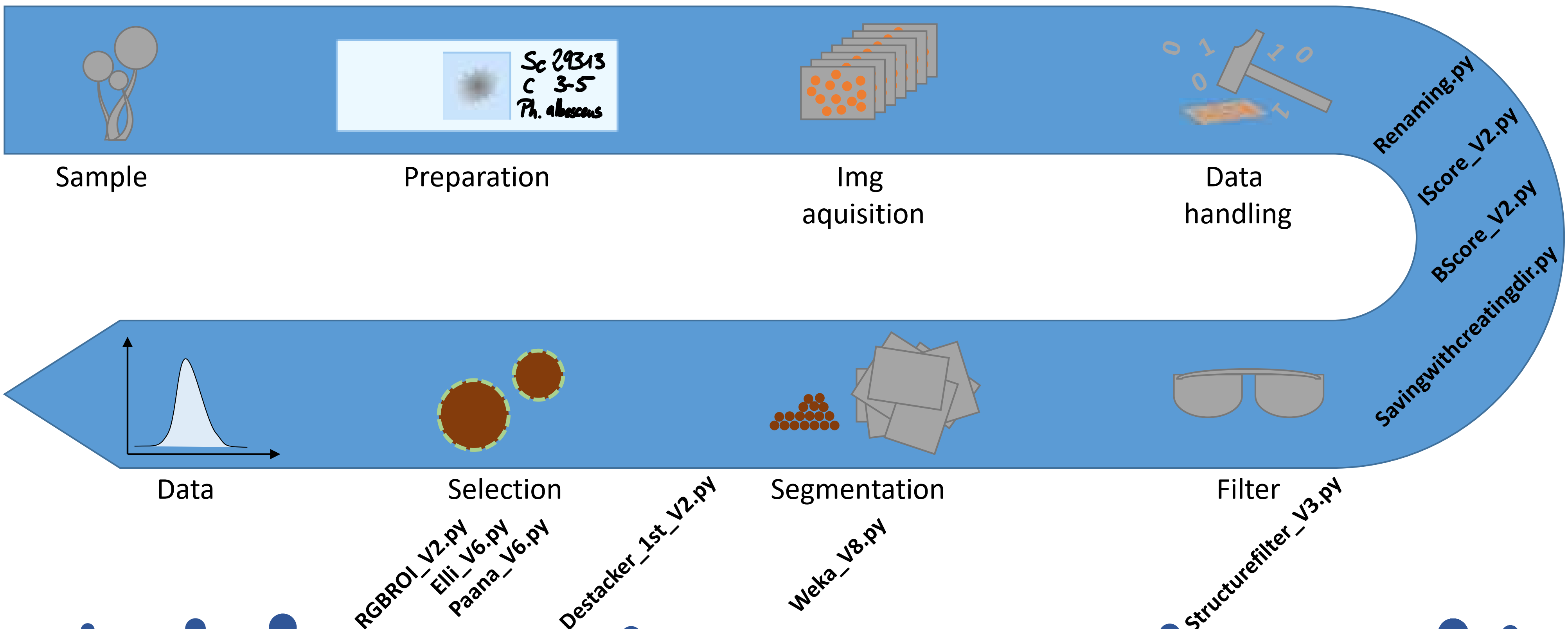
How would adaptation look like?

How many should we count and why so many?

- Full count of one sporocarp → total amount depends on resources
- Ratio between macro and “normal-sized” spores → proxy for disturbed development



Automated Imaging and Image analysis



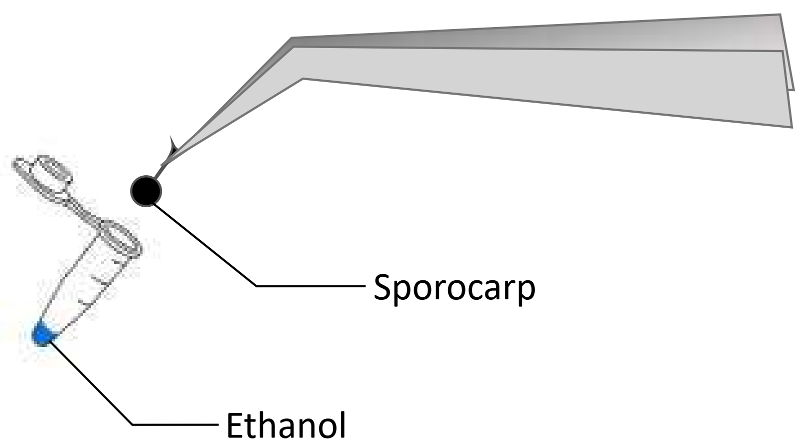
Automated Imaging and Image analysis

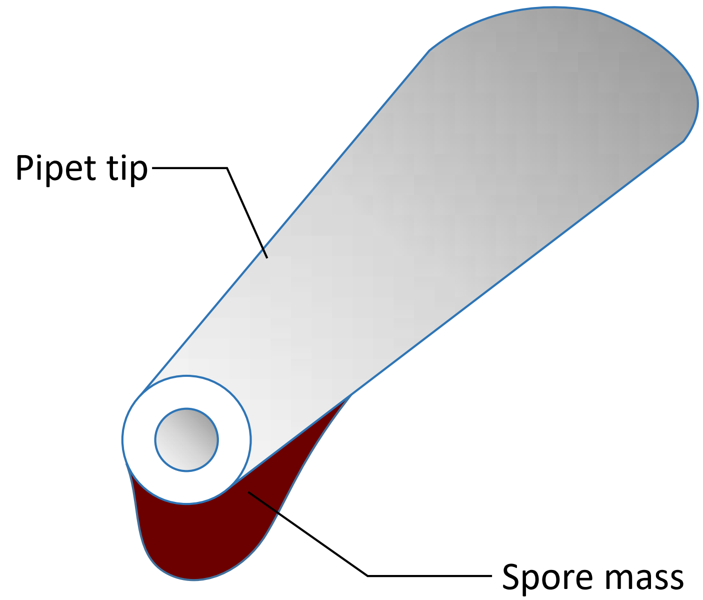
Requirements:
- Dark colored
- Round spheres

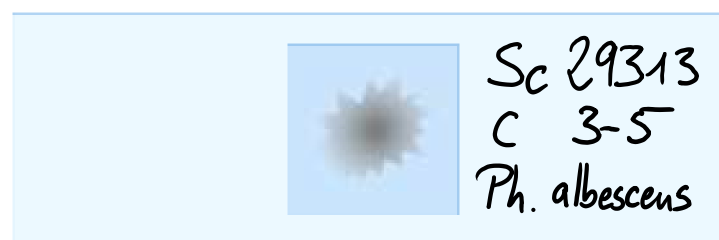
#	Accuring problems	consequence	solution
P1	Dirt particles	Measurements on wrong elements	• Screening • Feature value filter
P2	Time consuming, Inefficient	More data needs more time	Increase of spore density per mm²
P3	Weak contrast	Not correctly segmented	• Staining • Different contrast modi on microscope
P4	Not in focus	Wrong measurements	• Multi-layer focusing • Same z-layer
P5	„complex" particle	Wrong calculated area to volume	Coulter particle counter

Automated Imaging and Image analysis

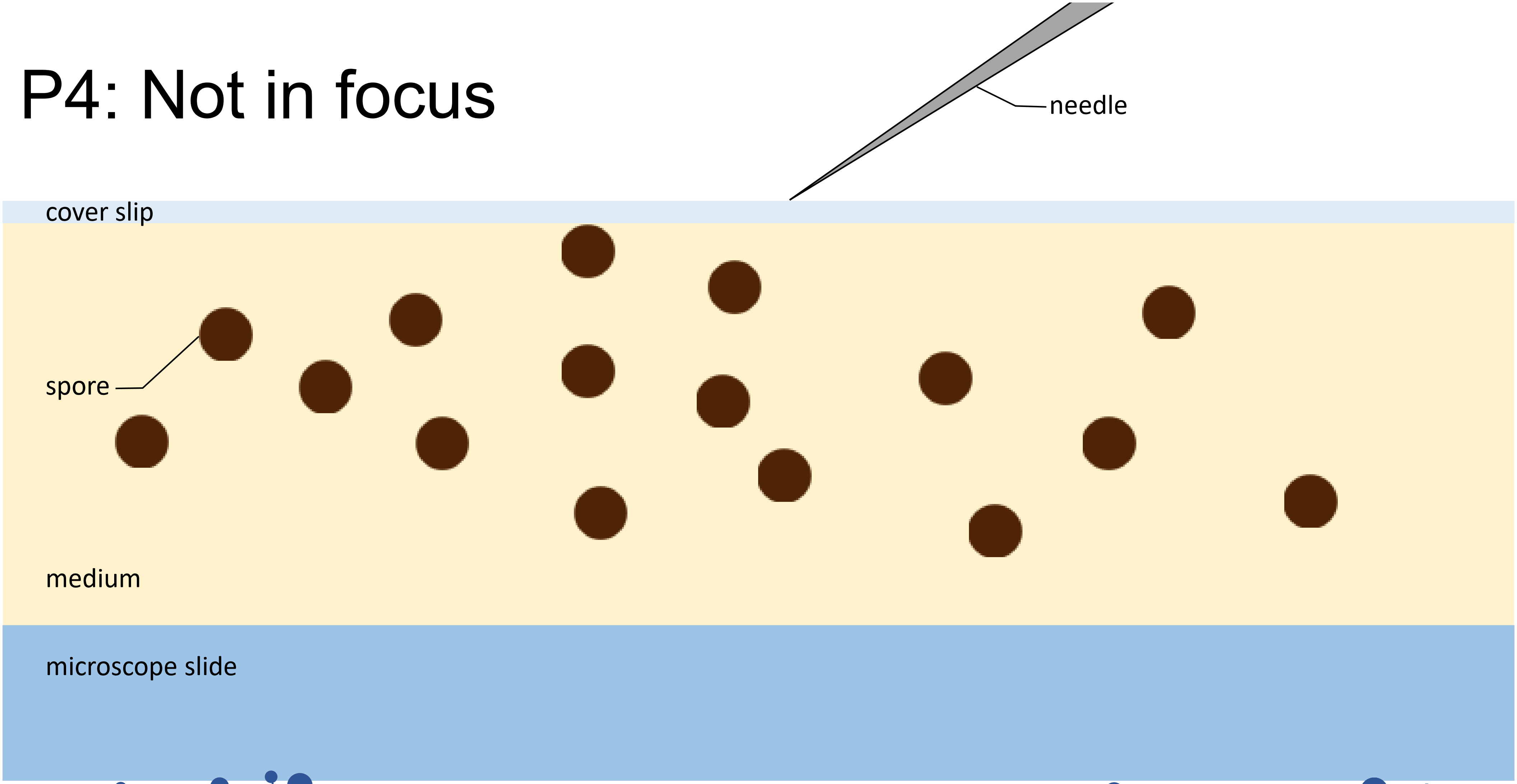
- To reduce dirt particles ➜ P1
- Increase spores per volume ➜ P2
- Staining to increase contrast ➜ P3



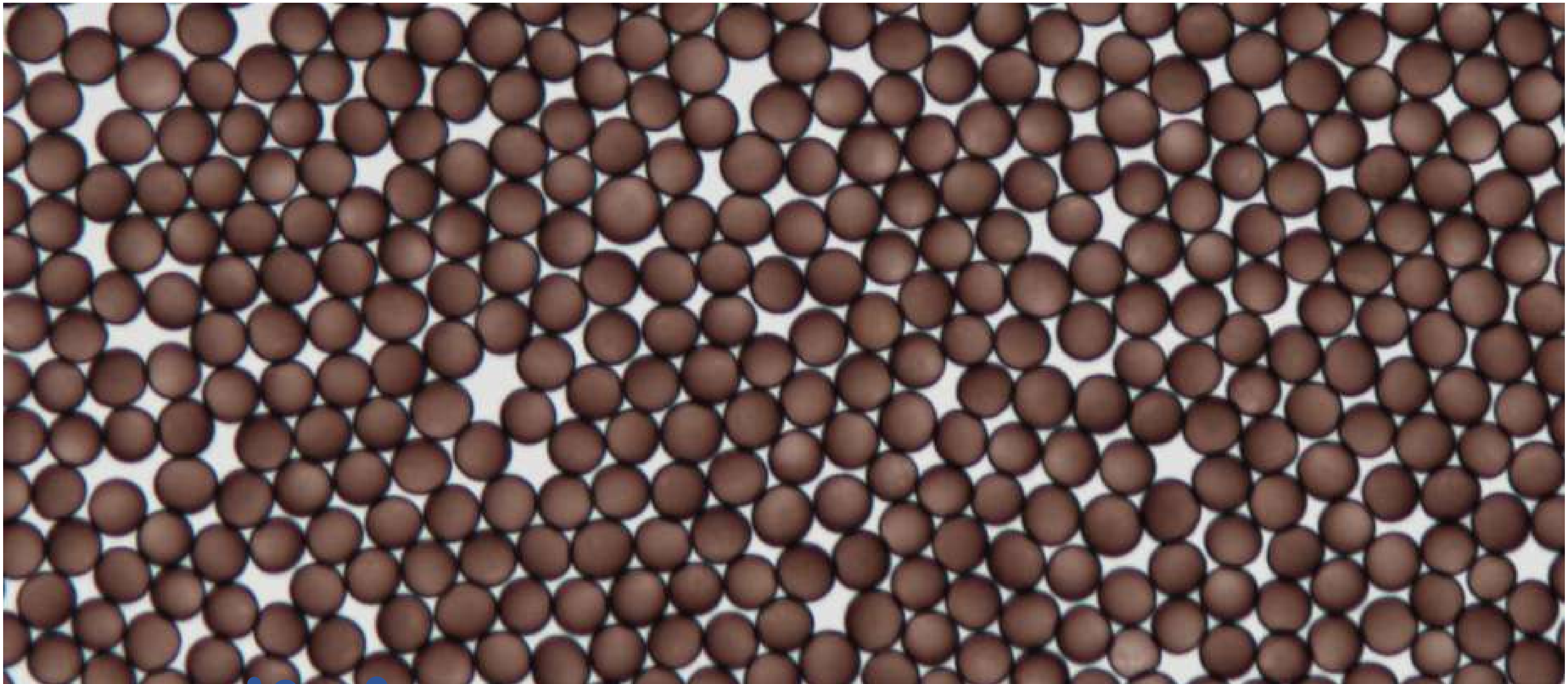




P4: Not in focus



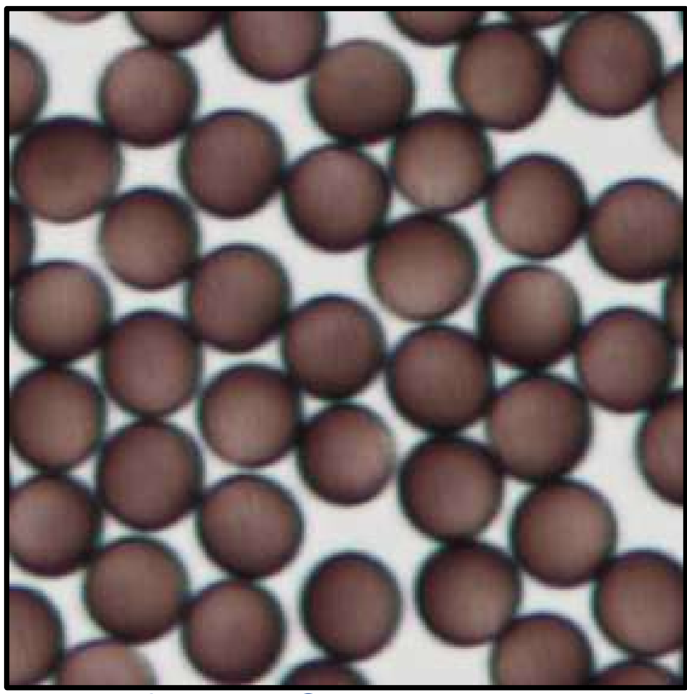
P4: Not in focus

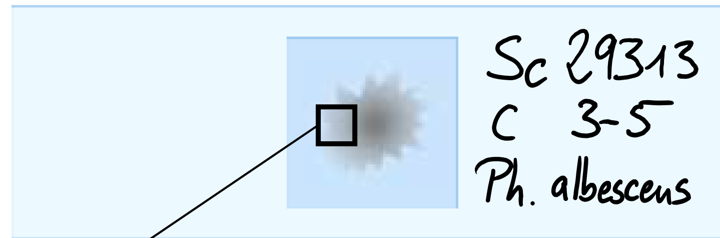


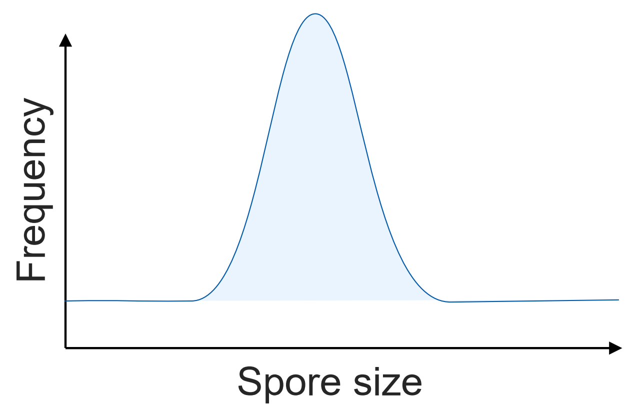
Automated Imaging and Image analysis

Semiautomatic measurement of spore size

- allows to measure up to 40,000 spores per sporocarp







Automated Imaging and Image analysis

#	Accuring problems	consequence	solution
P1	Dirt p…		…ening …ure value
P2	Time Ineffi…		…e of spore …per mm²
P3	Weak…		…ing …rent …rast modi …icroscope
P4	Not in focus	Wrong measurements	• Multi-layer focusing • Same z-layer
P5	„complex“ particle	Wrong calculated area to volume	Coulter particle counter

+

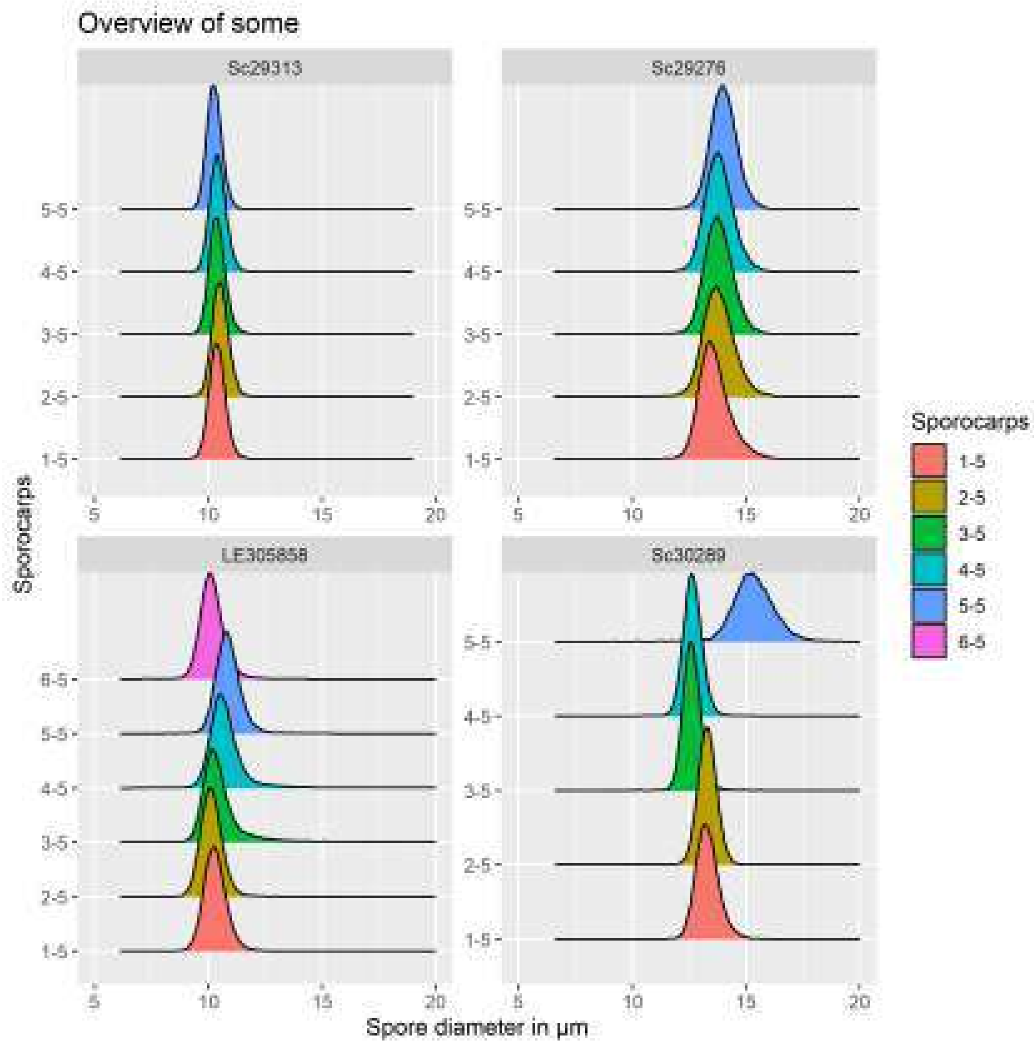
- Reproducible
- High resolution
- More feature extraction possible
- Minimal and uniform human bias

−

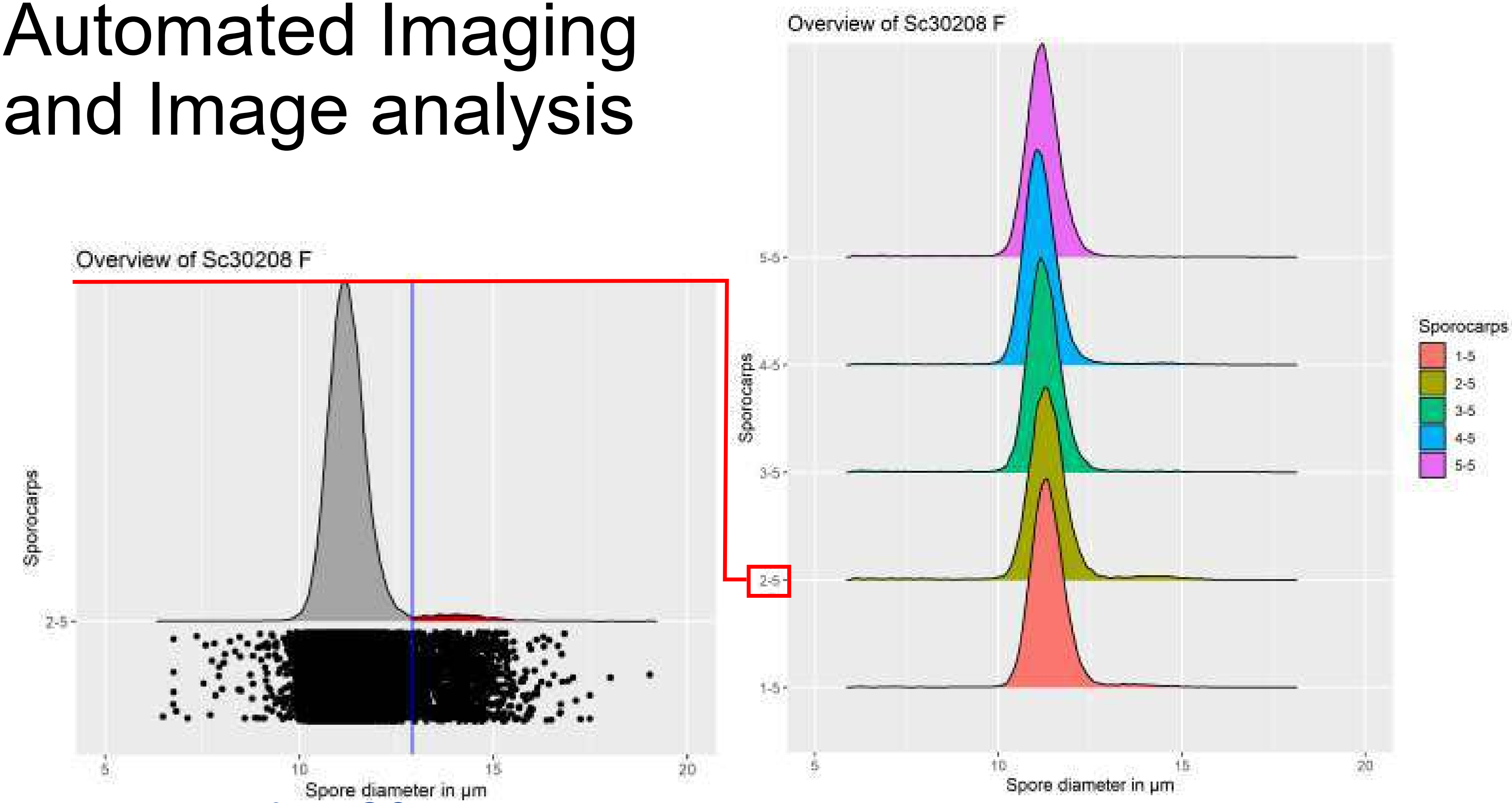
- Works best on “easy” predictable objects like spheres
- Needs high contrast

Automated Imaging and Image analysis

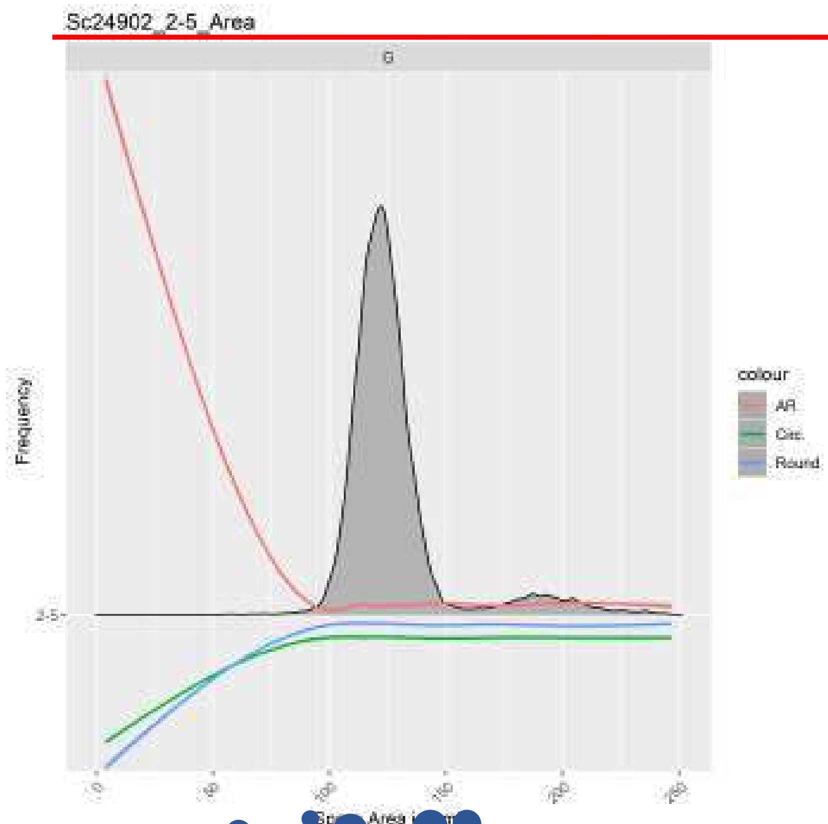
- per sample 5 sporocarps were measured
- per sporocarp 5.000 to 40.000 spores were analyzed

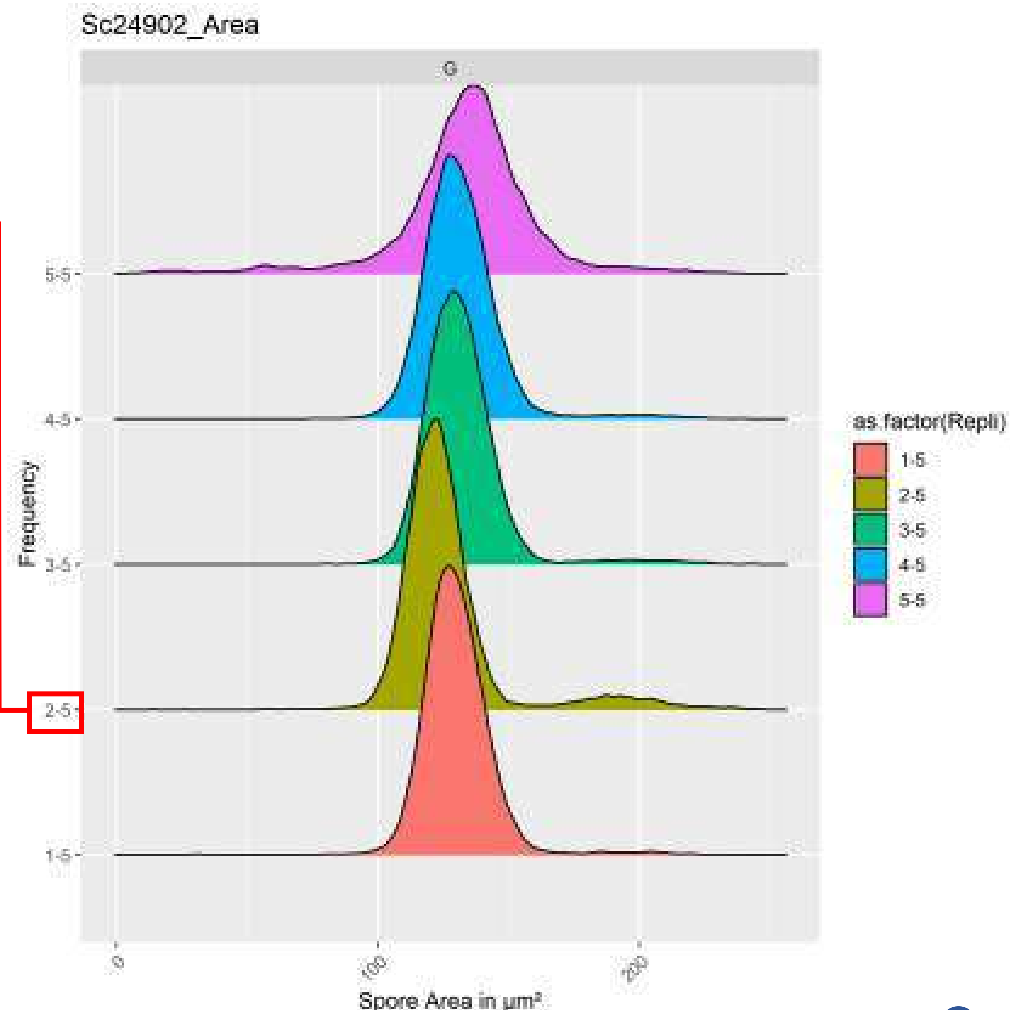


Automated Imaging and Image analysis

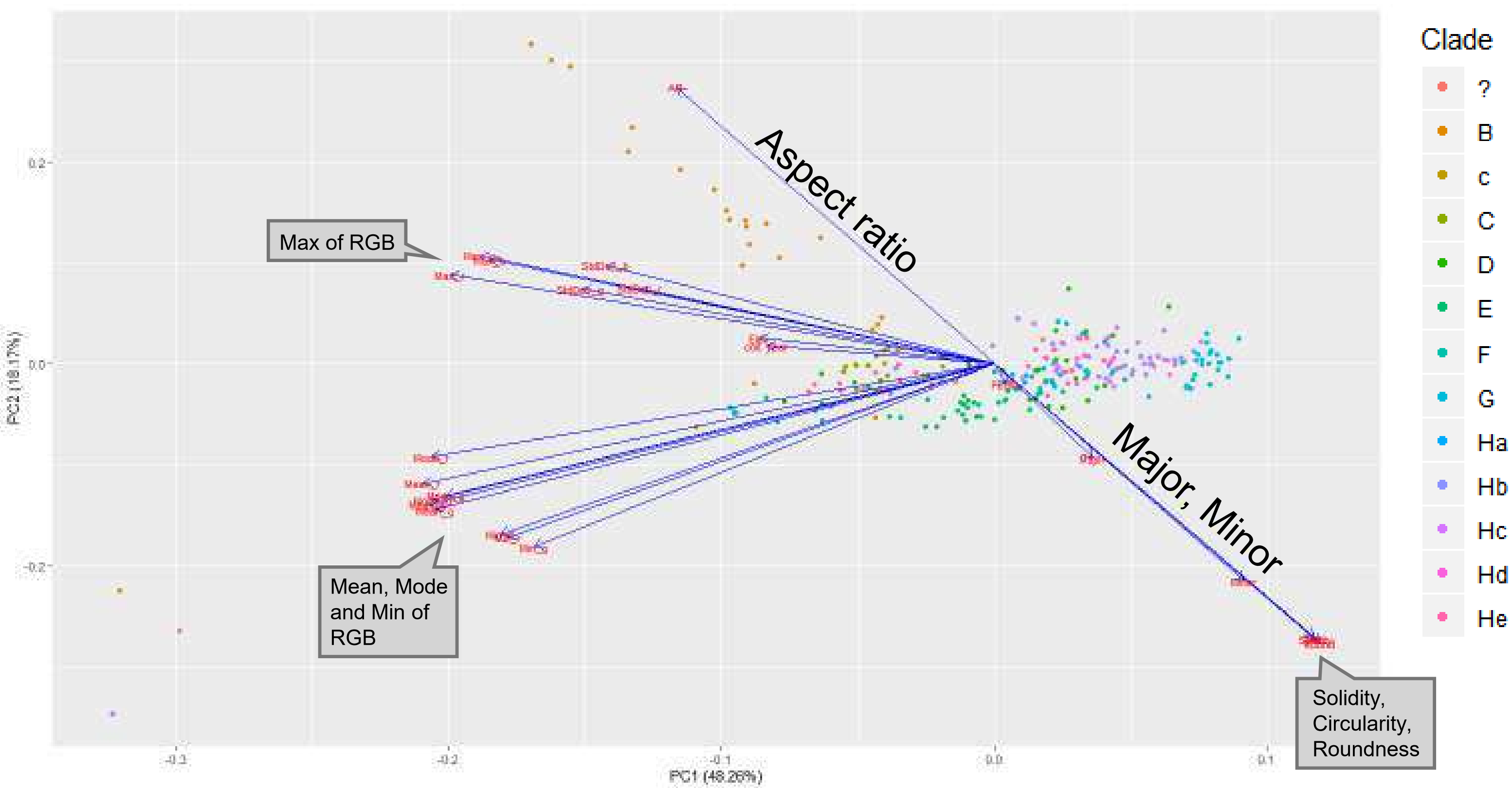


Automated Imaging and Image analysis

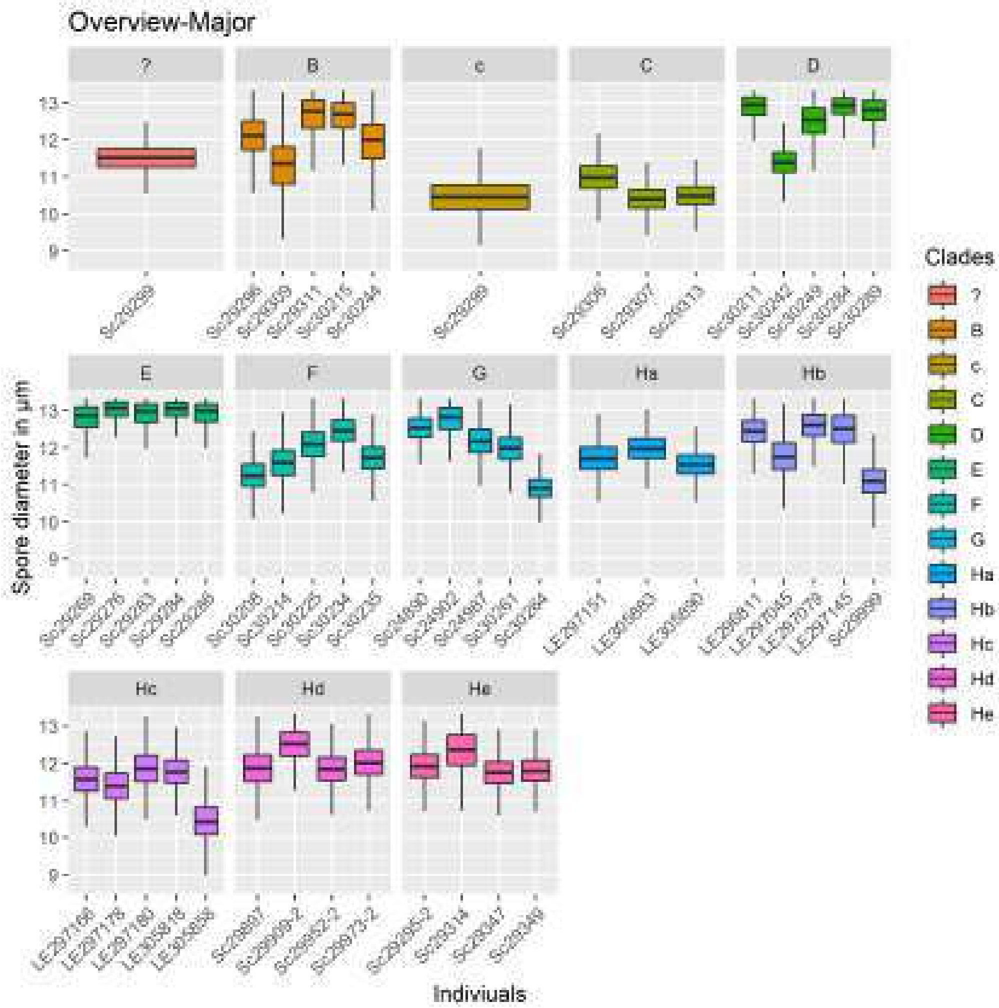




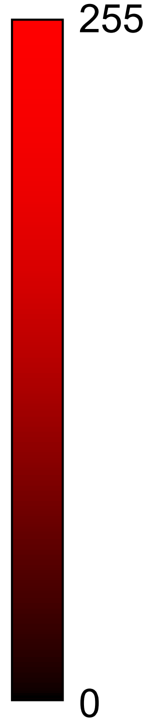
Automated Imaging and Image analysis

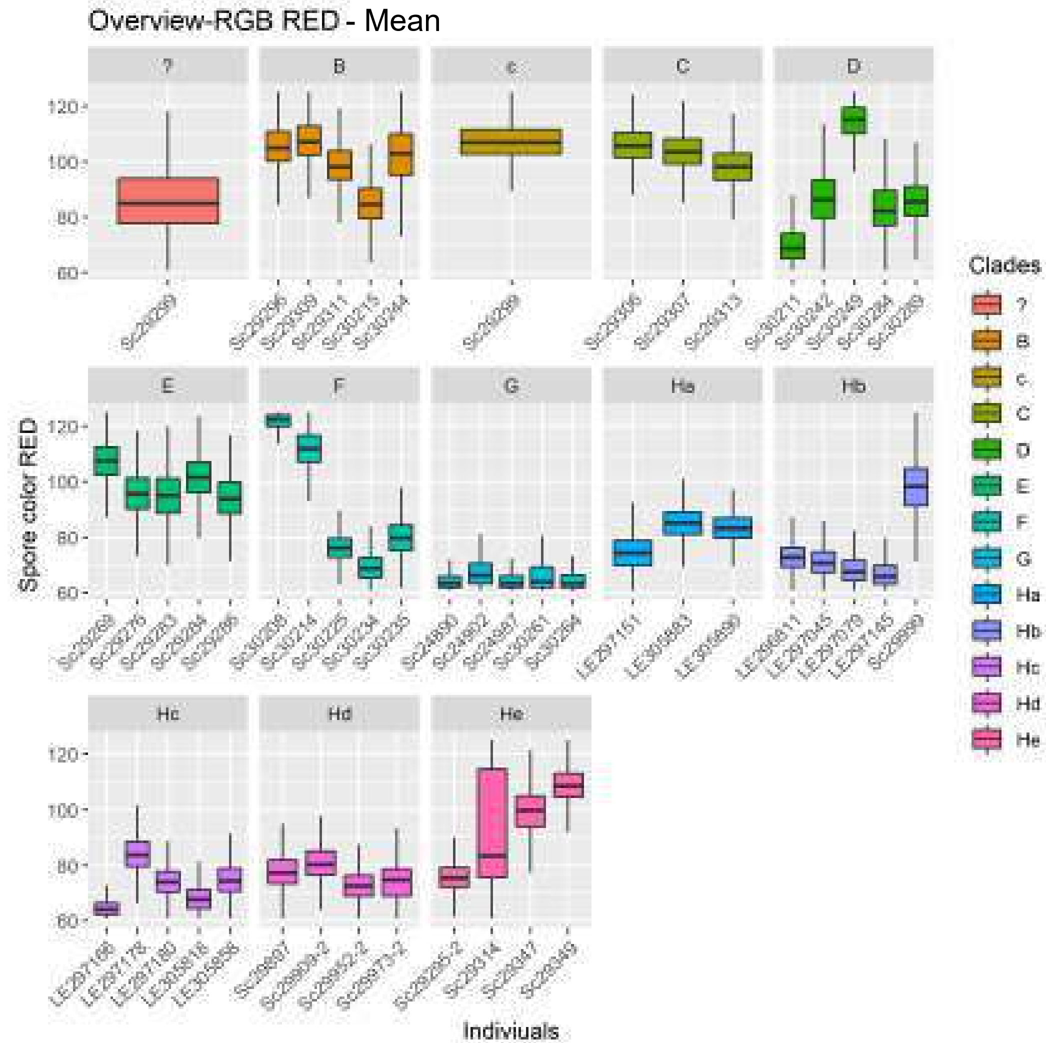


Automated Imaging and Image analysis



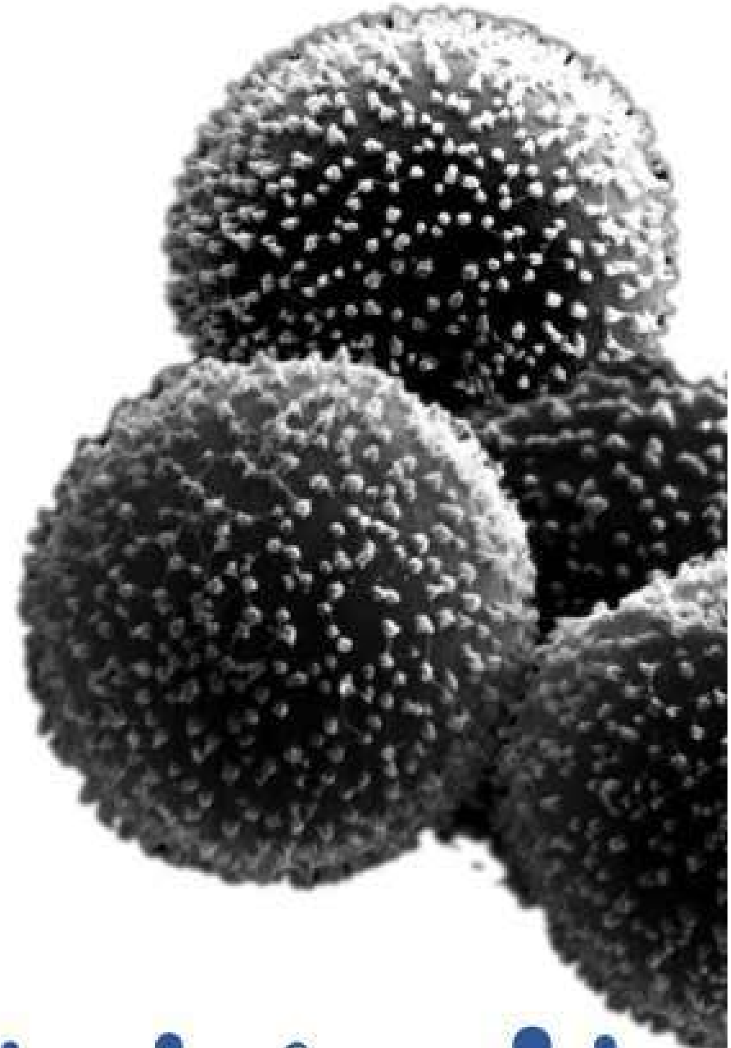
Automated Imaging and Image analysis





Take-home message

- Spore size is species specific
- …and is strong influenced from environmental factors
- Mass-spore measurements do matter!



Thank you for your attention!

https://imgs.xkcd.com/comics/beauty.png

Current and future investigations on the antagonistic activity of *Physarum* species on plant pathogenic fungi

ICSEM 10
Costa Rica

Johann Gangl

Marc Lemmens, Adrian Gack, Myriam de Haan

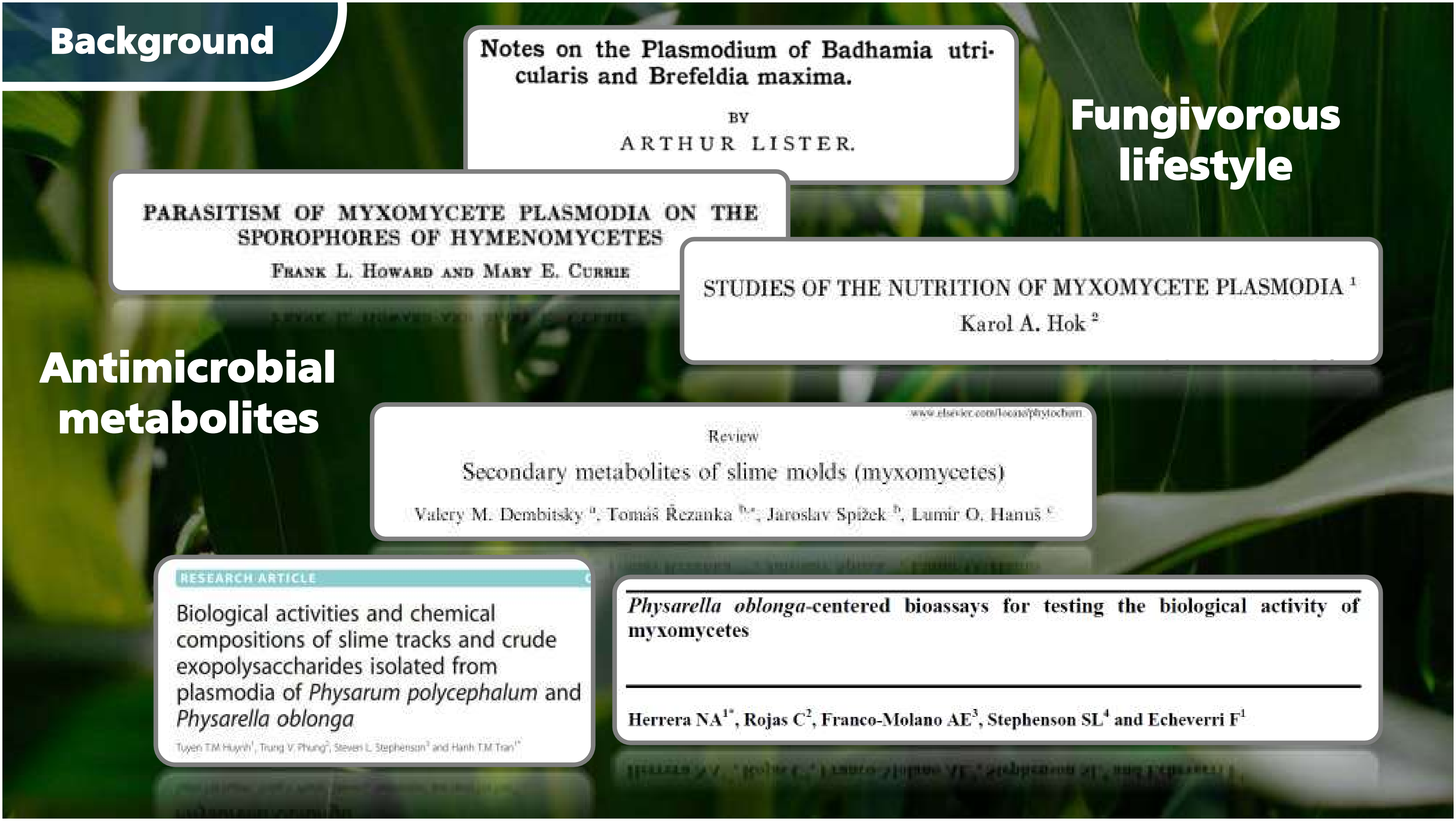
University of Natural Resources and Life Sciences Vienna
Institut of Biotechnology in Plant Production IFA Tulln
Meise Botanic Garden, Research Department, Belgium

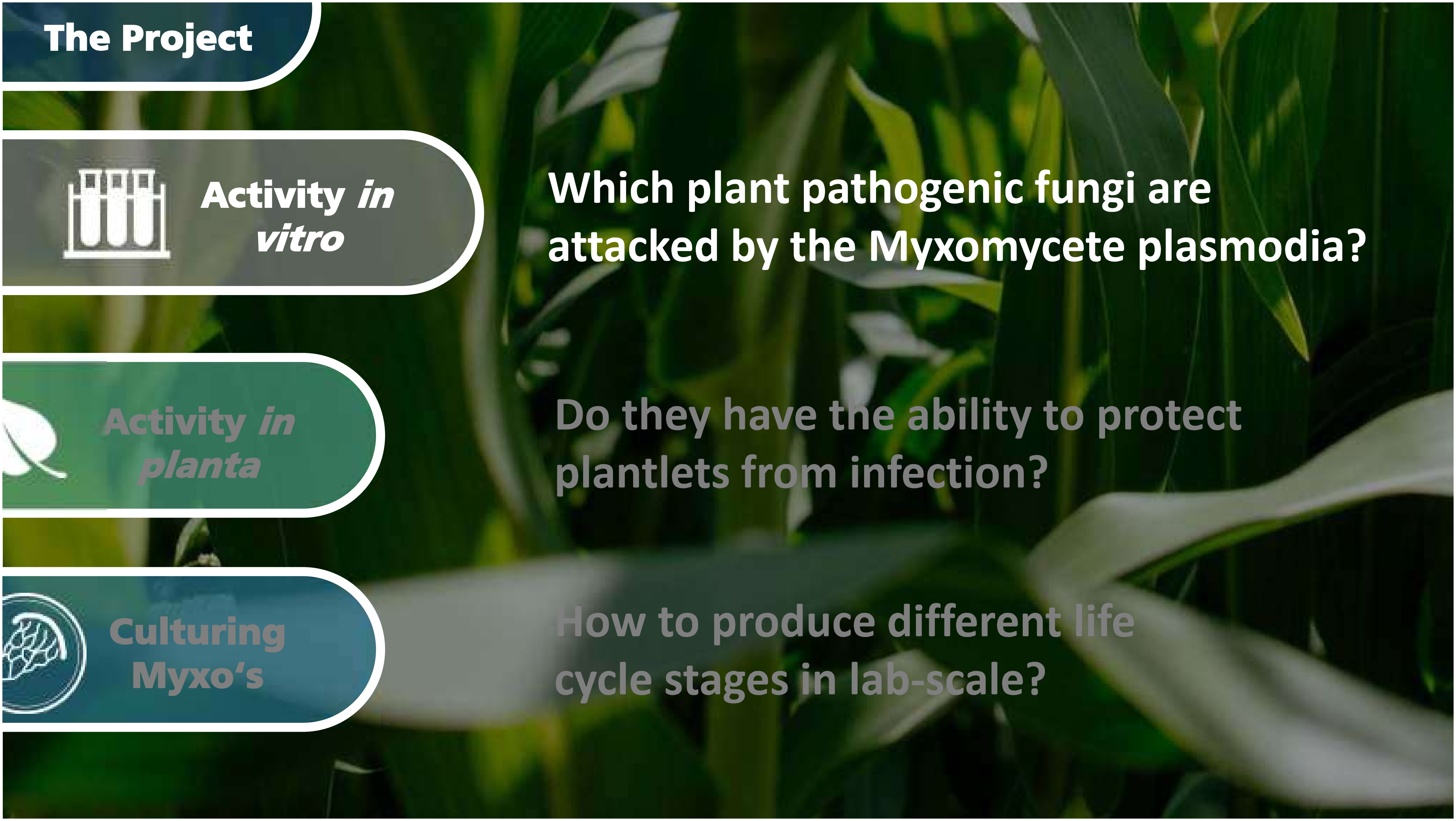
Background

Mist irrigated experimental field

Background

Grey structures on leaf sheath, silks etc.


Background
Notes on the Plasmodium of Badhamia utricularis and Brefeldia maxima.
BY
ARTHUR LISTER.
PARASITISM OF MYXOMYCETE PLASMODIA ON THE SPOROPHORES OF HYMENOMYCETES
Frank L. Howard and Mary E. Currie
Fungivorous lifestyle
STUDIES OF THE NUTRITION OF MYXOMYCETE PLASMODIA
Karol A. Hok
Antimicrobial metabolites
www.elsevier.com/locate/phytochem
Review
Secondary metabolites of slime molds (myxomycetes)
Valery M. Dembitsky, Tomáš Řezanka, Jaroslav Spížek, Lumír O. Hanuš
RESEARCH ARTICLE
Biological activities and chemical compositions of slime tracks and crude exopolysaccharides isolated from plasmodia of *Physarum polycephalum* and *Physarella oblonga*
Tuyen T.M. Huynh, Trung V. Phung, Steven L. Stephenson and Hanh T.M. Tran
Physarella oblonga-centered bioassays for testing the biological activity of myxomycetes
Herrera NA, Rojas C, Franco-Molano AE, Stephenson SL and Echeverri F


The Project
Activity in vitro
Which plant pathogenic fungi are attacked by the Myxomycete plasmodia?
Activity in planta
Do they have the ability to protect plantlets from infection?
Culturing Myxo's
How to produce different life cycle stages in lab-scale?

The Project

Activity *in vitro*

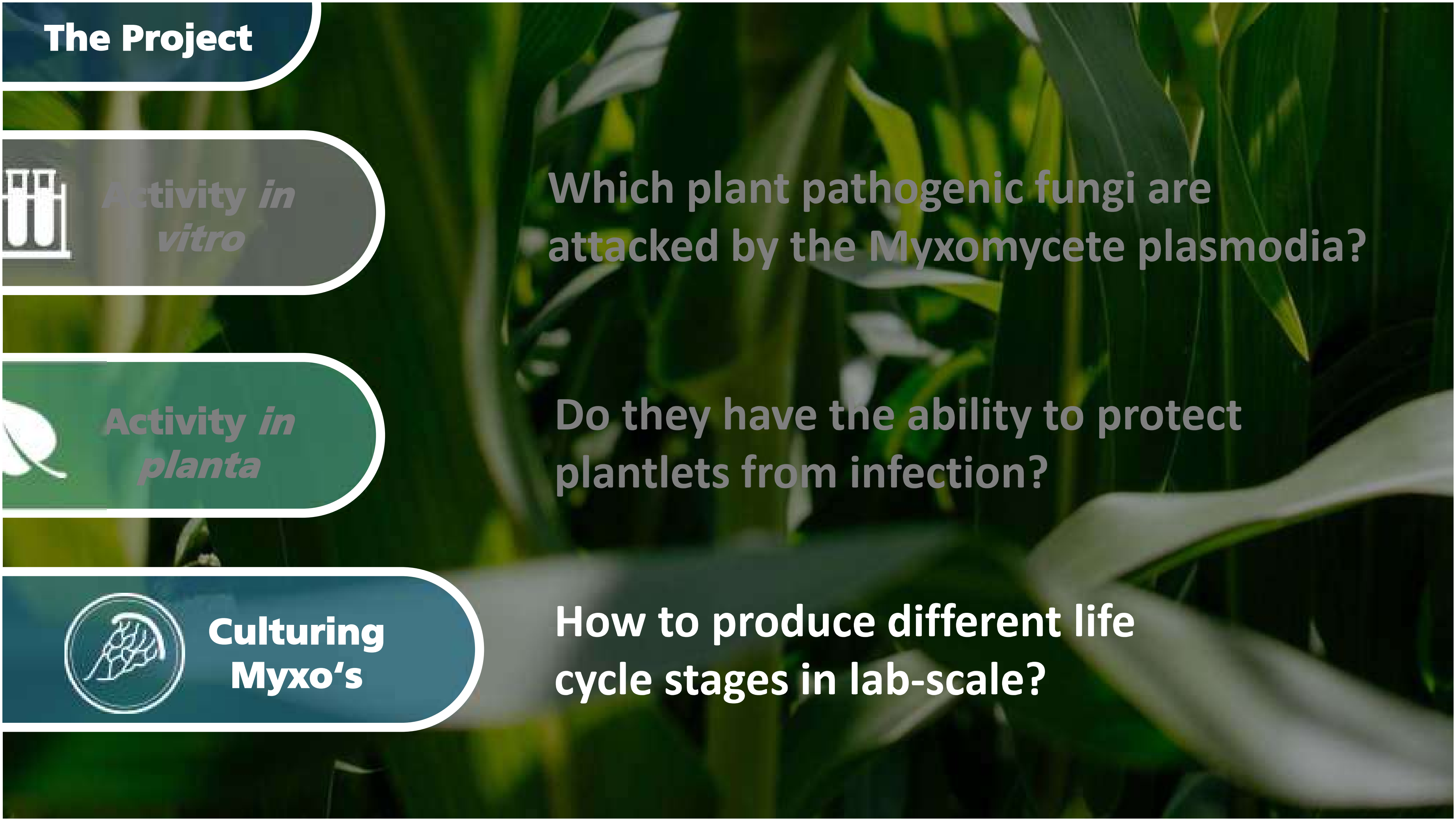
Which plant pathogenic fungi are attacked by the Myxomycete plasmodia?

Activity *in planta*

Do they have the ability to protect plantlets from infection?

Culturing Myxo's

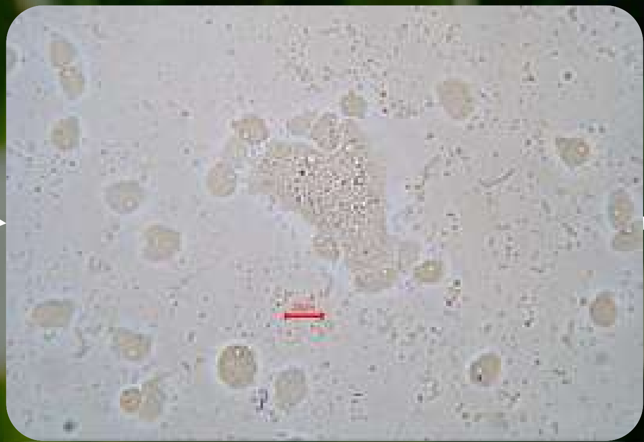
How to produce different life cycle stages in lab-scale?

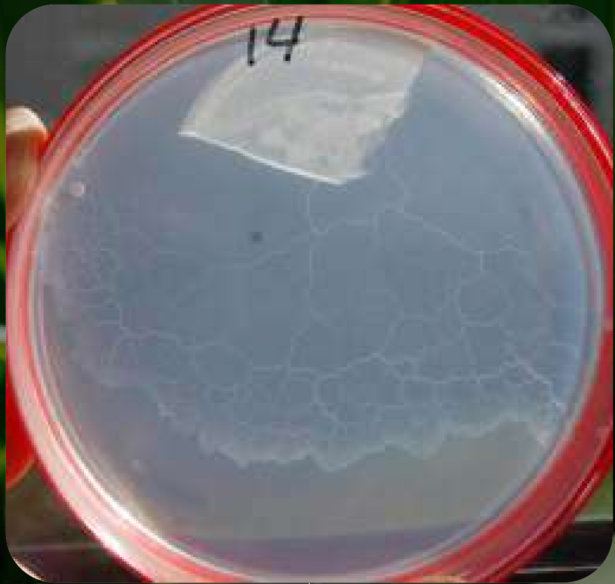

The Project
Activity *in vitro*
Activity *in planta*
Culturing Myxo's
Which plant pathogenic fungi are attacked by the Myxomycete plasmodia?
Do they have the ability to protect plantlets from infection?
How to produce different life cycle stages in lab-scale?

Culturing Myxo's

Current state of culturing plasmodia

Food mix
wMY-Agar
14 day's

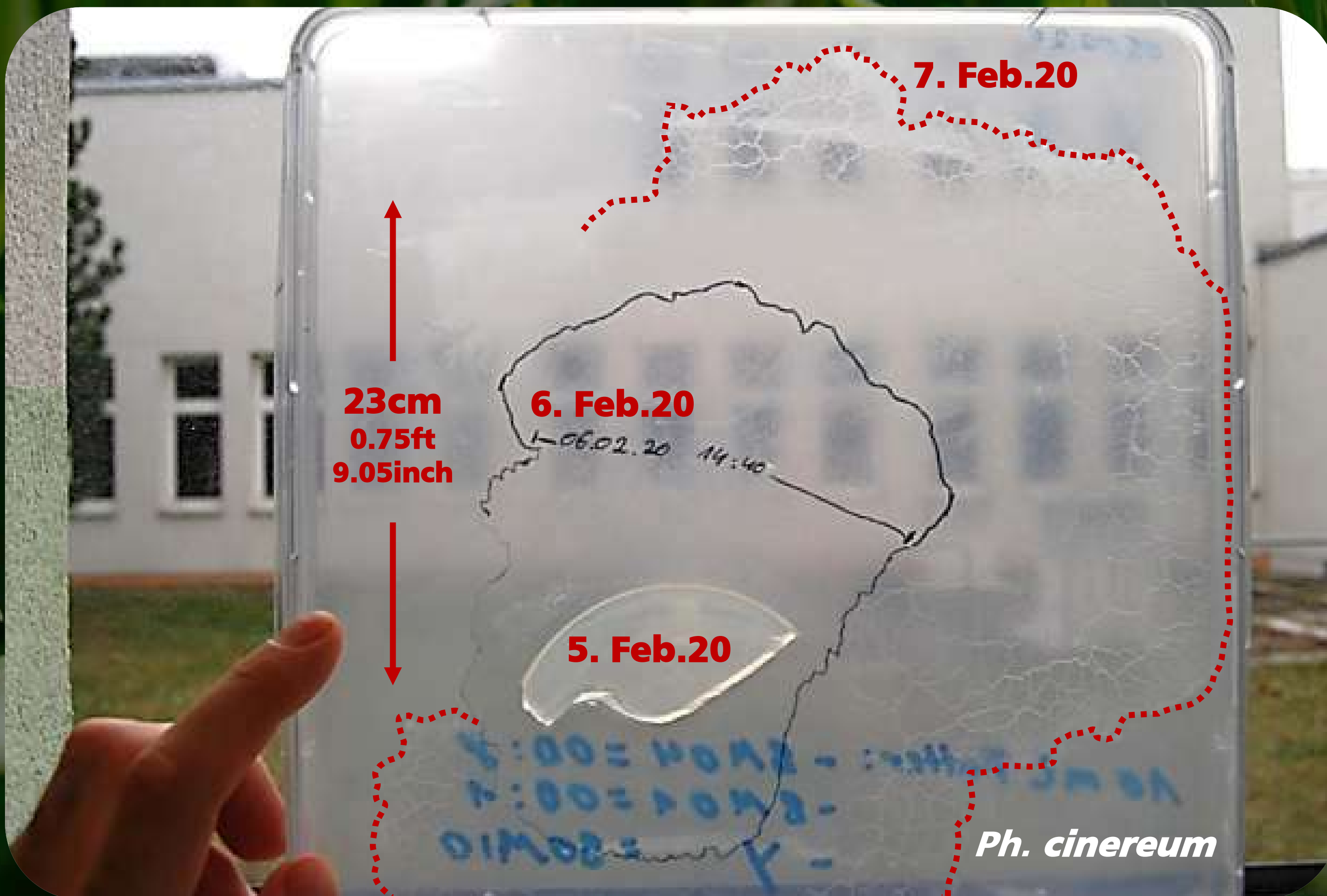




Ph. cinereum
Ph. gravidum
Ph. compressum

(Spiegel et al., n.d.; Hok, 1954; Gaertner, 1962; Gangl, 2019)

Current state of culturing plasmodia



Liquid culture of plasmodia

Pool plate

Complex medium with autoclaved yeast and living *E. coli*

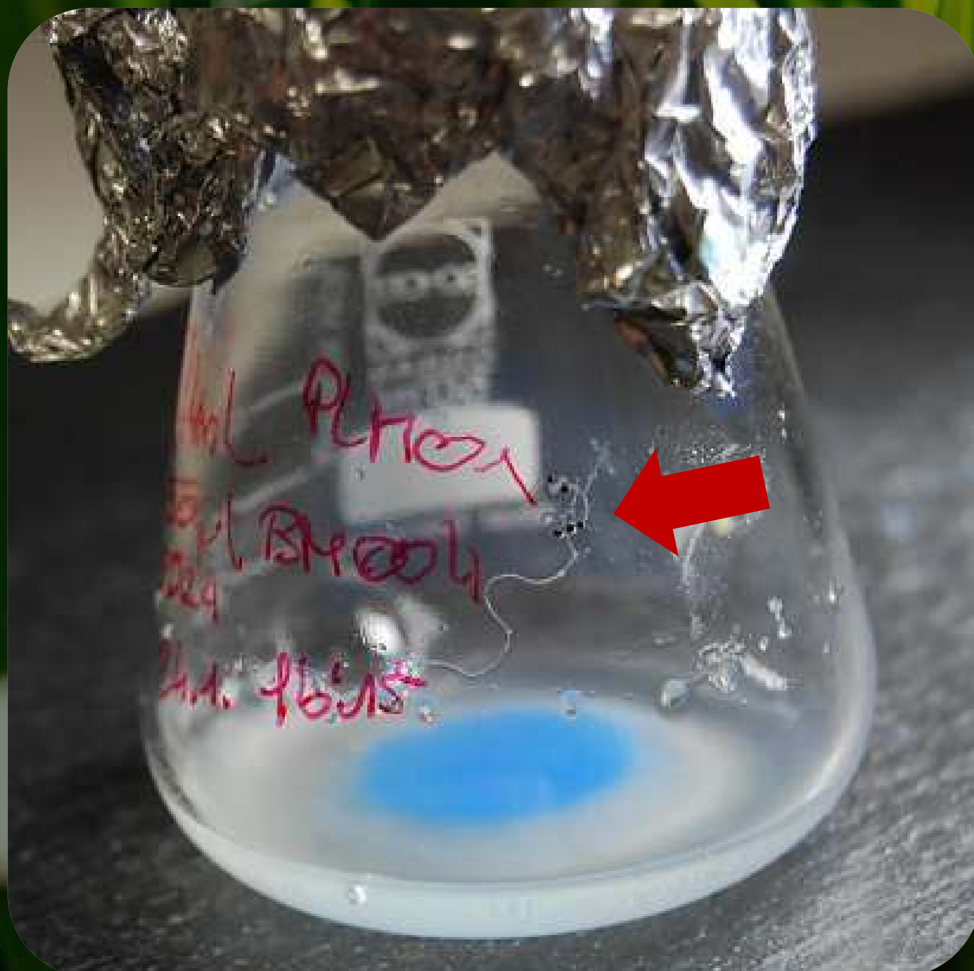
(Taylor & Mallette, 1976)

Liquid culture of plasmodia

Autonomous migration

Liquid culture of plasmodia

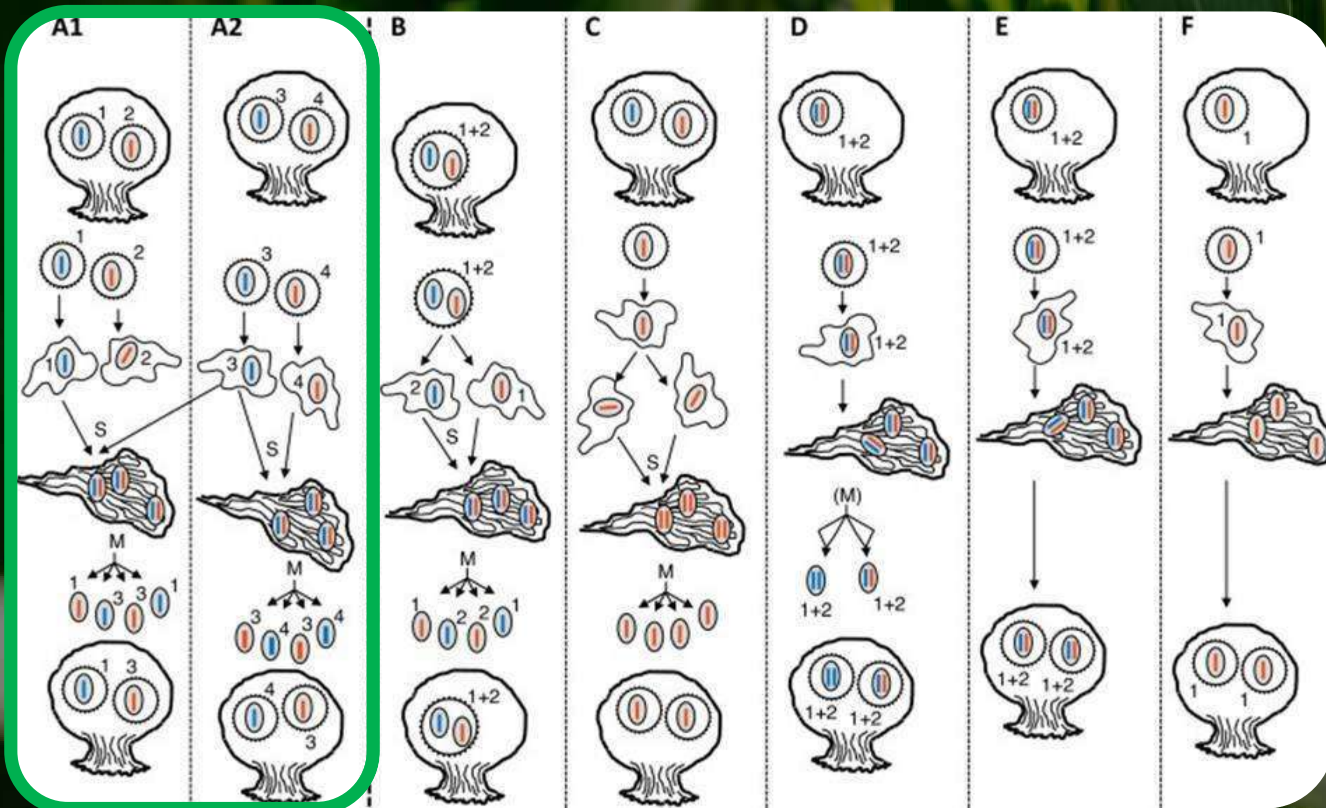
48h later



So far no success!

Screening for heterothallic strain

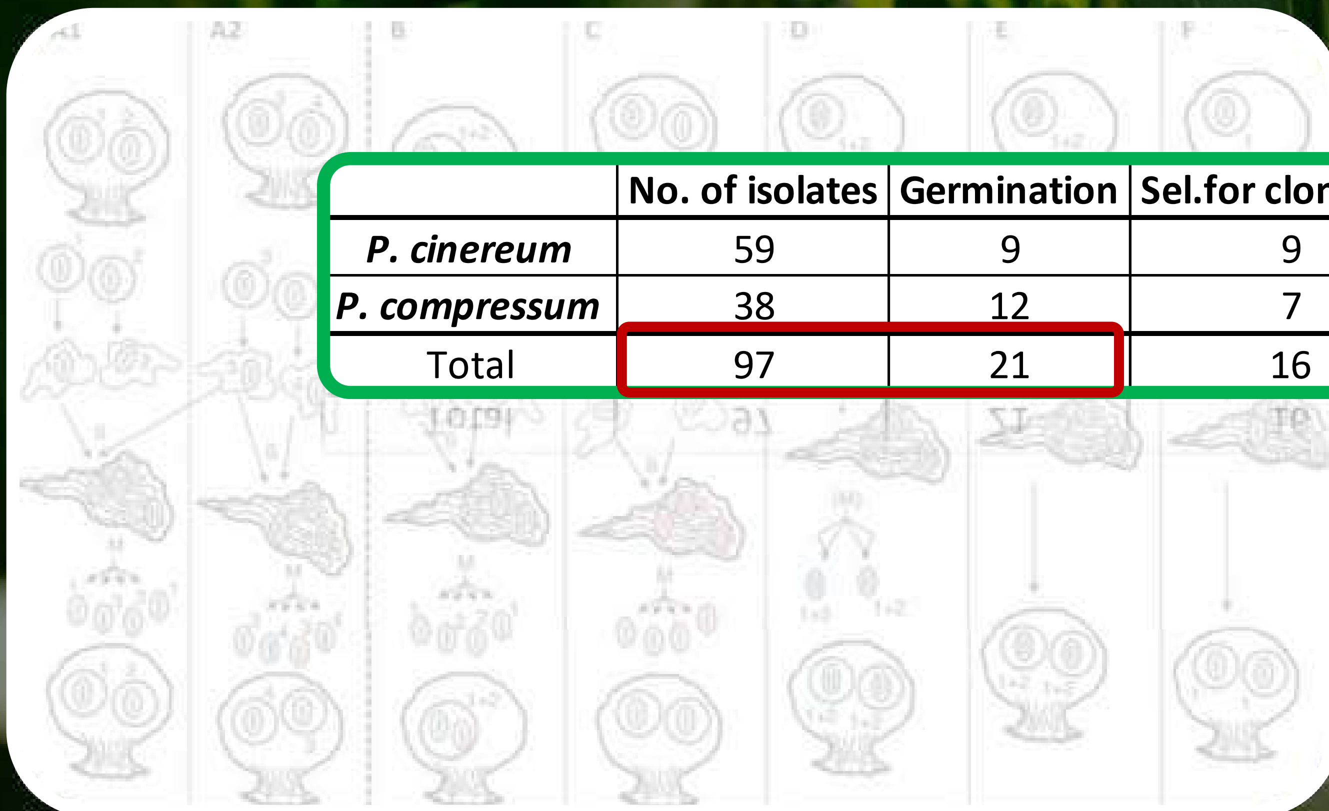
Heterothallic's desired



(Clark, Haskins, & Haskins, 2010; Feng et al., 2016)

Screening for heterothallic strain

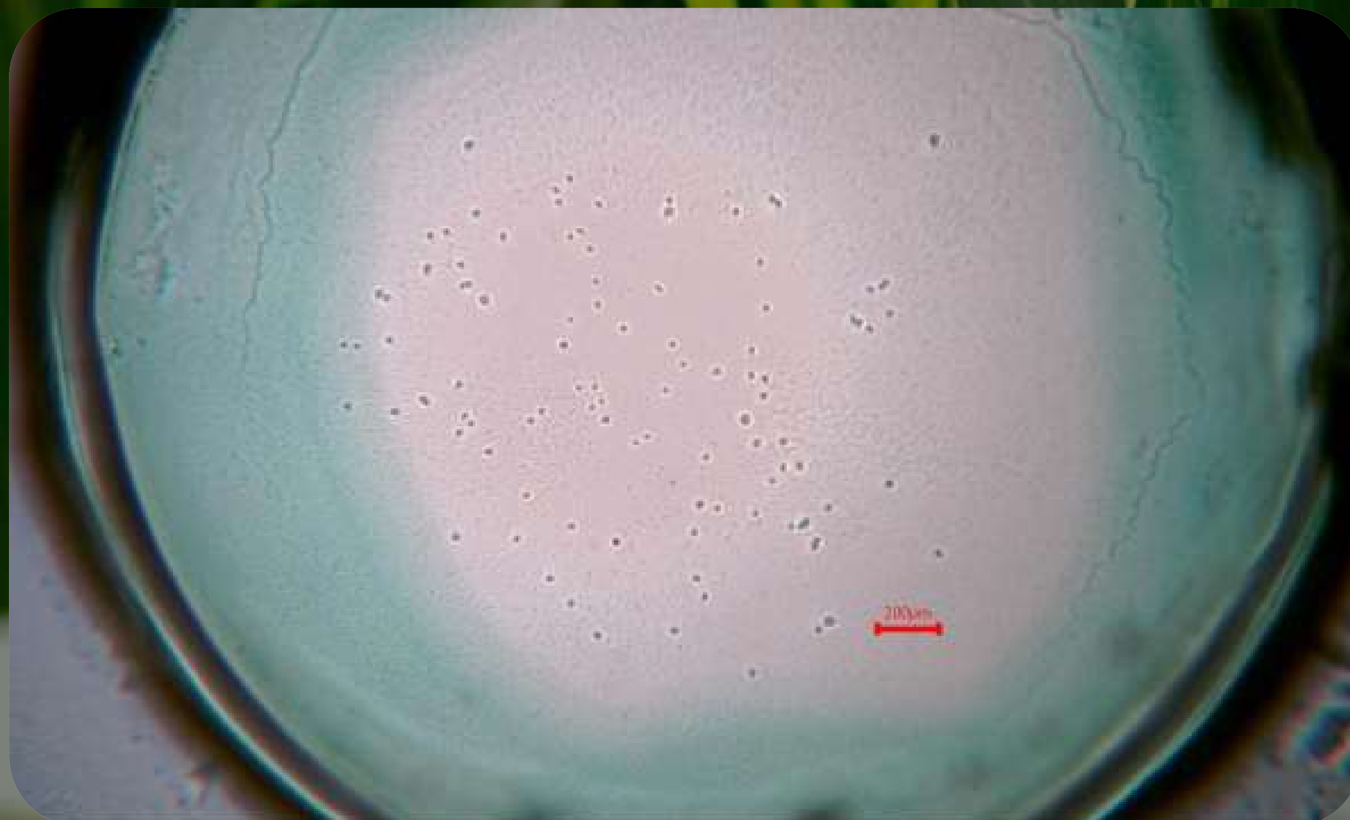
Heterothallic's desired



	No. of isolates	Germination	Sel.for clone isol.
P. cinereum	59	9	9
P. compressum	38	12	7
Total	97	21	16

Screening for heterothallic strain

Isolating true myxamoeba clones



Screening for heterothallic strain

			after 5 days			after 11 days		
Isolate no.	**Species**	**No. of clones**	**Myxamoeba**	**Microplasmodia**	**Macroplasmodia**	**Myxamoeba**	**Microplasmodia**	**Macroplasmodia**
140-16	*P. cinereum*	-						
264-18		10	X					X
268-18		20	X					X
515-18		-						
569-18		20	X					X
GH18002		8		X				X
GH19006		20			X			X
GH19007		-						
GH19009		-						
311-18	*P. compressum*	20			X			X
549-18		20			X			X
Pco18002		20			X			X
407-18		20			X			X
Pco19001		15		X				X
Pco19003		20		X				X
Pco18004		20			X			X
	Total no. clones	213						

Screening for heterothallic strain

			after 5 days			after 11 days		
Isolate no.	**Species**	**No. of clones**	**Myxamoeba**	**Microplasmodia**	**Macroplasmodia**	**Myxamoeba**	**Microplasmodia**	**Macroplasmodia**
140-16	*P. cinereum*	-						
264-18		10	X					X
268-18		20	X					X
515-18		-						
569-18		20	X					X
GH18002		8		X				X
GH19006		20			X			X
GH19007		-						
GH19009		-						
311-18	*P. compressum*	20			X			X
549-18		20			X			X
Pco18002		20			X			X
407-18		20			X			X
Pco19001		15		X				X
Pco19003		20		X				X
Pco18004		20			X			X
	Total no. clones	213						

Plasmodia inhibition

- 2% Glucose
- 30°C
- 0.25% Brucin
- 1mM EDTA

(Kerr & Sussman, 1958; Kerr, 1960; Anderson & Youngman, 1985)

Plasmodia inhibition

Ph. compressum **549-18**

	Medium	Rep.	Myxamoeba	Plasmodia
22°C	wMY	1	+	++
		2	+	+++
		3	+	+++
	SM5	1	(+)	-
		2	(+)	-
		3	-	-
	wMY 2%gl	1	++	++
		2	++	+
		3	++	+
	SM5 2%gl	1	(+)	-
		2	(+)	-
		3	-	-
30°C	wMY	1	-	-
		2	-	-
		3	-	-
	SM5	1	-	-
		2	(+)	-
		3	-	-
	wMY 2%gl	1	-	-
		2	-	-
		3	-	-
	SM5 2%gl	1	-	-
		2	-	-
		3	-	-

	Medium	Rep.	Myxamoeba	Microplasmodia	Macroplasmodia
22°C	wMY	1	(+)	+	+++
		2	(+)	+	+++
		3	(+)	+	+++
	WA	1	(+)	+	++
		2	(+)	+	++
		3	(+)	+	++
	Brucin 0.125%	1	++	(+)	-
		2	+	-	-
		3	++	(+)	-
	Brucin 0.25%	1	-	-	-
		2	-	-	-
		3	-	-	-
	Brucin 0.5%	1	-	-	-
		2	-	-	-
		3	-	-	-
	EDTA 0.5mM	1	(+)	++	+
		2	(+)	++	++
		3	(+)	++	+
	EDTA 1mM	1	(+)	++	-
		2	+	++	+
		3	-	-	-
	EDTA 2mM	1	(+)	++	(+)
		2	(+)	++	(+)
		3	+	++	(+)

After 6 days of incubation

Plasmodia inhibition

	Medium	Rep.	Myxamoeba	Plasmodia
22°C	wMY	1	+	++
		2	+	+++
		3	+	+++
	SM5	1	(+)	-
		2	(+)	-
		3	-	-
	wMY 2%gl	1	++	++
		2	++	+
		3	++	+
	SM5 2%gl	1	(+)	-
		2	(+)	-
		3	-	-
30°C	wMY	1	-	-
		2	-	-
		3	-	-
	SM5	1	-	-
		2	(+)	-
		3	-	-
	wMY 2%gl	1	-	-
		2	-	-
		3	-	-
	SM5 2%gl	1	-	-
		2	-	-
		3	-	-

Ph. compressum **549-18**

	Medium	Rep.	Myxamoeba	Microplasmodia	Macroplasmodia
22°C	wMY	1	(+)	+	+++
		2	(+)	+	+++
		3	(+)	+	+++
	WA	1	(+)	+	++
		2	(+)	+	++
		3	(+)	+	++
	Brucin 0.125%	1	++	(+)	-
		2	+	-	-
		3	++	(+)	-
	Brucin 0.25%	1	-	-	-
		2	-	-	-
		3	-	-	-
	Brucin 0.5%	1	-	-	-
		2	-	-	-
		3	-	-	-
	EDTA 0.5mM	1	(+)	++	+
		2	(+)	++	++
		3	(+)	++	+
	EDTA 1mM	1	(+)	++	-
		2	+	++	+
		3	-	-	-
	EDTA 2mM	1	(+)	++	(+)
		2	(+)	++	(+)
		3	+	++	(+)

After 6 days of incubation

Plasmodia inhibition

	Medium	Rep.	Myxamoeba	Plasmodia
22°C	wMY	1	+	++
		2	+	+++
		3	+	+++
	SM5	1	(+)	-
		2	(+)	-
		3	-	-
	wMY 2%gl	1	++	++
		2	++	+
		3	++	+
	SM5 2%gl	1	(+)	-
		2	(+)	-
		3	-	-
30°C	wMY	1	-	-
		2	-	-
		3	-	-
	SM5	1	-	-
		2	(+)	-
		3	-	-
	wMY 2%gl	1	-	-
		2	-	-
		3	-	-
	SM5 2%gl	1	-	-
		2	-	-
		3	-	-

Ph. compressum 549-18

	Medium	Rep.	Myxamoeba	Microplasmodia	Macroplasmodia
22°C	wMY	1	(+)	+	+++
		2	(+)	+	+++
		3	(+)	+	+++
	WA	1	(+)	+	++
		2	(+)	+	++
		3	(+)	+	++
	Brucin 0.125%	1	++	(+)	-
		2	+	-	-
		3	++	(+)	-
	Brucin 0.25%	1	-	-	-
		2	-	-	-
		3	-	-	-
	Brucin 0.5%	1	-	-	-
		2	-	-	-
		3	-	-	-
	EDTA 0.5mM	1	(+)	++	+
		2	(+)	++	++
		3	(+)	++	+
	EDTA 1mM	1	(+)	++	-
		2	+	++	+
		3	-	-	-
	EDTA 2mM	1	(+)	++	(+)
		2	(+)	++	(+)
		3	+	++	(+)

After 6 days of incubation

Plasmodia inhibition

	Medium	Rep.	Myxamoeba	Plasmodia
22°C	wMY	1	+	++
		2	+	+++
		3	+	+++
	SMS	1	(+)	-
		2	(+)	-
		3	-	-
	wMY 2%gl	1	++	++
		2	++	+
		3	++	+
	SMS 2%gl	1	(+)	-
		2	(+)	-
		3	-	-
30°C	wMY	1	-	-
		2	-	-
		3	-	-
	SMS	1	-	-
		2	(+)	-
		3	-	-
	wMY 2%gl	1	-	-
		2	-	-
		3	-	-
	SMS 2%gl	1	-	-
		2	-	-
		3	-	-

***Ph. compressum* 549-18**

	Medium	Rep.	Myxamoeba	Microplasmodia	Macroplasmodia
22°C	wMY	1	(+)	+	+++
		2	(+)	+	+++
		3	(+)	+	+++
	WA	1	(+)	+	++
		2	(+)	+	++
		3	(+)	+	++
	Brucin 0.125%	1	++	(+)	-
		2	+	-	-
		3	++	(+)	-
	Brucin 0.25%	1	-	-	-
		2	-	-	-
		3	-	-	-
	Brucin 0.5%	1	-	-	-
		2	-	-	-
		3	-	-	-
	EDTA 0.5mM	1	(+)	++	+
		2	(+)	++	++
		3	(+)	++	+
	EDTA 1mM	1	(+)	++	-
		2	+	++	+
		3	-	-	-
	EDTA 2mM	1	(+)	++	(+)
		2	(+)	++	(+)
		3	+	++	(+)

After 6 days of incubation

Plasmodia inhibition

	Medium	Rep.	Myxamoeba	Plasmodia
22°C	wMY	1	+	++
		2	+	+++
		3	+	+++
	SMS	1	(+)	-
		2	(+)	-
		3	-	-
	wMY 2%gl	1	++	++
		2	++	+
		3	++	+
	SMS 2%gl	1	(+)	-
		2	(+)	-
		3	-	-
30°C	wMY	1	-	-
		2	-	-
		3	-	-
	SMS	1	-	-
		2	(+)	-
		3	-	-
	wMY 2%gl	1	-	-
		2	-	-
		3	-	-
	SMS 2%gl	1	-	-
		2	-	-
		3	-	-

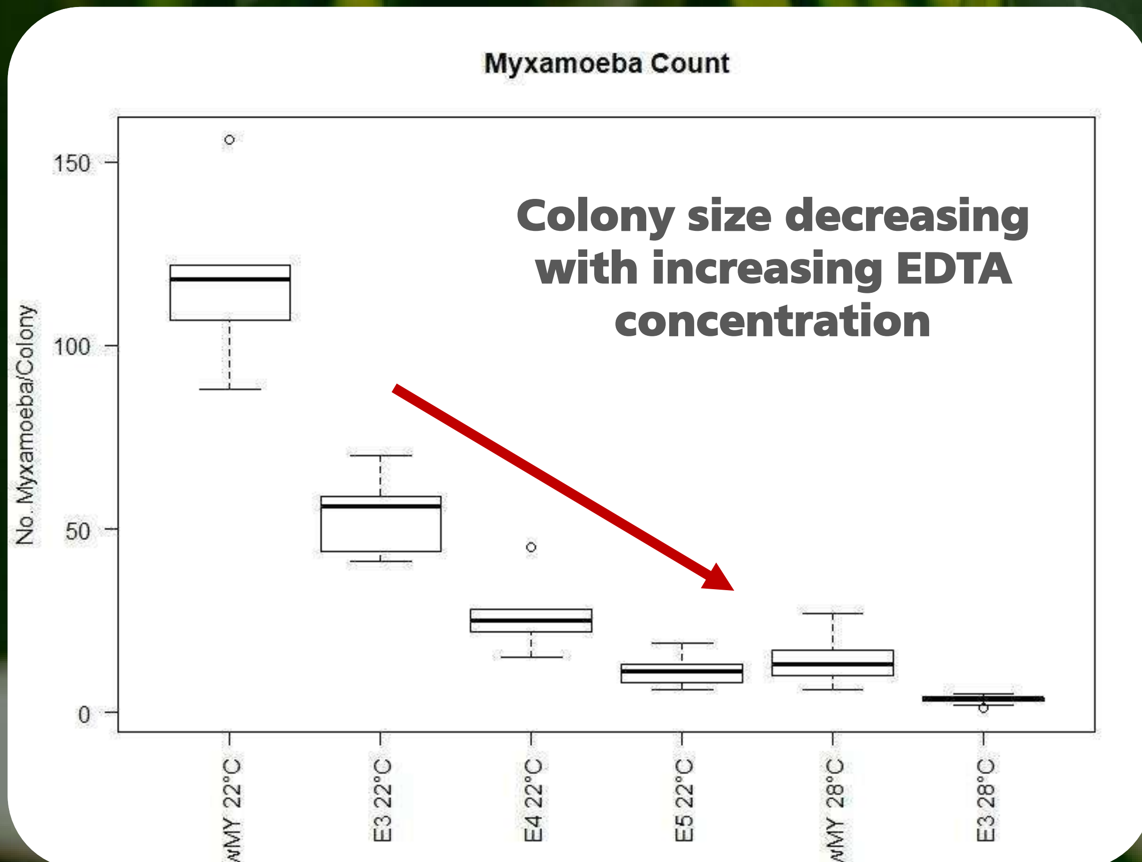
Ph. compressum **549-18**

	Medium	Rep.	Myxamoeba	Microplasmodia	Macroplasmodia
22°C	wMY	1	(+)	+	+++
		2	(+)	+	+++
		3	(+)	+	+++
	WA	1	(+)	+	++
		2	(+)	+	++
		3	(+)	+	++
	Brucin 0.125%	1	++	(+)	-
		2	+	-	-
		3	++	(+)	-
	Brucin 0.25%	1	-	-	-
		2	-	-	-
		3	-	-	-
	Brucin 0.5%	1	-	-	-
		2	-	-	-
		3	-	-	-
	EDTA 0.5mM	1	(+)	++	+
		2	(+)	++	++
		3	(+)	++	+
	EDTA 1mM	1	(+)	++	-
		2	+	++	+
		3	-	-	-
	EDTA 2mM	1	(+)	++	(+)
		2	(+)	++	(+)
		3	+	++	(+)

After 6 days of incubation

Plasmodia inhibition

Ph. compressum **549-18**



(Youngman et al., 1977; Pallotta, Blanchard, & Larue, 1983)


Activity *in vitro*

Predatory activity against the mycelium of plant path. fungi

	Ph. polycephalum		*Ph. gravidum*		*Ph. cinereum*	
Fungal genus (no. sp.)	Mycelium utilization		Mycelium utilization		Mycelium utilization	
	yes	no	yes	no	yes	no
Fusarium (7)		X	X		X	
Aspergillus (3)		[illegible]	[illegible]	[illegible]	[illegible]	n.a.
Penicillium (3)		[illegible]	[illegible]	[illegible]	[illegible]	n.a.
Alternaria (1)		[illegible]	[illegible]	[illegible]	[illegible]	
Thielaviopsis (1)	n.a.	[illegible]	[illegible]	[illegible]	[illegible]	
Acrostalagmus (1)	n.a.	n.a.	X		X	
Geomannomyces (1)	n.a.	n.a.	X		X	
Pythium (1)	n.a.	n.a.		X	X	
Phytophthora (1)	n.a.	n.a.	X		X	

Confrontation tests with
3 *Physarum* species and
11 fungal genera (21 species) so far

Predatory activity against the mycelium of plant path. fungi

	Ph. polycephalum		*Ph. gravidum*		*Ph. cinereum*	
Fungal genus (no. sp.)	Mycelium utilization		Mycelium utilization		Mycelium utilization	
	yes	no	yes	no	yes	no
Fusarium (7)		X	X		X	
Aspergillus (3)		X	X		n.a.	n.a.
Penicillium (3)		X	(X)	X	n.a.	n.a.
Alternaria (1)		X	X		X	
Thielaviopsis (1)	n.a.	n.a.	X		X	
Acrostalagmus (1)	n.a.	n.a.	X		X	
Geomannomyces (1)	n.a.	n.a.	X		X	
Pythium (1)	n.a.	n.a.		X	X	
Phytophthora (1)	n.a.	n.a.	X		X	

Predatory activity against the mycelium of plant path. fungi

Day 1

Day 4

Ph. polycephalum vs.
F. proliferatum

Predatory activity against the mycelium of plant path. fungi

	Ph. polycephalum		*Ph. gravidum*		*Ph. cinereum*	
Fungal genus (no. sp.)	Mycelium utilization		Mycelium utilization		Mycelium utilization	
	yes	no	yes	no	yes	no
Fusarium (7)		X	X		X	
Aspergillus (3)		X	X		n.a.	n.a.
Penicillium (3)		X	(X)	X	n.a.	n.a.
Alternaria (1)		X	X		X	
Thielaviopsis (1)	n.a.	n.a.	X		X	
Acrostalagmus (1)	n.a.	n.a.	X		X	
Geomannomyces (1)	n.a.	n.a.	X		X	
Pythium (1)	n.a.	n.a.		X	X	
Phytophthora (1)	n.a.	n.a.	X		X	

Predatory activity against the mycelium of plant path. fungi

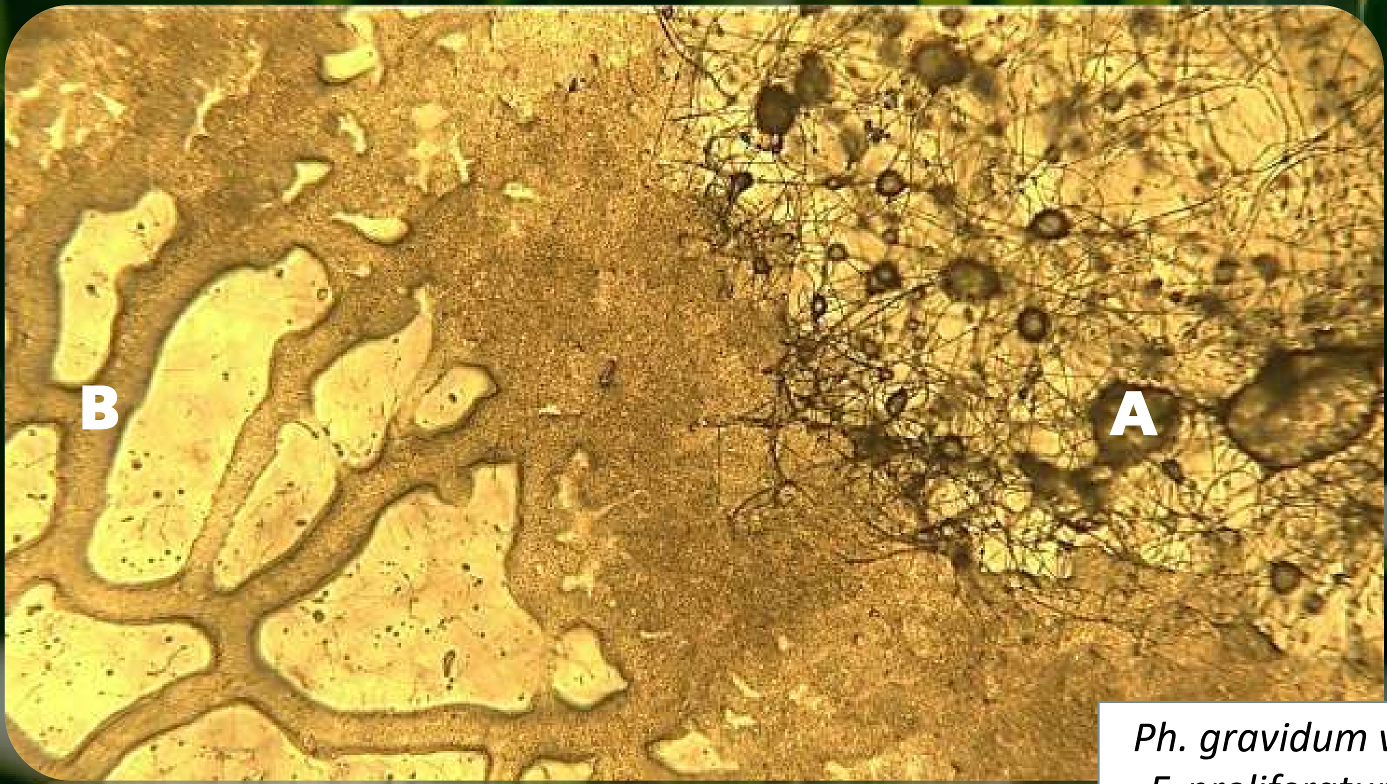
	Ph. polycephalum		*Ph. gravidum*		*Ph. cinereum*	
Fungal genus (no. sp.)	Mycelium utilization		Mycelium utilization		Mycelium utilization	
	yes	no	yes	no	yes	no
Fusarium (7)		X	X		X	
Aspergillus (3)		X	X		n.a.	n.a.
Penicillium (3)		X	(X)	X	n.a.	n.a.
Alternaria (1)		X	X		X	
Thielaviopsis (1)	n.a.	n.a.	X		X	
Acrostalagmus (1)	n.a.	n.a.	X		X	
Geomannomyces (1)	n.a.	n.a.	X		X	
Pythium (1)	n.a.	n.a.		X	X	
Phytophthora (1)	n.a.	n.a.	X		X	

Predatory activity against the mycelium of plant path. fungi

Day 4

Ph. gravidum vs. F. proliferatum

Predatory activity against the mycelium of plant path. fungi



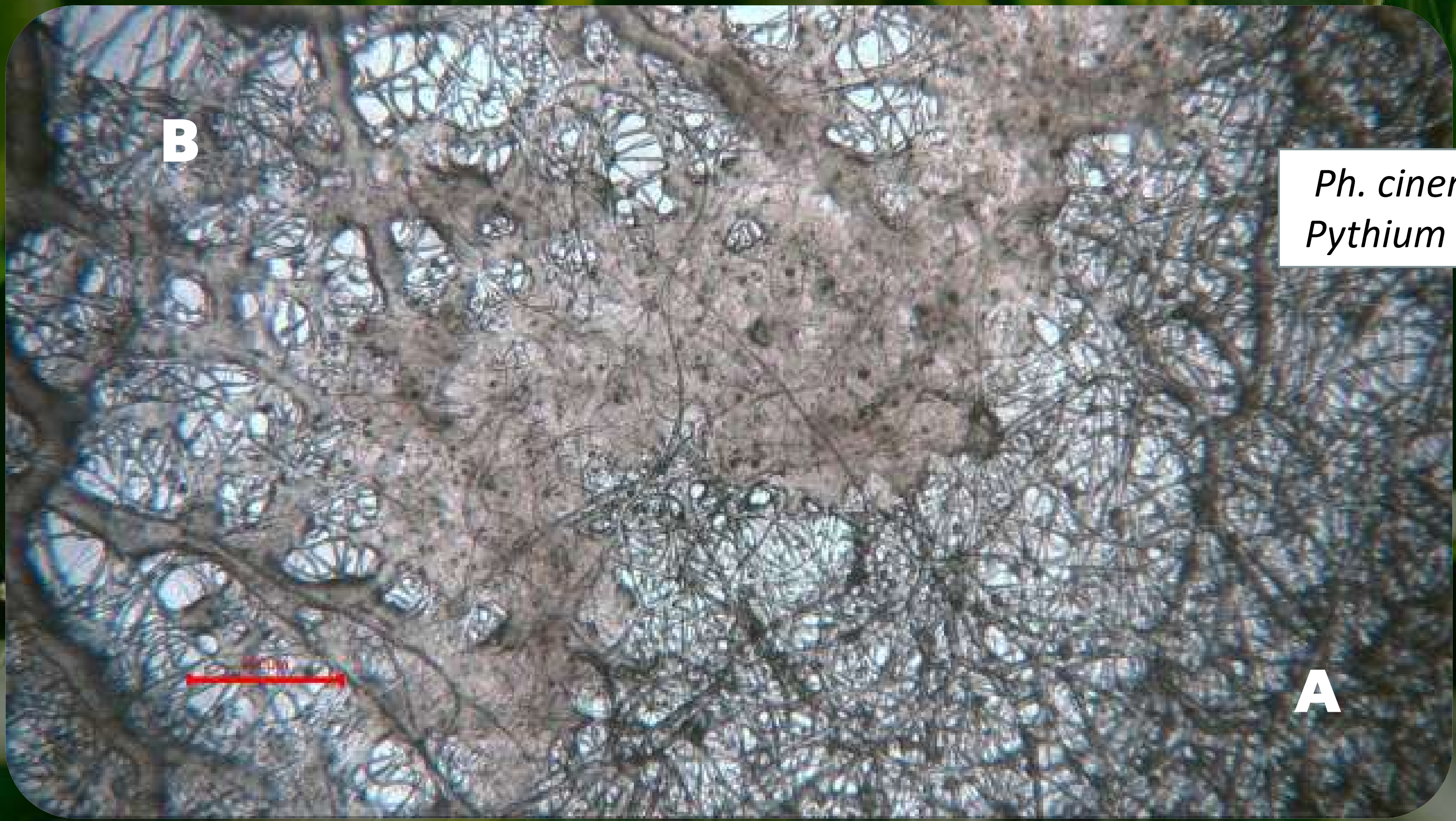
Ph. gravidum vs.
F. proliferatum

Predatory activity against the mycelium of plant path. fungi

	Ph. polycephalum		***Ph. gravidum***		***Ph. cinereum***	
Fungal genus (no. sp.)	Mycelium utilization		Mycelium utilization		Mycelium utilization	
	yes	no	yes	no	yes	no
Fusarium (7)		X	X		X	
Aspergillus (3)		X	X		n.a.	n.a.
Penicillium (3)		X	(X)	X	n.a.	n.a.
Alternaria (1)		X	X		X	
Thielaviopsis (1)	n.a.	n.a.	X		X	
Acrostalagmus (1)	n.a.	n.a.	X		X	
Geomannomyces (1)	n.a.	n.a.	X		X	
Pythium (1)	n.a.	n.a.		X	X	
Phytophthora (1)	n.a.	n.a.	X		X	

Predatory activity against the mycelium of plant path. fungi

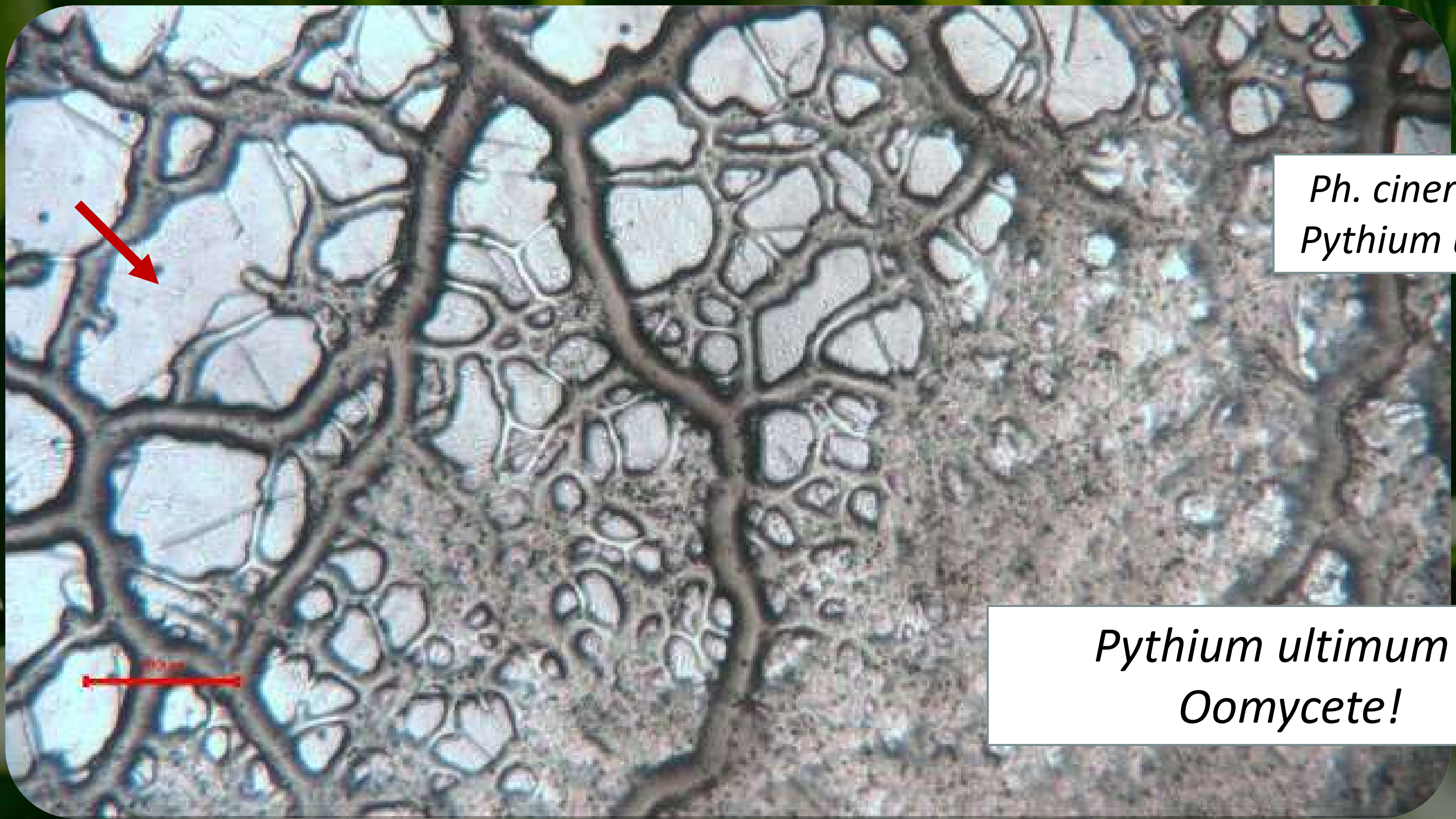
Day 3



Ph. cinereum vs.
Pythium ultimum

Predatory activity against the mycelium of plant path. fungi

Day 6



Ph. cinereum vs. Pythium ultimum

Pythium ultimum = Oomycete!

Predatory activity against the spores of plant path. fungi

	Ph. polycephalum		***Ph. gravidum***		***Ph. cinereum***	
Fungal genus	Spore uptake		Spore uptake		Spore uptake	
	yes	no	yes	no	yes	no
Fusarium		X	X		X	
Aspergillus	X		X		n.a.	n.a.
Penicillium		X	X		n.a.	n.a.
Alternaria		X	X		X	
Oidium	n.a.	n.a.	n.a.	n.a.	X	

Predatory activity against the spores of plant path. fungi

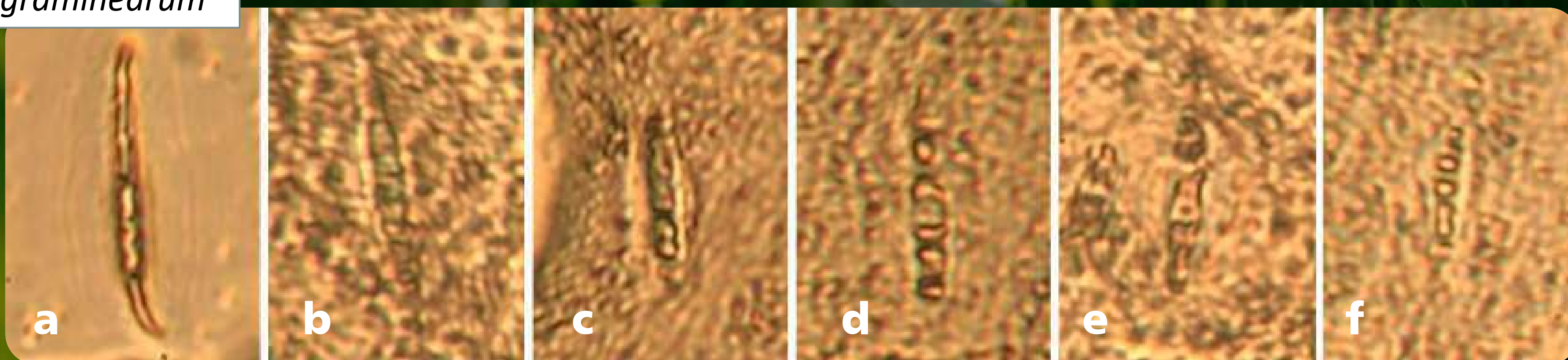
	Ph. polycephalum		*Ph. gravidum*		*Ph. cinereum*	
Fungal genus	Spore uptake		Spore uptake		Spore uptake	
	yes	no	yes	no	yes	no
Fusarium		X	X		X	
Aspergillus	X		X		n.a.	n.a.
Penicillium		X	X		n.a.	n.a.
Alternaria		X	X		X	
Oidium	n.a.	n.a.	n.a.	n.a.	X	

Predatory activity against the spores of plant path. fungi

Fungal genus	*Ph. polycephalum* Spore uptake		*Ph. gravidum* Spore uptake		*Ph. cinereum* Spore uptake	
	yes	no	yes	no	yes	no
Fusarium		X	X		X	
Aspergillus	X		X		n.a.	n.a.
Penicillium		X	X		n.a.	n.a.
Alternaria		X	X		X	
Oidium	n.a.	n.a.	n.a.	n.a.	X	

Predatory activity against the spores of plant path. fungi

Ph. gravidum vs.
F. graminearum



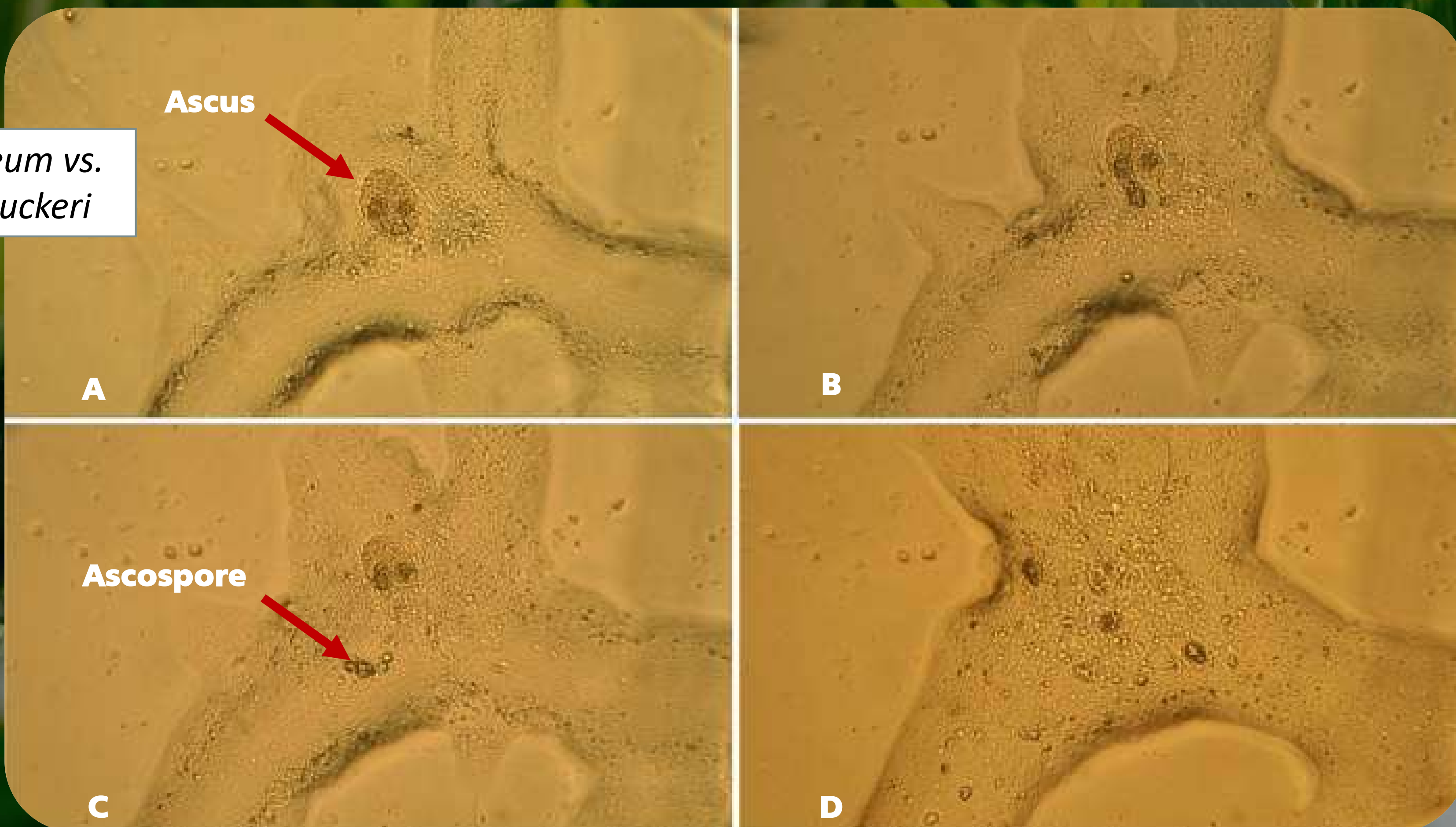
Increasing degree of digestion

Predatory activity against the spores of plant path. fungi

	Ph. polycephalum		*Ph. gravidum*		***Ph. cinereum***	
Fungal genus	Spore uptake		Spore uptake		Spore uptake	
	yes	no	yes	no	yes	no
Fusarium		X	X		X	
Aspergillus	X		X		n.a.	n.a.
Penicillium		X	X		n.a.	n.a.
Alternaria		X	X		X	
Oidium	n.a.	n.a.	n.a.	n.a.	X	

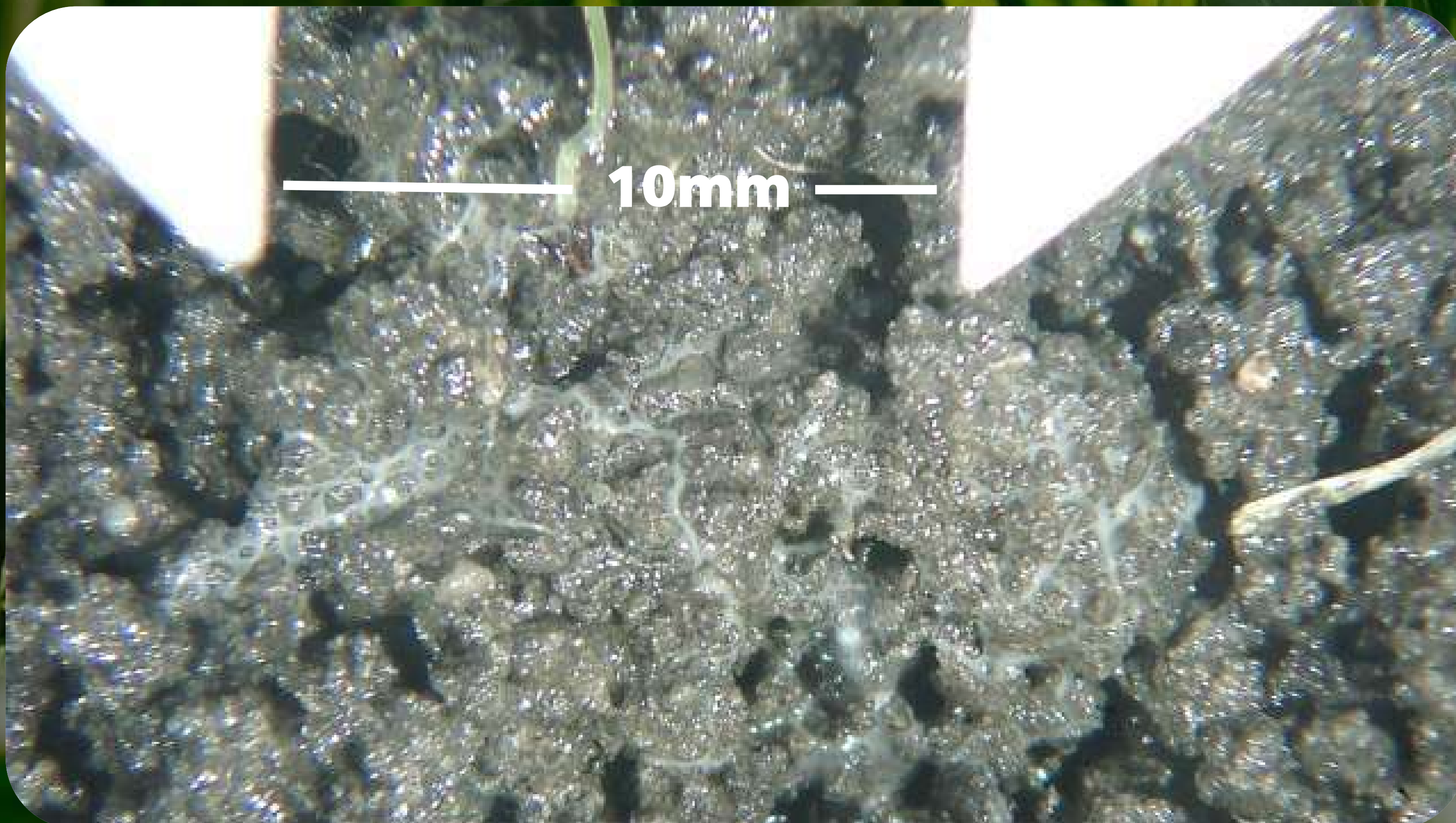
Predatory activity against the spores of plant path. fungi

Ph. cinereum vs. Oidium tuckeri

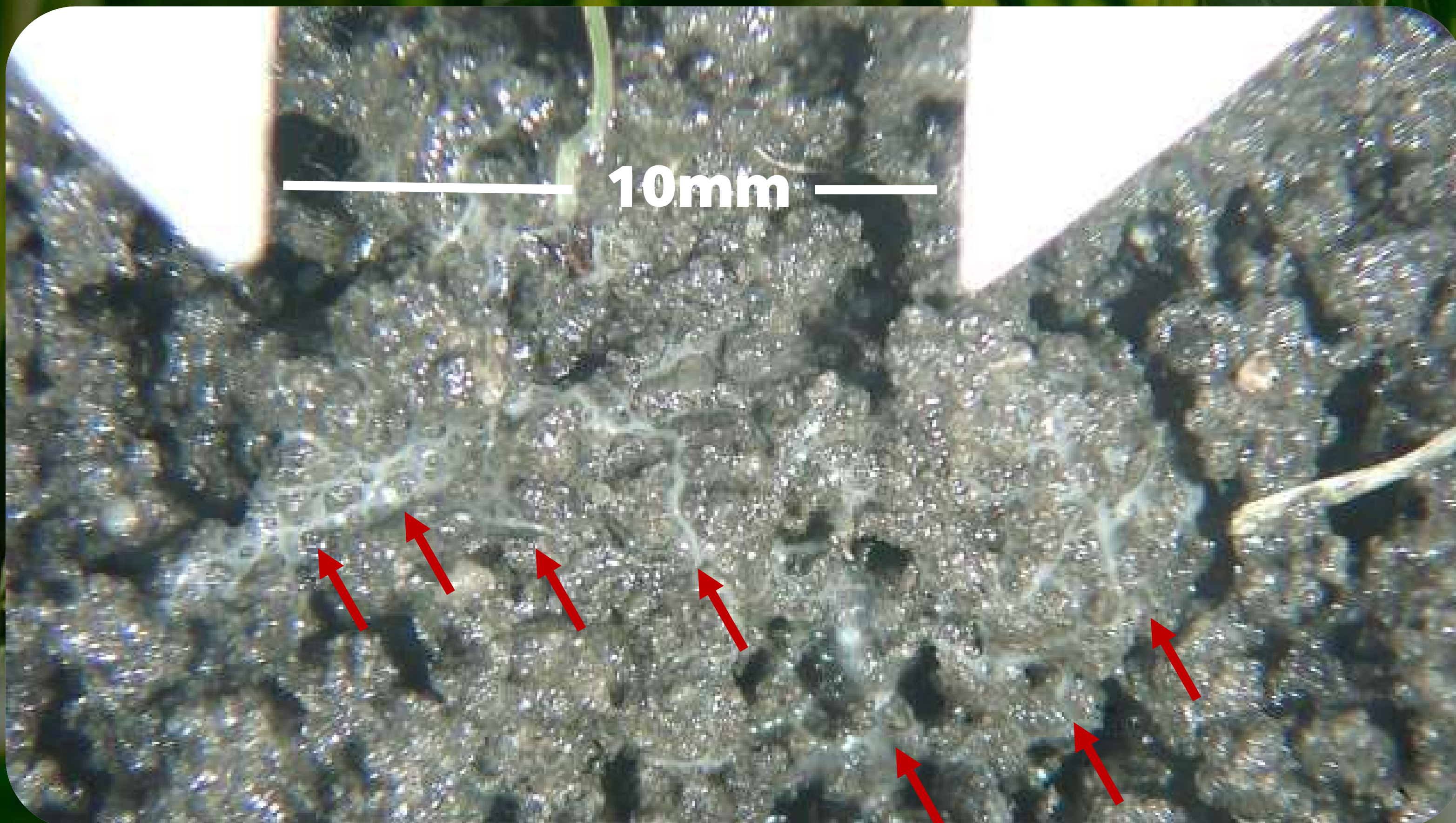



Activity *in planta*

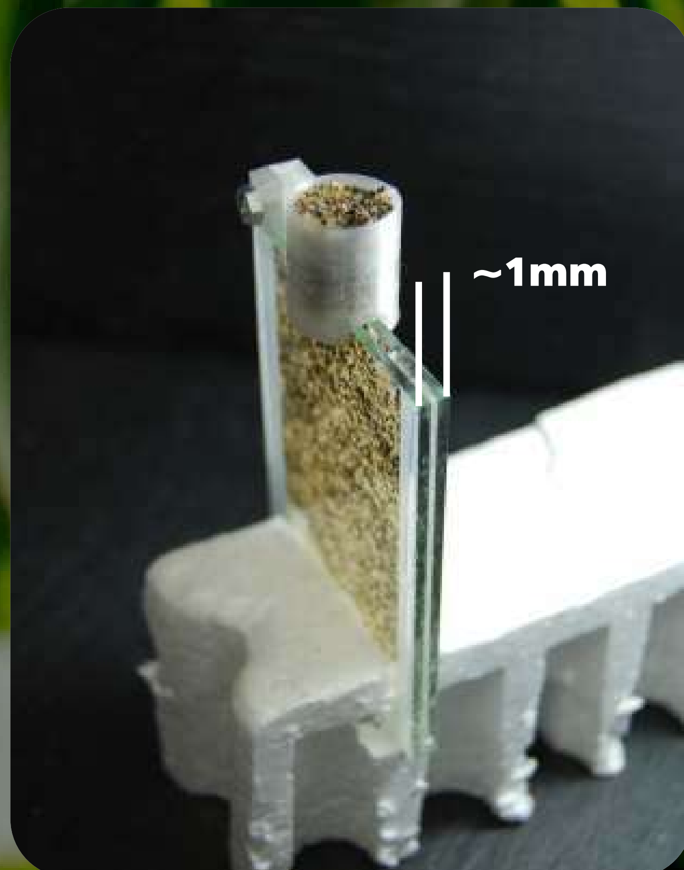
Behaviour of plasmodia in porous soil medium



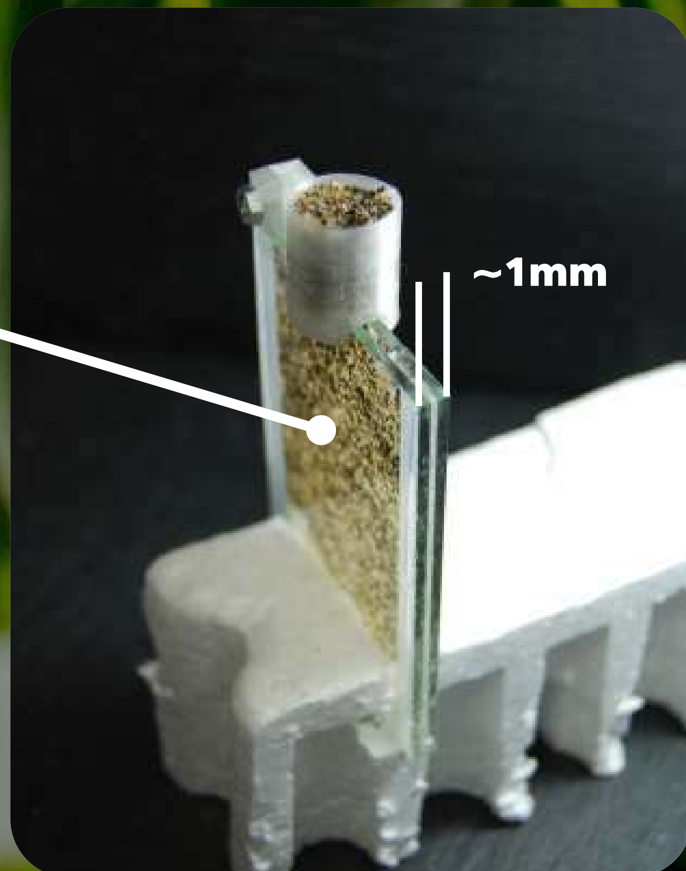
Behaviour of plasmodia in porous soil medium



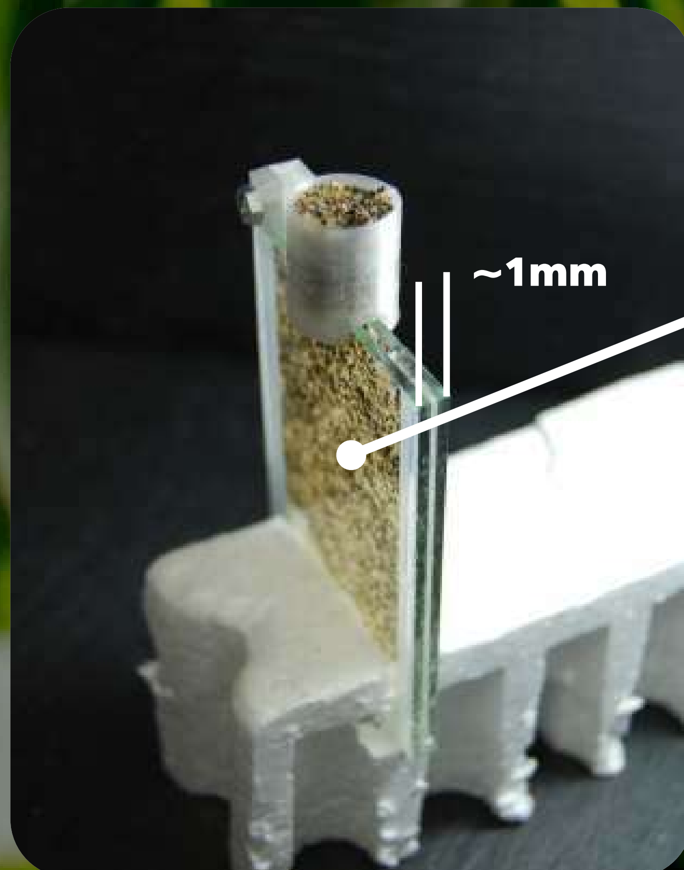
Rhizobox System



Rhizobox System

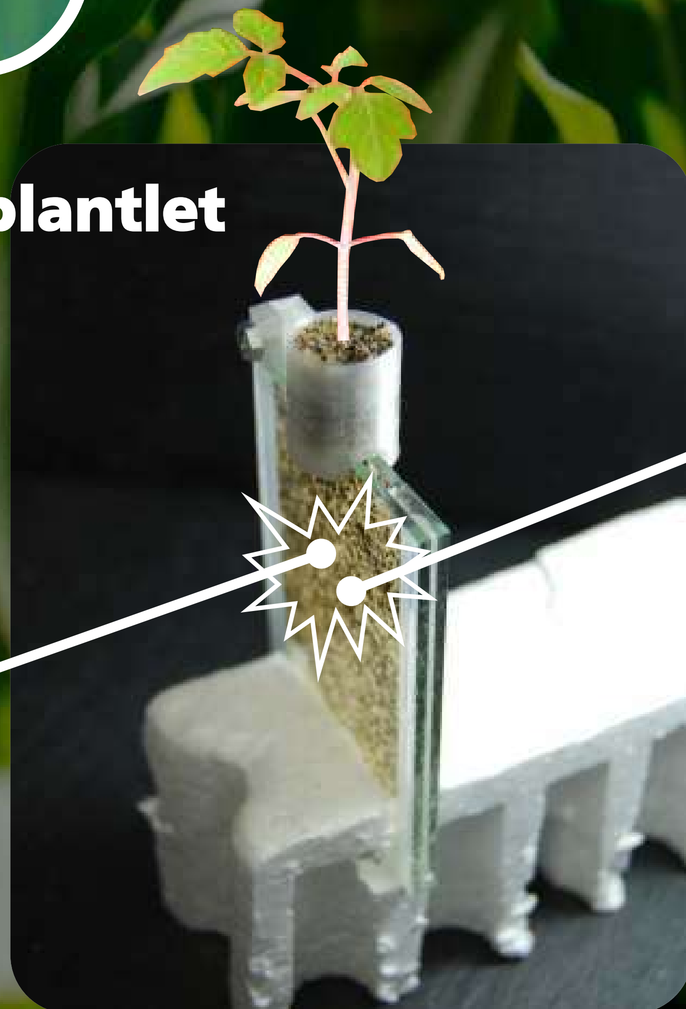


Rhizobox System



(Fey, Compton, & Cox, 1995)

Rhizobox System



(Schwarz, Thompson, & Kläring, 2014)

Summary

Activity *in vitro*

Activity *in planta*

Culturing Myxo's

Introduction of reproducible methods for culturing plasmodia from spores

Liquid culture too far away from natural conditions?

Methods for the lab scale production of other life cycle stages missing so far

Optimization of protocols

Summary

Activity *in vitro*

Activity *in planta*

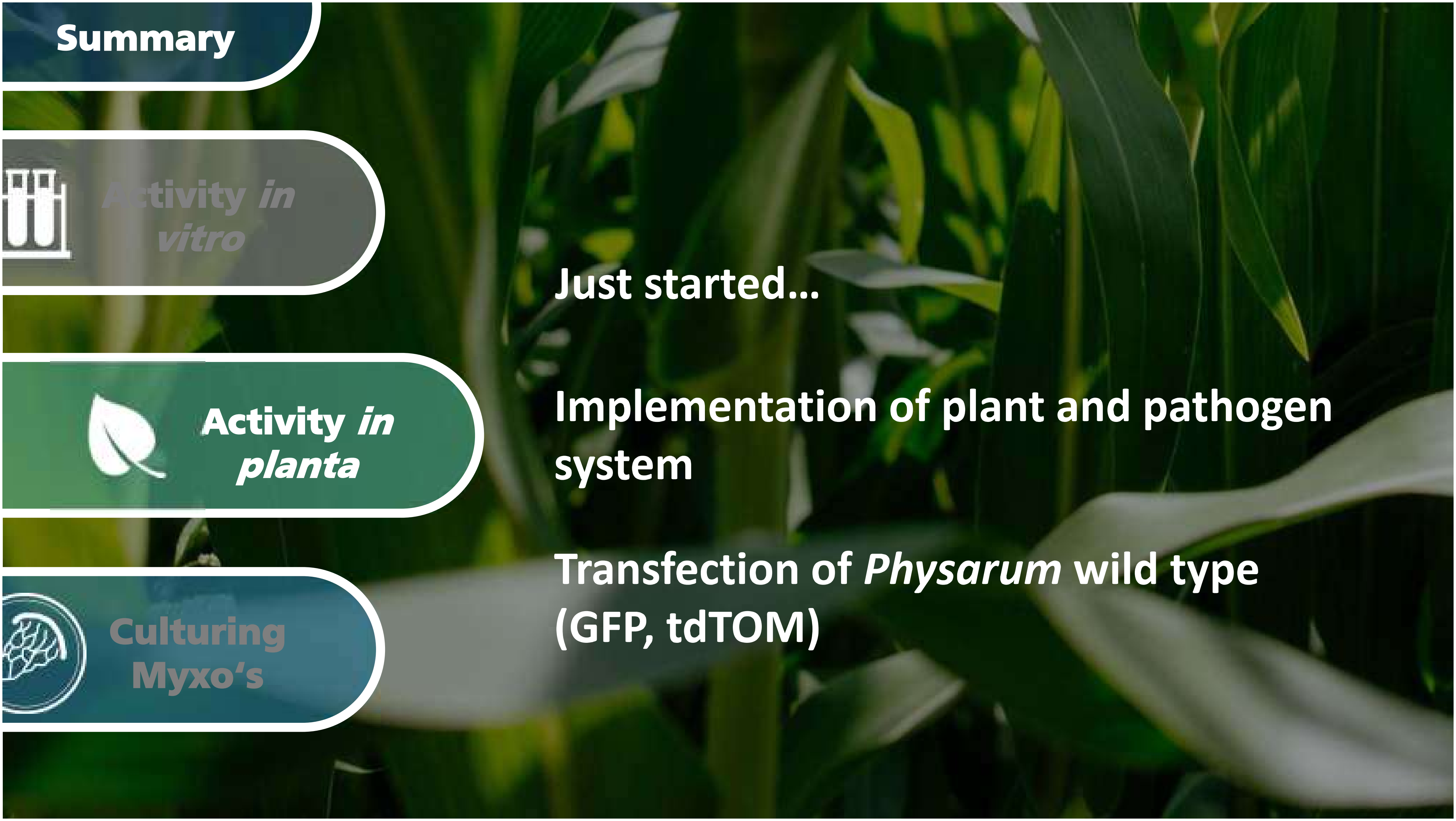
Culturing Myxo's

Ph. polycephalum no or almost no activity against plant pathogenic fungi

Ph. gravidum and *Ph. cinereum* showed activity against several plant pathogenic fungi

First record of *Oomycete* beeing utilized as food source?

In vitro experiments are promissing and motivating for further investigations


Summary
Activity in vitro
Activity in planta
Culturing Myxo's
Just started…
Implementation of plant and pathogen system
Transfection of Physarum wild type (GFP, tdTOM)

Thank‘s for your attention!

Adrian Johann Myriam Marc

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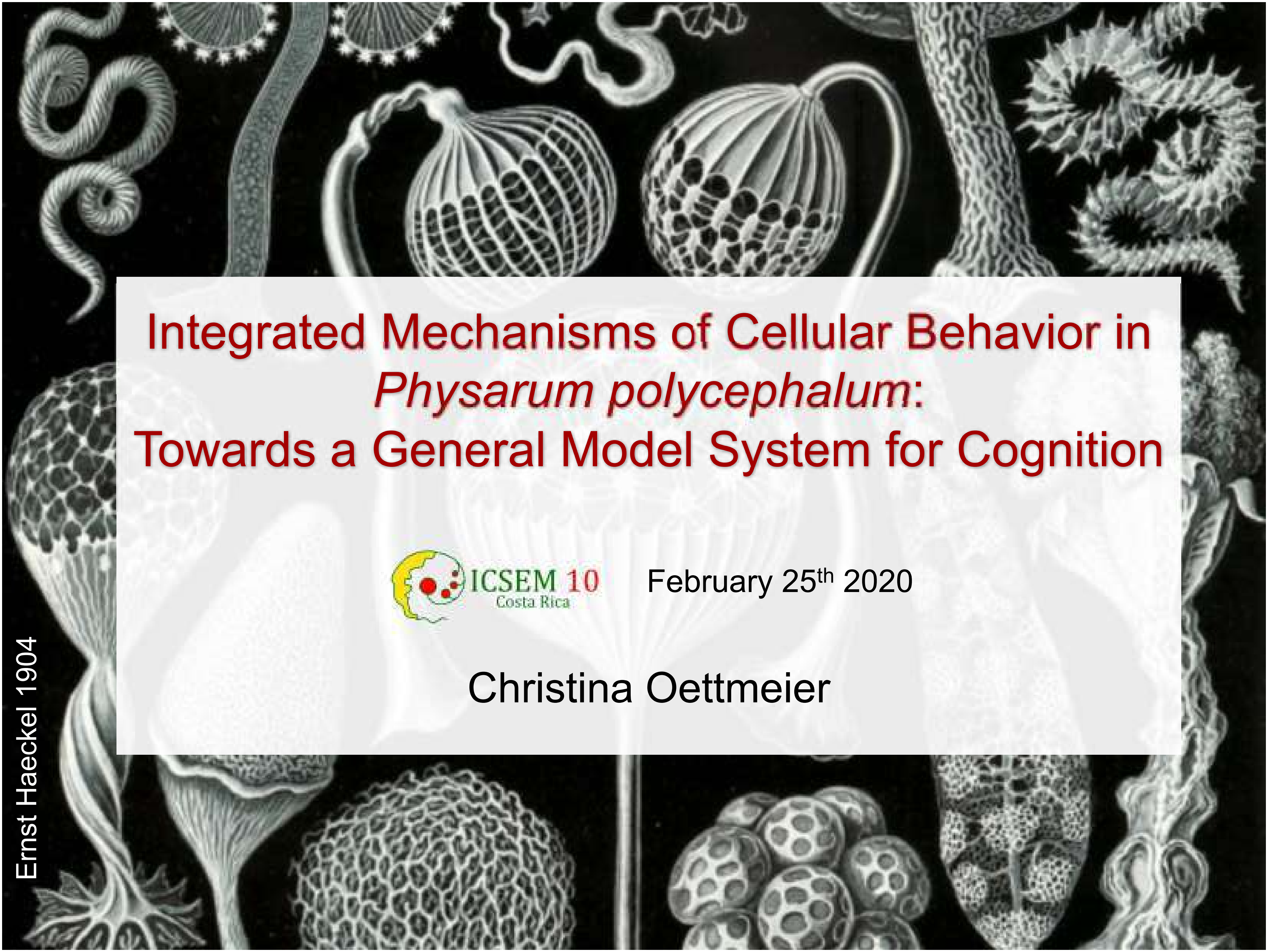
Integrated Mechanisms of Cellular Behavior in *Physarum polycephalum*: Towards a General Model System for Cognition

ICSEM 10 Costa Rica

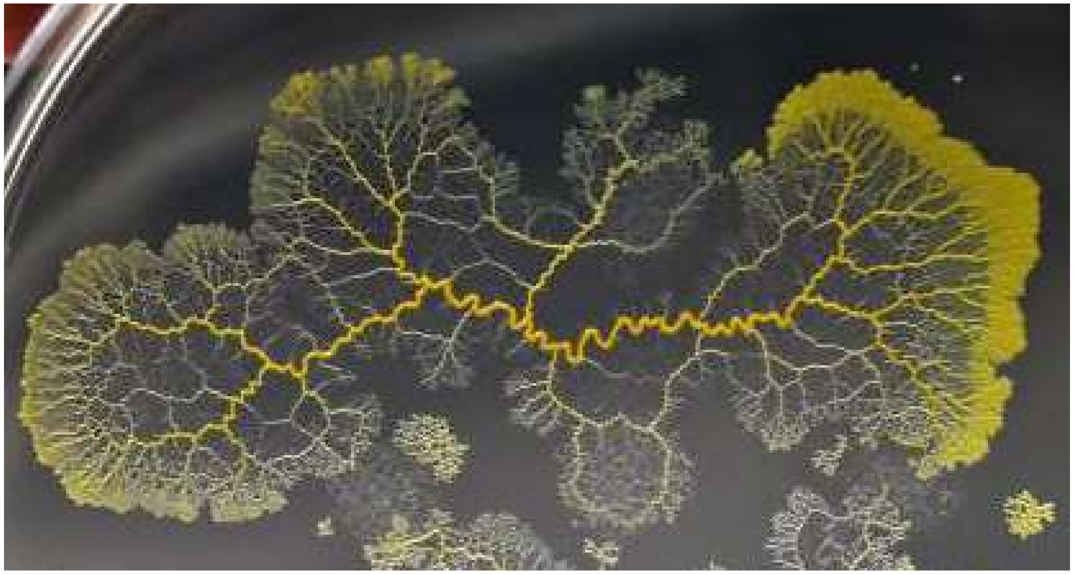
February 25th 2020

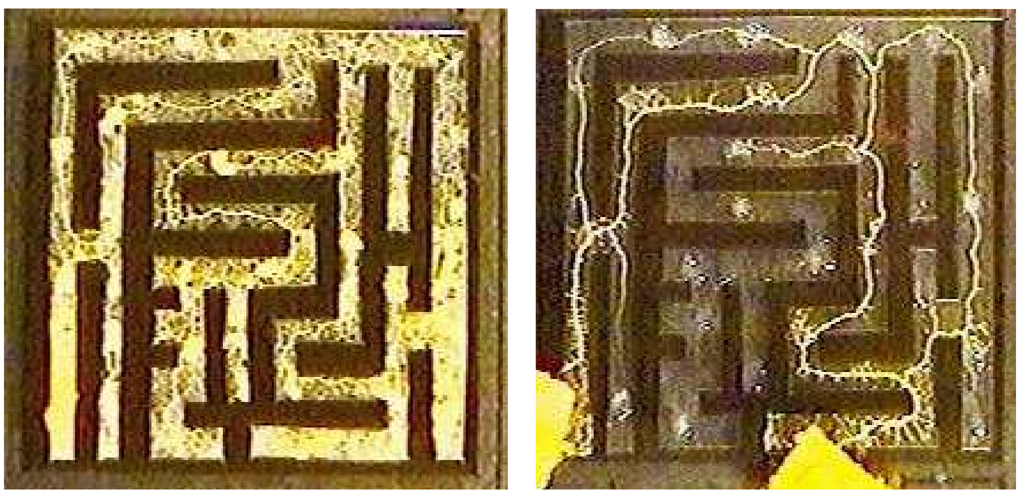
Christina Oettmeier



Ernst Haeckel 1904

Physarum polycephalum





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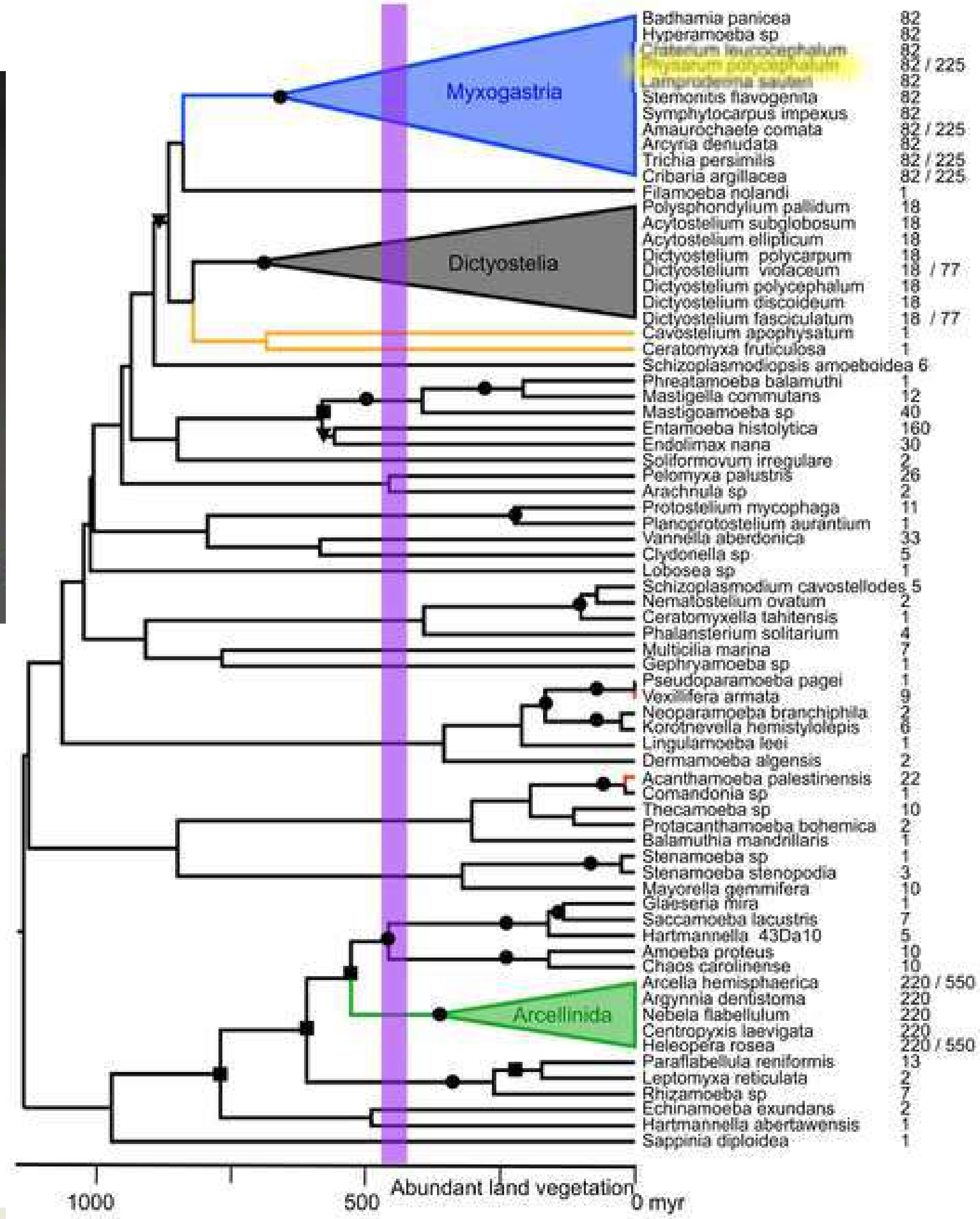

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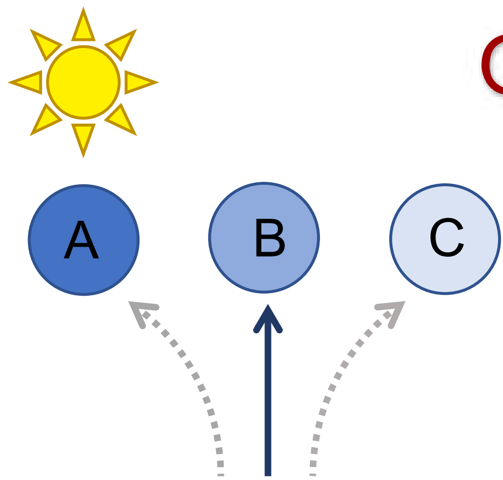
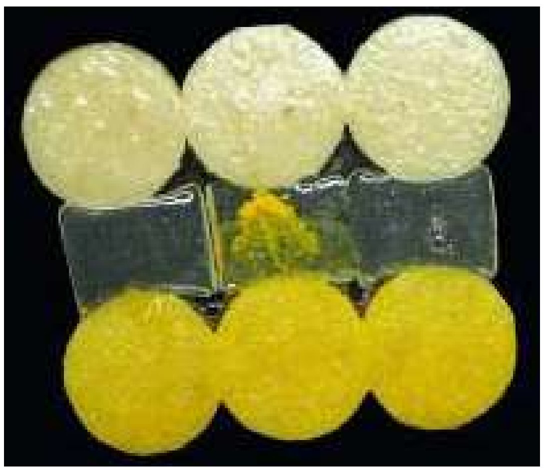
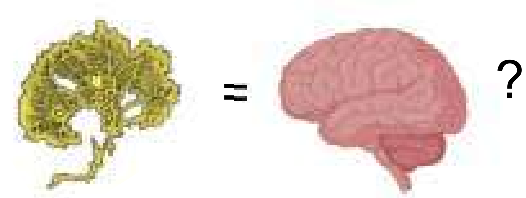
Observed complex behavior



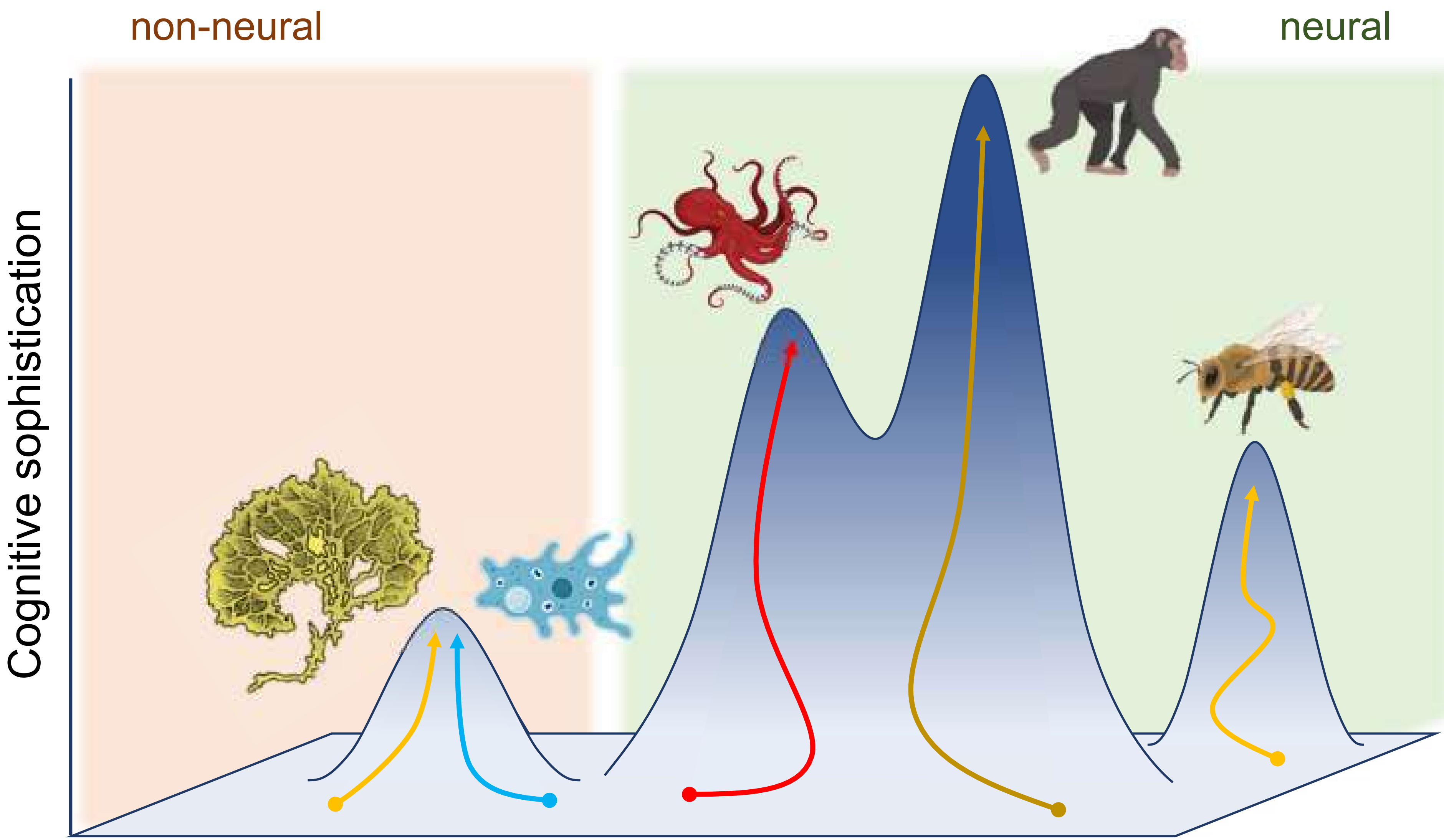


decision making	Latty & Beekman (2011), *Proc. R. Soc. B* **278**
network optimization	Shirakawa & Gunji (2007), *Biophys. Chem.* **128** Tero et al. (2010), *Science* **327**
habituation	Boisseau et al. (2016), *Proc. R. Soc. B* **283**
external memory	Reid et al. (2012), *PNAS* **109**
anticipation of periodic events	Saigusa et al. (2008), *PRL* **100**

Minimal cognition



Convergent evolution of cognition



Non-neural substrate

Ultrastructure

- cytoskeleton
- cell organelles
- composition and structure

Cell movement

- fluid flows
- locomotion
- network organisation

Metabolism

- metabolic state

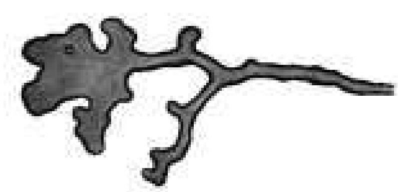
- cell signaling
- receptors (light, stretch, chemicals…)
- calcium
- (epi)genetics

…

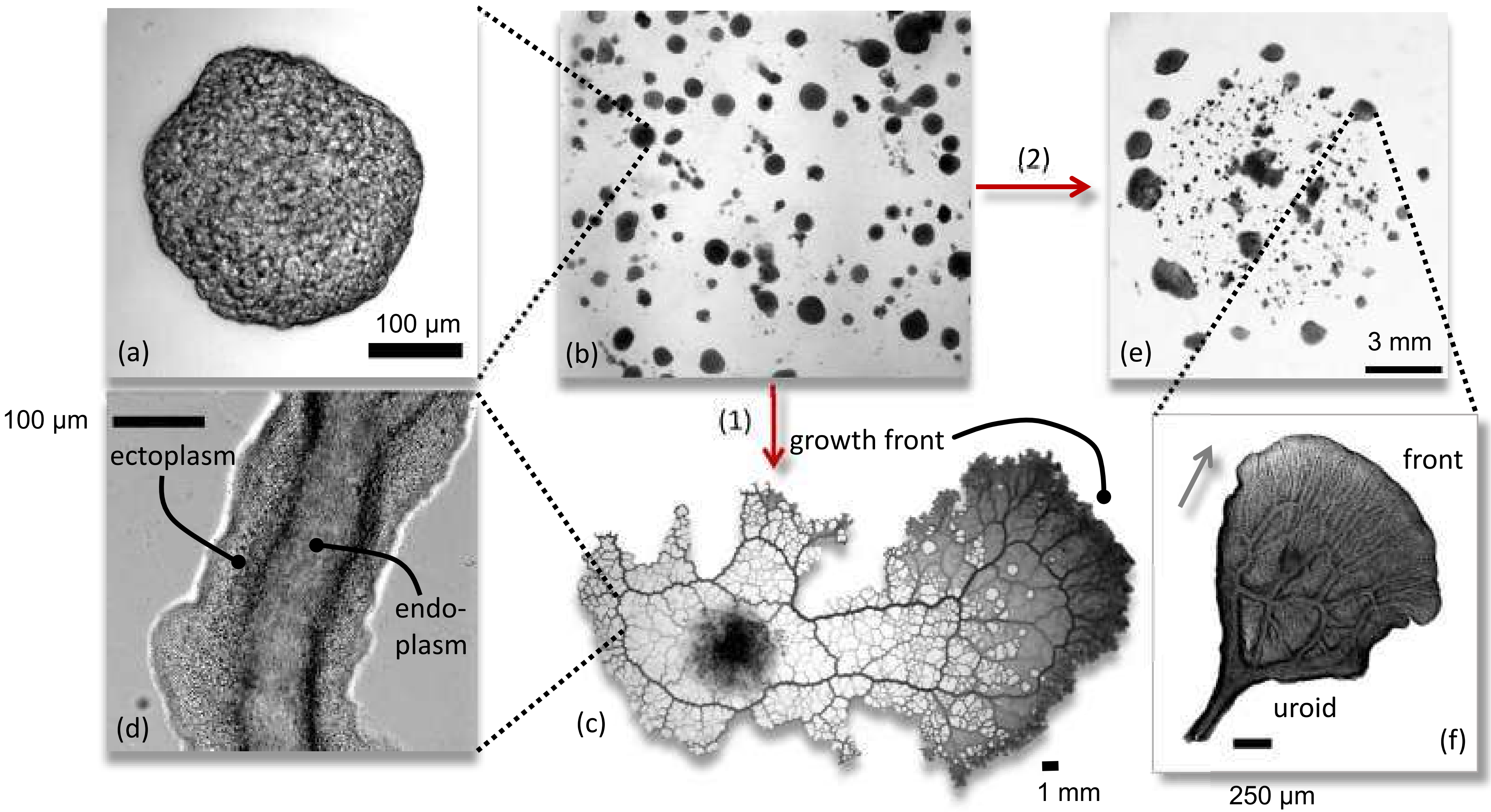
sensory input

information processing

behavior



Morphological variation

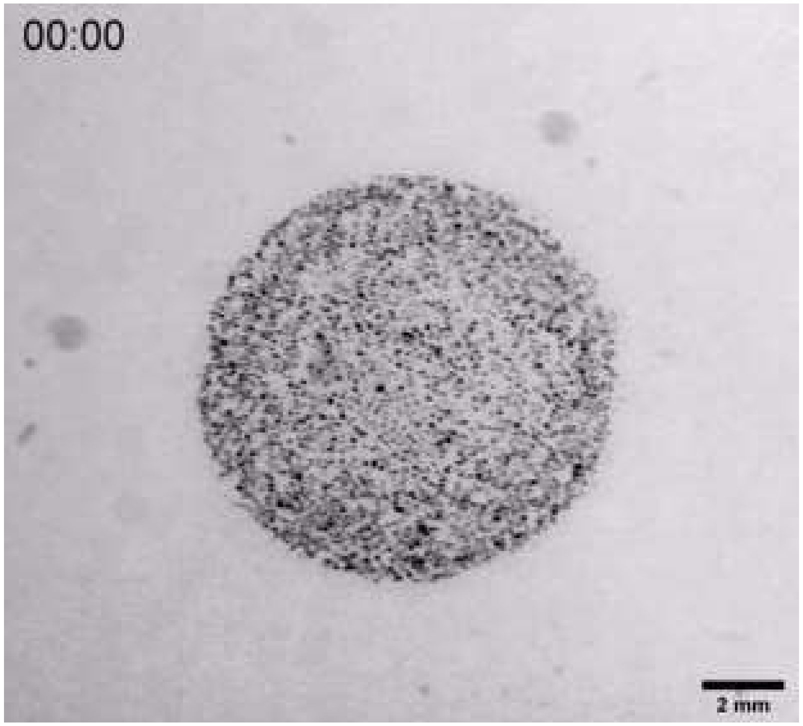


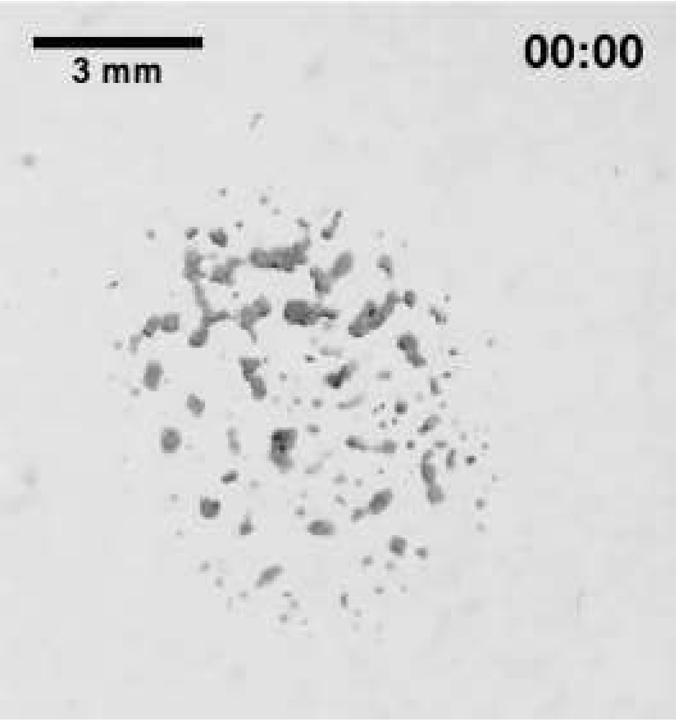
Oettmeier et al. (2018), *J. Phys. D: Appl. Phys.* **51**

Decision-making without a brain

developmental decisions versus **behavioural decisions**

[hh:mm]





[hh:mm]

no glucose

→ foraging pattern

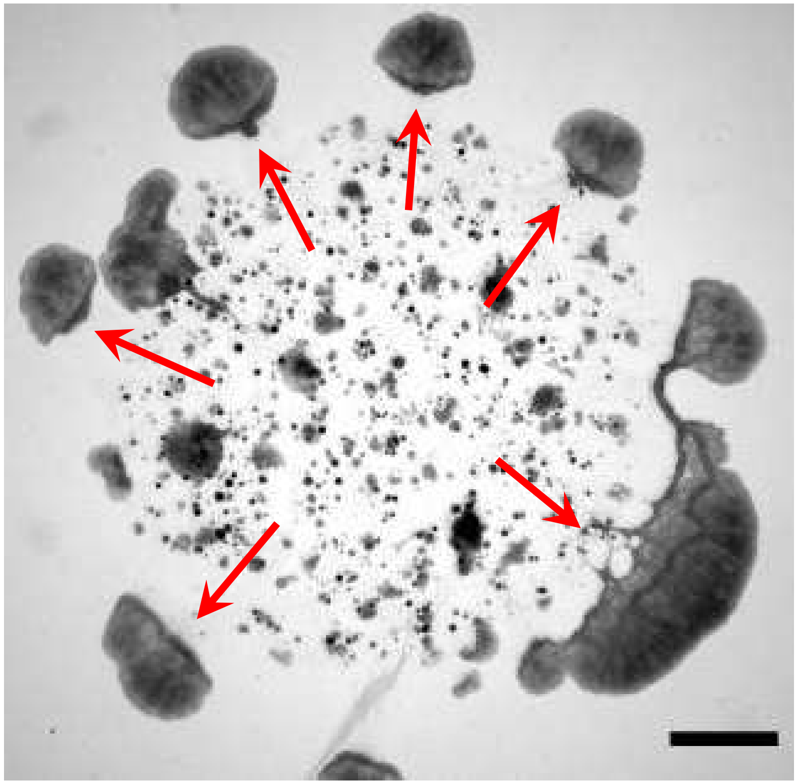
Lee et al. (2018), *J. Phys. D: Appl. Phys.* **51**

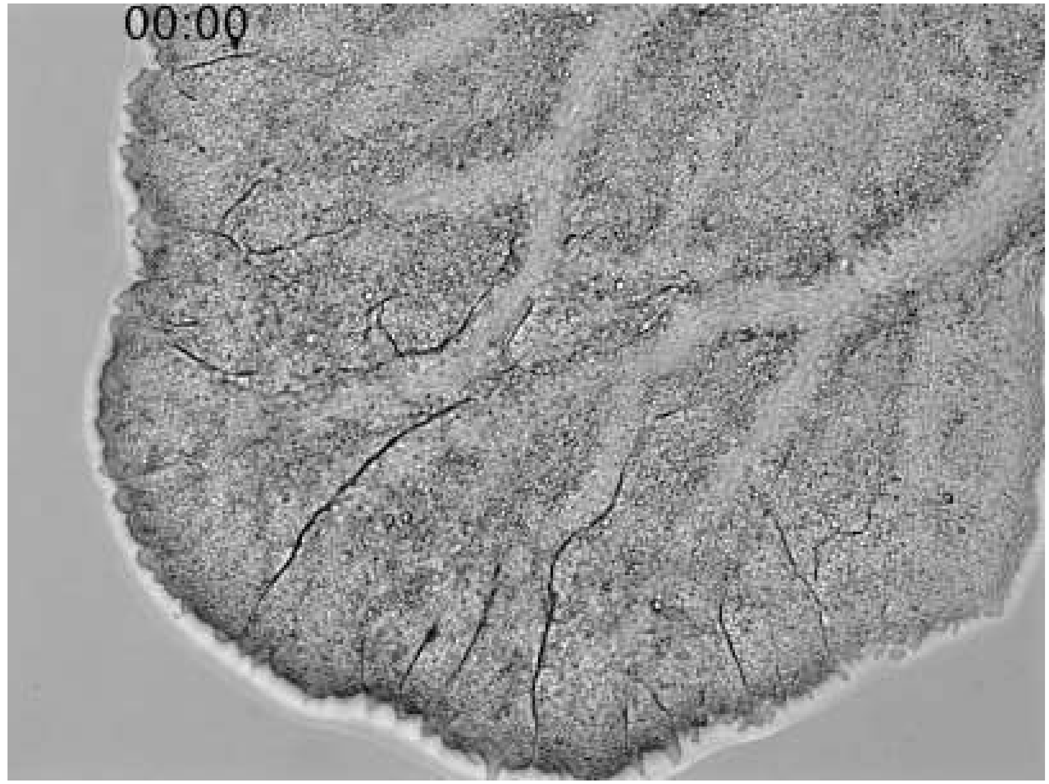
enough nutrients

→ percolation transition

Fessel et al. (2012), *PRL* **109**

Migrating mesoplasmodia

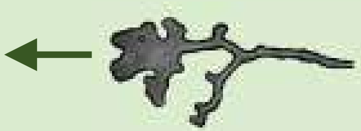




[min:s]

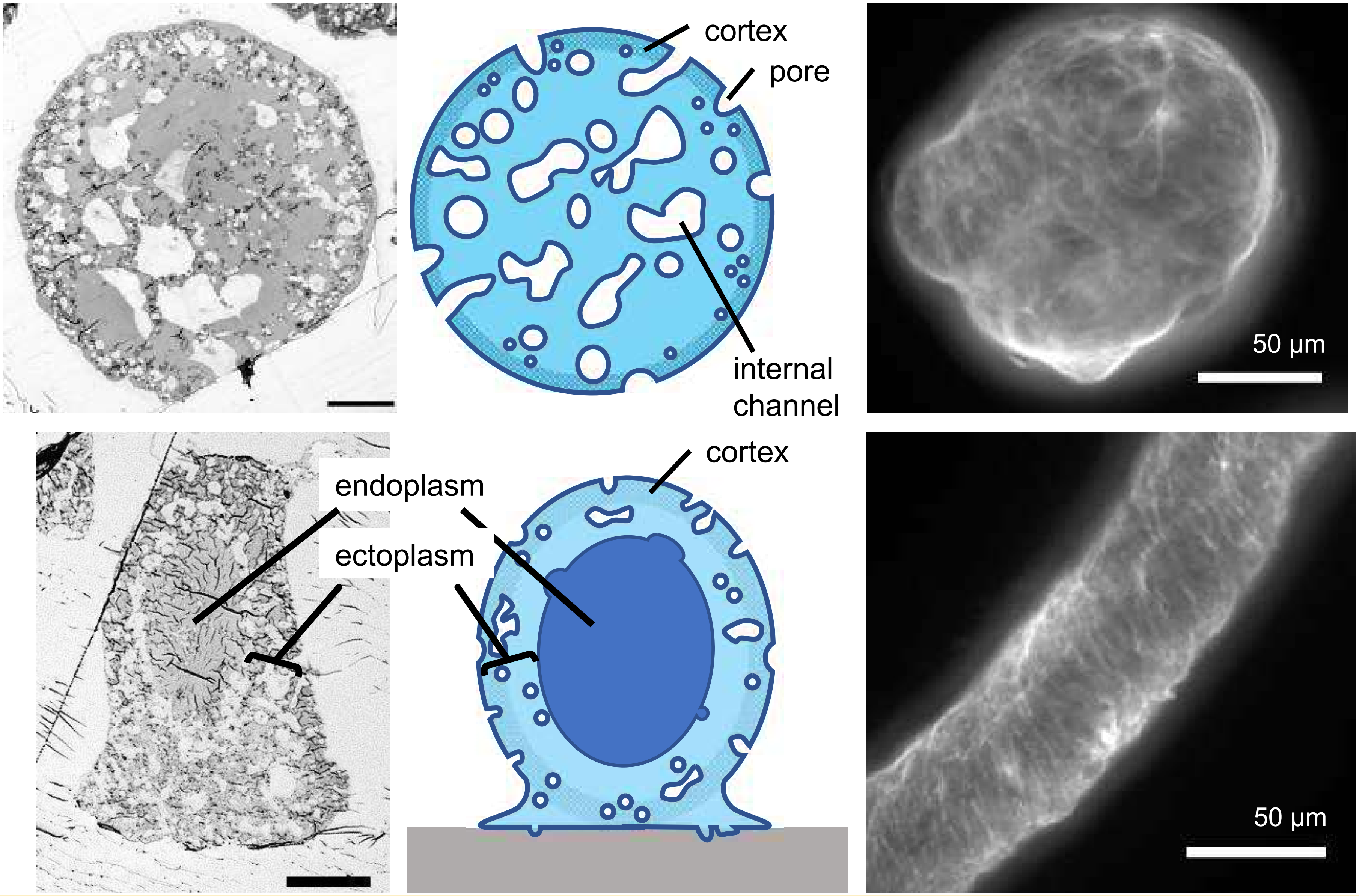
How does an apparently simple organism coordinate sophisticated behavior?

oscillations carry information



cell movement

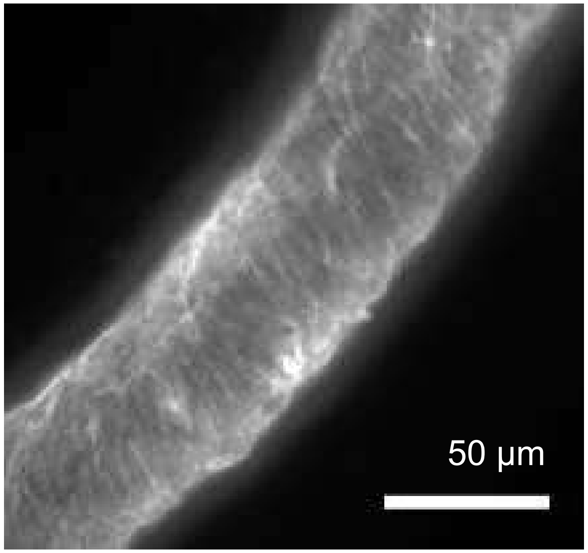
Ultrastructure = 'hardware'

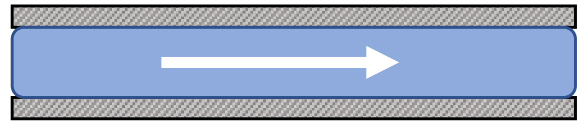


Oettmeier et al. (2018), *J. Phys. D: Appl. Phys.* **51**

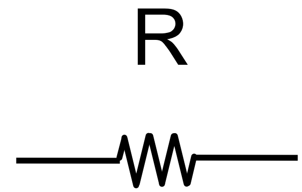
microanatomy

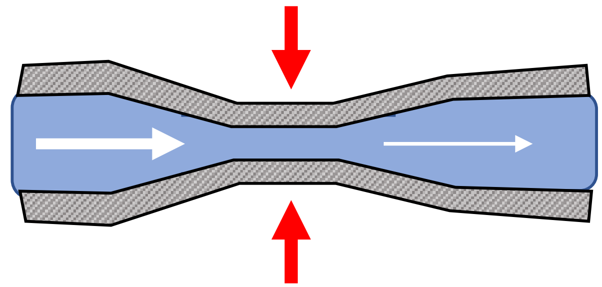
Electronic-hydraulic analogy





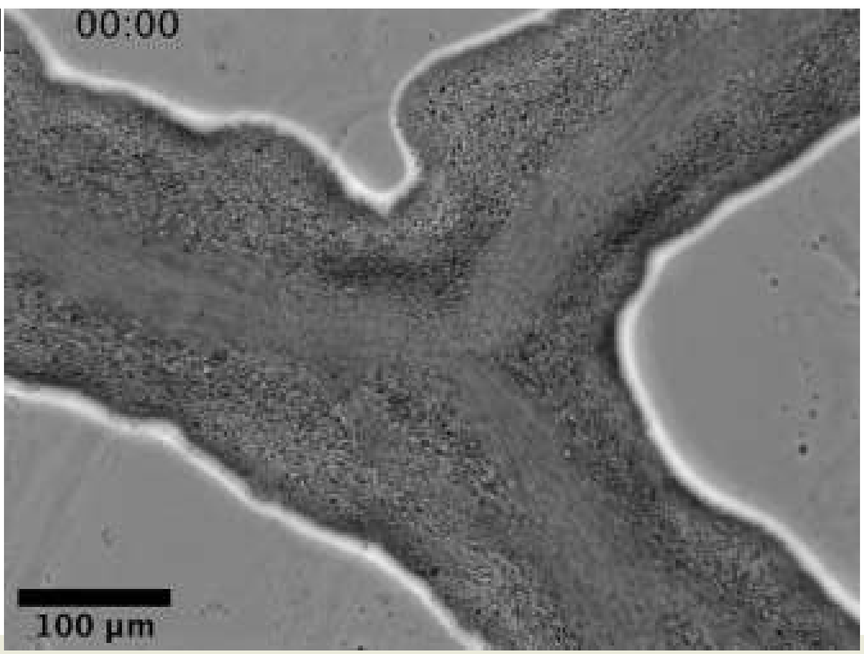
less resistance (R)



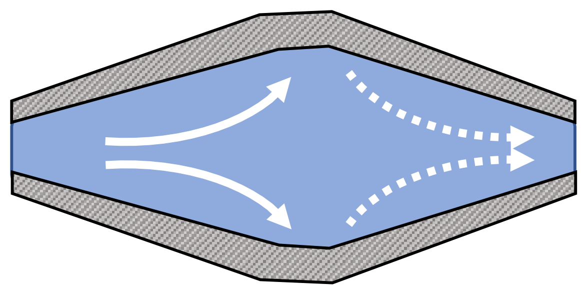


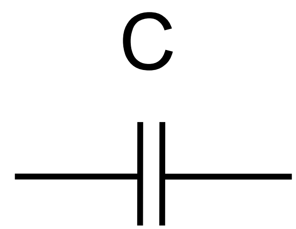
more resistance (R)

[s]



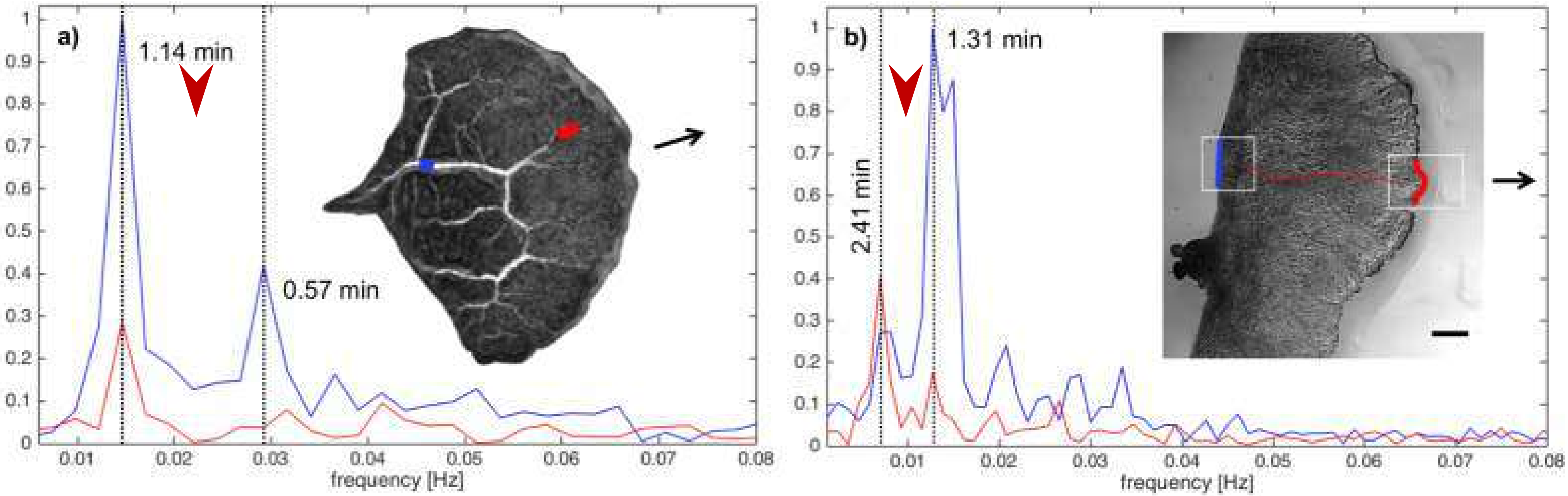
V = pressure
I = volumetric flow rate



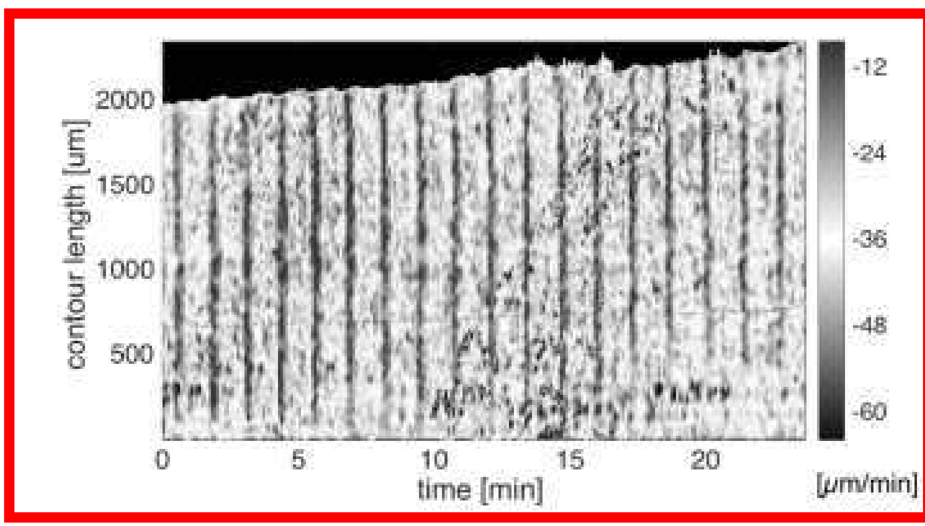


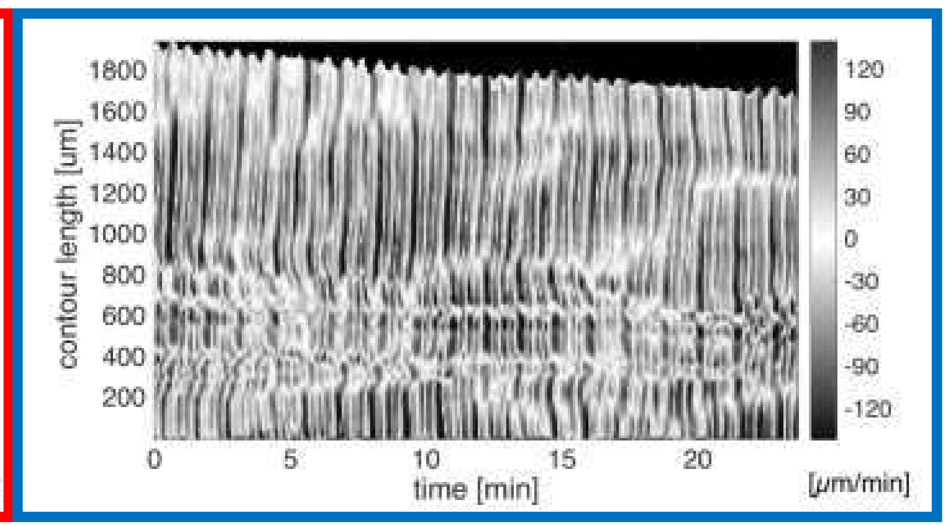
Capacitors = elastic walls

Frequency selection in mesoplasmodia



Low-pass filter

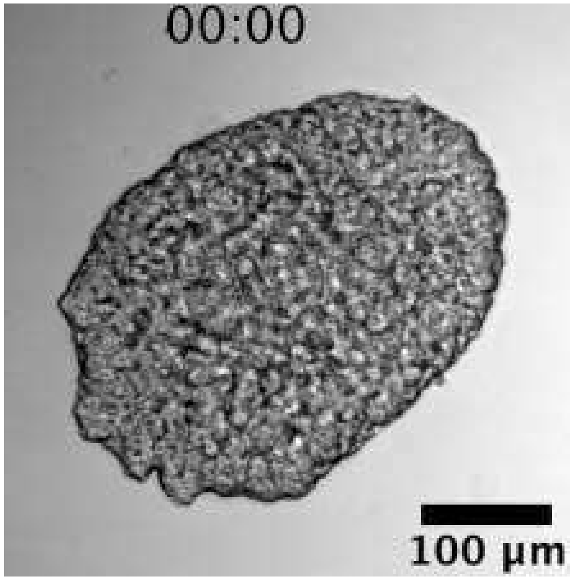


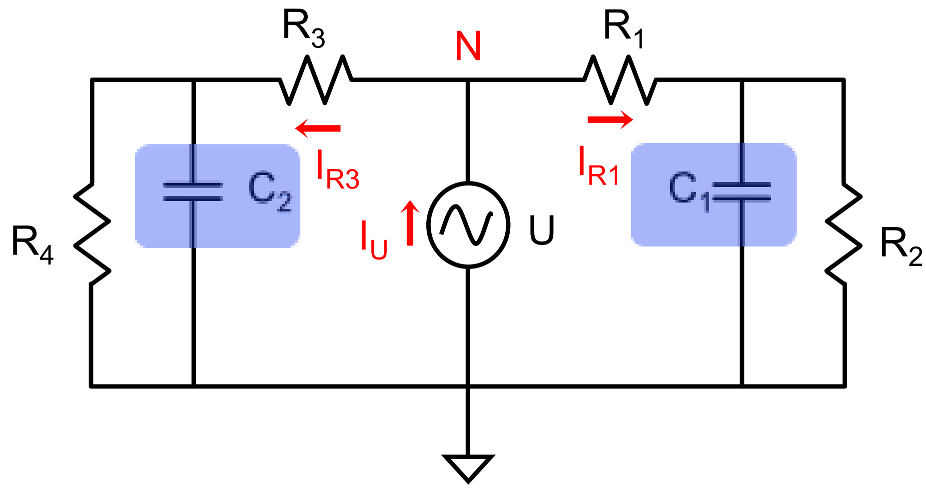


Oettmeier & Döbereiner (2019), *PLOS one* **14**

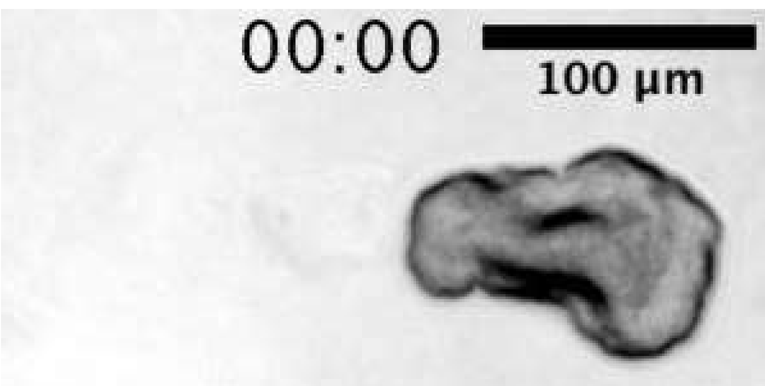
Onset of migration

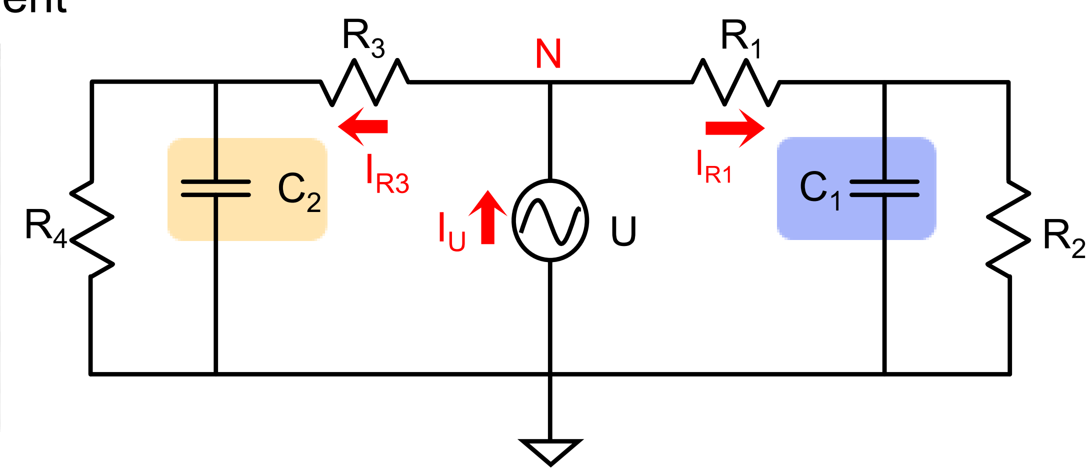
[min:s]





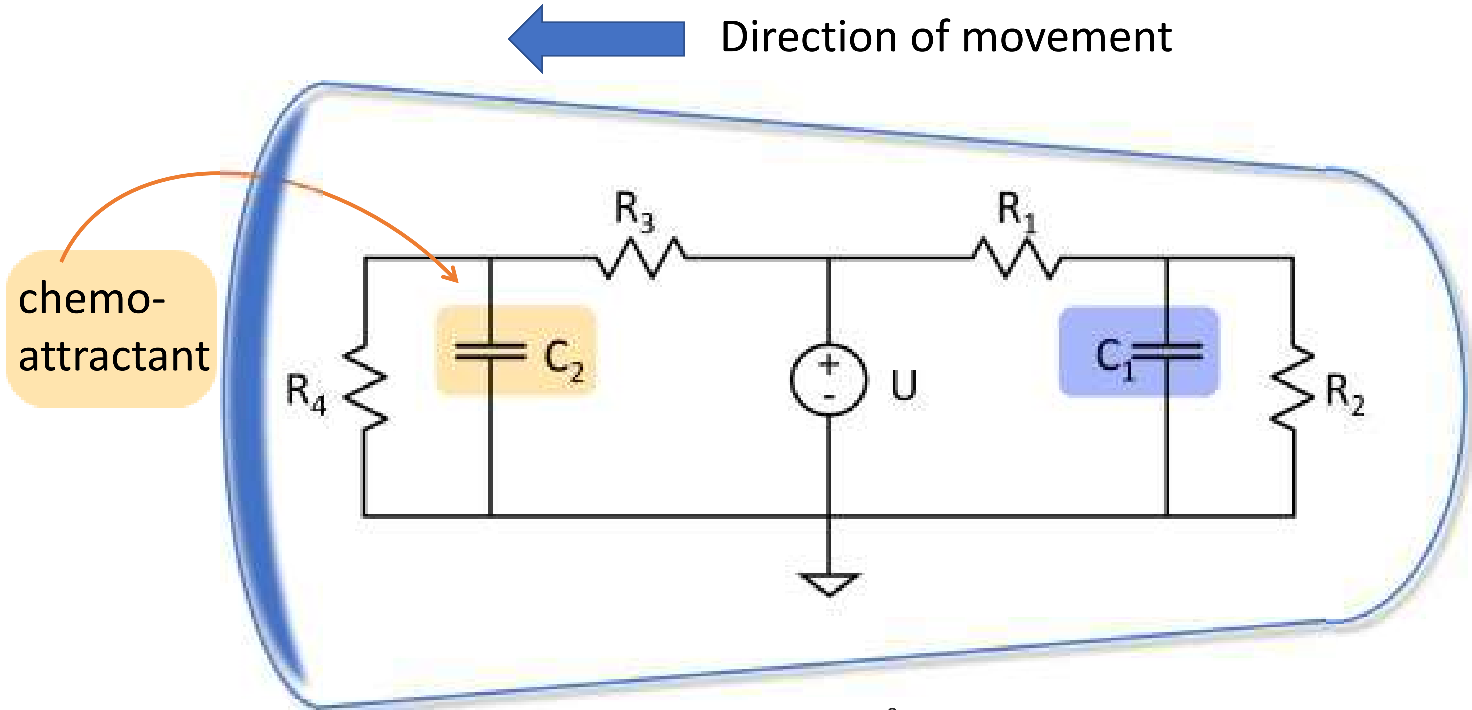
[min:s] Direction of movement



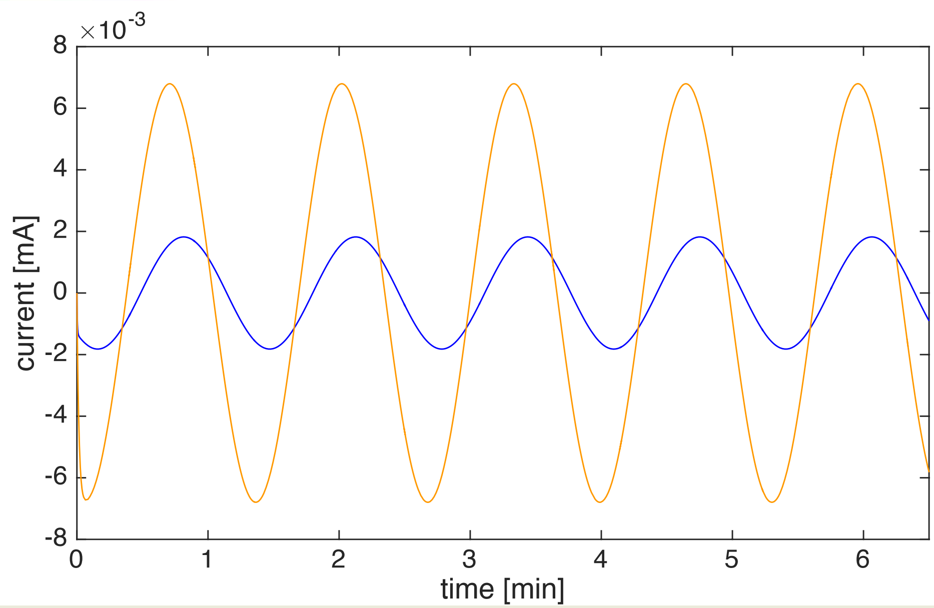


$I_{R3} > I_{R1}$

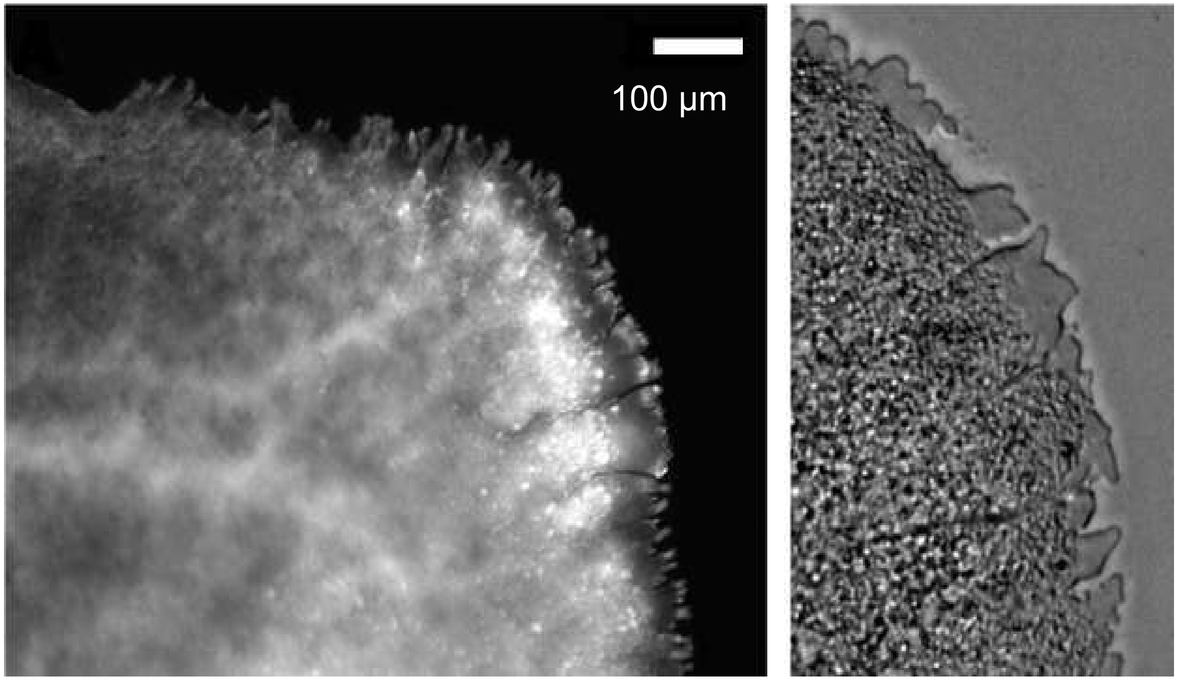
Model for chemotaxis

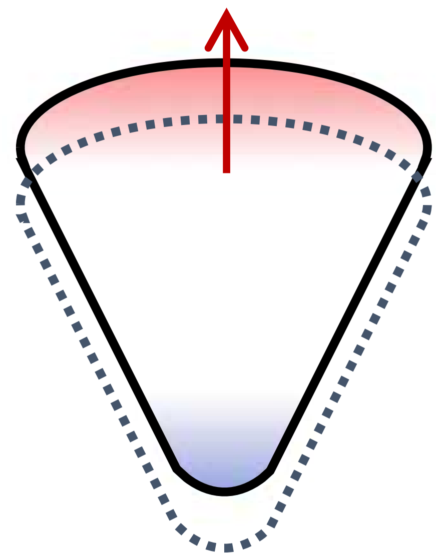


- ➤ Elasticity gradient $C_2 > C_1$
- ➤ Current flows to the left



Softness gradient

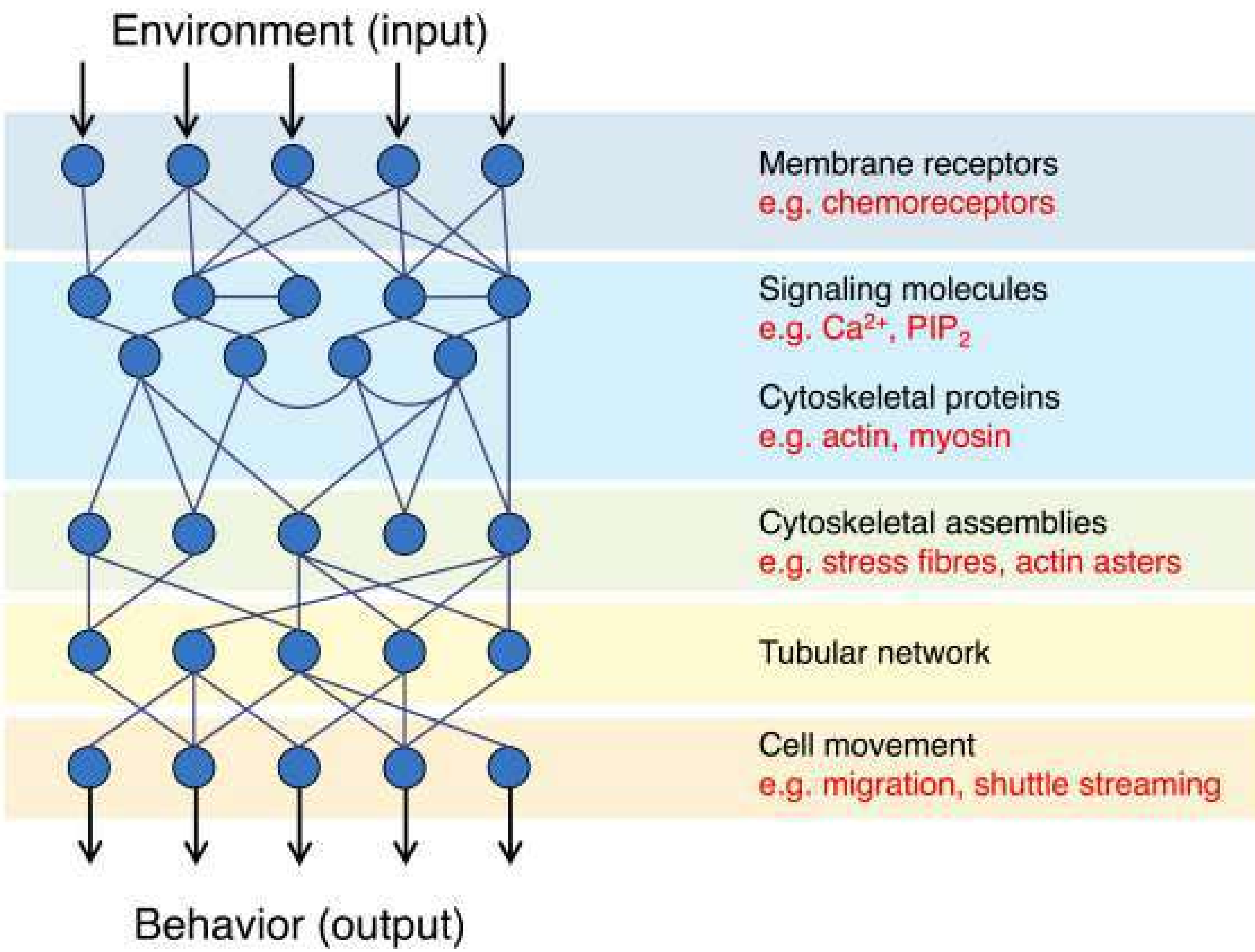




Symmetry breaking induced by softness gradient

Oettmeier et al. (2018), *J. Phys. D: Appl. Phys.* **51**

Summary: Minimal cognition as network of networks

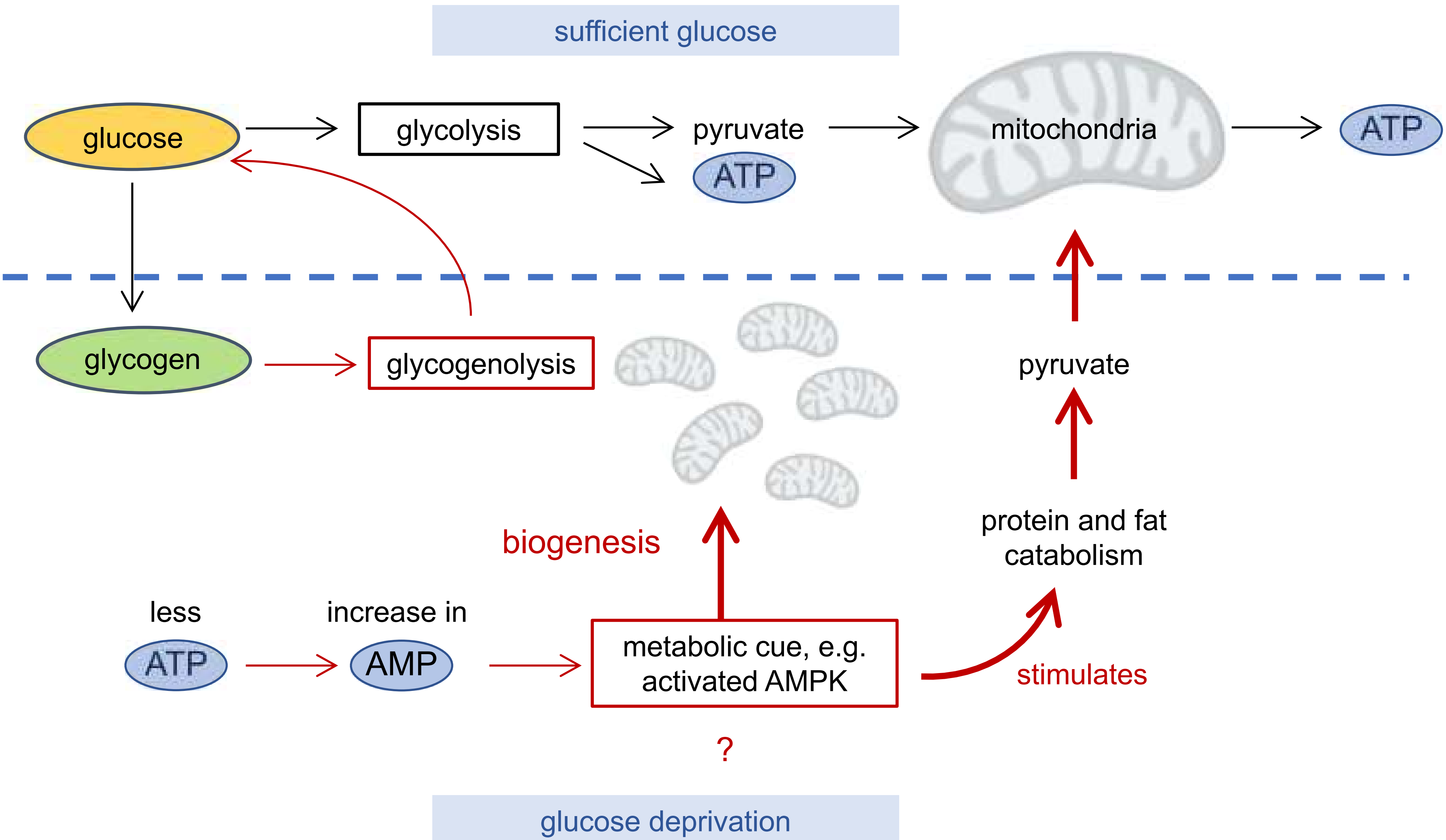


emergence of minimal cognition

ability to make **decisions**

high molecular complexity, eg. tyrosine kinases

Role of mitochondria



Oettmeier & Döbereiner (2019), *Protoplasma*

Summary

lumped parameter model

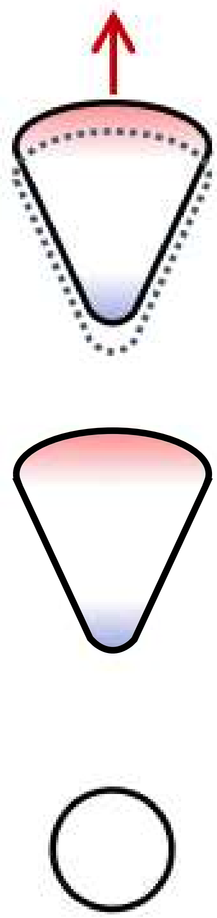
Cell movement

- fluid flows
- locomotion
- network organisation

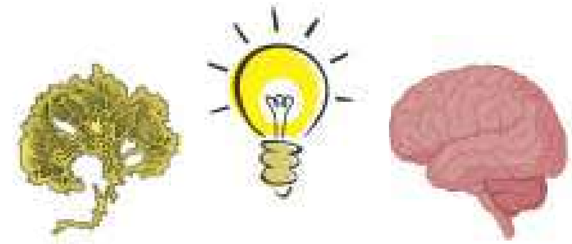
Ultrastructure

- actin cytoskeleton
- elasticity
- vein parameters

'substrate'



ATP



Mitochondria

- ROS
- Ca^{2+}
- NADPH

dilate veins, increase flow

contractility, stiffness, time-keeping

A morphological and molecular study of myxomycetes collected from *Zea mays*

Myriam de Haan[a], Johann Gangl[b], Marc Lemmens[b]

[a]Meise Botanic Garden, Research Department, Nieuwelaan 38, BE-1860 Meise, Belgium

[b]University of Natural Resources and Life Sciences, Vienna, Austria

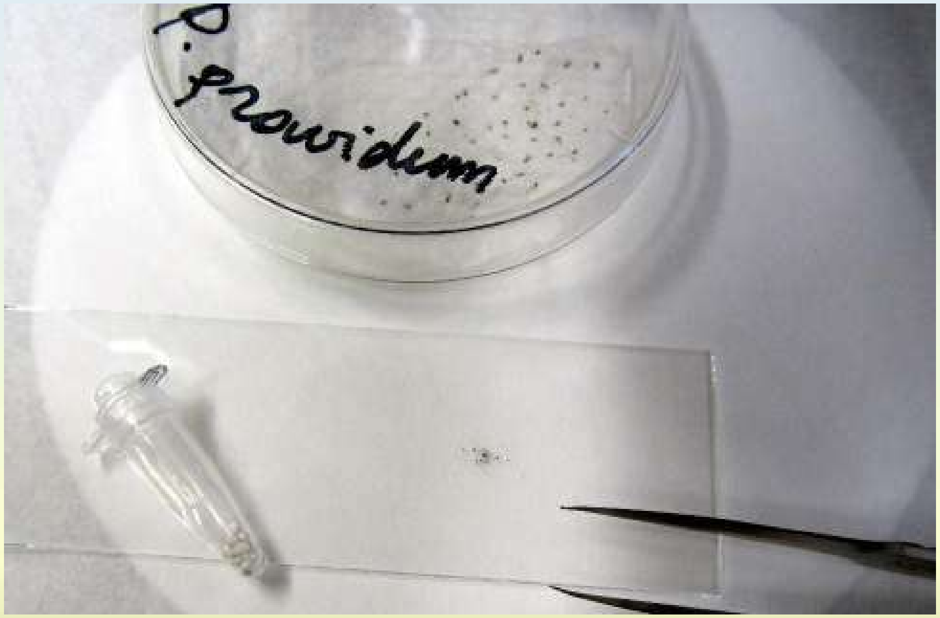
32 moist chamber cultures

10 silks

10 side ear

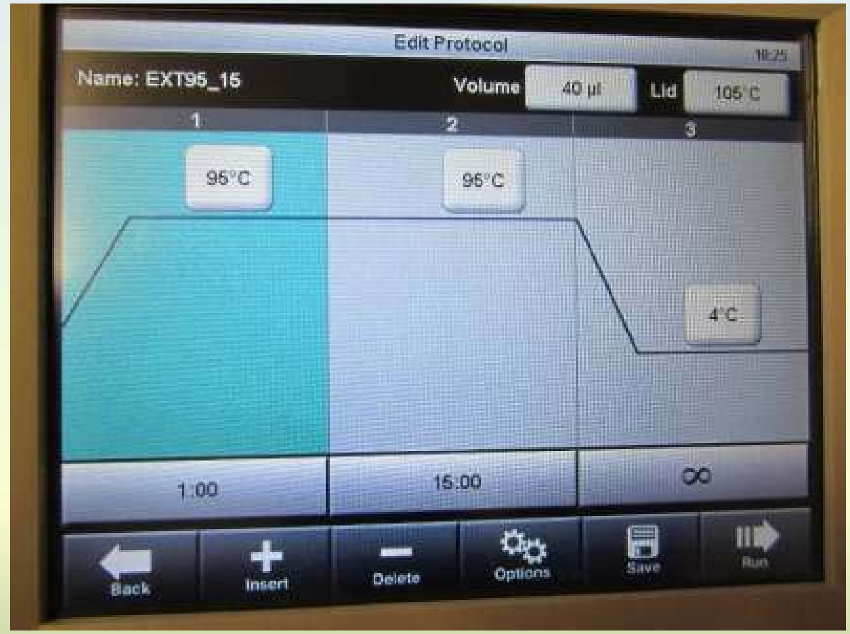
12 leaves

and a selection 41 samples from the field specimens collected 2015-2019



Zirconia/Silica beads 1 mm diam
BioSpec Products

Extraction program



PCR program for amplification of small-subunit ribosomal RNA gene

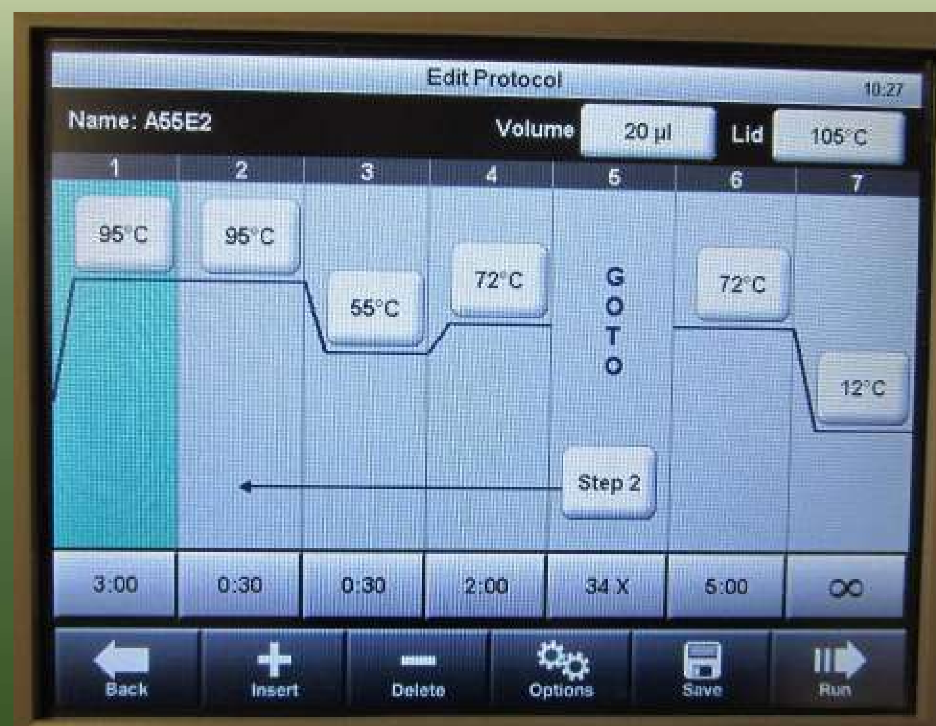
Primers:

GATCCTGCCAGTAGTGTATGC

GCAGGTTCACCTACGATTACC

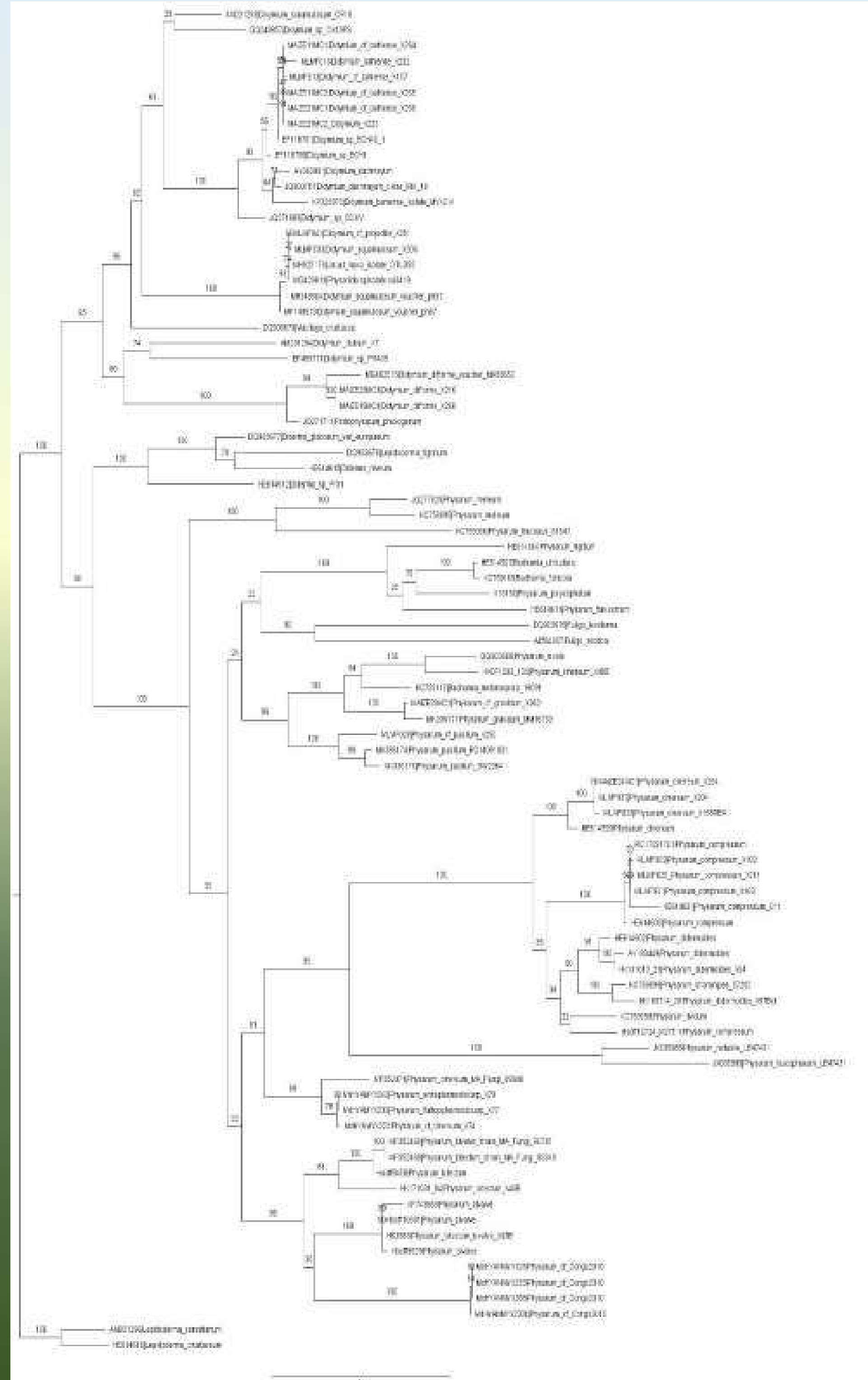
CTTTCGCTCTTGATCAACGGG

GGCGAGTGGTGAAATACG



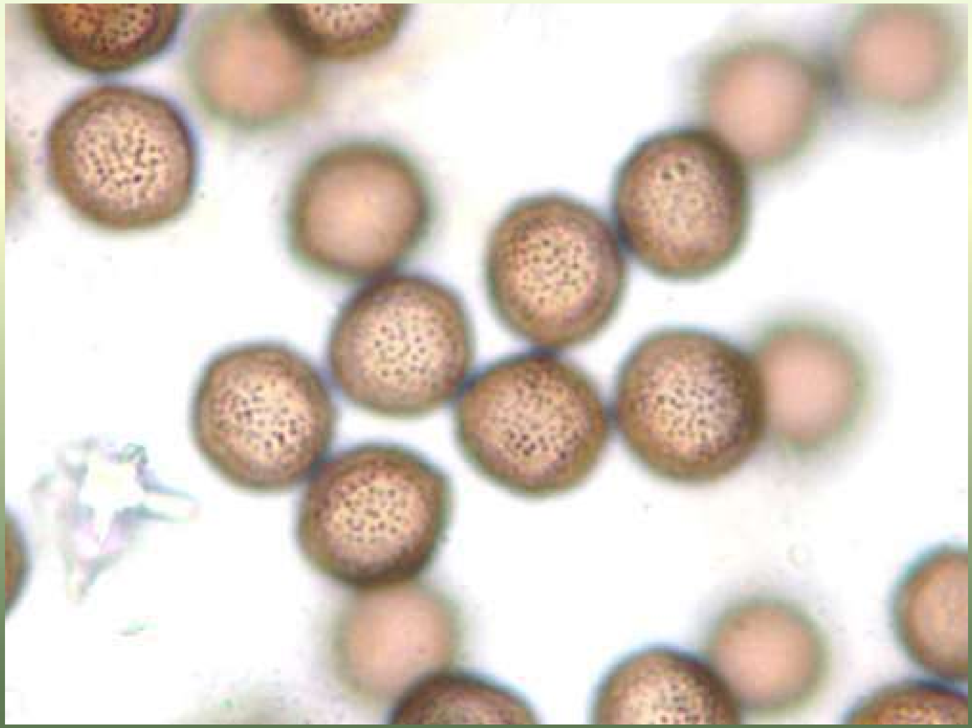
RAxML result

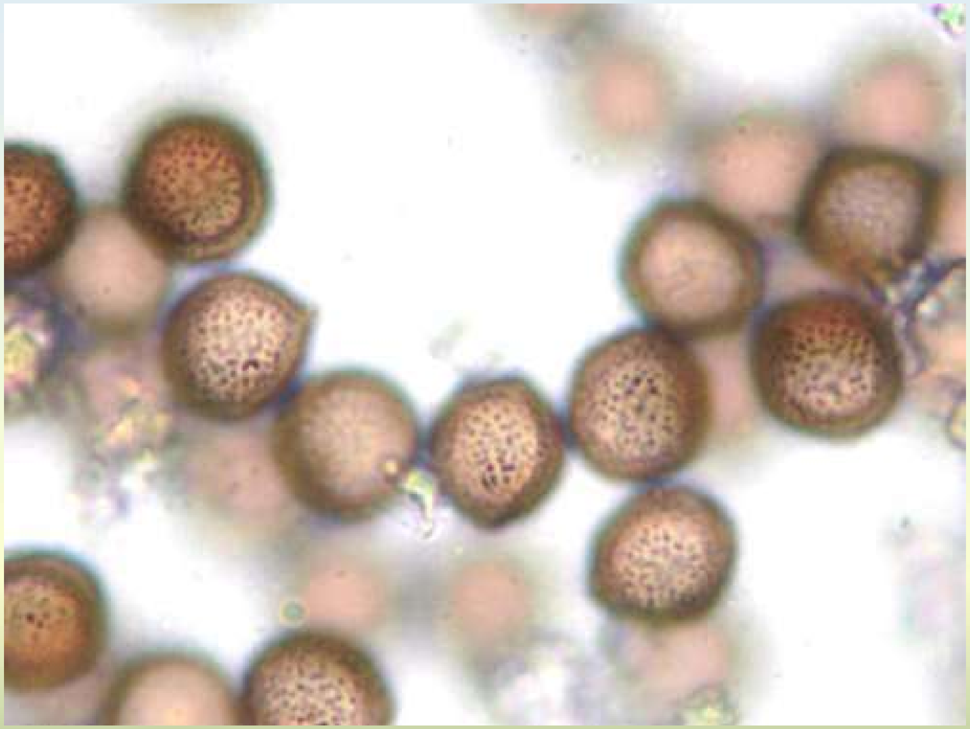
86 sequences
1577 aligned positions

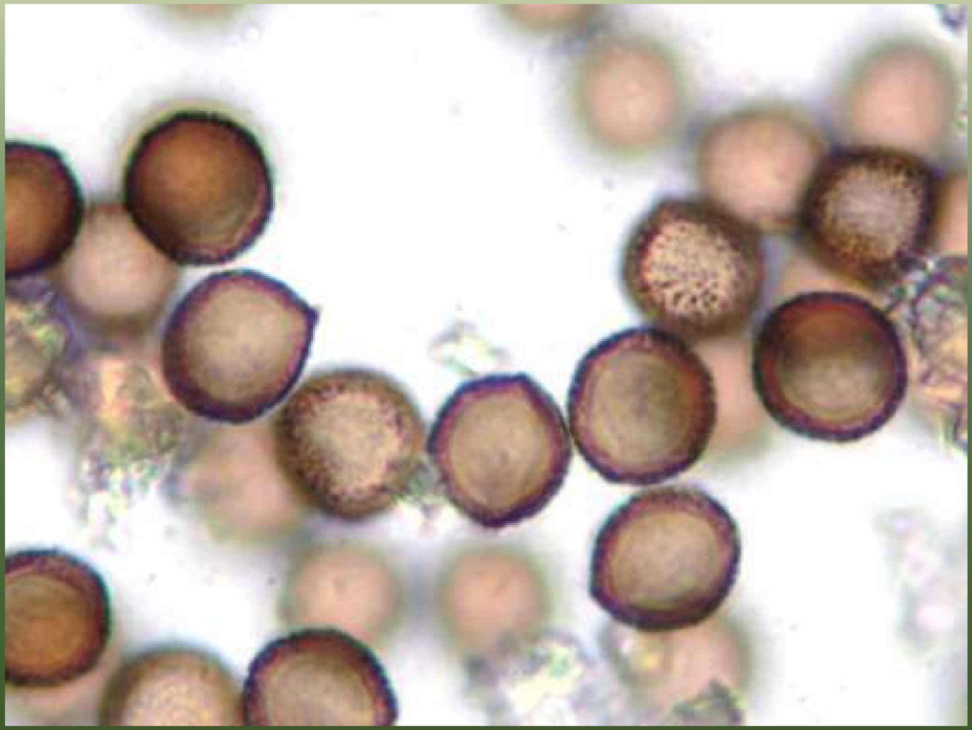


Didymium squamulosum?
MLMF041

Didymium squamulosum?
MLMF041



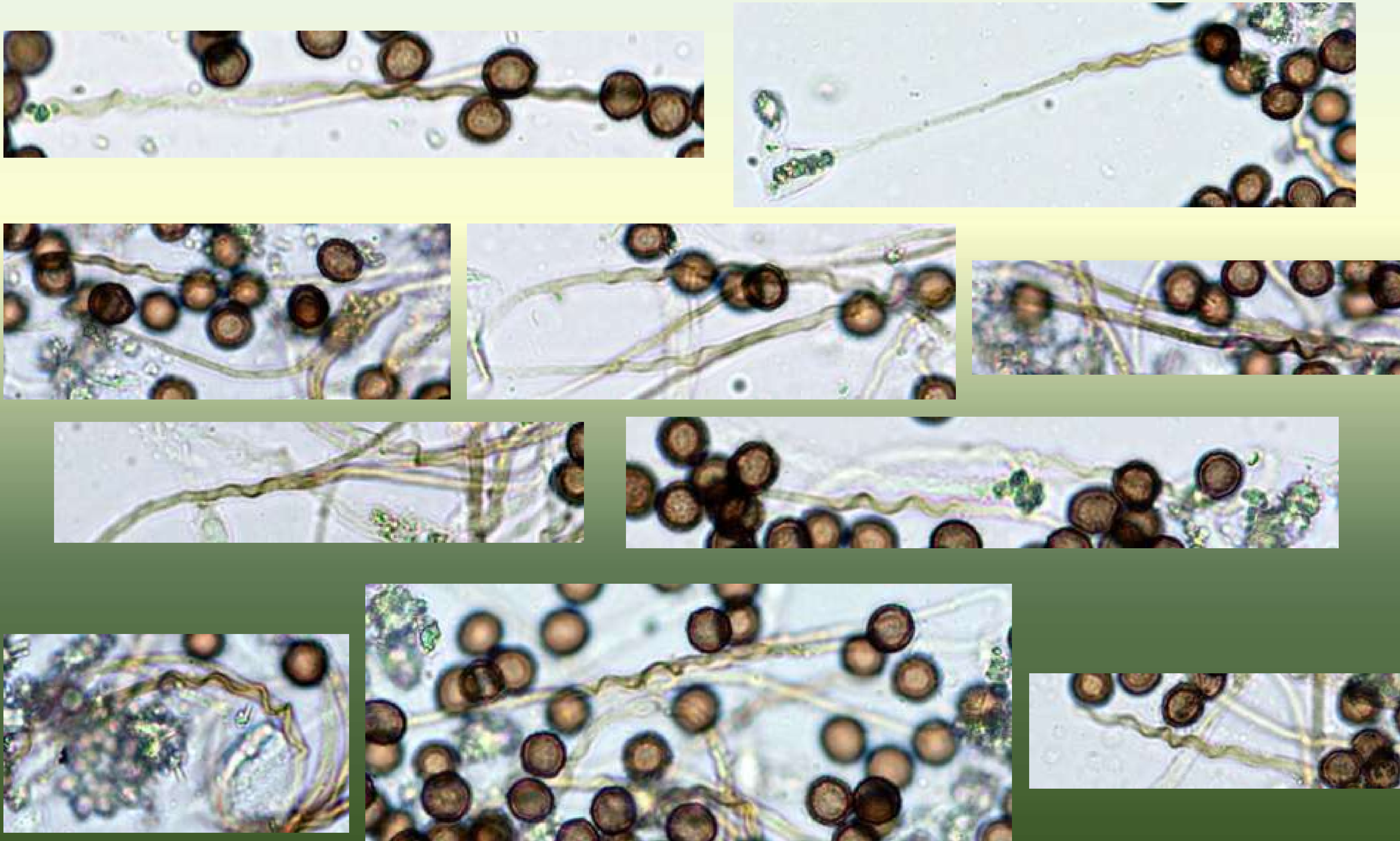




Spores: 8-9 µm

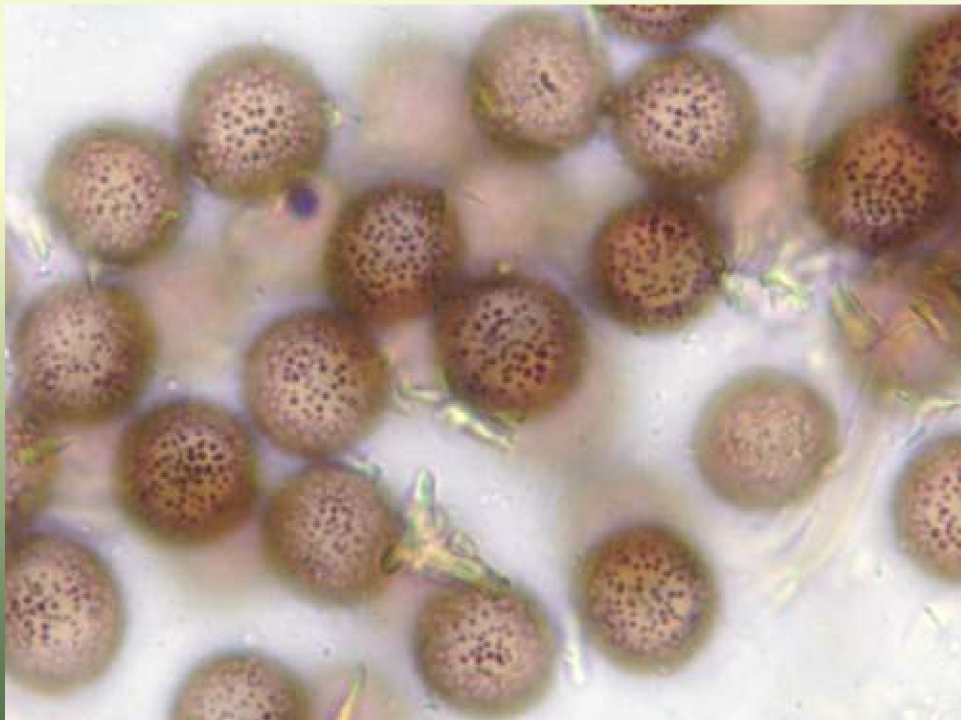
Didymium squamulosum or *projectile*?

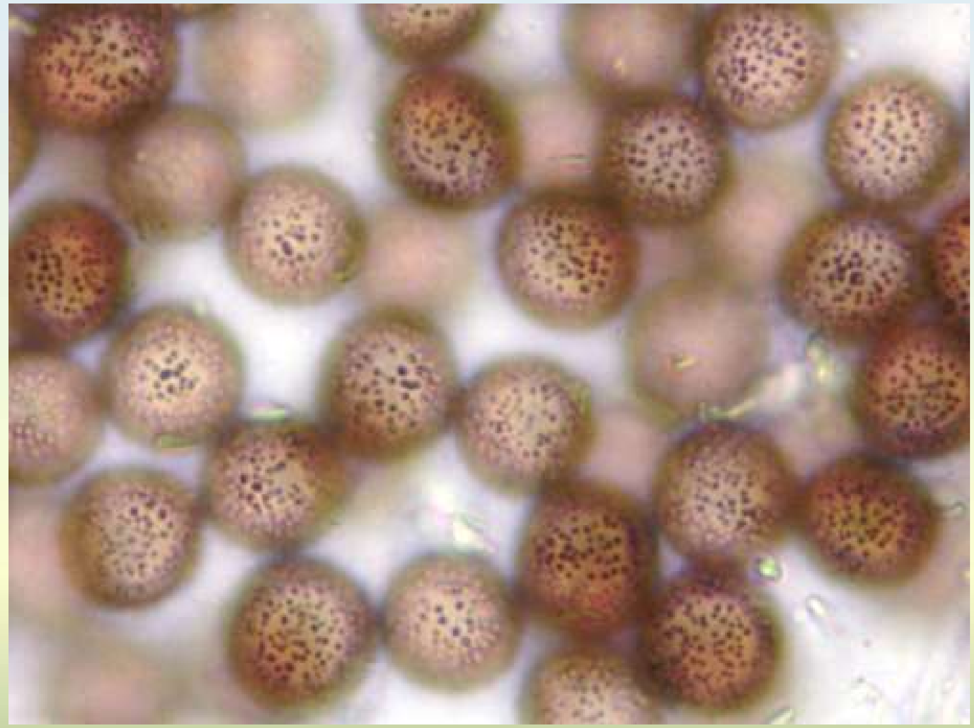
MLMF041

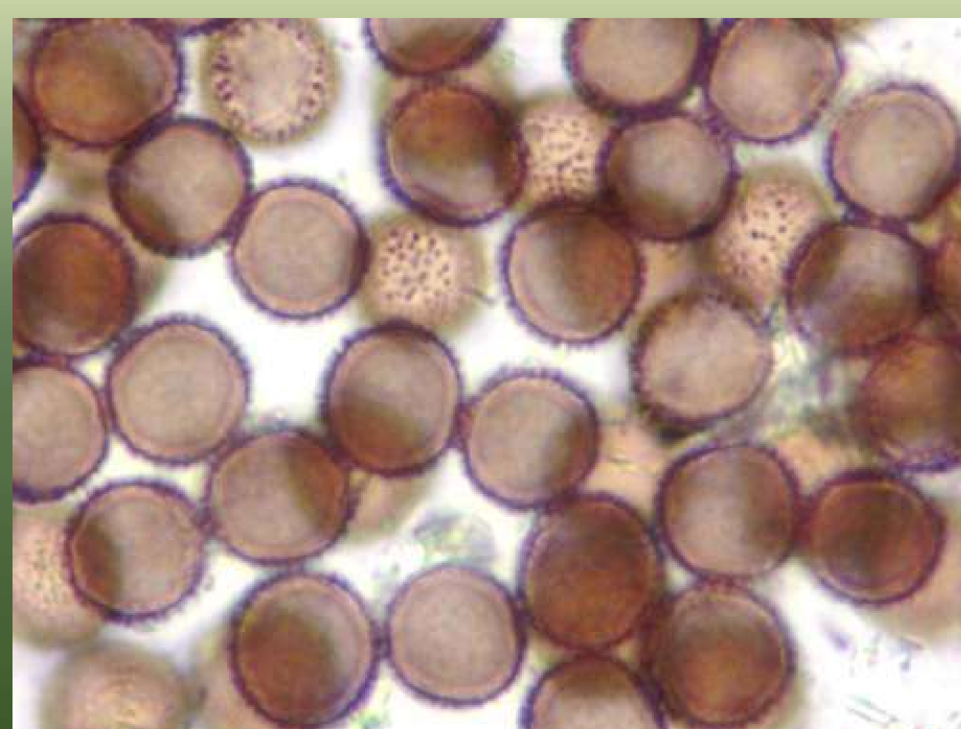


Didymium squamulosum
MLMF033

Didymium squamulosum
MLMF033



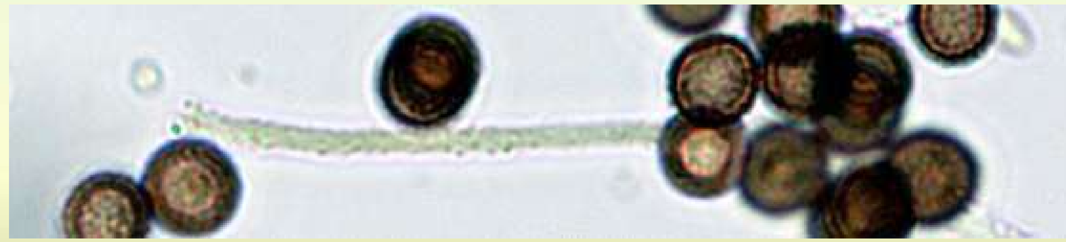


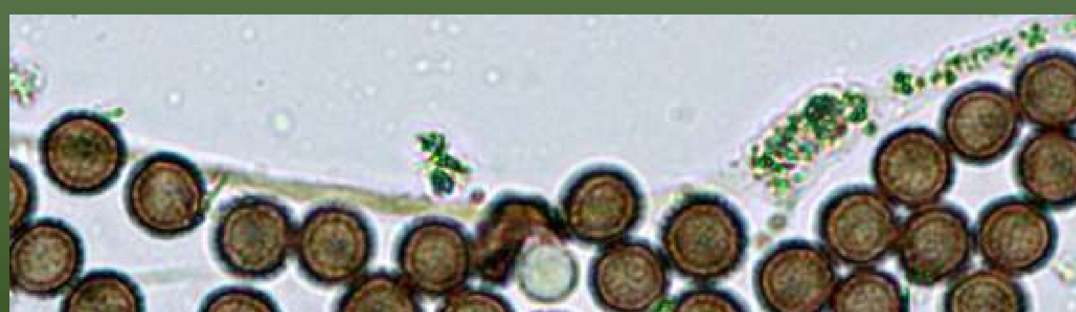


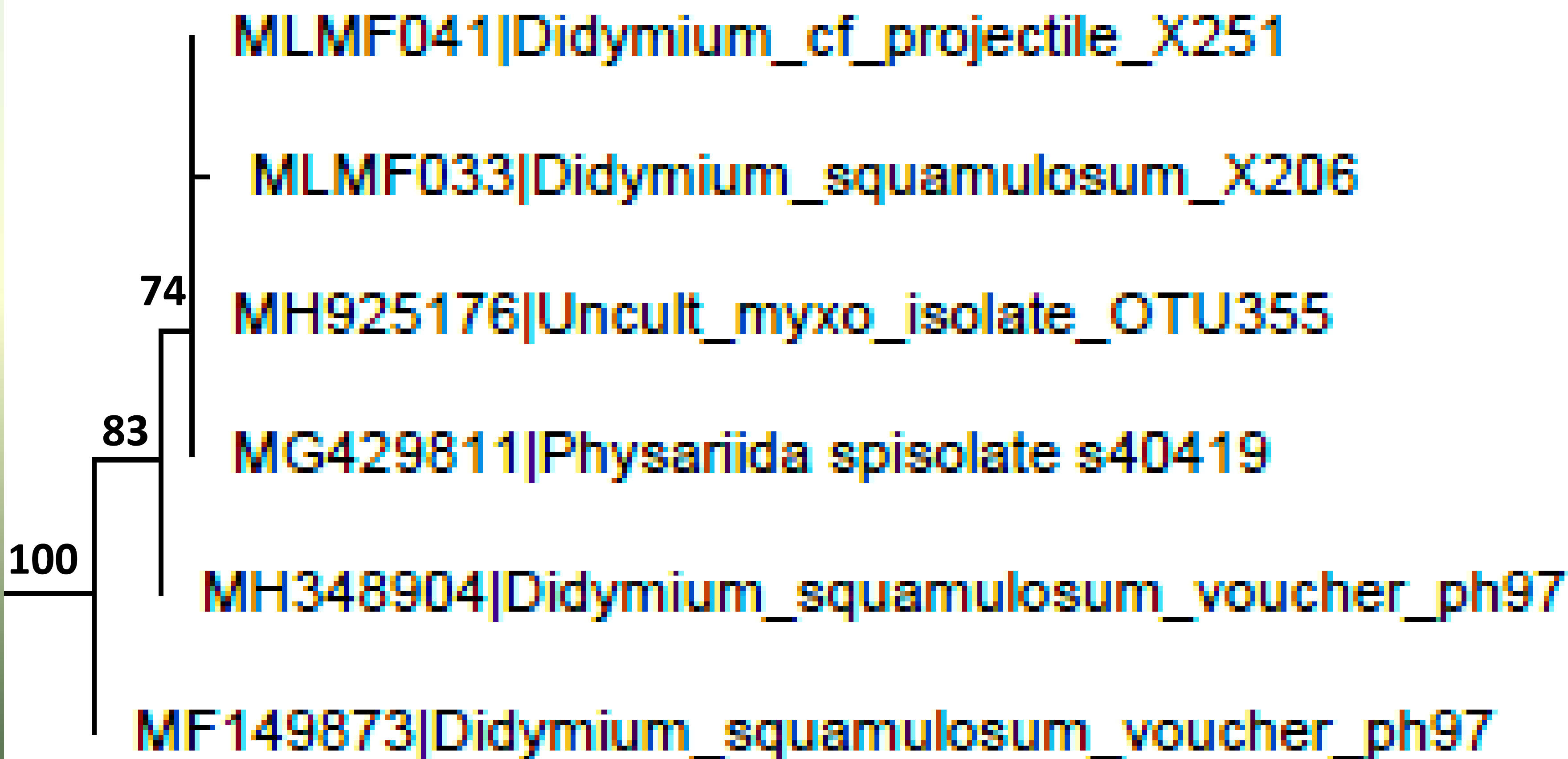
Spores: 8-9 µm

Didymium squamulosum

MLMF033



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MLMF033|Didymium_squamulosum_X206
MH925176|Uncult_myxo_isolate_OTU355
MG429811|Physariida spisolate s40419
MH348904|Didymium_squamulosum_voucher_ph97
MF149873|Didymium_squamulosum_voucher_ph97
74
83
100

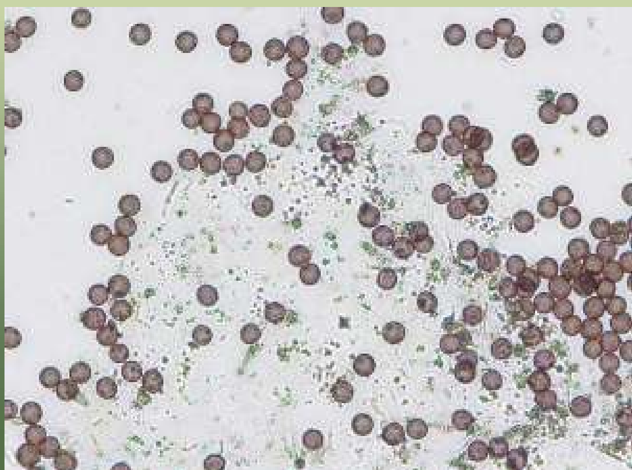
Didymium cf. *bahiense*

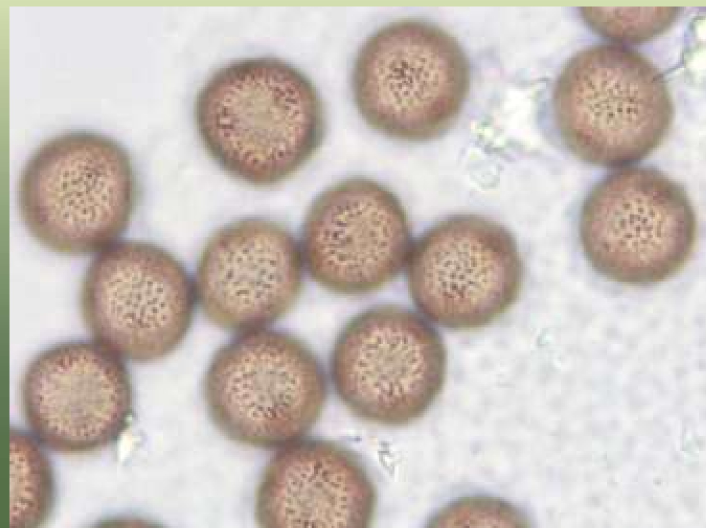
MLMF013

Spores: 9-10 µm

Didymium cf. *bahiense*

MLMF016

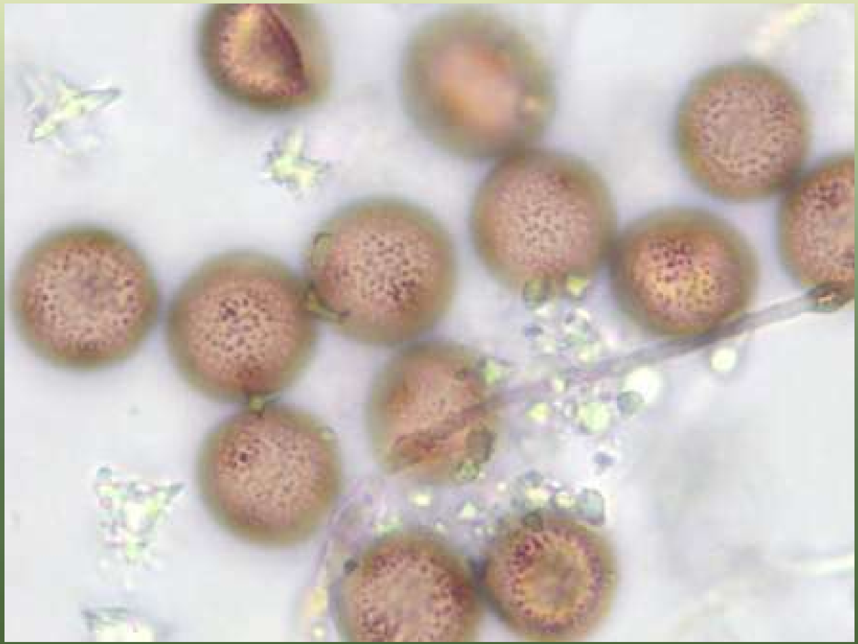




Spores: 8-10 µm

Didymium cf. *bahiense*

MAIZE11MC01

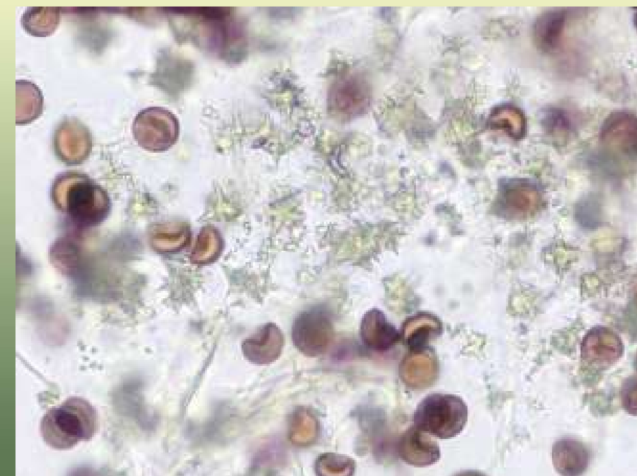


Spores: 9-10 µm

Didymium cf. *bahiense*

MAIZE11MC02

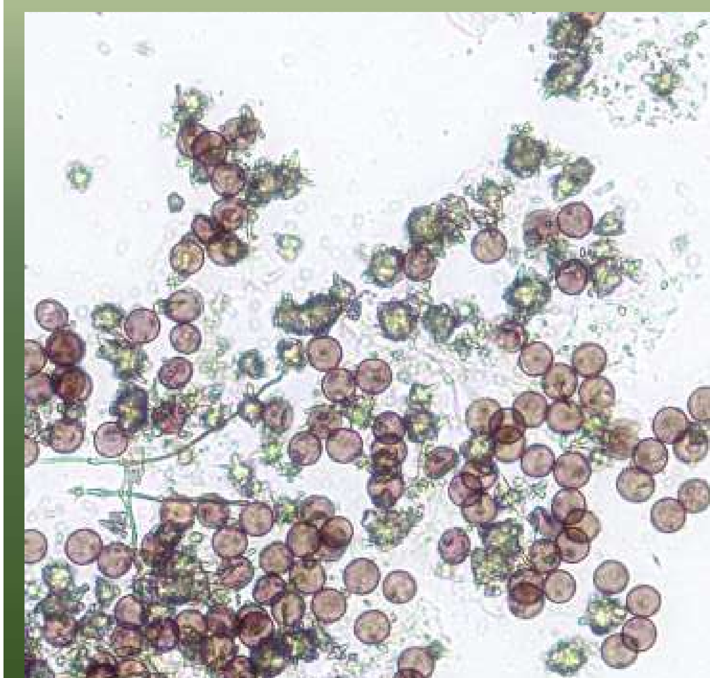
Spores: 9-10 µm

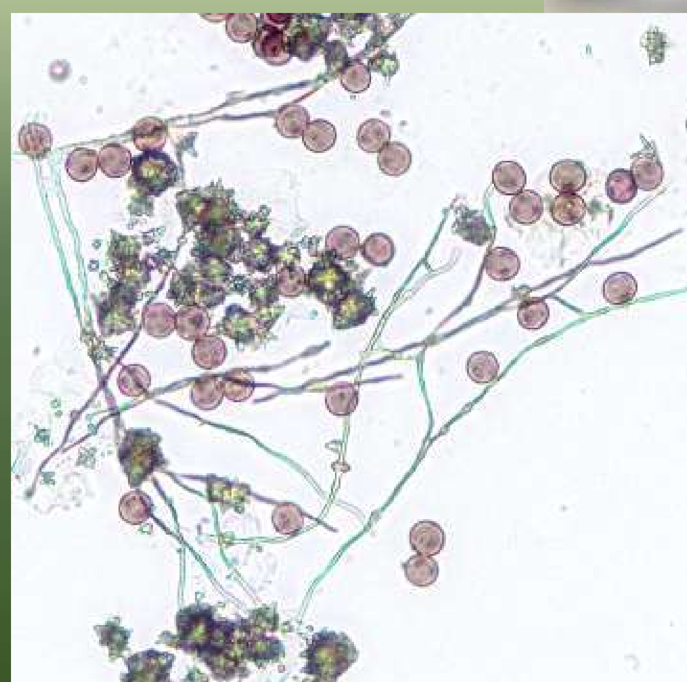


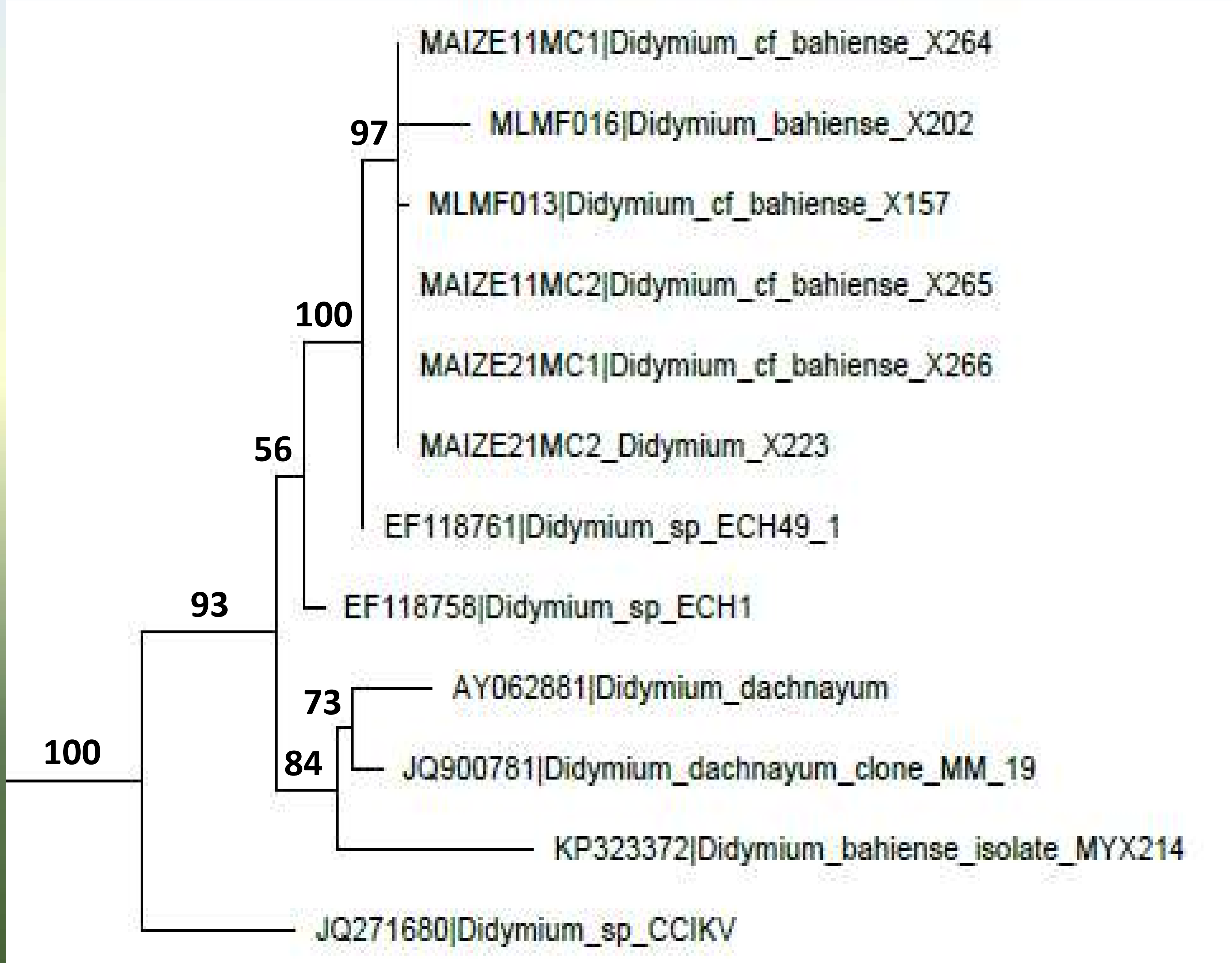
Didymium cf. *bahiense*

MAIZE21MC

Spores: 9-10 µm





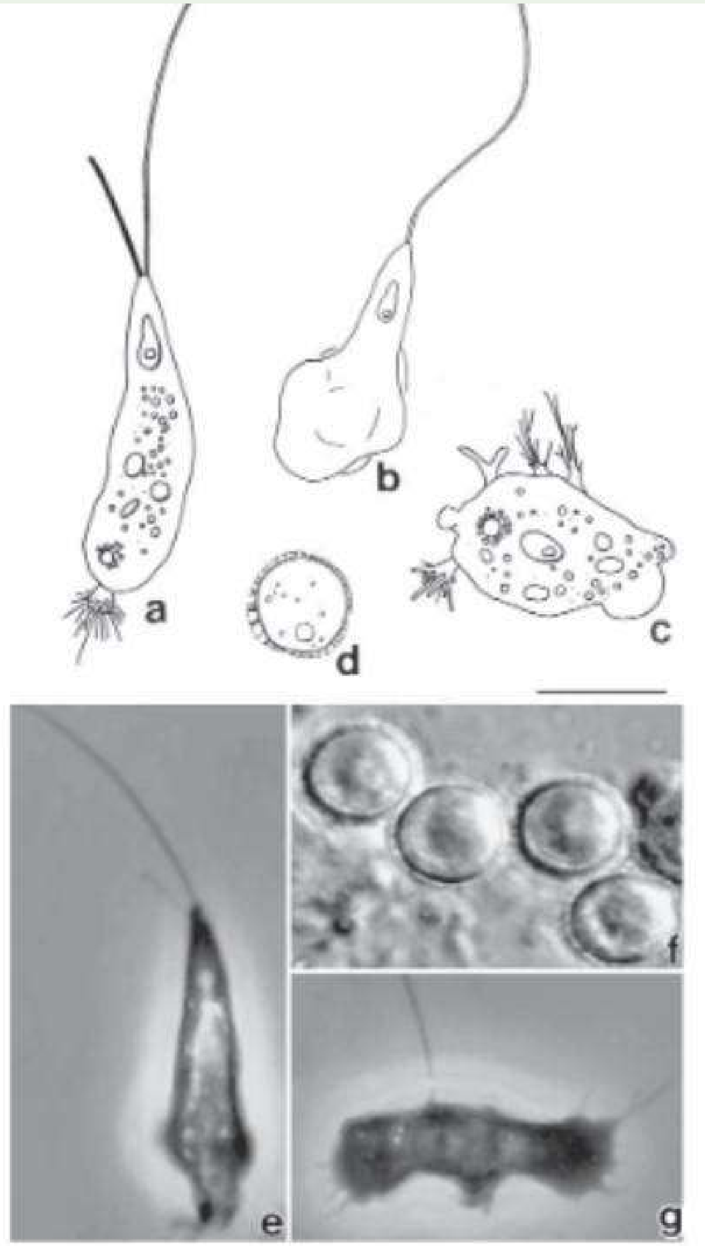


MAIZE11MC1|Didymium_cf_bahiense_X264
MLMF016|Didymium_bahiense_X202
97
MLMF013|Didymium_cf_bahiense_X157
MAIZE11MC2|Didymium_cf_bahiense_X265
100
MAIZE21MC1|Didymium_cf_bahiense_X266
56
MAIZE21MC2_Didymium_X223
EF118761|Didymium_sp_ECH49_1
93
EF118758|Didymium_sp_ECH1
AY062881|Didymium_dachnayum
73
100
84
JQ900781|Didymium_dachnayum_clone_MM_19
KP323372|Didymium_bahiense_isolate_MYX214
JQ271680|Didymium_sp_CCIKV

Didymium dachnayum

Flagellated cells are round to elongate, up to 25 μm long. A single, apically inserted flagellum up to 40 μm long is present in gliding and swimming cells. In sessile cells (Fig. 1g) the flagellum is about 10 μm long. In gliding cells there is usually a single filose pseudopodium up to 15 μm long, arising just next to the base of the flagellum (Figs 1a, e). The nucleus is pyriform and flexible, about 4 μm long. In gliding, swimming and sessile flagellates its anterior, pointed end is loosely associated with the base of the flagellum (Figs 1a, b, g). The anterior end of the cell usually appears hyaline. Food vacuoles and other inclusions are present in the posterior region of moving cells (Figs 1a, e). The contractile vacuole is located posteriorly in swimming cells, and fills by fusion of smaller vesicles (Fig. 1a). Rounded, finger-shaped or filose (sometimes branching) pseudopodia may form from the sides or the posterior end of the cell. Filose pseudopodia are most common in sessile flagellates (Fig. 1g). A posterior uroid, composed of very fine pseudopodia up to 5 μm long, is usually present in gliding cells (Figs 1a, e).

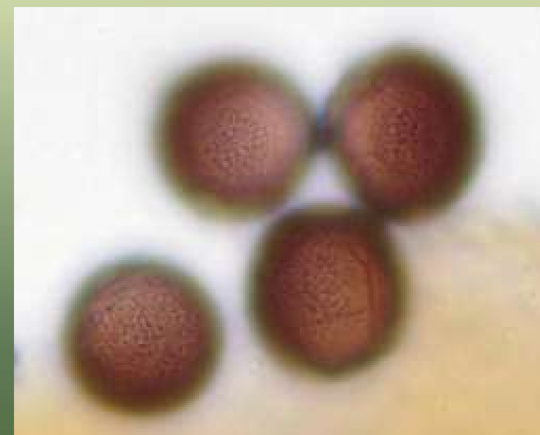
Amoeboid cells are rounded to elongate, up to 15 μm long. The nucleus is rounded and about 4 μm in diameter. Food vacuoles and a contractile vacuole are present (in the posterior region of moving cells) (Fig. 1c). In moving cells, eruptive, hyaline pseudopodia form at the anterior end, while a uroid of fine filose pseudopodia forms at the posterior end. Sessile amoebae exhibit eruptive, finger-shaped and fine, branching pseudopodia. Some sessile cells do not form



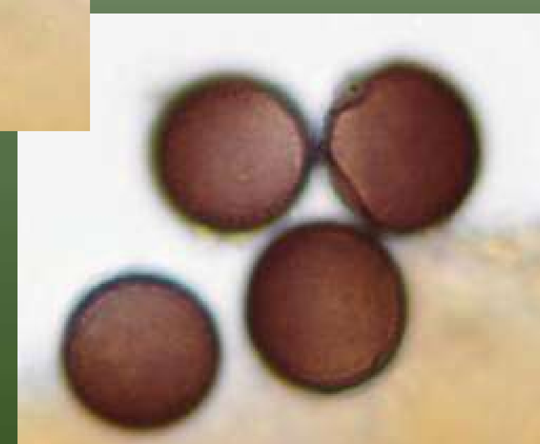
Didymium cf. *difforme* MAIZE19MC

Didymium cf. *difforme*

MAIZE19MC



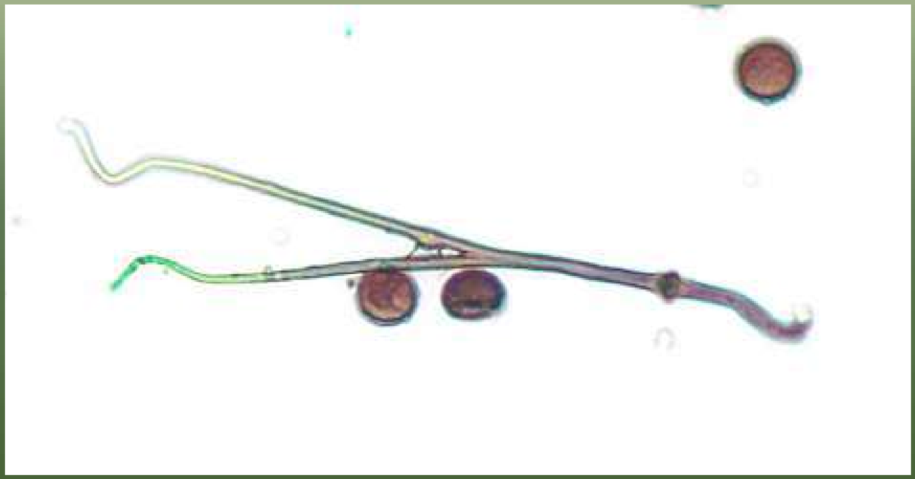
Spores: 11.5-13 µm



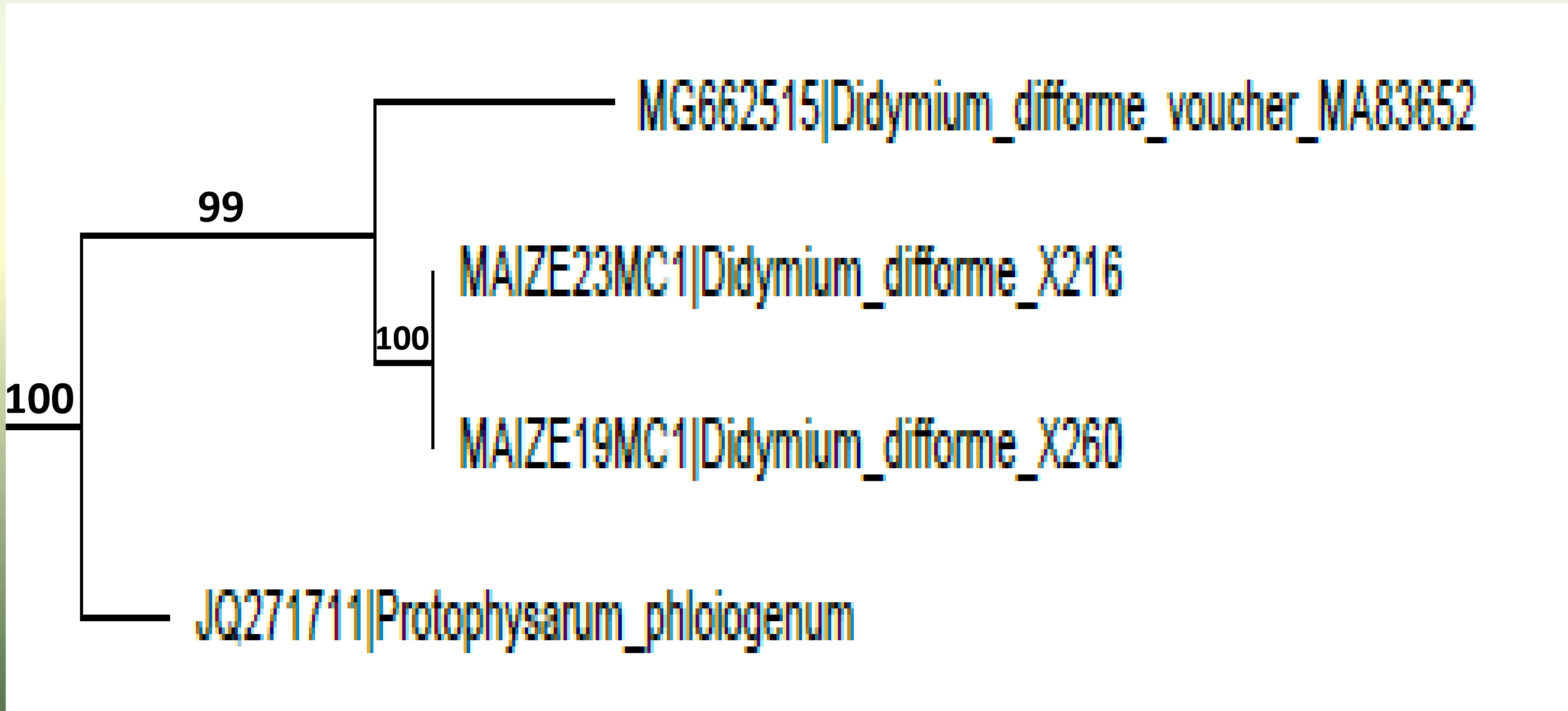
Didymium difforme
MAIZE23MC

Didymium difforme

MAIZE23MC



Spores: 11-14 µm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99
MAIZE23MC1|Didymium_difforme_X216
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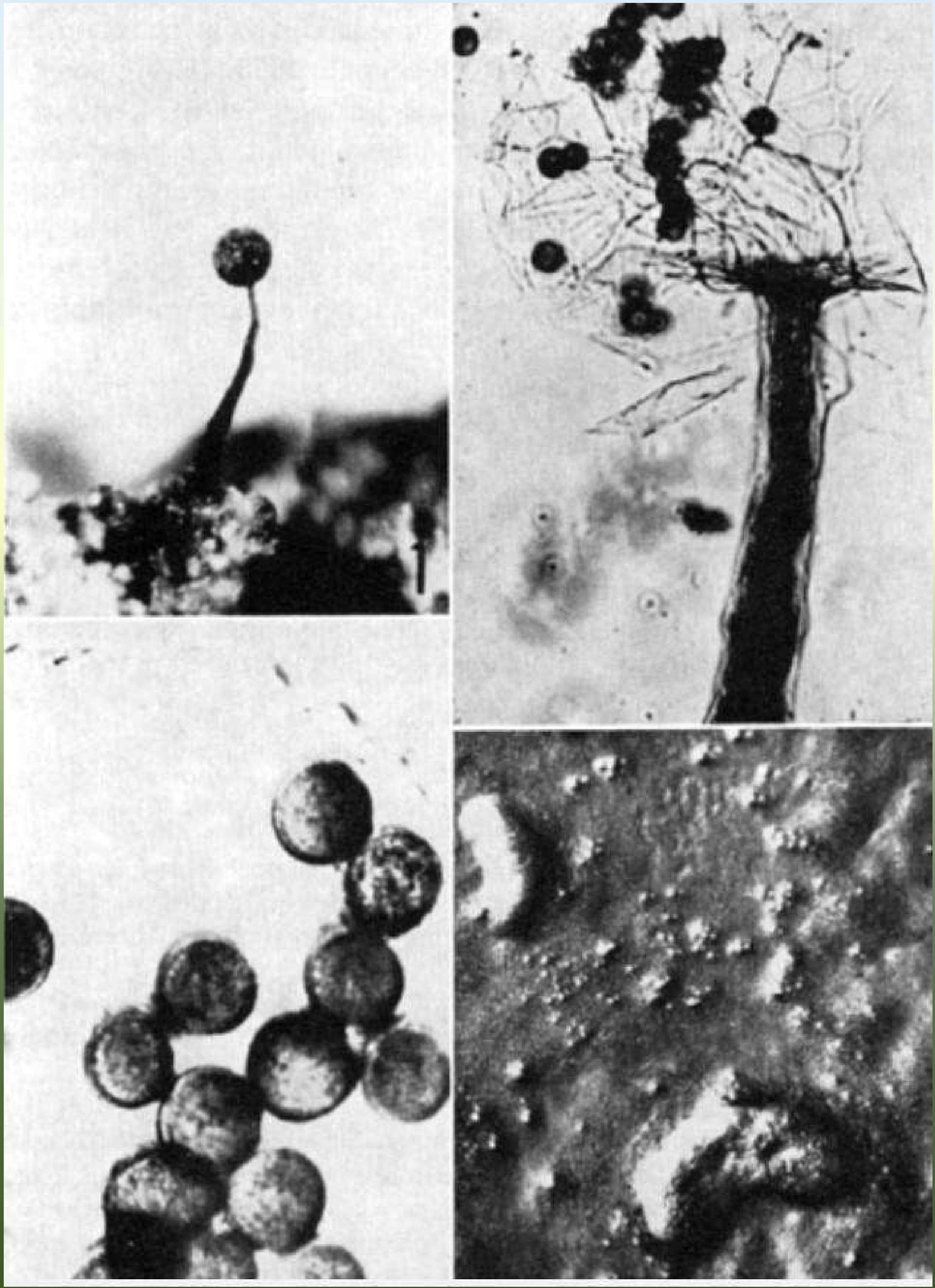
MAIZE19MC1|Didymium_difforme_X260
JQ271711|Protophysarum_phloiogenum

Protophysarum phloiogenum



Physarum compressum

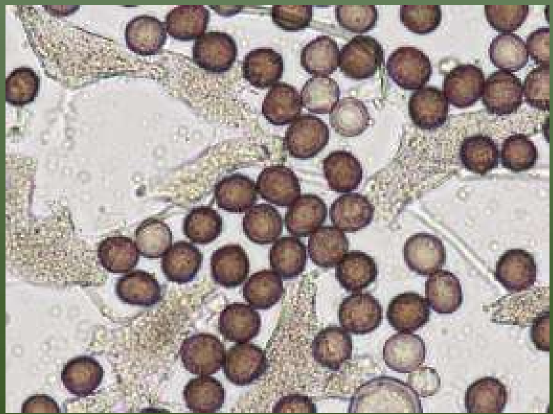
MLMF001

Spores: 9.5-12 μm

Physarum compressum

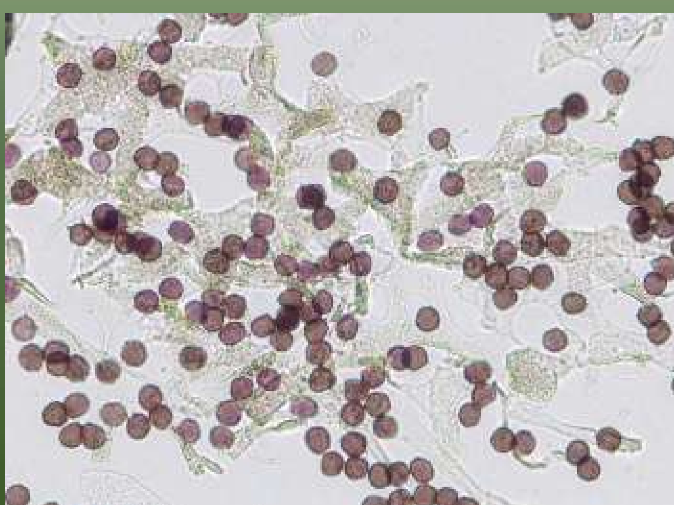
MLMF002

Spores: 10-12 µm

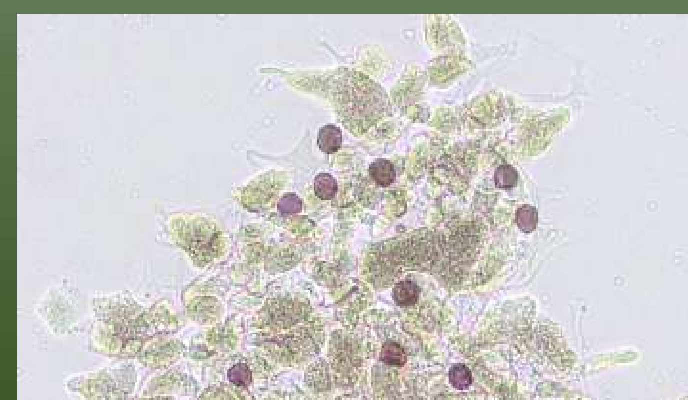


Physarum compressum?

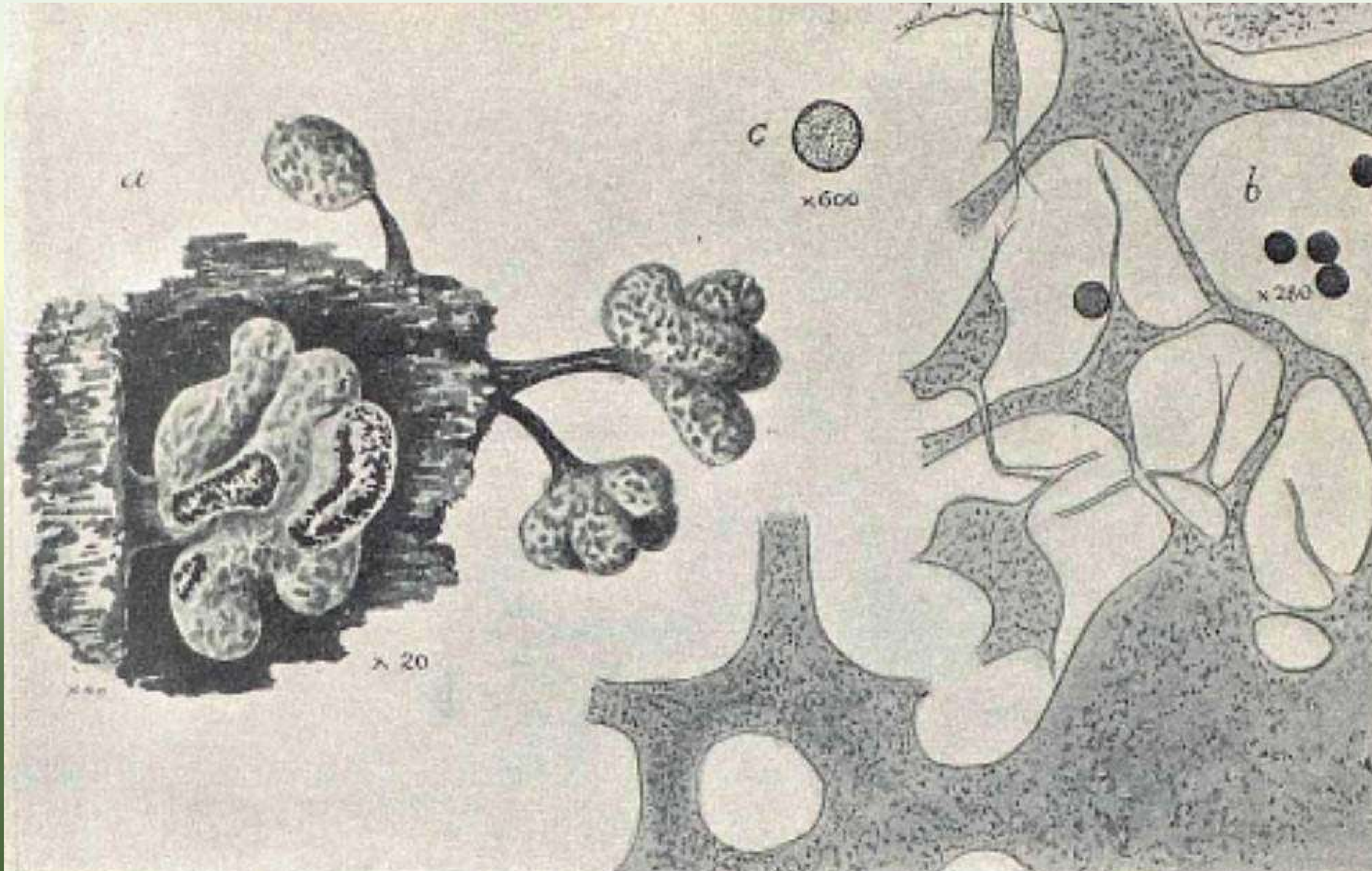
MLMF025

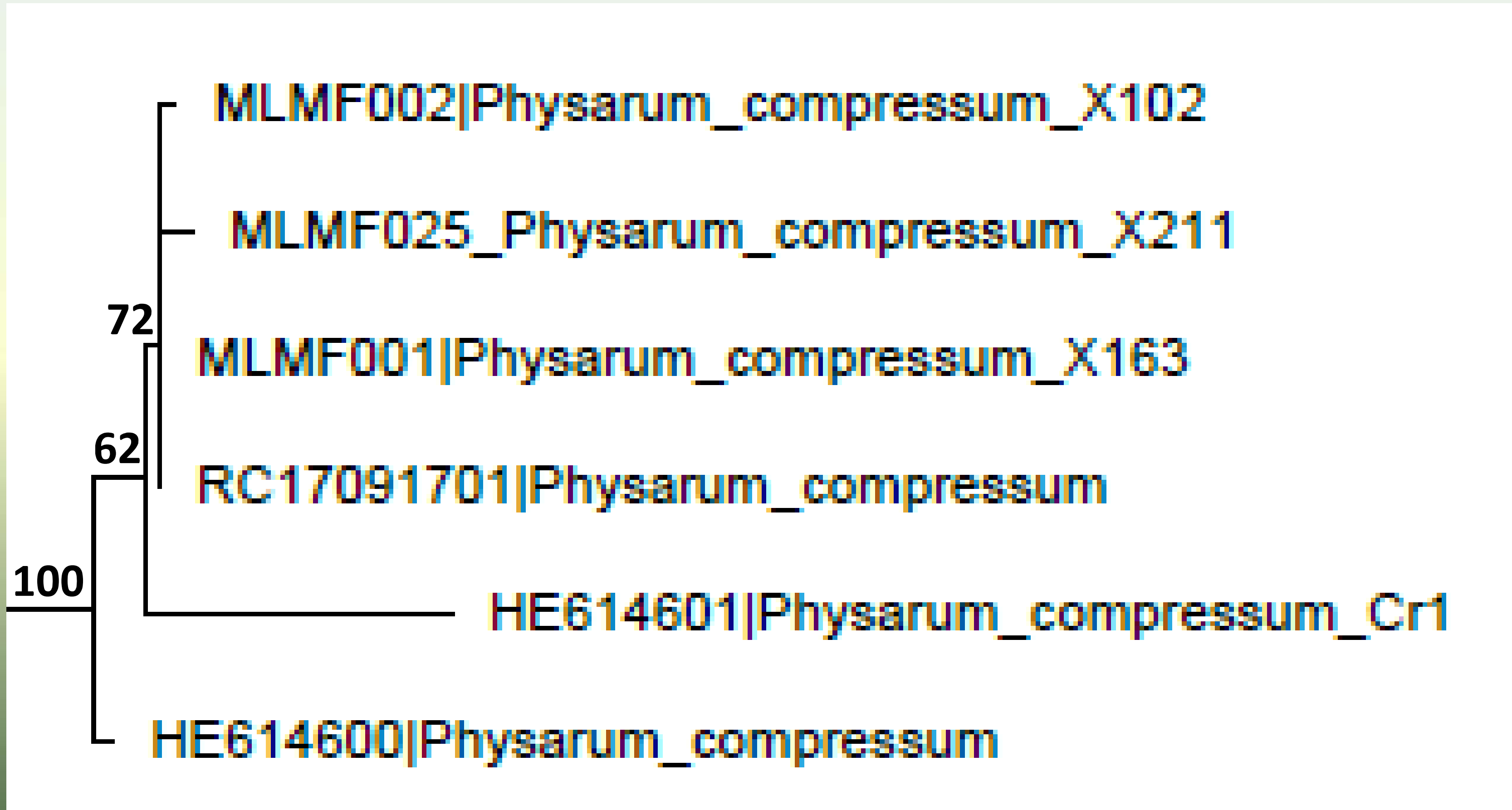


Spores: 9-10 µm



Physarum reniforme



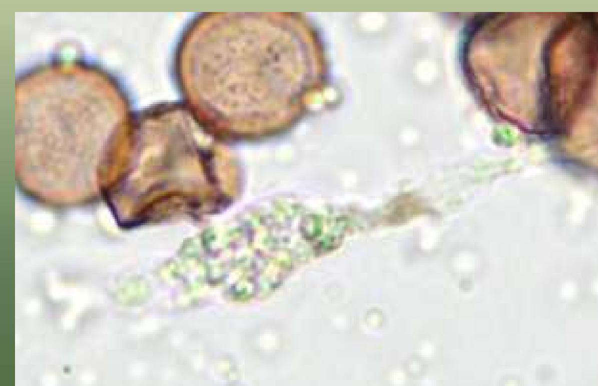


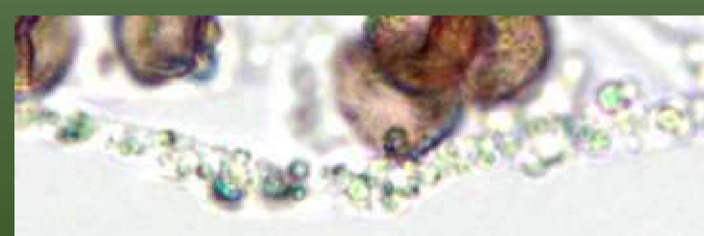
MLMF002|Physarum_compressum_X102
MLMF025_Physarum_compressum_X211
72
MLMF001|Physarum_compressum_X163
62
RC17091701|Physarum_compressum
100
HE614601|Physarum_compressum_Cr1
HE614600|Physarum_compressum

Physarum cf. gravidum

MAIZE29MC

Spores: 9-15 µm

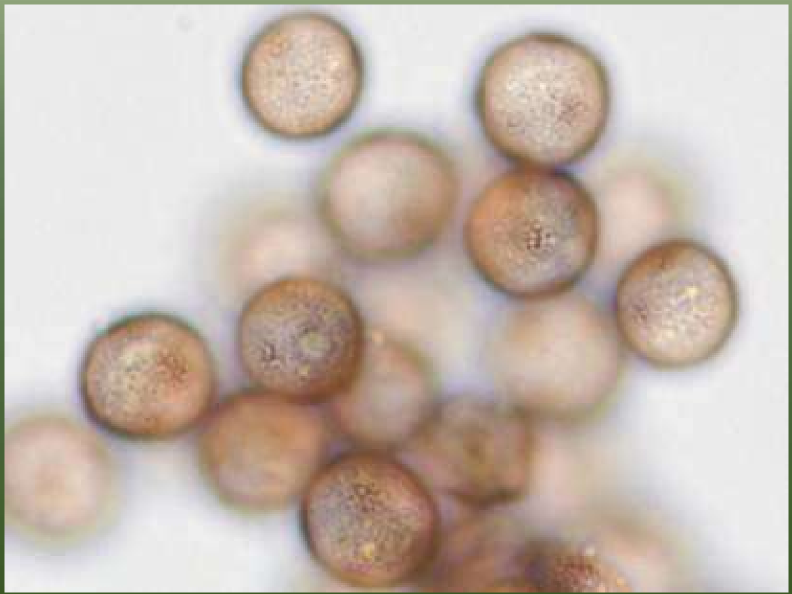




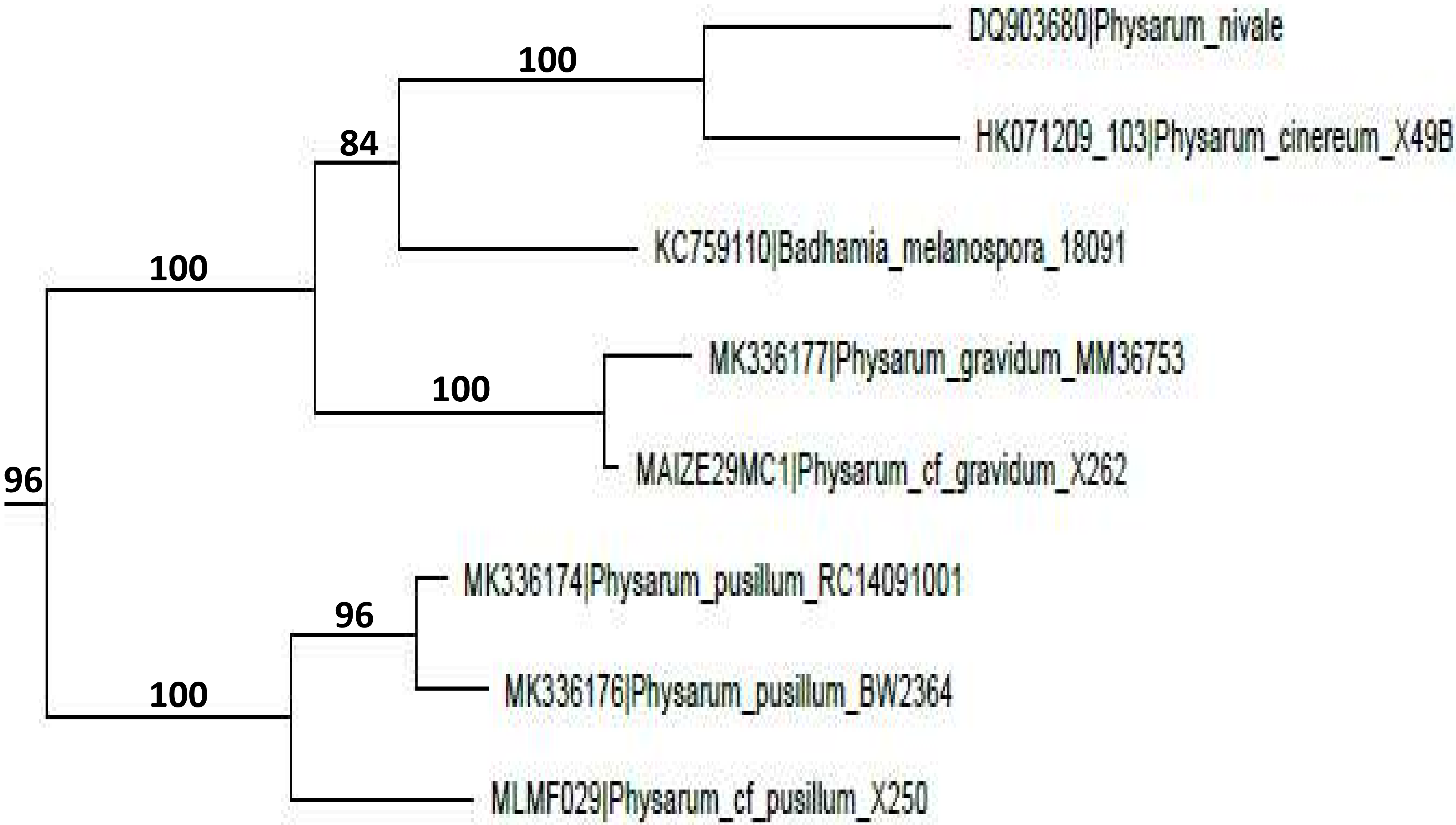
Physarum cf. pusillum
MLMF029





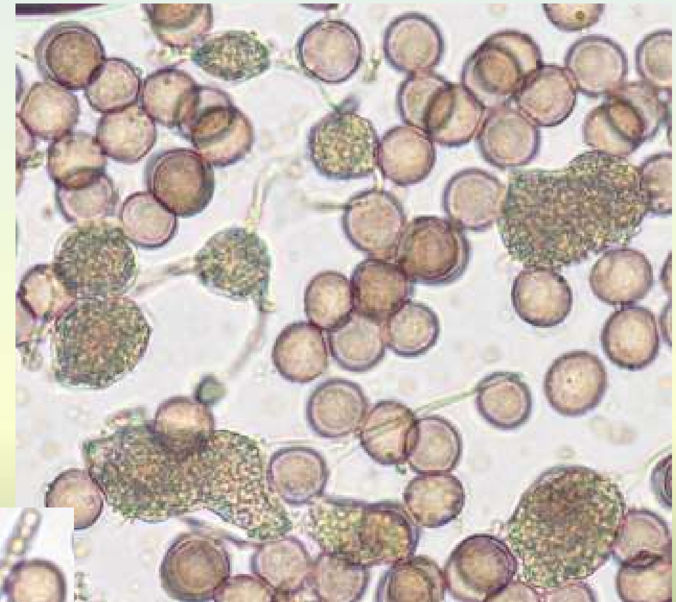



Spores: 9-11 µm


DQ903680|Physarum_nivale
HK071209_103|Physarum_cinereum_X49B
KC759110|Badhamia_melanospora_18091
MK336177|Physarum_gravidum_MM36753
MAIZE29MC1|Physarum_cf_gravidum_X262
MK336174|Physarum_pusillum_RC14091001
MK336176|Physarum_pusillum_BW2364
MLMF029|Physarum_cf_pusillum_X250
100
84
100
100
96
96
100

Physarum cinereum

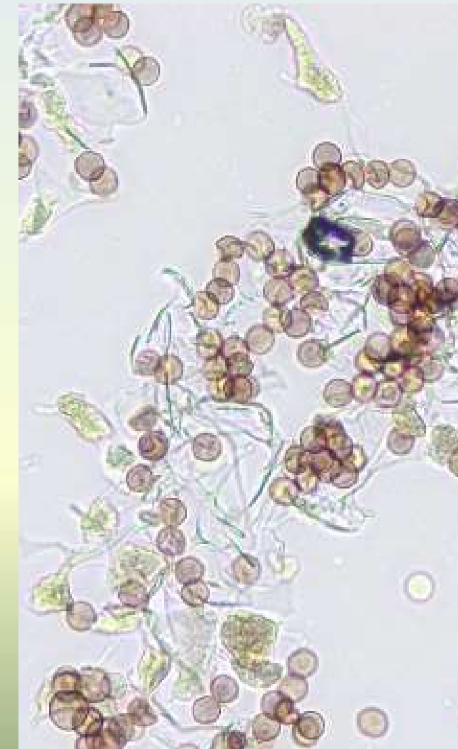
MLMF003



Spores: 10-11 µm

Physarum cinereum

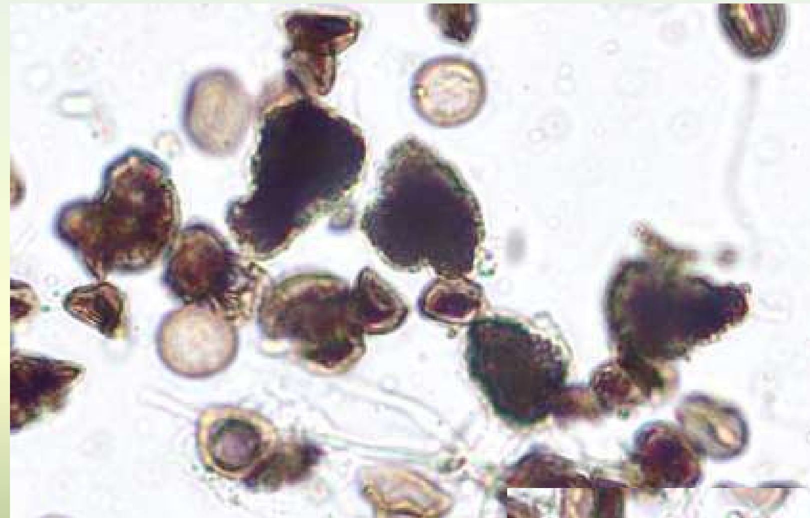
MLMF037

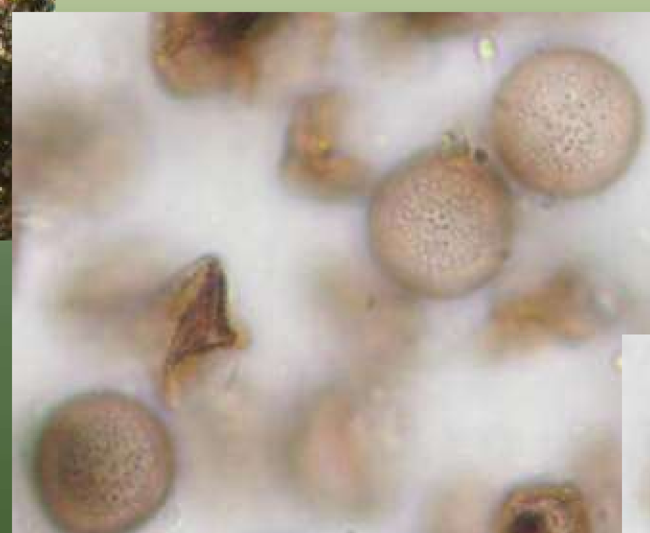


Spores: 10-11 µm

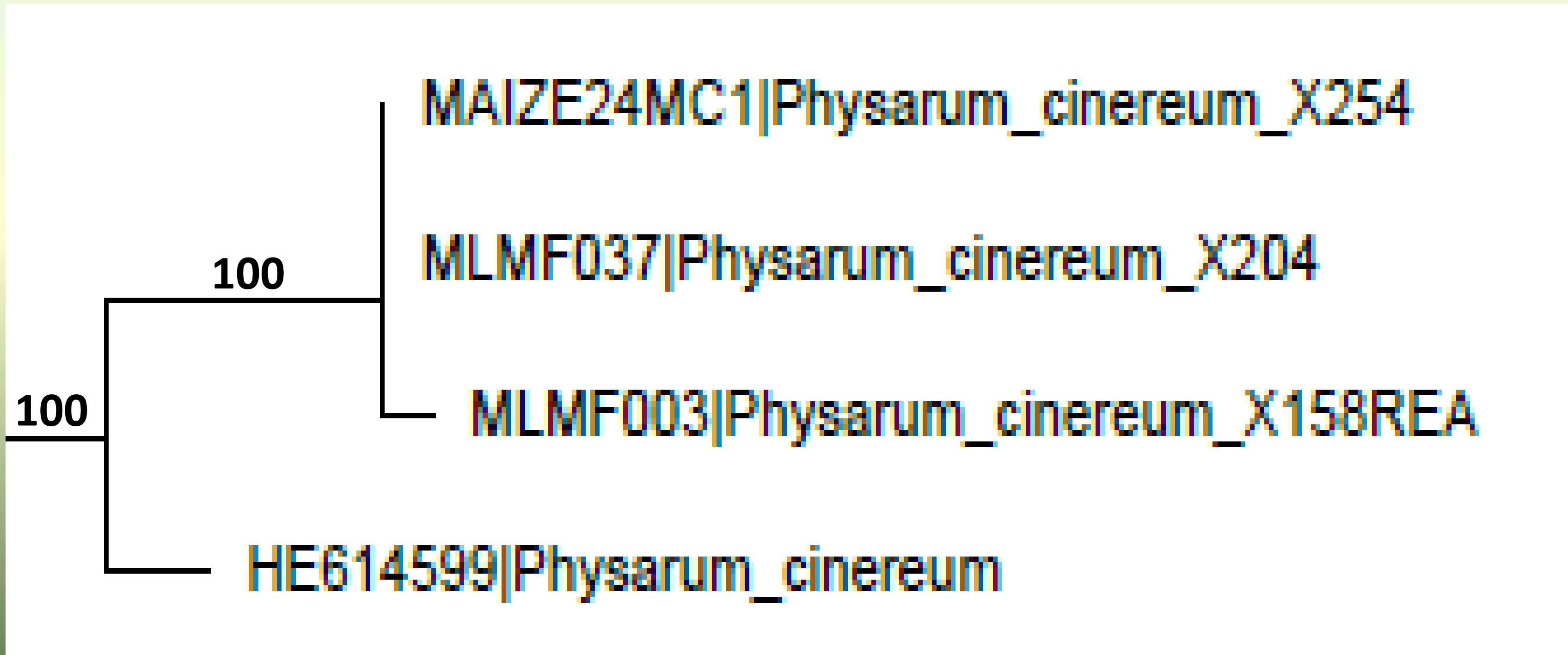
Physarum cinereum

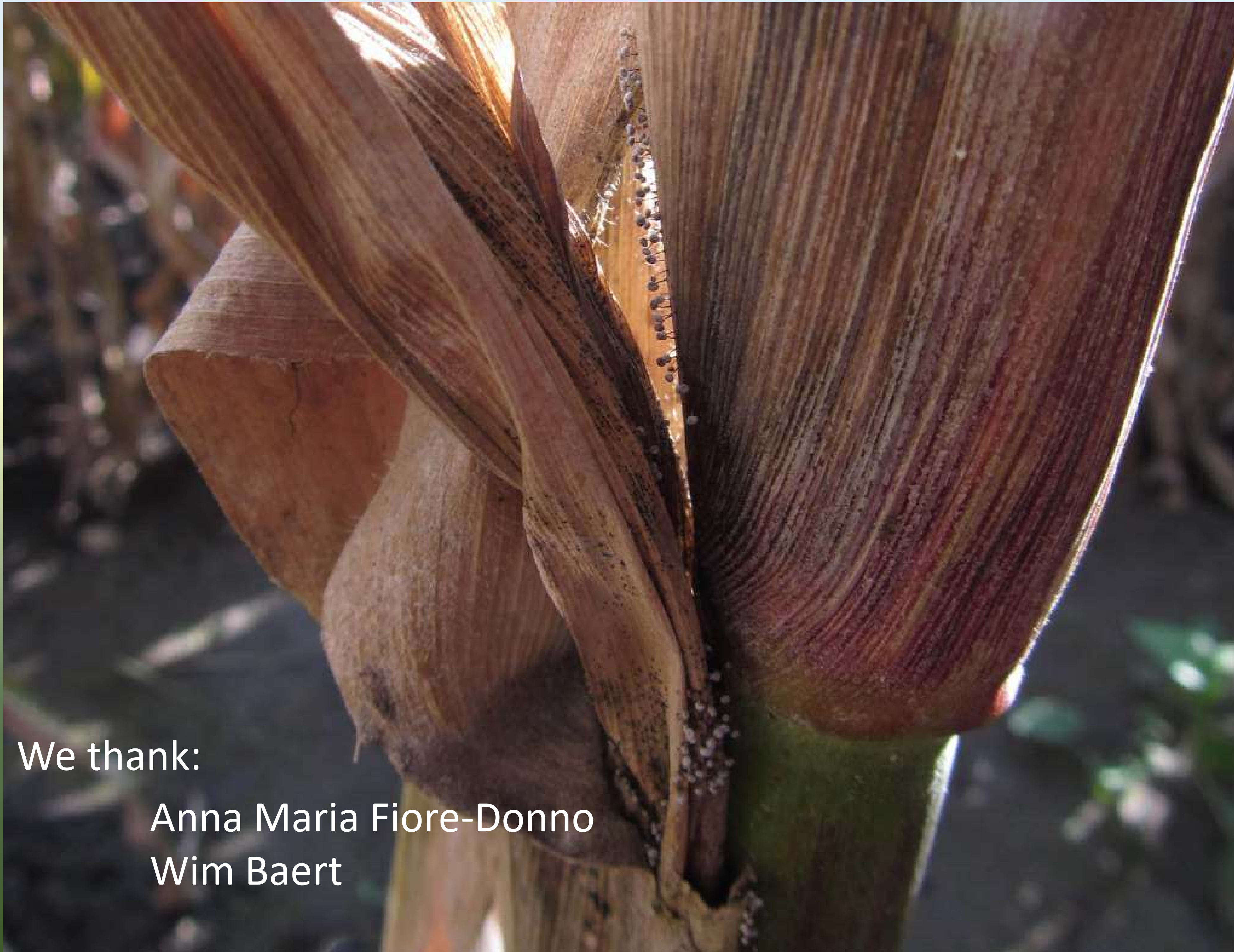
MAIZE24MC





Spores: 9.5-12 (-14) µm


MAIZE24MC1|Physarum_cinereum_X254
MLMF037|Physarum_cinereum_X204
MLMF003|Physarum_cinereum_X158REA
HE614599|Physarum_cinereum
100
100


We thank:
Anna Maria Fiore-Donno
Wim Baert

We thank you for your attention!

UNIVERSITY OF SANTO TOMAS

Impacts of natural disasters on microbial diversity:

a case study of myxomycetes from tropical forests and grasslands in the Philippines

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[c]Fungal Biodiversity, Ecogenomics and Systematics (FBeS) Group,

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ICSEM 10, Costa Rica
25-28 February 2020

most spectacular and beautiful features of the physical world

(National Geographic, 2017)

most spectacular and beautiful features of the physical world

(National Geographic, 2017)


Earthquakes


gettyimages
Bettmann
Rock falls


Mudslides


THE COUNTY OF HAWAII/AP
Lava crawls

Lahar flow

Bacolor after lahar cascaded from Mt. Pinatubo in 1991

Effects on vegetation

Mount Etna eruption in 2001

Mt Etna Photo by Bill Curry in 2012

Re-establishment

Mt Pinatubo lahar devastation in 1991

"The ecosystem damaged by eruption needs several years to form new soil for the growth of plants".

(Bressan, 2016)

Grass growing in lahar devastated areas

"Devastated areas are mostly occupied by a few ecological generalist such as the pantropical grass.

(Langenberger, 2004)

"..east flanks of Mount Pinatubo was dominated by the large grass *Saccharum spontaneum* and the woody tree *Parasponia rugose*"

Primary Succession along an Elevation Gradient 15 Years after the Eruption of Mount Pinatubo, Luzon, Philippines

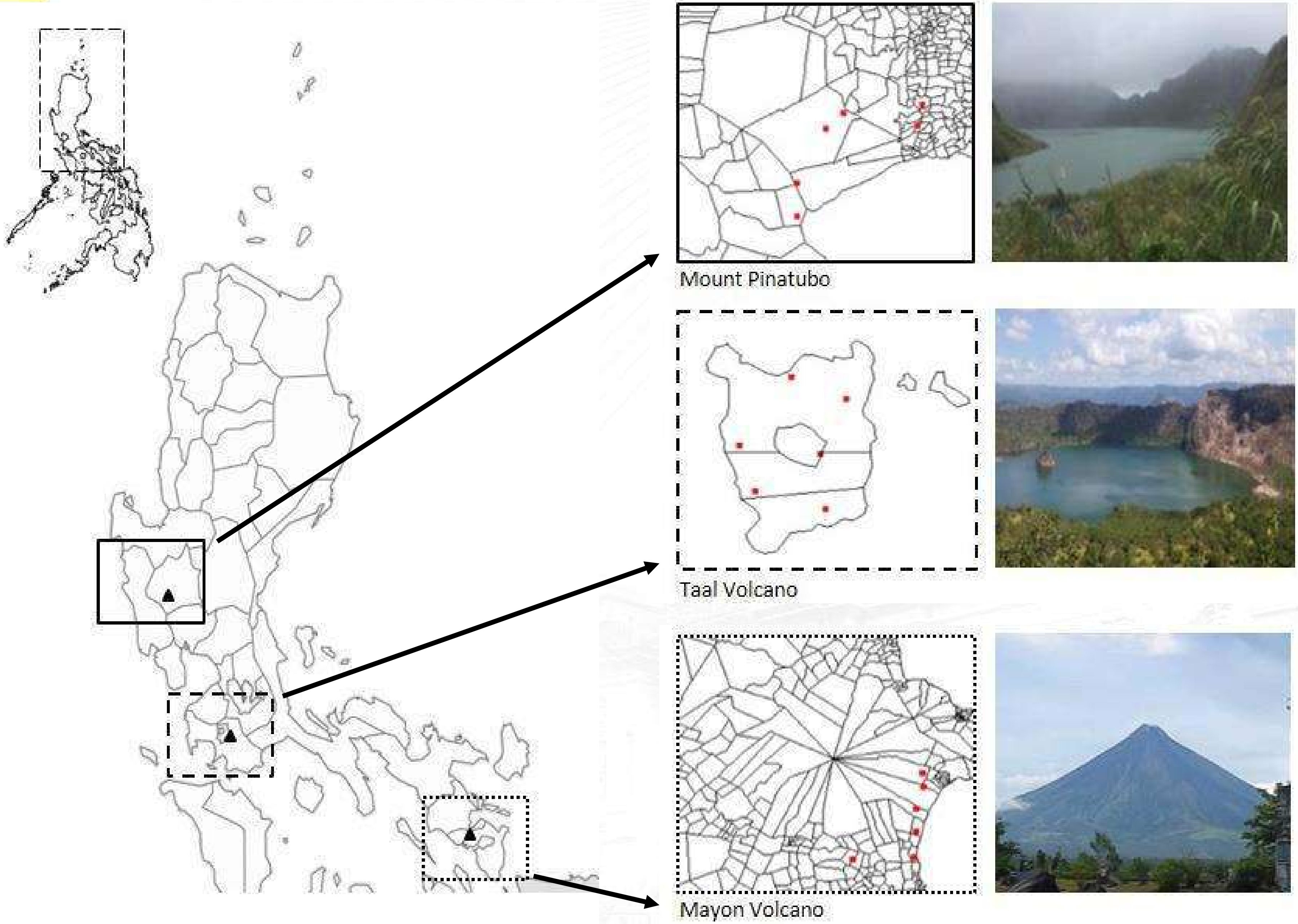
Author(s): Thomas E. Marler and Roger del Moral

Source: Pacific Science, 65(2):157-173. 2011.

Published By: University of Hawai'i Press

A more established grassland following lahar devastation harbor a higher number and diversity of myxomycetes.

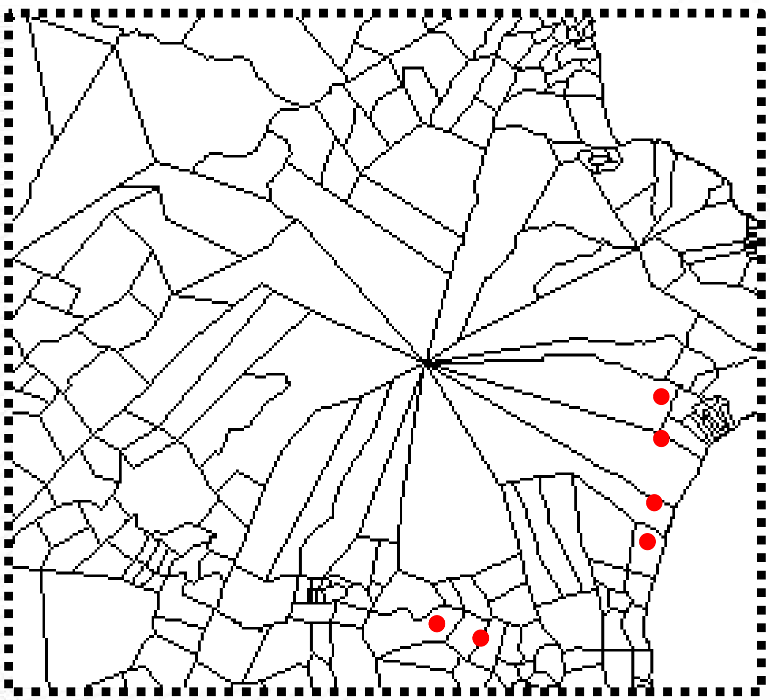
Our hypothesis


Mount Pinatubo
Taal Volcano
Mayon Volcano

Eruption: Mayon (11 years ago)

- November 30, 2006
- Typhoon "Reming"or Durian
- Lahar flows in municipalities:
  - Guinobatan, Camalig, Daraga, Legazpi and Sto. Domingo

Orense, 2007

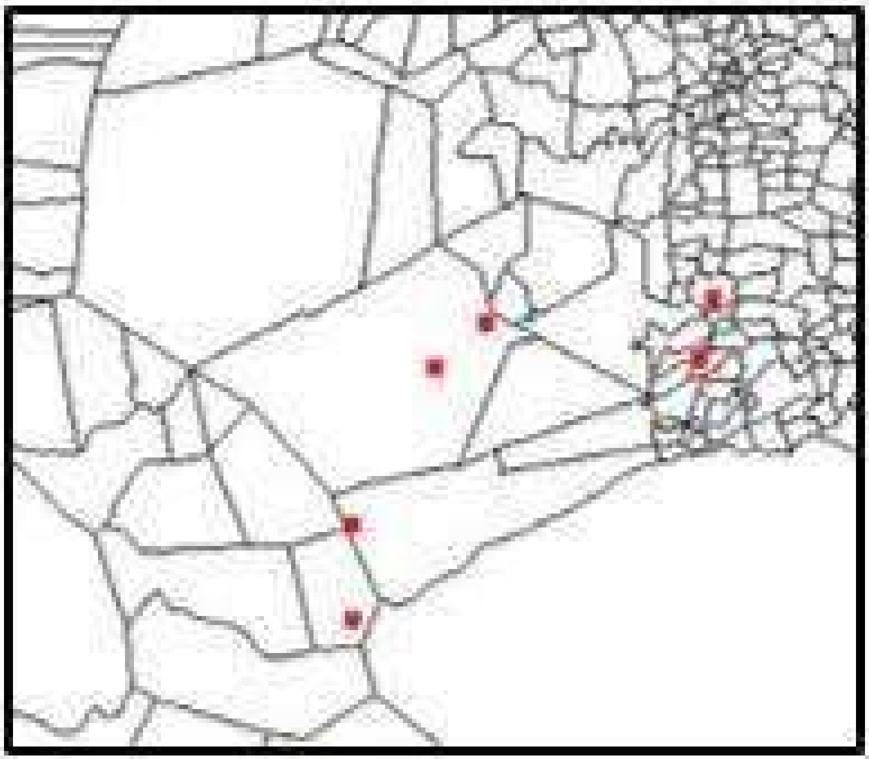


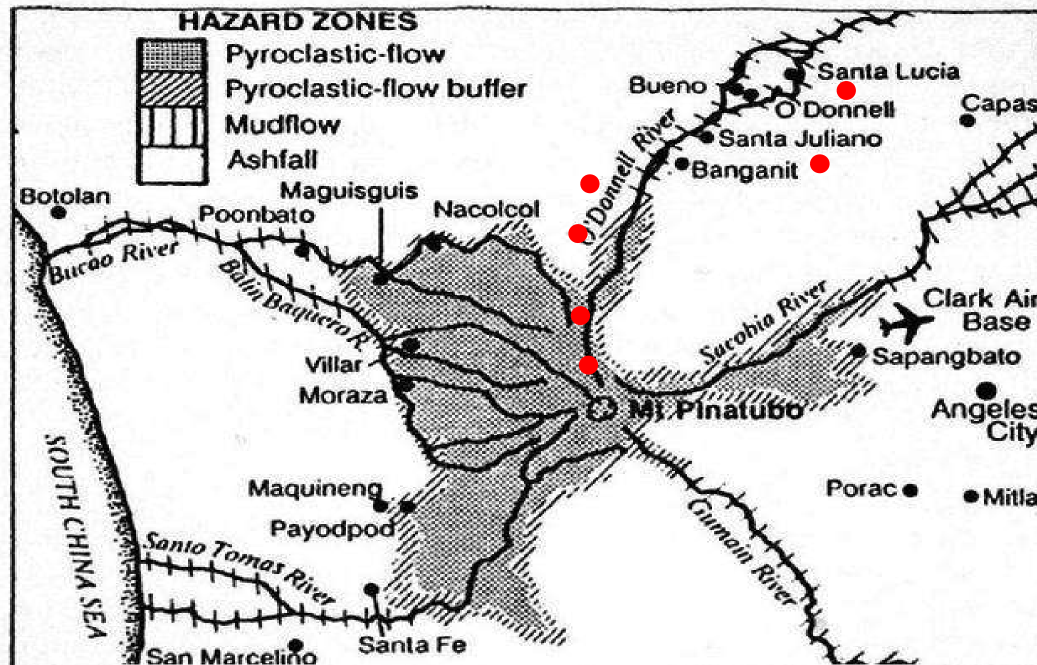
LAHAR FLOWS FROM MT. MAYON

Eruption: Pinatubo(26 years ago)

- June 15, 1991
- ash shot 34 kilometers in the sky
- supported by a simultaneous typhoon “Yunya”
- affected plains of Central Luzon and neighboring countries

Marler, 2011



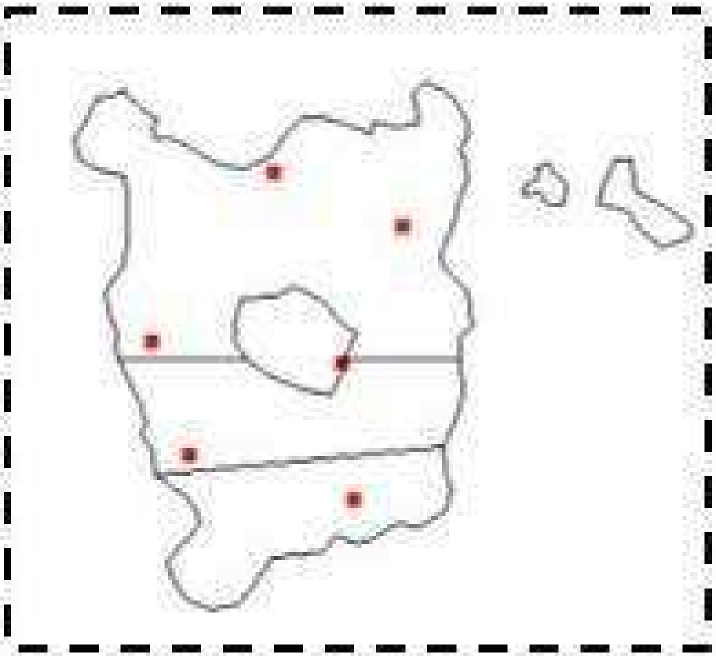


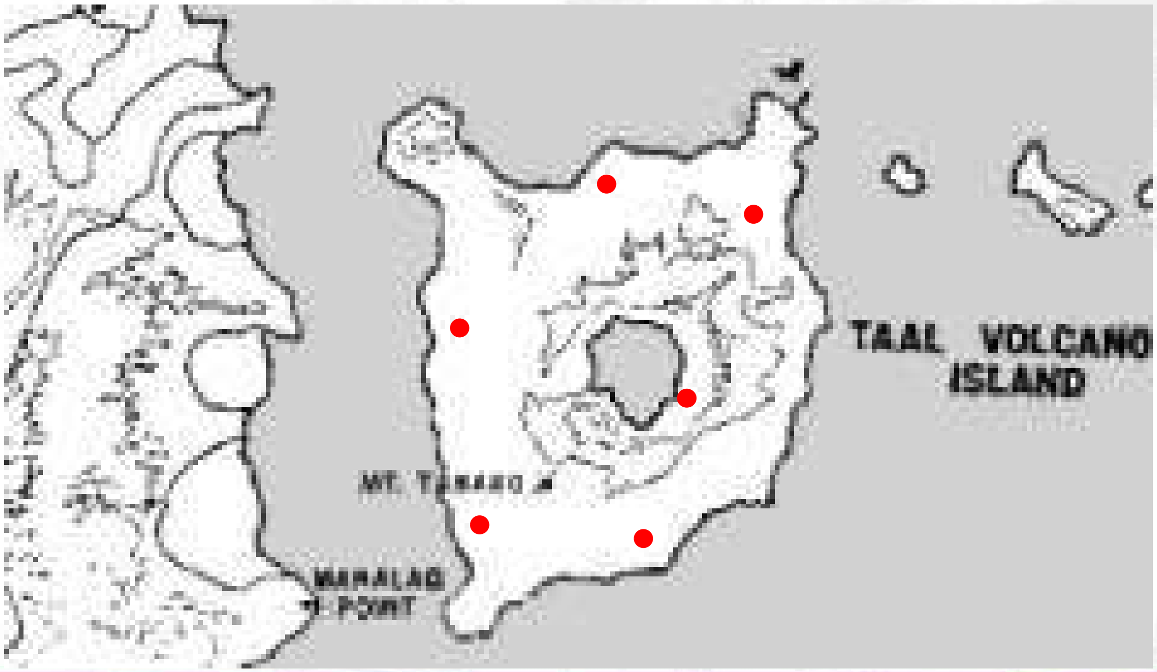
Hazard map of Mount Pinatubo, as issued to provincial authorities on May 23, 1991. (Pinatubo Volcano Observatory Team 1991)

Eruption: Taal (52 years ago)

- Sept 28-30, 1965
- formation of new crater
- first record of lahar flow in the volcano

Moore et al., 1966





Our Methods

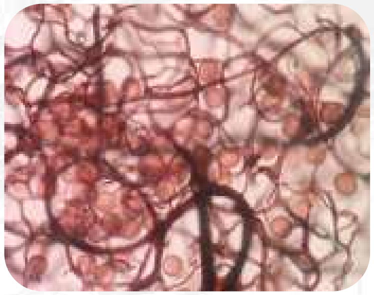
Collection of Samples from each sites:
180 for AL; 180 for GL

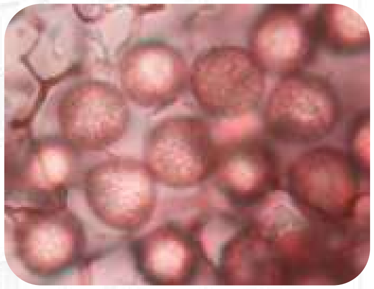
Moist Chambers (1,080)

Identification of myxomycetes

Fruiting Body:

- morphological characteristics of the stalk and sporotheca
- presence and absence of lime



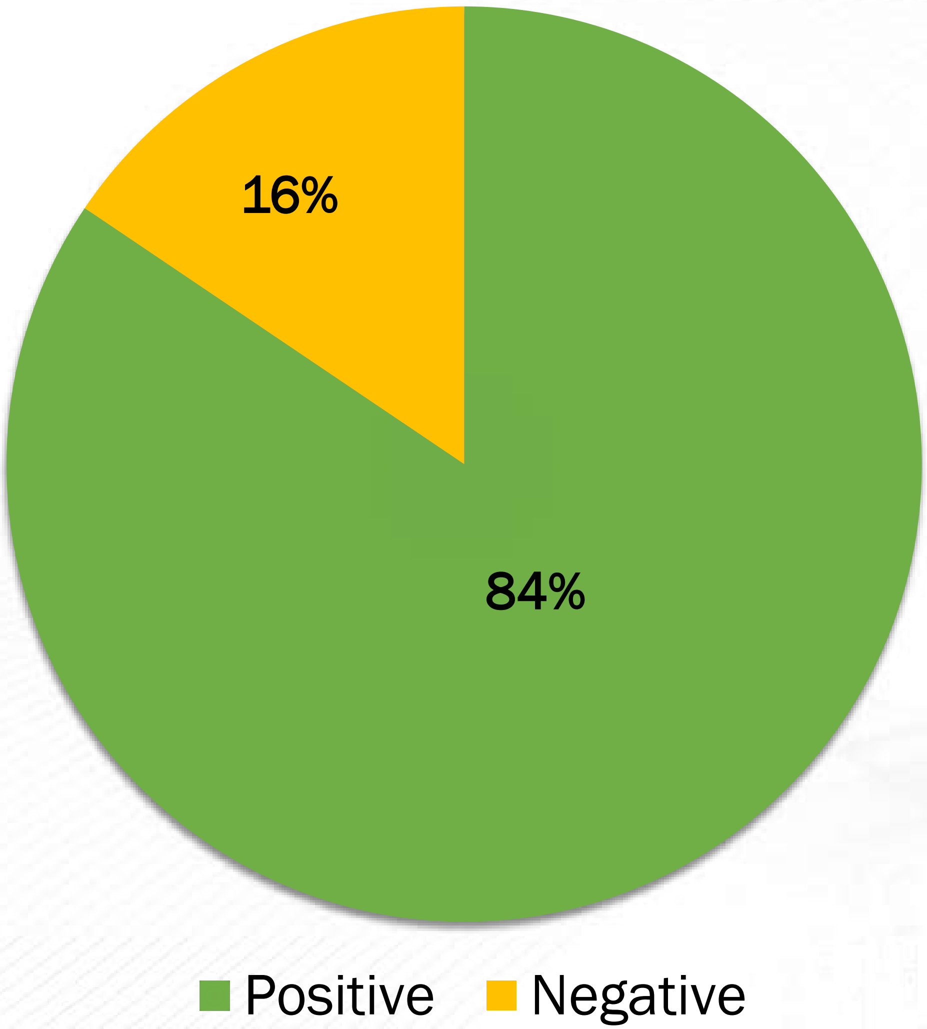


Microscopic Examination:

- columella
- spore morphology
- presence and absence of lime globules

Biodiversity and Ecological Analysis

- Occurrence and Distribution
- Taxonomic Diversity and Species Diversity
  - *S/G Ratio*
  - *Shannon Index (Hs)*
  - *Gleason Index (Hg)*
  - *Pielou's Index (E)*
  - *Fisher's Alpha Index (FAI)*
  - *Simpson Index (SID)*
- Community Analysis
  - *Coeefficient of Community*
  - *Percent Similarity*



Out of 1,080 prepared moist chambers,

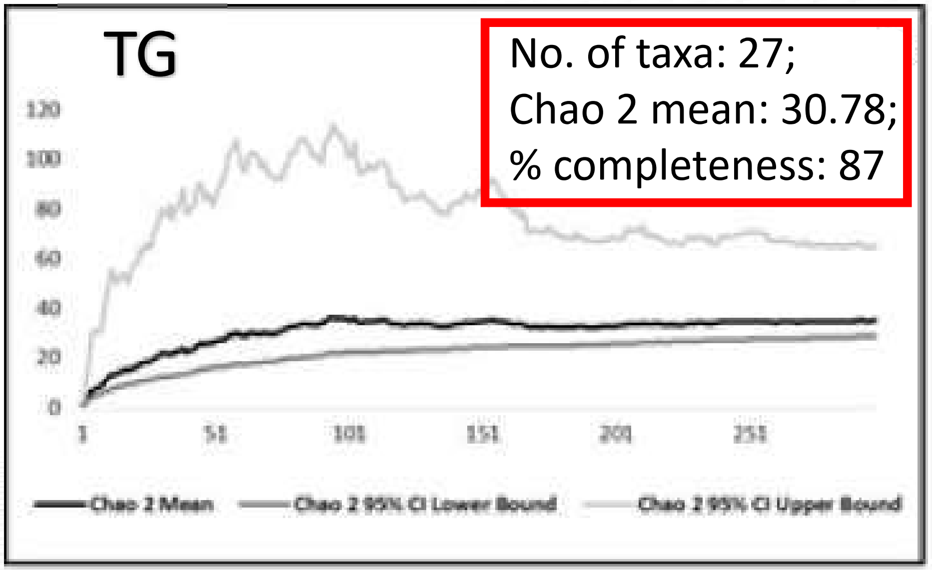
912 are positive for fruiting body or plasmodium.

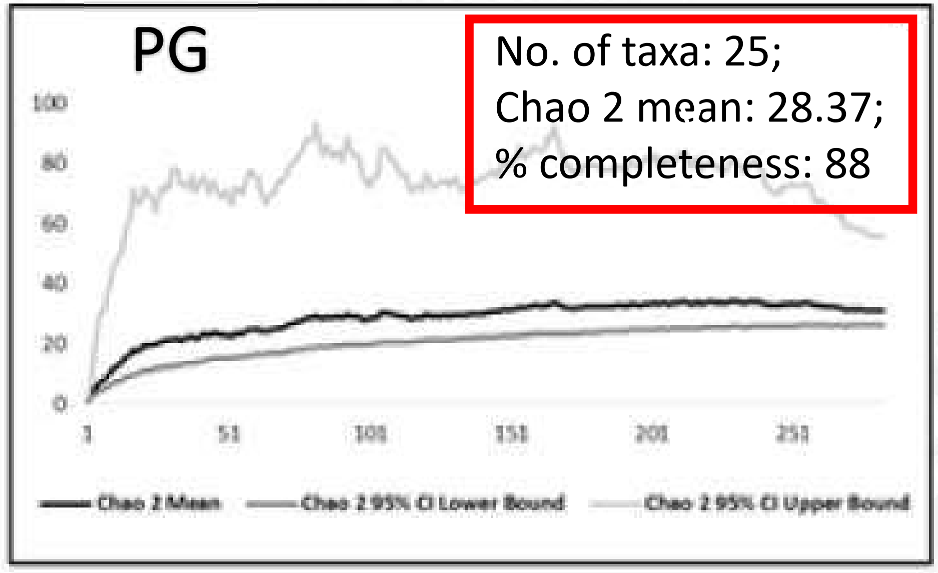
TG = 27 species

PG = 25 species

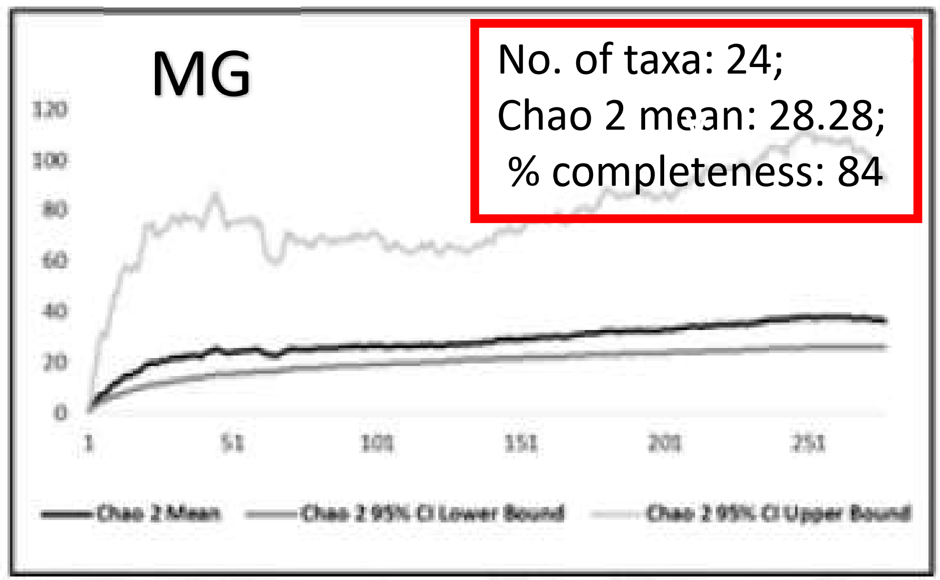
MG= 24 species

Taal > Pinatubo > Mayon





Species Accumulation Curve (SAC)



Taxa	Taal	Pinatubo	Mayon
Cribraria microcarpa	O		
Cribraria violacea	R		
Arcyria cinerea	A	A	A
Arcyria denudata	R	R	R
Arcyria sp.	O	O	
Hemitrichia calyculata		R	
Hemitrichia serpula			R
Perichaena chrysosperma	A	A	R
Perichaena corticalis	O	O	A
Perichaena depressa	A	C	C
Perichaena pedata	C		C
Diderma chondrioderma		R	
Diderma effusum	C	R	O
Diderma hemisphaericum	A	A	A
Didymium clavus		O	
Didymium difforme		O	
Didymium flocossum		R	
Didymium nigripes	R		A
Didymium serpula	O		C
Didymium squamulosum	A	R	R
Didymium sp.	R		
Physarum bivalve			R
Physarum cinereum	O	C	C
Physarum decipiens	O		C
Physarum compressum	A	C	C
Physarum javanicum			C
Physarum melleum	O	O	O
Physarum oblatum		O	O
Physarum sp.1	O		
Physarum sp. 2	O		
Collaria arcyrionema		A	O
Collaria sp. 1		R	
Comatricha nigra	O	A	
Comatrichia pulchella	O	O	
Comatricha tenerrima	C	A	A
Lamproderma scintillans	R		R
Stemonitis fusca	R	A	C
Stemonitis fuscoides			O
Stemonitis herbatica	R		
Stemonitis splendens		C	

Relative Abundance:

Taal grassland

Abundant - 7

Common - 2

Occasional - 11

Rare - 7

Mayon grassland

Abundant - 5

Common - 8

Occasional - 5

Rare - 6

Pinatubo grassland

Abundant - 7

Common - 4

Occasional - 7

Rare - 7

- *Arcyria cinerea*
- *Diderma hemisphaericum*

Taxonomic and Species Diversity: Per substrate

STUDY SITES /SUBSTRATES		NO. OF GENERA	NO. OF SPECIES	S/G	HS	HG	E	FAI	D
TG	AL	9	25	2.70	1.02	5.94	0.45	8.00	0.16
	GL	7	14	2.00	0.87	2.70	0.41	4.06	0.20
PG	AL	9	20	2.20	0.98	3.74	0.44	6.03	0.16
	GL	8	17	2.10	0.91	3.32	0.43	5.35	0.19
MG	AL	9	21	2.30	0.87	3.86	0.39	6.28	0.27
	GL	9	18	2.00	0.83	3.56	0.38	5.22	0.38

Species diversity: **Aerial grass litter**

Taxonomic and Species Diversity: Per site

SITES	NO. OF GENERA	NO. OF SPECIES	S/G	HS	HG	E	FAI	SID
TG	9	27	3.0	0.989	4.564	0.40	**7.21**	**0.17**
PG	9	25	2.8	0.988	4.251	0.39	**6.62**	**0.17**
MG	10	24	2.2	0.881	3.964	0.35	**6.31**	**0.18**

Taal grassland
High species diversity

Mayon grassland
High taxonomic diversity

Taal Grassland
(52 years ago)

>

Pinatubo Grassland
(26 years ago)

>

Mayon Grassland
(11 years ago)

A more established grassland ecosystem has a more diverse assemblages of myxomycetes.

CNN World Africa Americas Asia Australia China Europe India Middle East United Kingdom Edition

Philippines warns of 'explosive eruption' after Taal Volcano spews ash near Manila

By Jinky Jorgio, Jessie Yeung and Alaa Elassar, CNN

Updated 1223 GMT (2023 HKT) January 14, 2020

Photo Credit: Taro Hama *Getty Images*


TON FRANSISCO

Our sincerest thanks and appreciation to…

- DOST-NSC-ASTHRDP Graduate Scholarship
- UST- Research Center for the Natural and Applied Sciences (RCNAS)
- Philippine Atmospheric Geophysical and Astronomical Services Administration (PAGASA), Diliman, Quezon City
- Melissa H. Pecundo, MSc

UNIVERSITY OF SANTO TOMAS

Fungal Biodiversity, Ecogenomics and Systematics (FBeS) Group

#USTFBeST

The UST-RCNAS Fungal Biodiversity, Ecogenomics and Systematics (FBeS) Group

Our Vision: At the Forefront of Fungal Research in the Philippines

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FBES GROUP, JULY 2019

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Thank you very much!

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Does the response of Cerrado litter mixobiota to burning differ from the intensity of the fire?



Master's Degree Student: Izabel Cristina Moreira
Teacher: Profa. Dra. Solange Xavier dos Santos

Fung Lab
Micologia básica, aplicada e divulgação científica
Universidade Estadual de Goiás

Introduction

The Cerrado

- It is the predominant biome in central Brazil;

- Vegetation formations- savanna-like phytophysiognomies to forests

- Highly flammable during the dry season

Introduction

The fire:

- most relevant and essential agent for the maintenance and functioning of this ecosystem

- transformation of natural areas into spaces for agricultural activities

Introduction

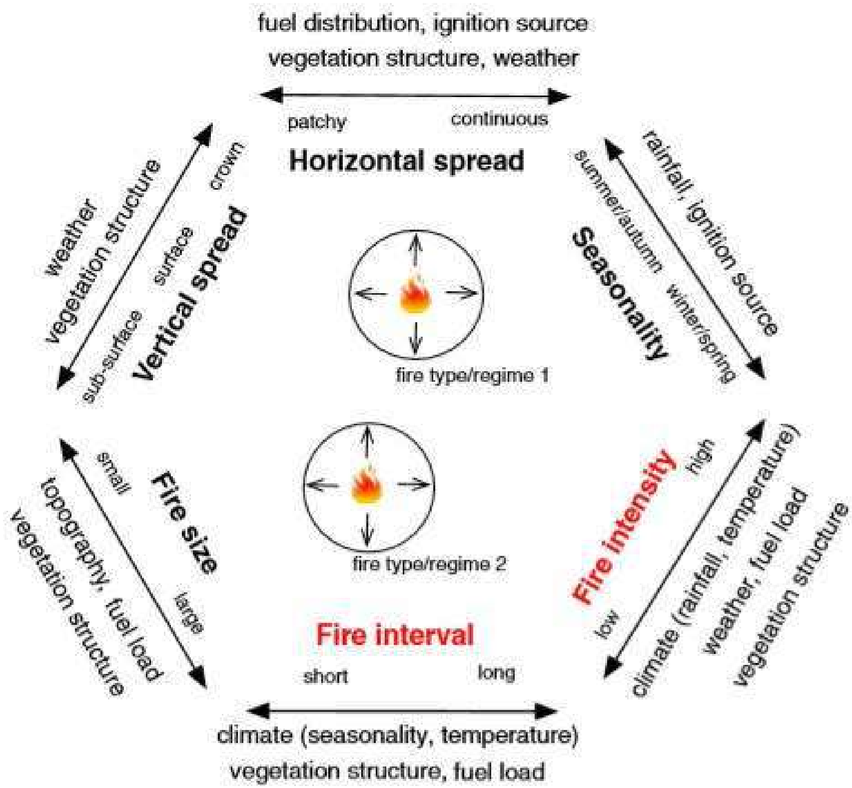
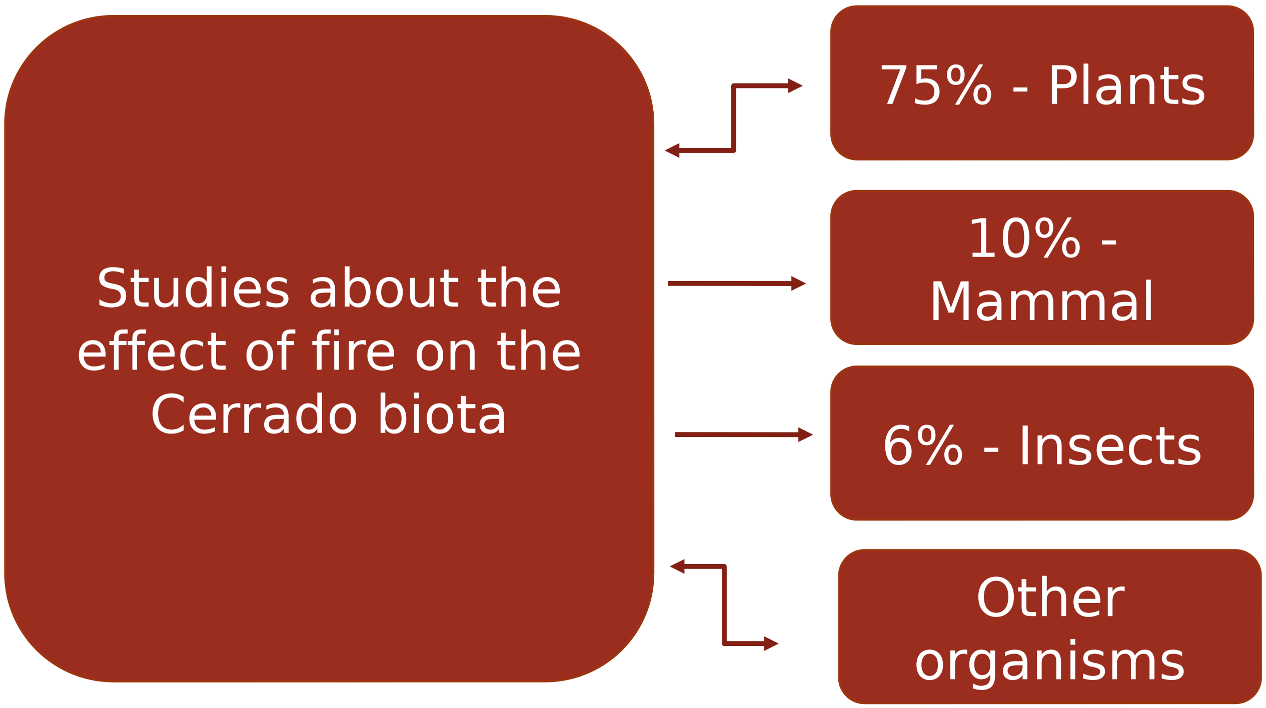


Fig. 1. The six components (the two 'core' components in red) of individual fires (fire events) and environmental factors that control the properties of each component to define the fire type. Ignition source (lightning, anthropogenic) may affect the properties of each component but is not itself a component of fire. 'Fire interval' refers to to the time since last fire for individual fires and mean fire interval for the fire regime. The fire regime arises from repeated patterns (means plus variance) over time of the properties of the components for each fire. For a certain vegetation structure under a given climate, fire regime is relatively predictable (as indicated by the circles) and selects for an adapted group of plants, microflora and associated fauna.

HE et al. 2019

Introduction



Arruda et al. 2018

Introduction

- Few works involving myxomycetes and fire

- Temperate regions

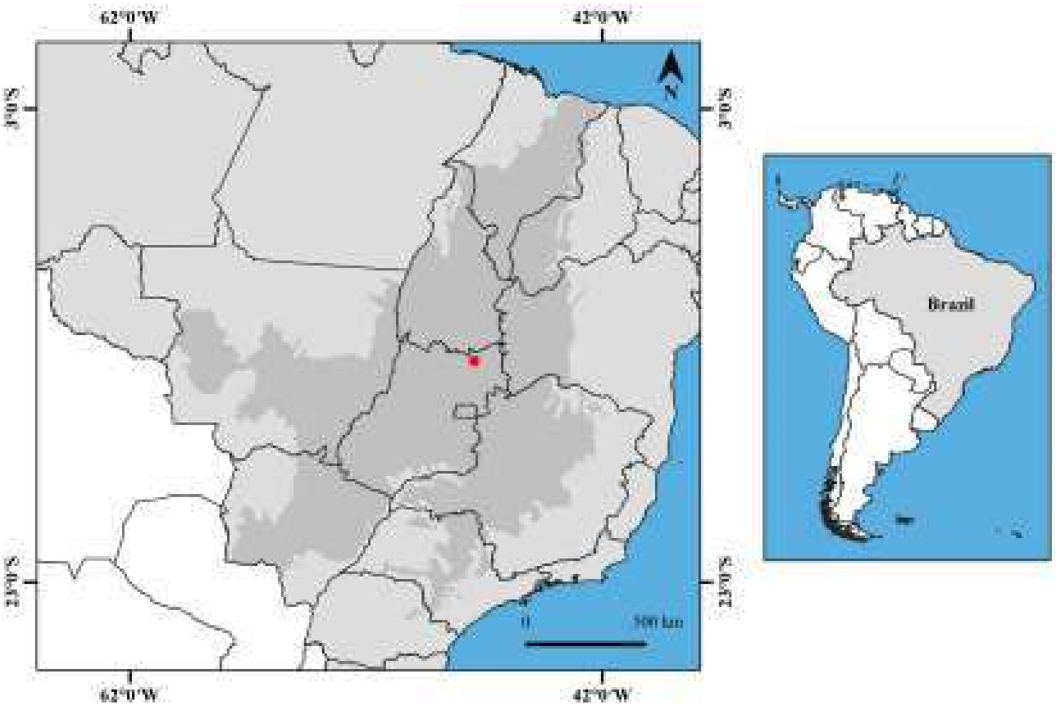
- Tropical Region

Objective

- To comparatively analyze the impact of the different intensities of the imposed (managed) fire on the litter myxomycete community, considering the species richness and composition.

Methodology

➢ Study area :

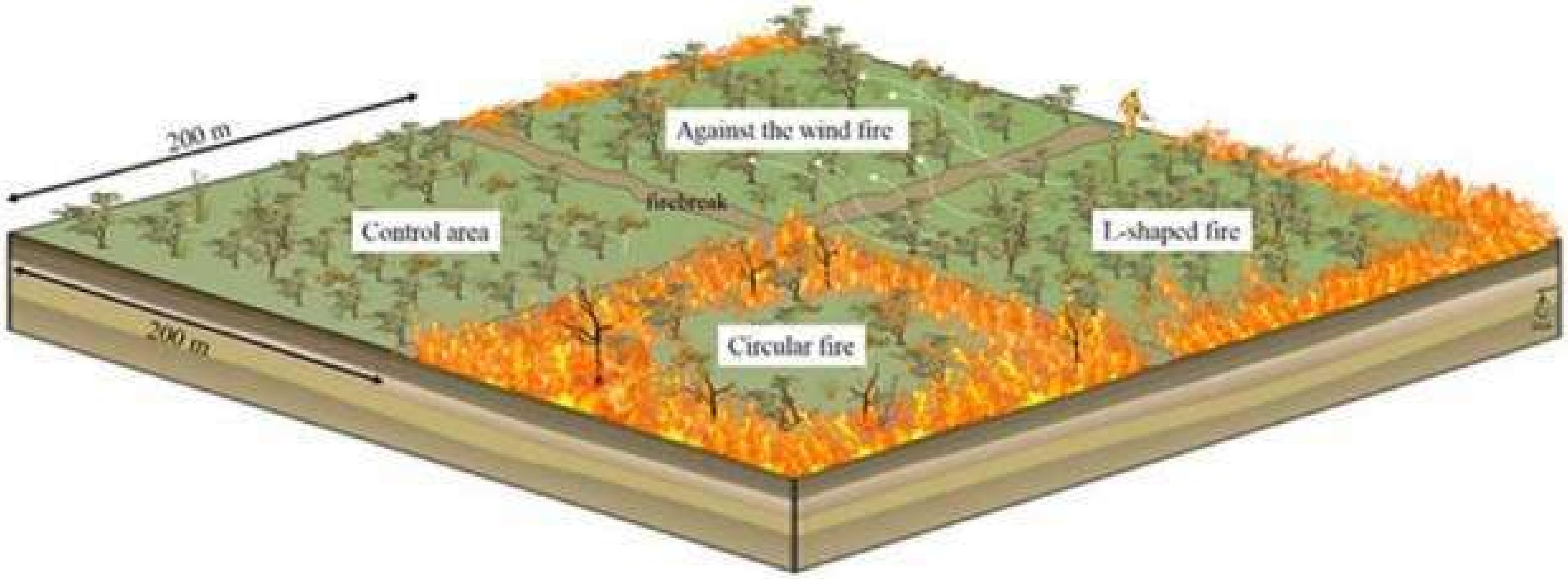


Geographic location of the study area in the Kalunga quilombola community, municipality of Cavalcante, state of Goiás, Brazil (red dot). In dark gray the extension of the Cerrado biome in the Brazilian territory.

QQuilombola community Kalunga located in the Northeast region of the state of Goiás, municipality of Cavalcante.

Methodology

- **Treatments**



Representation of the different types of fires carried out in the sampled area. Against the wind fire = low intensity fire; L-haped fire = fire of intermediate intensity; Circular fire = high intensity fire; Control area = without burning by Calaça, F.J.S.

Control

Burning against

Burning in L

Circular

Methodology

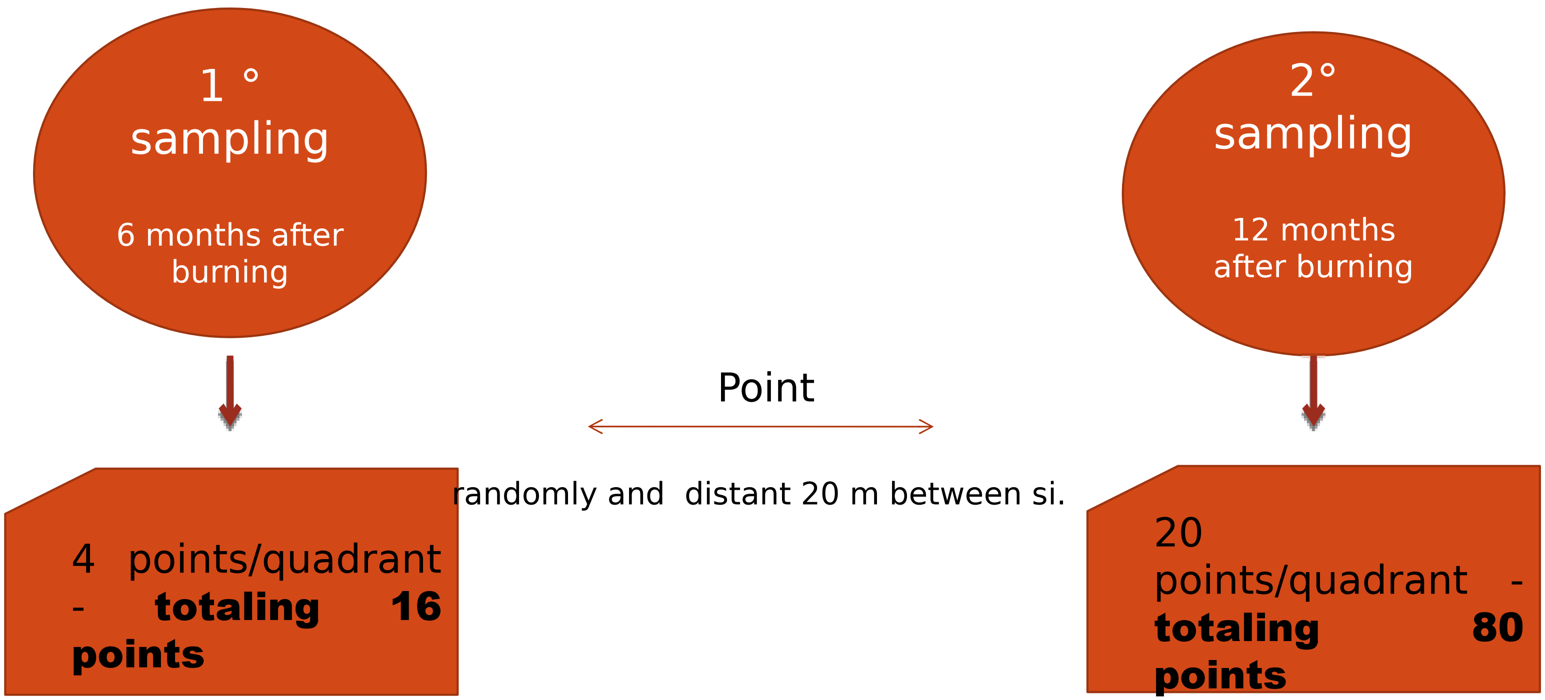
➢ Treatments

Characterization of the different types of firing, according to time, height, spped and impact level (based on speed and height data. Upwind= low fire; in L= fire of intermediate intensity; circular= high intensity fire; control= without burning.

Burning intensity	Burning time (min)	Average fire height (m)	Fire speed (m/s)	Impact level
Control	-	-	-	0
Upwind	50	0,6	1	1
in L	16	1,3	41	2
Circular	8	3,05	83	3

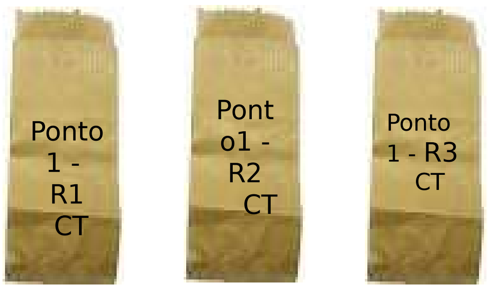
Methodology

- **Sampling**



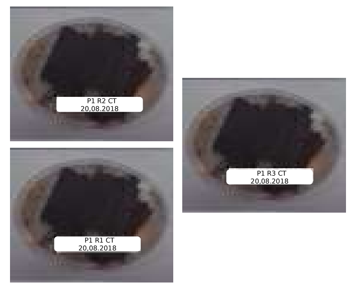
Methodology

- **Sampling**
  - 30g litter collection/point - 3 litter samples were collected, divided into R1, R2, R3



Collection of subsamples

Manufacture of wet chambers



Subsamples in wet chambers

Sporocarps seen in moist chambers

- Data analysis was computed considering the richness and composition of species that appeared in the humid chambers in each treatment.

Results

- **We obtained :**
- **37 specimens**
- **24 species**
- **11 genres**
- **5 families**
- **4 orders**

Familie	Specie	Treatament			
		CT	CV	FL	FC
Ceratiomyxaceae	*Ceratiomyxa fruticulosa* (O.F. Müll.) T. Macbr.	1	-	-	-
Didymiaceae	*Diderma chondrioderma* (de Bary & Rostaf.) Kuntze	1	2	-	-
	D. effusum (Schwein.) Morgan	-	1	-	-
	Diderma cf. *spumarioide* (Fr. & Palmquist) Fr.	1	-	-	-
	Diderma cinereum Morgan	-	1	1	-
	cf. *Diderma*	1	-	-	-
	Didymium comatum (Lister) Nann.-Bremek	2	-	-	-
	Didymium cf. *difforme* (Pers.) Gray	1	-	-	-
	Didymium serpula Fr.	1	-	-	-
	Didymium cf. *verrucisporum* A.L. Welden	1	-	-	-
Physaraceae	*Craterium rubronodum* G. Lister	-	1	-	-
	Craterium minutum (Leers) Fr.	-	1	-	-
	Craterium sp2.	-	1	-	-
	Cf. Physarum serpula Morgan.	-	1	-	-
Stemonitidaceae	*Comatricha* cf. *laxa* Rostaf.	2	-	-	-
	Collaria arcyrionema (Rostaf.) Nann.-Bremek. ex Lado	3	-	1	-
	Stemonitis flavogenita E. Jahn.	1	1	-	1
	Stemonitis axifera (Bull.) T.Macbr.	-	1	-	-
	Stemonitopsis cf. *aequalis* (Peck) Y. Yamam.	1	1	-	-
	S. typhina (F.H.Wigg.) Nann.-Bremek.	2	-	-	-
	Stemonitis sp1	-	1	-	-
Trichiaceae	*Perichaena corticalis* (Batsch) Rostaf.	-	1	-	-
	Arcyria cinerea (Bull.) Pers.	1	1	-	-
	A. denudata (L.) Wettst.	1	-	-	-
Total		20	14	2	1

Results

➢ **Species richness**

P = 0.004

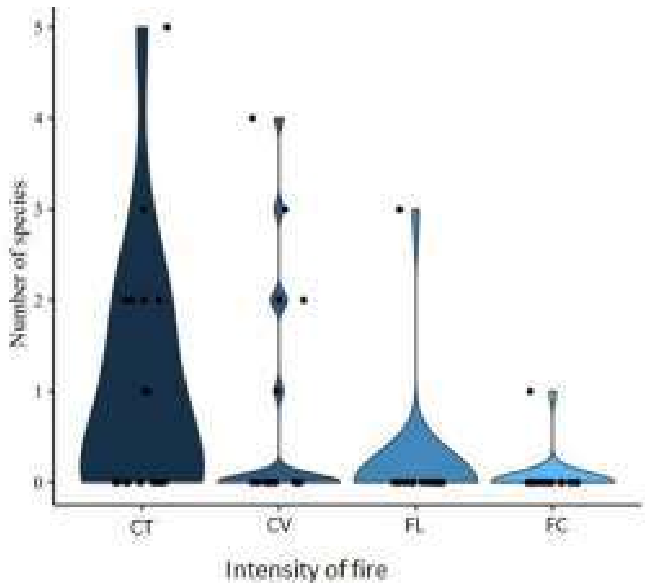
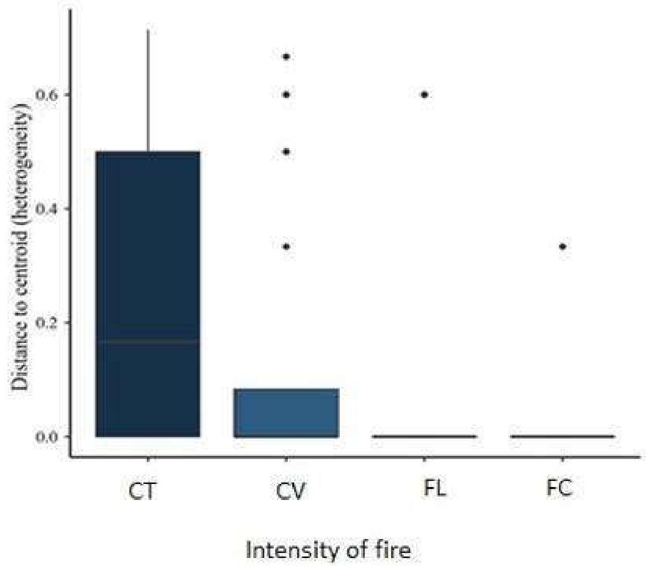


Figure 3. Variation in the richness of litter myxomycete species in relation to the intensity of the fire, in stricto sensu cerrado areas. Control (CT), low intensity fire (CV), intermediate intensity fire (FL), high intensity fire (FC)

Results

➢ Species composition



Values of D_{mean}
Control = 0.232
Low intensity fire = 0.130
Medium intensity fire = 0.030
high intensity fire = 0.017

Figure 4. Variation in the composition of litter myxomycete species (Bray-Curtis Zero-Adjusted dissimilarity) in relation to fire intensity, in stricto sensu cerrado areas. CT = control; CV = low intensity fire; FL = fire of intermediate intensity; FC = high intensity fire.

Results

➢ **Species composition**

- The beta diversity partition - total variation in species composition (Total BD = 0.463).

30% : replacement of species (Repl = 0.140)

70% : differences in species richness (RDiff = 0.323)

Results

➢ Species composition

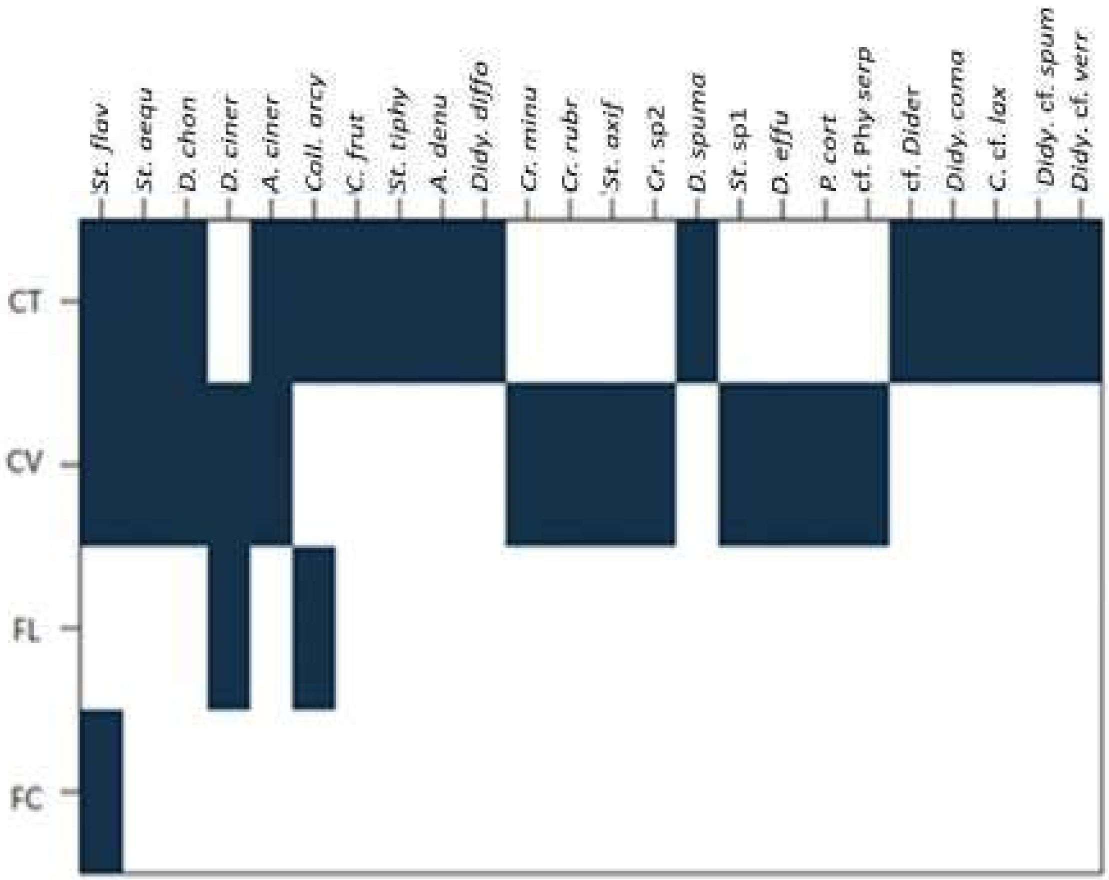


Figure 5. Representation of the nesting (sorted loss of species) of mycelium moths in relation to fire intensity, in areas of strict sensory closure. CT = controls; CV = low intensity fire; FL = intermediate intensity fire; FC = high intensity fire. St.flav = *Stemonitis flavogenita*; St.aequ = *S. aequalis*; D.ciner = *Diderma cinereum*; A.ciner = *Arcyria cinerea*; Coll.arcy = *Collaria arcyrionema*; C.frut = *Ceratiomyxa fruticulosa*; St.tiphy = *Stemonitopsis. typhina*; A.denu = *A. denudata*; Didy.difo = *Didymium diforme*; Cr.minu = *Craterium minutum*; Cr.rubr = *C. rubronodum*; St.sp1 = *Stemonitis* sp1; Cr.sp1 = *Craterium* sp1; D.spum = *Diderma spumarioide*; St.axif = *Stemonitis axifera*; D. effu = *Diderma effusum*; P.cort = *Perichaena corticalis*; cf. Phy serp. = cf. *Physarum serpula*; cf. Dider = cf. *Diderma*; Didy. coma = *Didymium comatum*; Coll. cf. lax = *Collaria* cf. *laxa*; D cf. spum = *Diderma* cf. *spumarioide*; Didy. Cf.verru = *Didymium* cf. *verrucosum*.

Final considerations

Increased fire intensity:

- It led to a decrease in species richness, promoting homogenization of communities and diversity reduction through species loss;

- The different burning intensities act as a filter on myxomycete species, affecting the structure of this community.

Final considerations

- This information provides relevant subsidies for eventual fire prevention and management programs, consequently, for the conservation of myxobiota and can guide complementary studies on the effect of fire on myxobiota.
- This work represents the first systematic and ecological study to evaluate the impacts of different burning intensities of managed myxobiota in a savanna ecosystem.

Acknowledgment

Fire brigade and partner researchers

To the Kalunga quilombola community

UNIVERSITY OF SANTO TOMAS

Diversity of myxomycetes along forest edge of Mt.Isarog Natural Park, Camarines Sur, Philippines

Eloreta MFB[1,2,3] Policina MS[1,2] and dela Cruz TEE [1,2]

[1]*The Graduate School, and*

[2]*Fungal Biodiversity, Ecogenomics and Systematics Group, Research Center for the Natural and Applied Sciences, University of Santo Tomas, España Blvd. 1008 Manila, Philippines*

[3] *Philippine Science High School – Bicol Region Campus, Bgy. Tagongtong, Goa 2247 Camarines Sur, Philippines*

The Mt. Isarog Natural Park

Source: https://www.hellotravel.com

Source: https://www.wetravelfearlessly.com

... a strato volcano located at the southern part of Luzon Island at the heart of the province of Camarines Sur

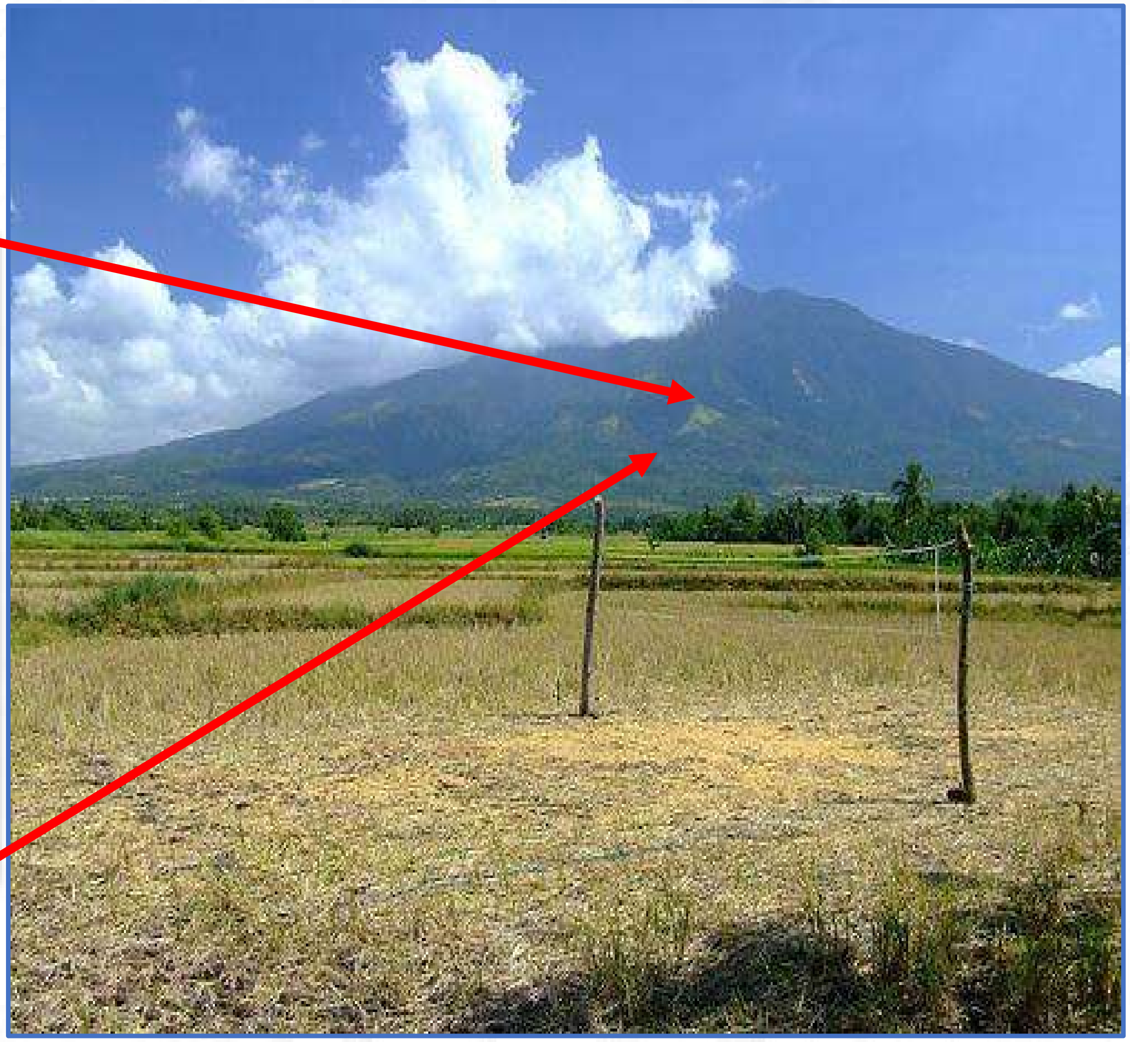
PAMB, Camarines SUr

Flora and Fauna

- around **143 bird species** with **15 endemic species**
- **8 species** of snakes
- **19** species of lizards
- some **3,000 species of plants**

Threats to Mt. Isarog National Park

"slash and burn" farming



Activities such as "kaingin" have created a mosaic of forested and non-forested areas in Mt. Isarog.

increased human activities creates forest edge

Biodiversity of Forest Edges…

Forest edges in the mixed-montane zone of the Bavarian Forest National Park – hot spots of biodiversity

Jörg Müller[1,*], Heinz Bußler[2], Martin Goßner[3], Axel Gruppe[4], Andrea Jarzabek-Müller[1], Manuel Preis[1] & Thomas Rettelbach[5]

Acta Zoologica Academiae Scientiarum Hungaricae 48 (Suppl. 2), pp. 75–87, 2002

FOREST EDGES ARE BIODIVERSITY HOTSPOTS – ALSO FOR NEUROPTERA

DUELLI, P.[1], OBRIST, M. K.[1] and P. F. FLÜCKIGER[2]

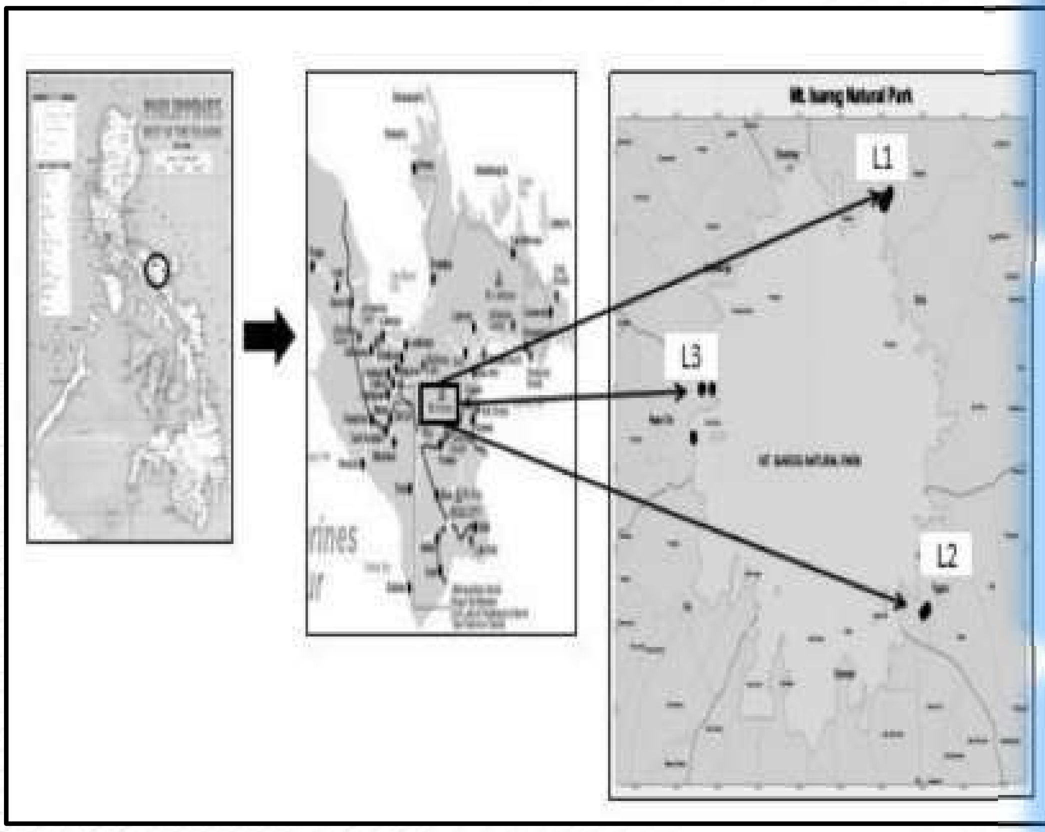
Our research questions...

What are the species of myxomycetes found along the forest edges of Mt. Isarog Natural Park?

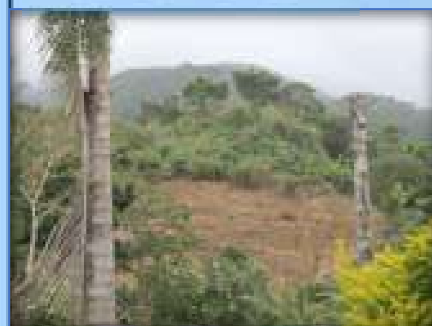
Do forest edges influence community composition of myxomycetes?

Assemblages of myxomycetes along **forest edges** would be **similar in composition**.

Our Hypothesis...




L1_Bgy.Digdigon


L2_Bgy. Consocep


L3_Bgy. Panicuason

Our Sampling Localities

Our Methods…

Collection of substrates

- ground leaf litter
- twigs

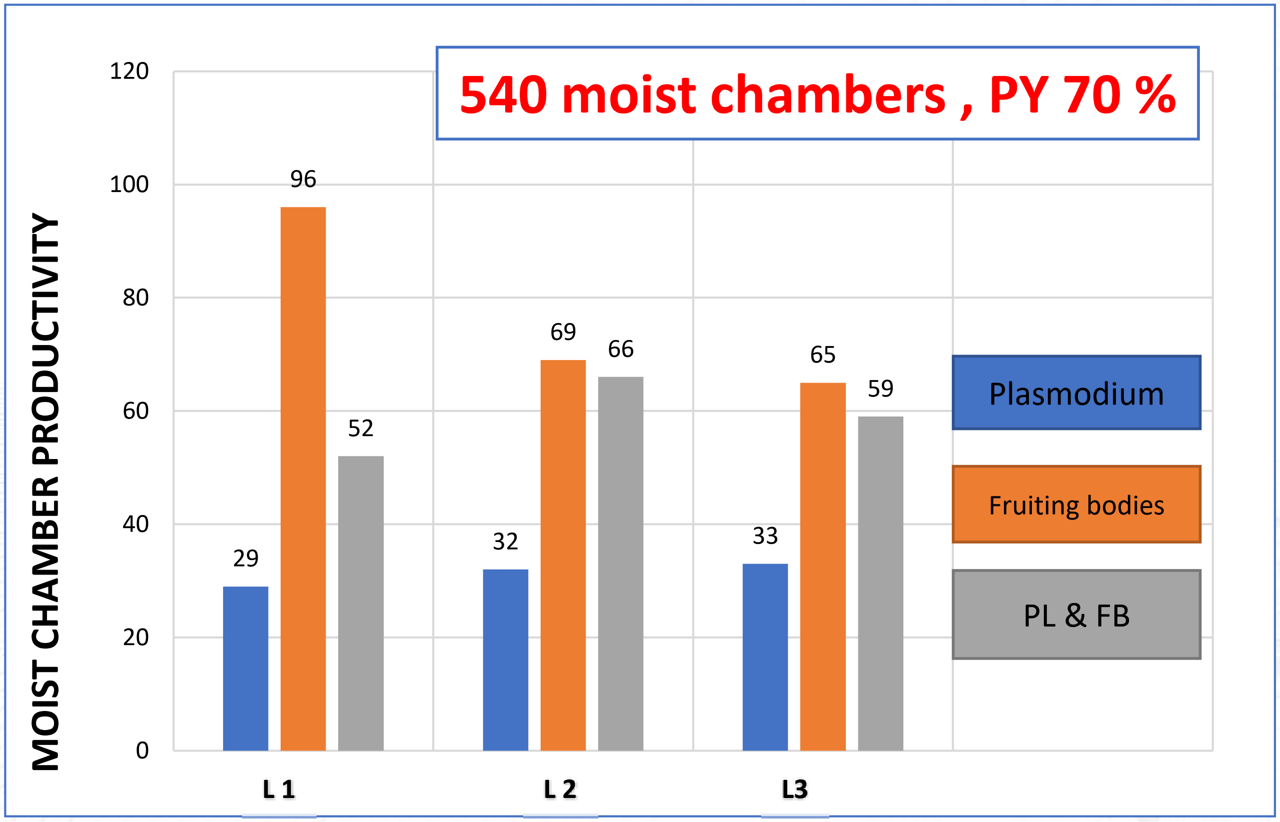
Moist Chambers

Species Identification

Ecological Analysis

- Percent Yield
- Species Accumulation Curve
- Species Occurrence/Relative Abundance
- Taxonomic Diversity and Species Diversity
  - *S/G Ratio*
  - *Shannon Index (Hs))*
  - *Fisher's Alpha Index (FAI)*
  - *Simpson Index (SID)*

Moist chambers in relation to locality



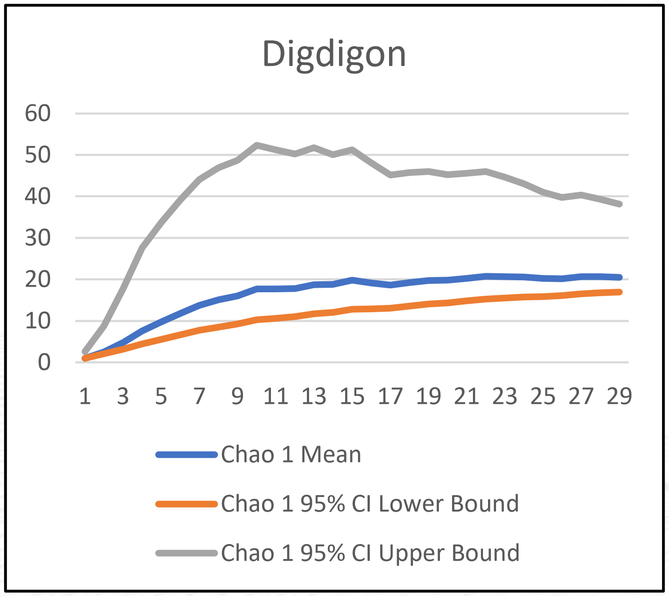
L1_Bgy.Digdigon

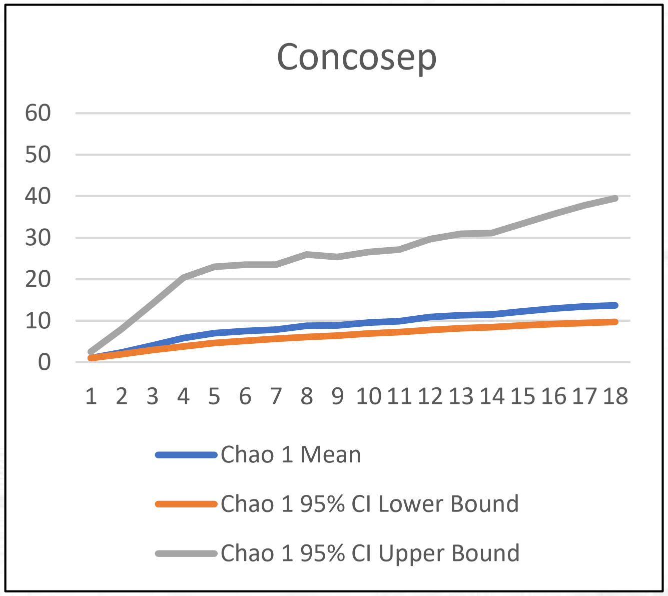
L2_Bgy. Consocep

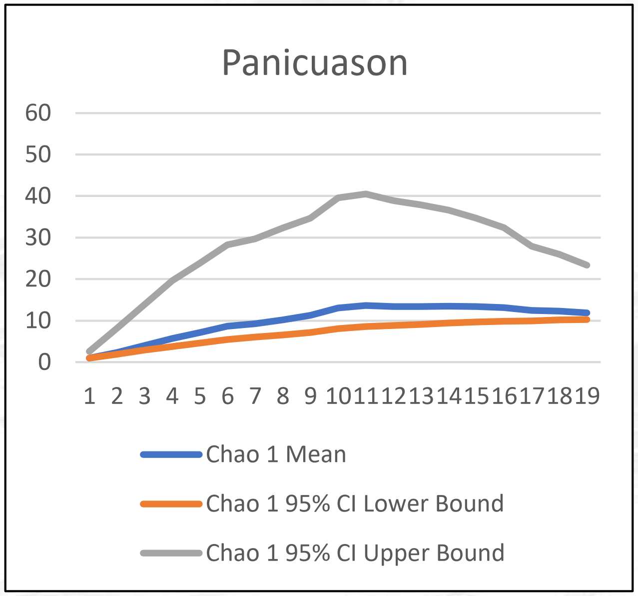
L3_Bgy. Panicuason

Concosep > Panicuason > Digdigon

Species Accumulation Curve: Twigs





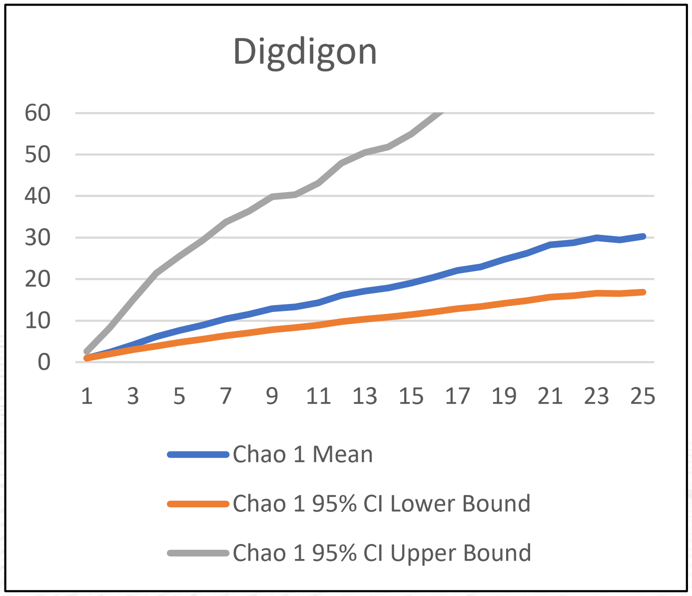


% completeness = 78

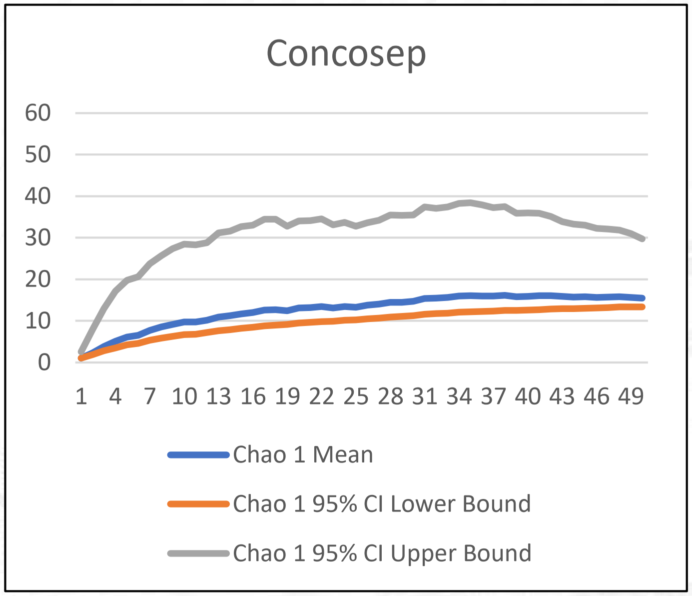
% completeness = 66

% completeness = 84

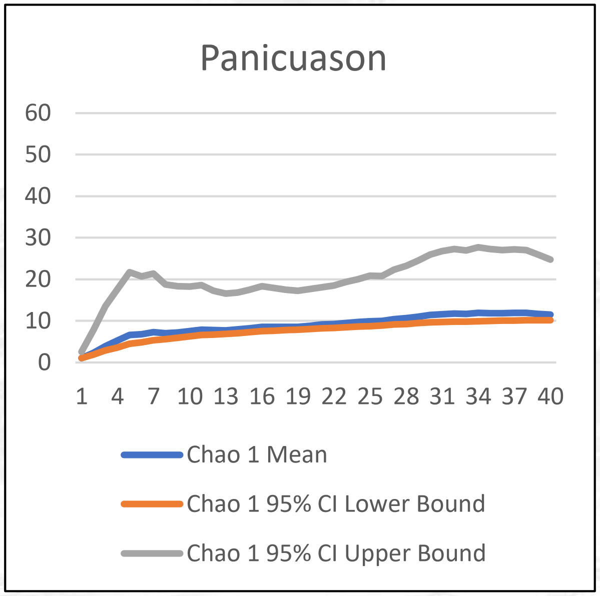
Species Accumulation Curve: Ground Leaf Litter



% completeness = 42



% completeness = 84



% completeness = 87

Species listing & Abundance

TAXA	AI	Pooled Frequency	L1	L2	L3	TW	GL
Arcyria cinerea (Bull.)Pers.	A	29	6	12	11	14	15
Arcyria denudata (L.) Wettst	A	7	3	2	2	6	1
Hermitrichia calyculata (Speg) M.L. Farr	A	6	2	3	1	3	3
Hermitrichia serpula (Scop.) Rostaf.	O	2	1	0	1	1	1
Perichaena chrysosperma (Currey) Lister	A	6	5	1	0	5	1
Perichaena depressa Libert	O	8	0	4	4	3	5
Perichaena pedata (lister & G.Lister) G.Lister	A	3	2	0	1	2	1
Diachea leucopodia(bull) rostaf.	O	1	0	1	0	0	1
Diderma effusum (Schwein.) Morgan	A	27	9	8	10	2	25
Diderma hemisphaericum (Bull.)Hornem	A	8	1	1	6	1	7
Didynium bahiense Gottsb	C	8	1	5	2	1	7
Didynium nigripes (Link) Fr.	A	6	2	1	3	2	4
Didynium squamulosum (Alb. & Schwein.) Fr.	A	15	6	3	6	5	10
Physarum sp.	R	1	1	0	0	1	0
Physarum compressum Alb.& Schwein.	A	4	2	2	0	2	2
Physarum decipiens M.A. Curtis	O	2	2	0	0	1	1
Physarum globuliferum (Bull.) Pers	A	25	1	17	7	2	23
Physarum melleum (Berk. & Broome) Massee	R	1	1	0	0	1	0
Physarum oblatum T.Macbr	R	1	1	0	0	1	0
Cribraria microcarpa (Schrad) pers.	O	2	1	1	0	1	1
Comatricha nigra (Pers ex J.F Gmell) J.Schrot	C	4	1	2	1	1	3
Comatrichia pulchella (C.Bab.& Berk.) Rostaf.	O	2	2	0	0	2	0
Stemonitis pallida Wingate	O	2	0	0	2	1	1
Stemonitis smithii T. Macbr	A	6	1	3	2	6	0

Taxonomic Diversity

	Locality				Substrates	
	Frequency data	L 1	L2	L3	TW	GL
Total numbers of records	177	52	66	59	64	113
Number of species	24	22	16	16	23	18
Number of genera	10	9	10	8	10	10
Taxonomic Diversity Index (TDI)	-	2.4	1.6	2.0	2.3	1.8

L2 Bgy. Consocep is taxonomically diverse than L1 and L3

TW > GL

Species Diversity in relation to Substrata and Locality

Locality	Substrate	FAI	Shannon	Simpson
Digdigon	**TW**	**14.66**	**2.62**	**11.68**
	GL	**10.91**	**2.26**	**7.18**
Consocep	TW	7.16	2.00	6.23
	GL	5.7	2.08	5.63
Panicuason	TW	8.54	2.09	6.33
	GL	4.28	2.06	6.27

L1 Digdigon is diverse in terms of species diversity.

TW > GL

Myxomycete diversity in fragmented forest patches


COMMUNITY ECOLOGY 19(3): 289-299, 2018
1585-8553 © AKADÉMIAI KIADÓ, BUDAPEST
DOI: 10.1556/168.2018.19.3.10

Myxomycete communities occurring in fragmented forest patches in two municipalities of Laguna, Philippines

J. L. M. Bernardo[1], L. J. Q. Arioder[1], K. J. Almadrones-Reyes[1] and N. H. A. Dagamac[2]

Los Baños

Calauan

From a total of 240 moist chambers,
42 species, 14 genera

Localities along forest edges harbour almost similar assemblages of myxomycetes.

Our Take-Home Points...

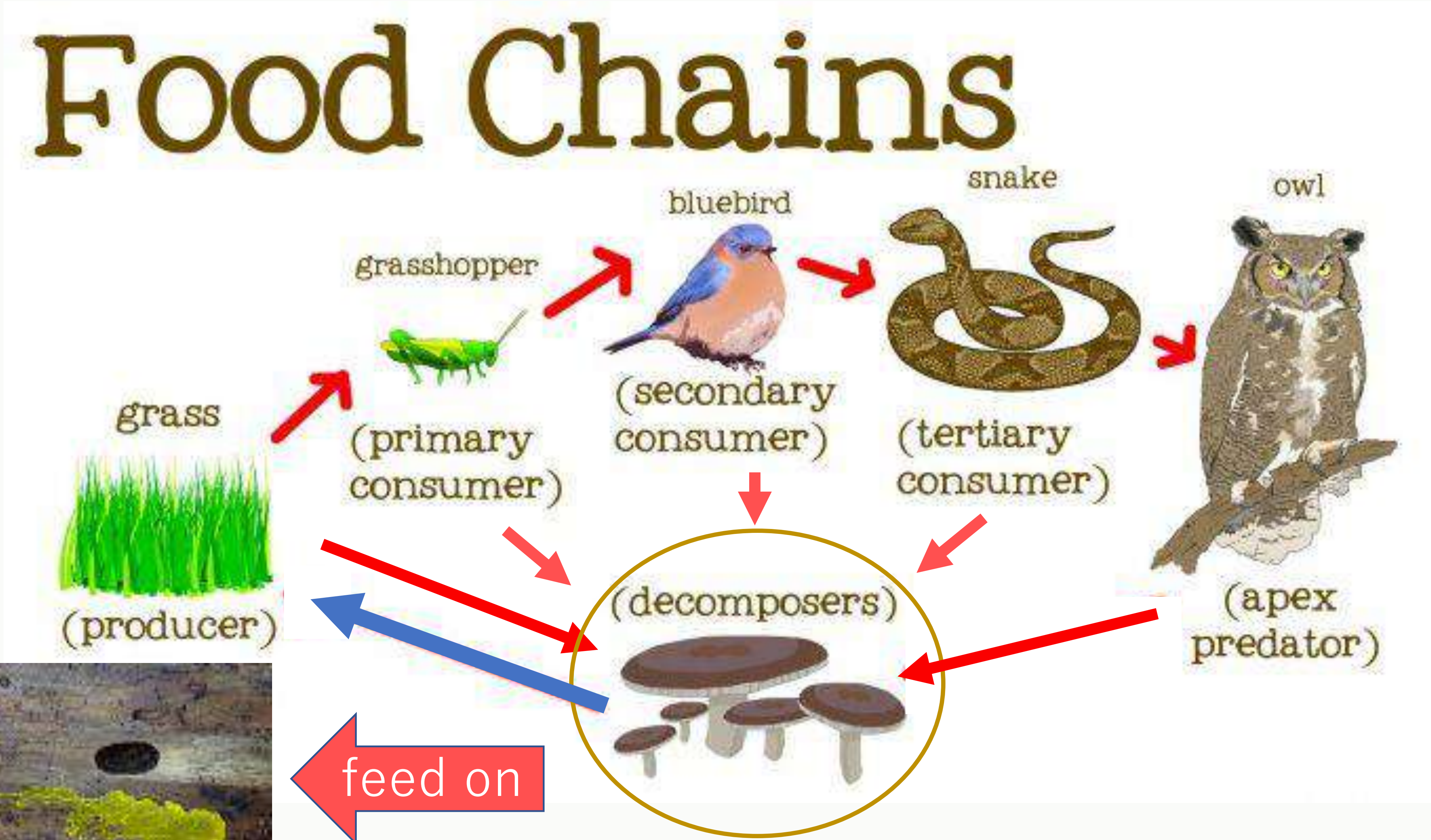
- Philippine Science High School- Bicol Region Campus
- DOST-HRDP Graduate Scholarship
- UST-Research Center for the Natural and Applied Sciences
  - Fungal Biodiversity, Eco-genomics and Systematics Group
- UST Office of the Graduate School
- DENR Regional Office V
- Protected Area Management Bureau (PAMB),Camarines Sur


muchas gracias !

ISCEM10_O13

Association between myxomycetes and the decay stage of coarse woody debris in an evergreen broadleaf forest in warm temperate Japan

Yuichi Harakon ・Kazunari Takahashi



https://www.onlinebiologynotes.com/food-chain-trophic-levels-and-flow-of-energy-in-ecosystem/

【World】

〇Boreal coniferous forests in Finland(Ukkola,2002)

〇Alpine mixed fir forest in Germany
(Schnittler & Novozhilov,1998)

〇Tropical rainforests in Brazil
(de Lima & Cavalcanti,2015)

【In Japan】

〇Beech forests(Takahashi & Hada,2008)

〇Coniferous forests
(Takahashi,2010 and Takahashi & Hada,2009)

〇Subalpine forests(Takahashi & Harakon,2016)

Goal

To reveal the relationship between the microenvironmental elements (decay and moisture of wood) and myxomycete assemblages in the Japanese evergreen broadleaved forest.

Study site ①

【canopy layer】

Castanopsis sieboldii
Machilus thunbergii
Quercus glauca
Cinnamomum camphora

Study site ②

1981y-2010y
mean annual temperature ： 17.0°C
mean annual precipitation： 1612mm

Field survey ①

- Logs are over 10cm in diameter and over 1m in length.
- Colonies within 30cm are counted as a same sample.
(Stephenson,1989)

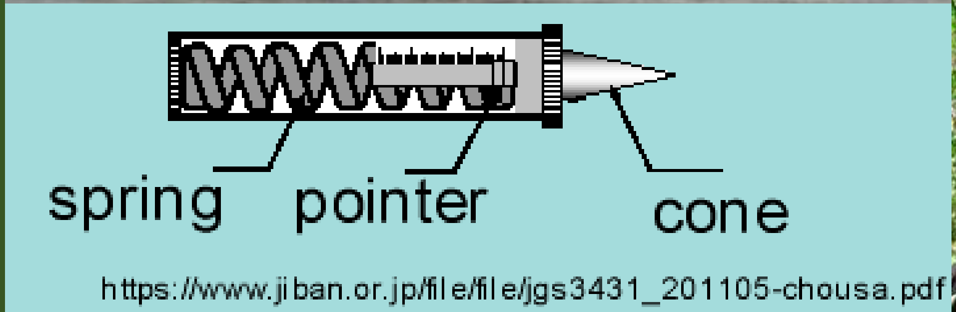
Field survey ②

Moderately decayed

Slightly decayed
(hard)

heavy decayed
(soft)

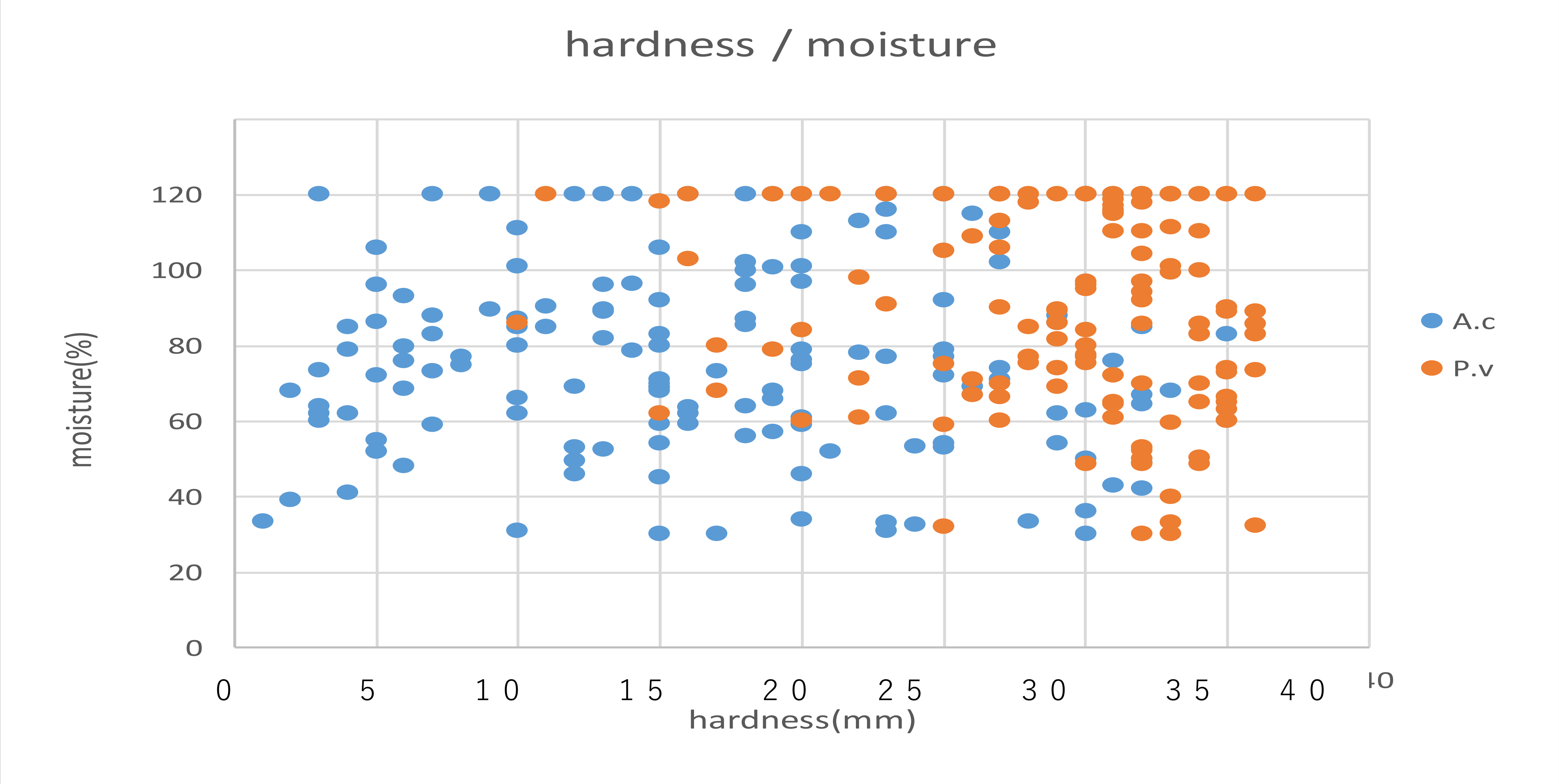
There are many different decay stages in a log.



the soil hardness tester(upper)
the wood moisture tester(lower)

researching scene of high school students

Analysis①



hardness / moisture
moisture(%)
120
100
80
60
40
20
0
0
5
1 0
1 5
2 0
2 5
3 0
3 5
4 0
hardness(mm)
A.c
P.v

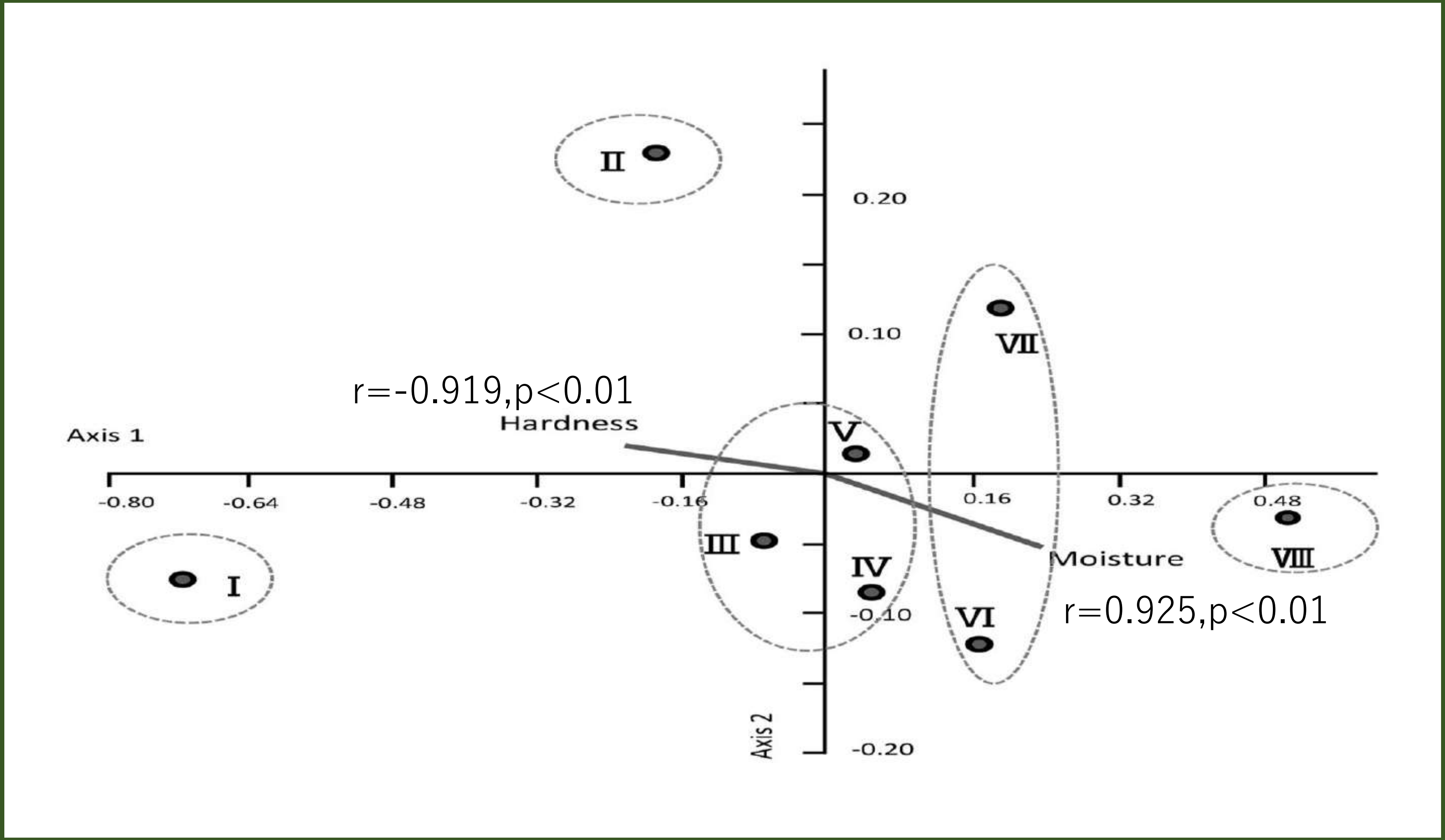
	hard ⟵						⟶ soft
Decay Stage	Ⅰ	Ⅱ	Ⅲ	Ⅳ	Ⅴ	Ⅵ	Ⅶ	Ⅷ
Xmm depth	35<X	30<X<35	25<X<30	20<X<25	15<X<20	10<X<15	5<X<10	X<10
Samples	21	207	234	192	201	111	62	24
Spiecies	12	42	43	39	37	31	26	14

X(mm) is the resistance value measured by preesing a cone against the wood surface.

decay stage Ⅰ (undecayed)

decay stage Ⅷ (brittle)

The positions of myxomycete assemblages in relation to the different stages of decaying wood



Biplots of nonmetric multidimensional scaling, analyzed by Jaccard similarity.

Analysis②

the decay stage index formula

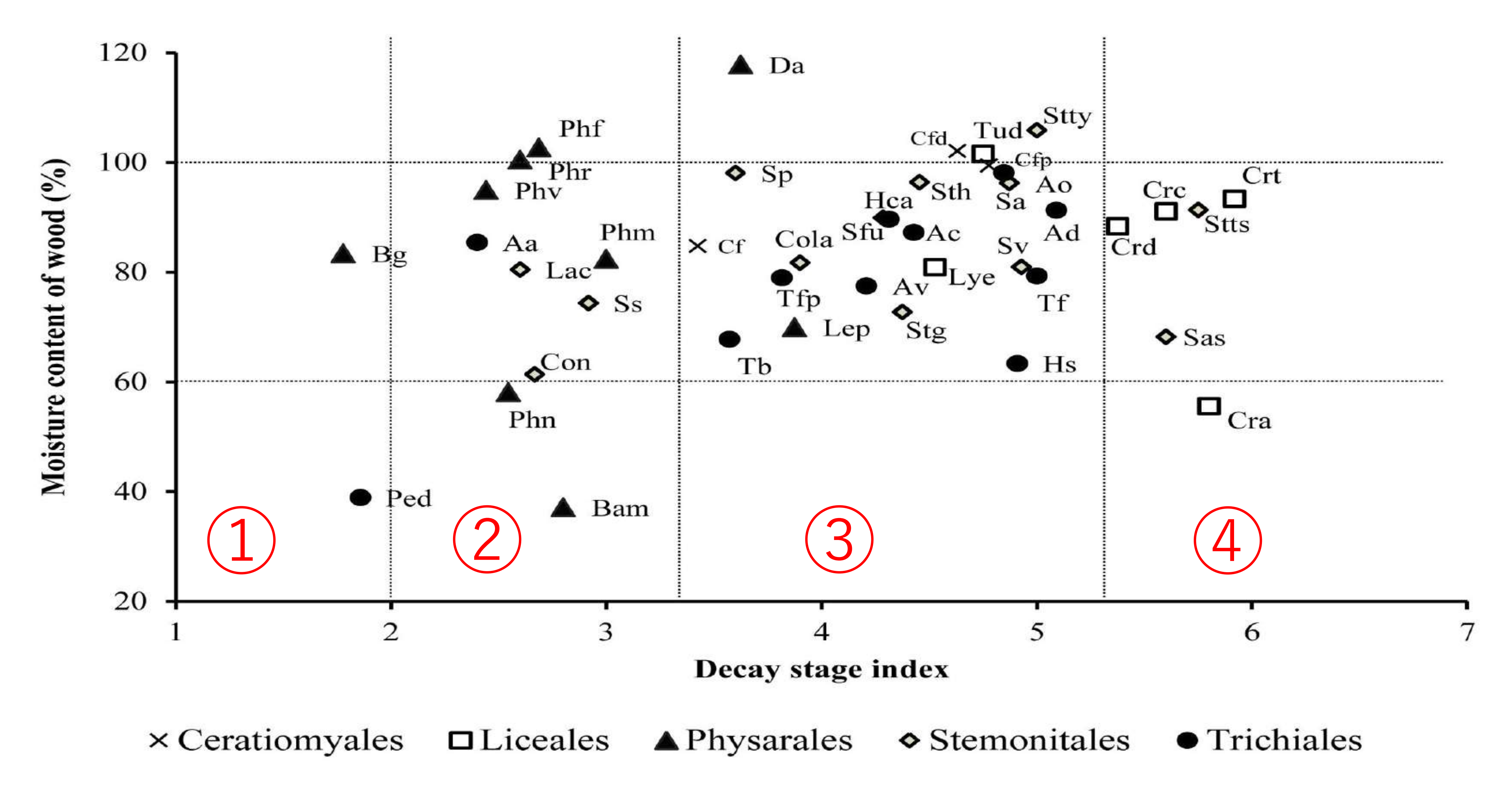
$$DI = \left(\sum_{i=1}^{8} i \cdot \mathrm{n}i\right) / \mathrm{N}$$

the decay deviation formula

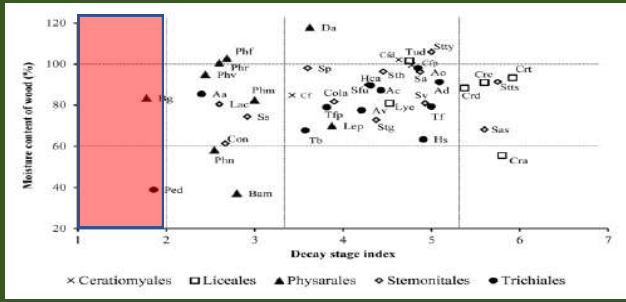
$$D = \sqrt{\left(\sum_{i=1}^{8} \mathrm{n}i(i - \mathrm{DI})^2\right) / \mathrm{N}}$$

Hasegawa(1997)

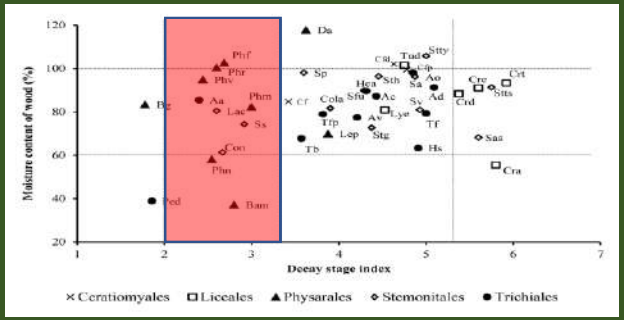
The DI values for these species were plotted against the wood moisture content.



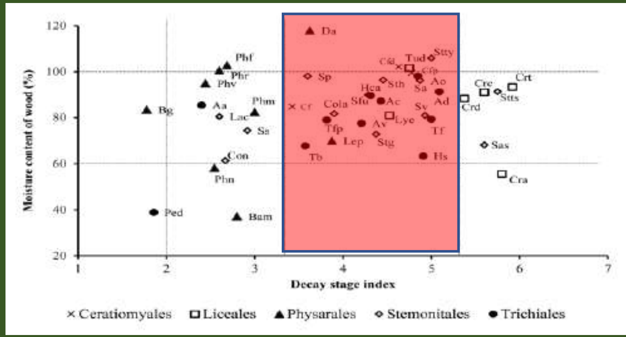
Group①
（D≦3.0）


Moisture content of wood (%)
Decay stage index
× Ceratiomyales
□ Liceales
▲ Physarales
◇ Stemonitales
● Trichiales
Da
Phf
Phr
Phv
Aa
Lac
Phm
Ss
Con
Phn
Ped
Bam
Cf
Sp
Cola
Tfp
Tb
Lep
Hca
Sfu
Ac
Av
Stg
Lye
Sth
Tud
Stty
Sa
Ao
Ad
Sv
Tf
Hs
Crd
Crc
Crt
Stts
Sas
Cra

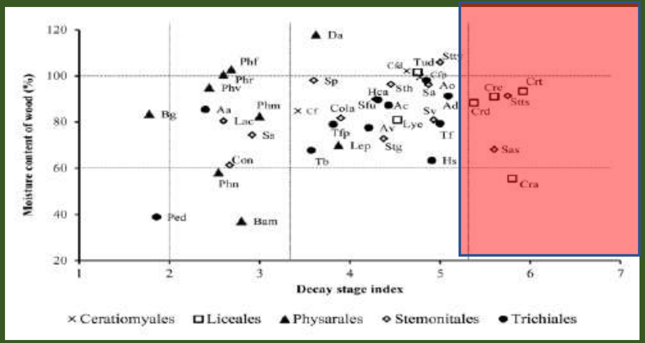
Group②
（D≦3.0）


Moisture content of wood (%)
Decay stage index
120
100
80
60
40
20
1
2
3
4
5
6
7
Da
Phf
Phr
Phv
Aa
Phm
Lac
Sx
Bg
Con
Phn
Ped
Bam
Sp
Cf
Cola
Sfu
Hea
Sth
Ac
Tfp
Av
Lep
Stg
Tb
Tud
Stty
Sa
Ao
Ad
Sv
Lye
Tf
Hs
Crd
Cre
Crt
Sts
Saa
Cra
× Ceratiomyales
□ Liceales
▲ Physarales
◇ Stemonitales
● Trichiales

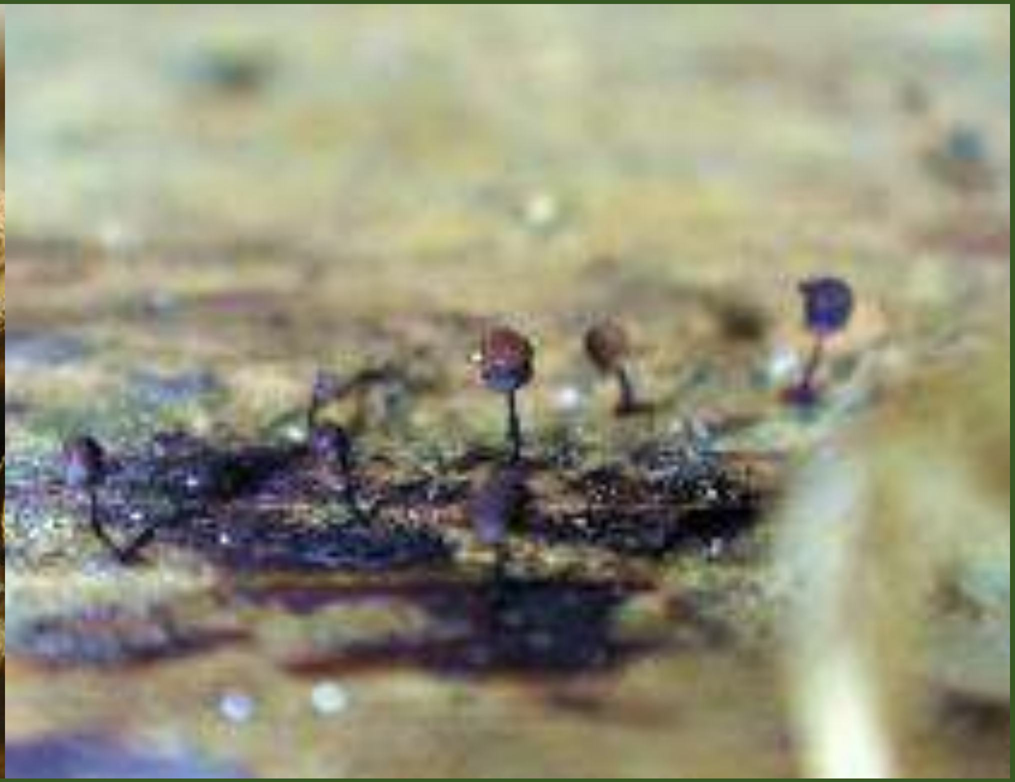
Group③
（D≦3.0）


Moisture content of wood (%)
Decay stage index
× Ceratiomyales
□ Liceales
▲ Physarales
◇ Stemonitales
● Trichiales

Group④（D≦3.0）

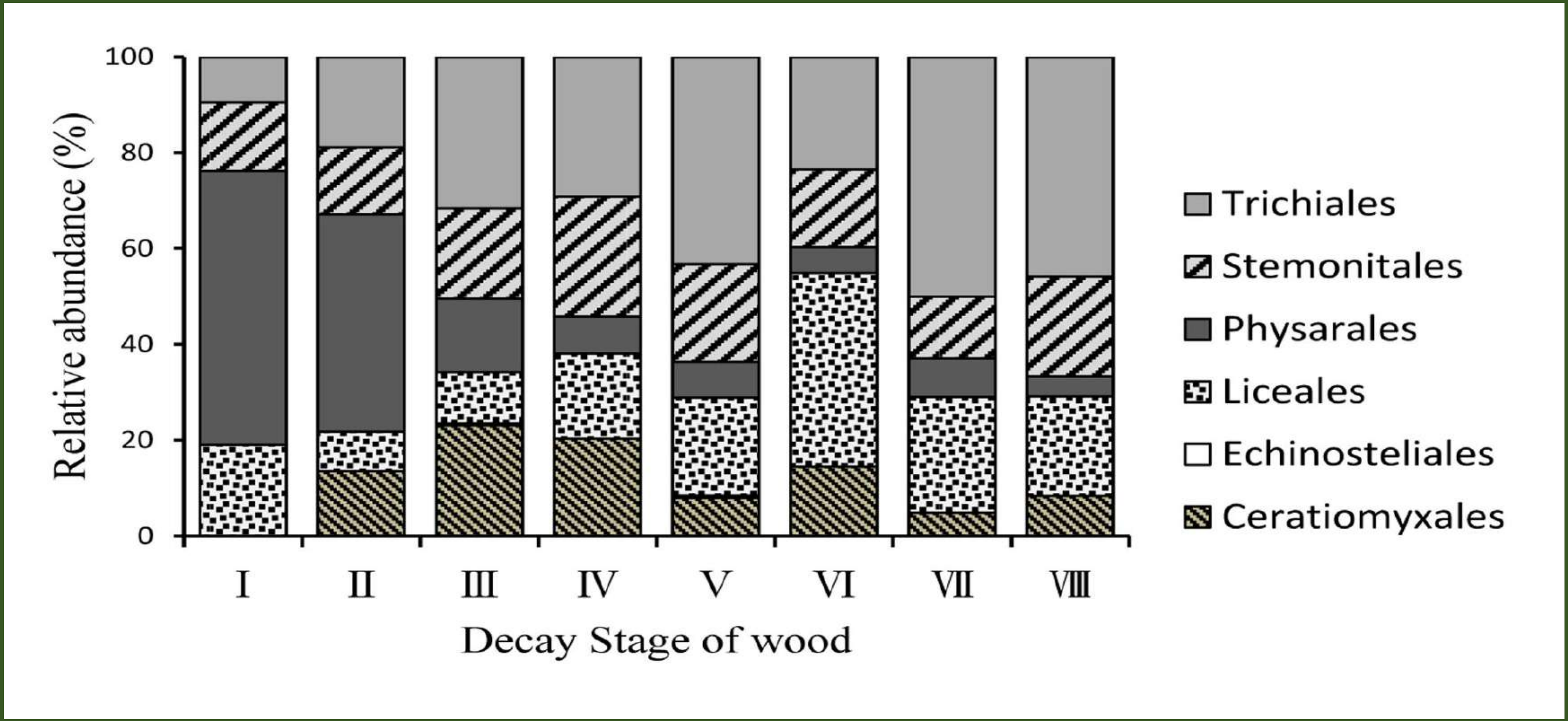


Moisture content of wood (%)
Decay stage index
× Ceratiomyales
□ Liceales
▲ Physarales
◇ Stemonitales
● Trichiales



Analysis③

the relative abundances of species in different taxonomic orders at each decay stage.



Conclusions

- Most myxomycete species showed a preference for moderately decaying wood with moist conditions.
- Species from the order Physarales prefer the less-decayed wood ,whereas species from the Trichiales and Liceales prefer the well-decayed wood.
- These findings are sure to give us the keys to clear the ecosystem in a evergreen broadleaved forest.

Acknowledgments

Professor Shoji Ohga of Kyushu University

Dr. Yu Fukasawa of Tohoku University

Dr. Hiroshi Ikeda of Tokyo University

Thank you for your kind attention.

Xylophilic myxomycetes: will the largest logs harbor **the most, and the most rare,** myxomycetes?

Martin Schnittler, Oleg N. Shchepin, Yuri K. Novozhilov

reSPOnse

Deutsche Forschungsgemeinschaft DFG

ERNST MORITZ ARNDT UNIVERSITÄT GREIFSWALD

Wissen lockt. Seit 1456

Xylophilous myxomycetes

- old-growth beech - fir - spruce forests
- Urwald Mittelsteighütte as one of the last old-growth forests in Germany
- interesting mxyo assemblage of wood-inhabiting myxomycetes, e.g.

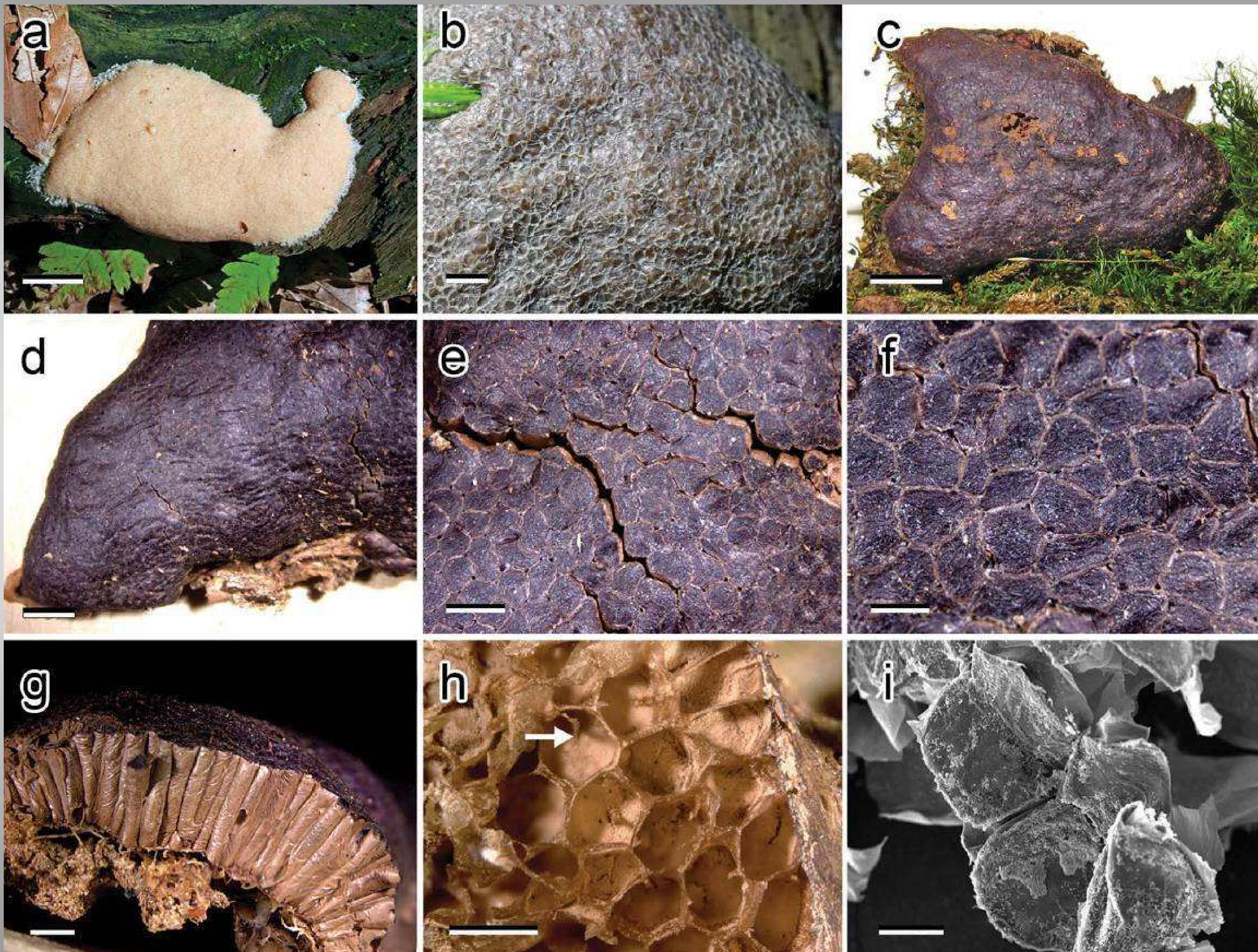
  Dianema corticatum
  Siphoptychium violaceaum

  Lamproderma columbinum
  Lepidoderma trigrinum
  Diderma ochraceum

- Method: careful examination of randomly selected logs (pre-defined plots of the NP staff)
- measuring min - max diameter
- recording all myxomycetes at a log

Borg Dahl, M., et al. (2018): Sci. Rep. 8: 11662

Siphoptychium violaceum



Leontyev et al.. (2019): Mycologia 111: 981-997

NP Bavarian Forest

One of the last old-growth forests

What are myxyomycetes

Species richness

Germany: 370 taxa [1]

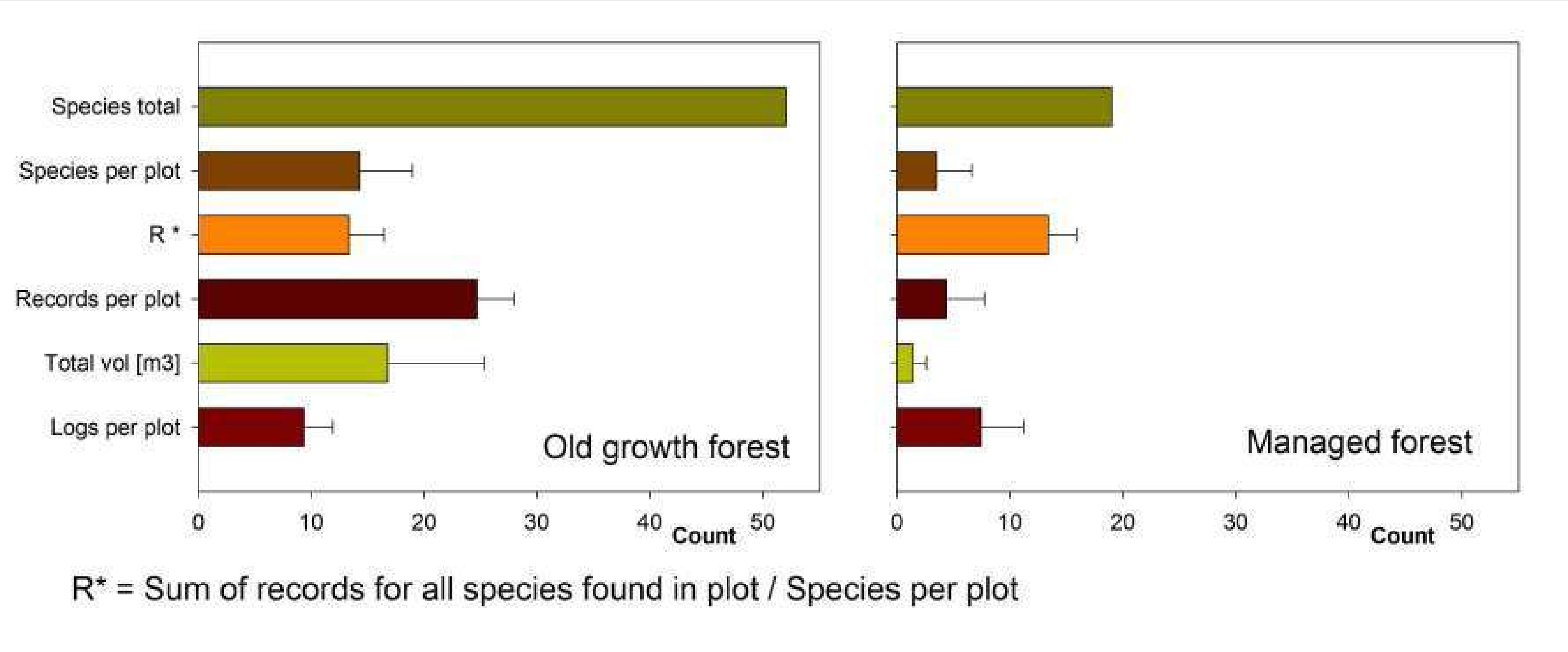
NP Bavarian Forest: 71 taxa from 552 records, 3 years [2]

[1] Schnittler et al. 2011, Schr.R. Vegetationskunde 70(6)
Abundant: sh
Common: h
Occasional: s, mh
Rare: ex, es, ss, ?

[2] unpublished checklist
Abundant: >3%
Common: >1.5-3%
Occasional: >0.5-1.5%
Rare: <=0.5%

Old growth vs. managed forests

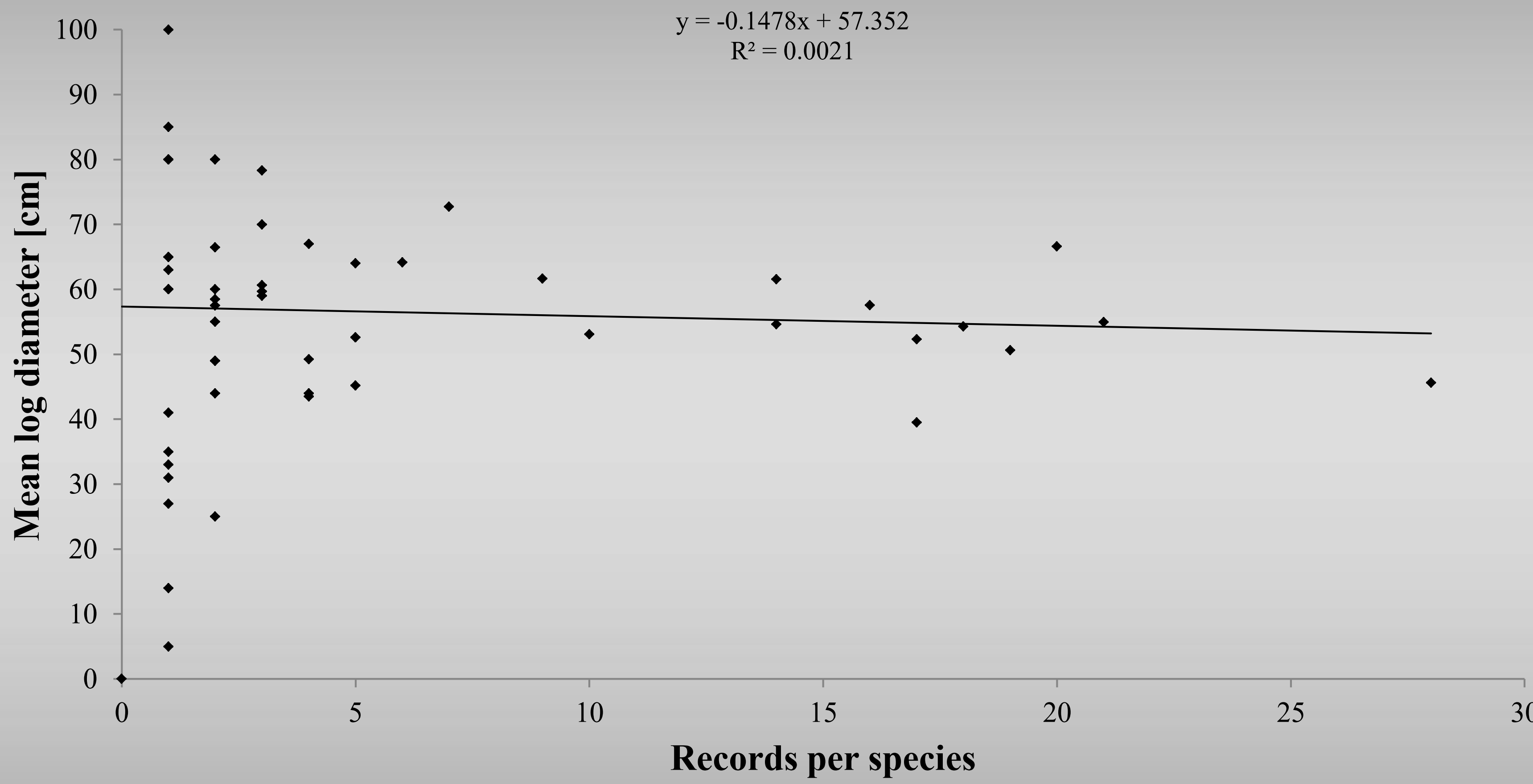
transect sampling, 10 plots for each transect
all logs in a plot where examined, recorded was
- logs per plot
- size of the log (length, diameter 1, 2)
- myxomycete colonies and species per plot



More records / more species in old-growth forests √

Species abundance and log diameter

What is the relationship between
Species abundance and size of logs they are found on?



The most common species are found on logs of all sizes. √

Species abundance and log diameter

What is the relationship between
mean log diameter and 1 species richness
2 species abunance

Abundance class	Mean Ø logs	records in old growth	%	managed forest	%
A (>3%)	54 cm	166	63.1	28	63.6
C (>1.5-3%)	60 cm	34	12.9	8	18.1
O (>0.5-1.5%)	59 cm	49	18.6	4	9.1
R (<0.5%)	57 cm	14	5.3	4	9.1
(all records for a species)		263		44	

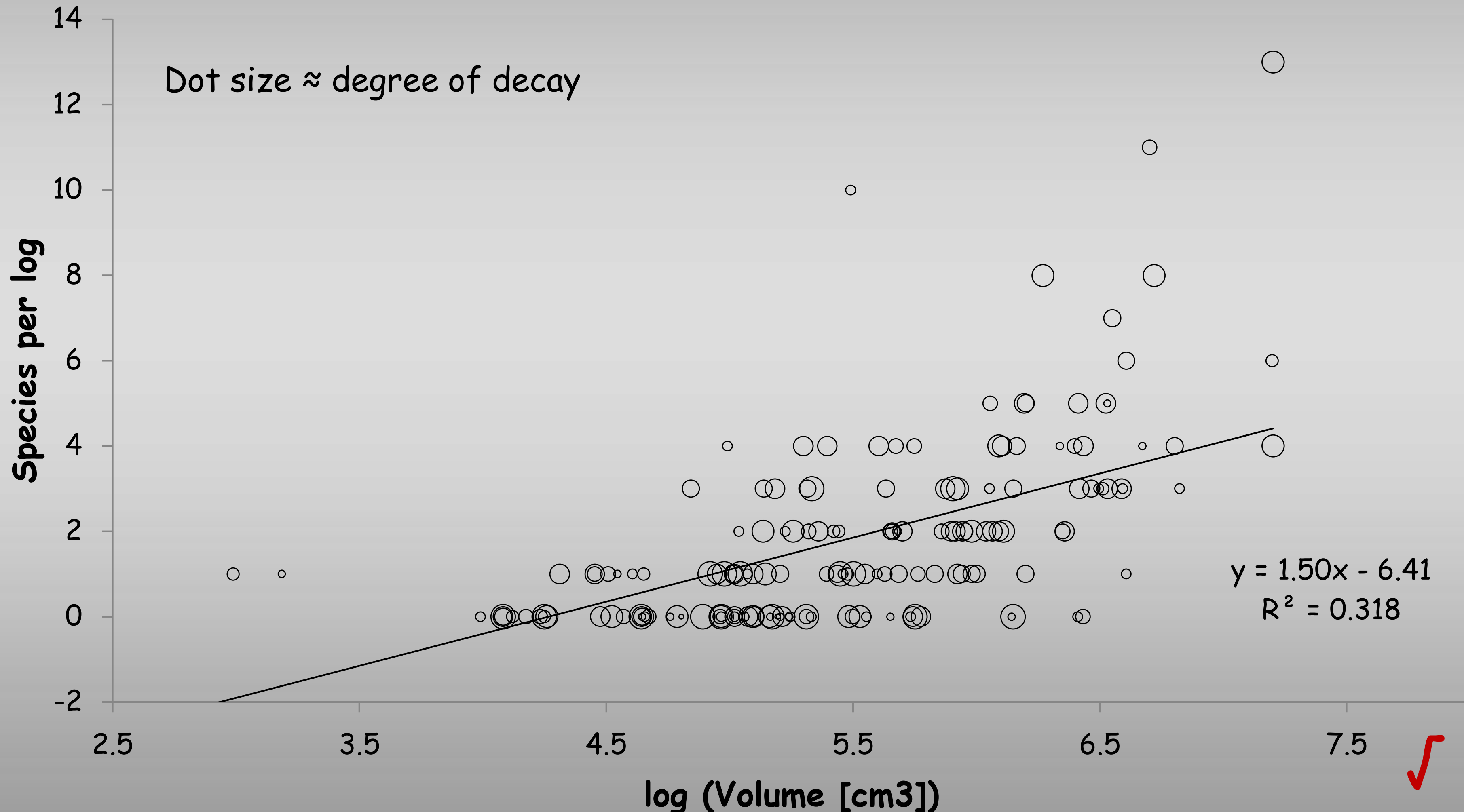
Rare species (class R) show no preference for large logs!

Old growth forests do not show a higher proportion of rare species!

Log size vs species per log

What is the relation between log size and

1 records per log
2 records of rare taxa per log



Thicker logs have more species!

Summary

1. Tick logs have more species per log than thinner ones - as to expect. √

2. We could not proof that rare species (rare in the given survey) show a preference for large logs - contrary to the expection! ~~√~~

However, we need to extent the data set to draw statistically sound conclusions!


Thanks for your attention!

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Myxomycetes Associated with Mahogany Trees in Angat Watershed Forest Reserve, Bulacan Province, Philippines

Monica S. Policina and Thomas Edison E. dela Cruz

The Graduate School

University of Santo Tomas

Email: monica_policina@yahoo.com

ICSEM 10 Costa Rica International Congress on the Systematics and Ecology of Myxomycetes (ICSEM)

Turrialba, Costa Rica, 25-28 February 2020

Corticolous Myxomycetes

- Found on **bark of living trees**
- ca. **120** species
- **minute fruiting bodies**
- **Sporadic** distribution
- Can be detected effectively via **moist chamber culture technique**

(Harkonen, 1977; Penfound, 1940; Snell et al., 2003)

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Studies on tropical bark myxomycetes

Available online at www.sciencedirect.com

MYCOSCIENCE

ISSN 1340-3540 (print), 1618-2545 (online)

journal homepage: www.elsevier.com/locate/myc

Full paper

Corticolous myxomycetes assemblages in a seasonally dry tropical forest in Brazil

Aline B.M. Vaz [a,b], Daniela S. dos Santos [c], Domingos Cardoso [d], Cássio van den Berg [c], Luciano P. de Queiroz [c], Fernanda Badotti [a], Paula L.C. Fonseca [a], Laíse H. Cavalcanti [f], Aristóteles Góes-Neto [a,*]

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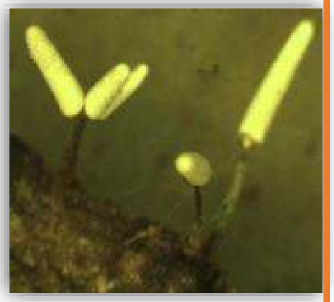
[c] Universidade Estadual de Feira de Santana, Departamento de Ciências Biológicas, Av. Transnordestina, s/n, Novo Horizonte, 44036-900, Feira de Santana, BA, Brazil
[d] Universidade Federal da Bahia, Instituto de Biologia, Rua Barão de Jeremoabo, s/n, Ondina, 40170-115, Salvador, Bahia, Brazil

- **High diversity** of corticolous myxomycetes in a seasonally dry tropical forest
- **Bark pH** acts as a *selective factor* for the establishment of an acidophilic myxomycete assemblage



Arcyria cinerea

Diderma subasteroides

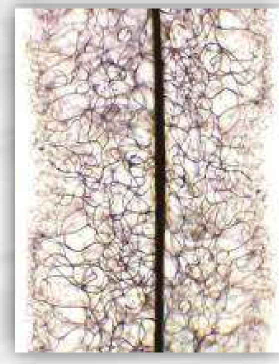
Physarum album

Physarum leucophaeum

Samanea saman (Jacq) Merr.

***5** out of 7 are **new records** in the Philippines*

Dianema harveyi



Stemonitis pallida

Clastoderma microcarpum

Studies on Philippine Corticolous Myxomycetes (Dagamac et al., 2010)

Research Questions:

What are the **species of myxomycetes** present on the barks of mahogany trees in Angat Watershed Forest Reserve?

Swietenia macrophylla (Mahogany Tree)

- Native to Mexico and South America
- Commonly planted in Asia as a source of wood
- Dark color and fairly smooth bark
- Fairly acidic bark pH
- Considered as an invasive species in Angat Watershed Forest Reserve

Our Sampling Area: Angat Watershed Forest Reserve

- Presence of:
  - lowland dipterocarp forest
  - submontane forests
  - scrublands
  - secondary bamboo
  - grassland

(BirdLife International, 2019)

- **Dry season:** November to April
  Wet season: May to October.
- **Mean temperature:** 26°C - 29 °C
- **Mean Annual Rainfall:** 2,385mm

Collection of Substrata

Collection of Tree barks
- at 1.2-1.5m above ground
- in four directions: **North, East, South, West**

Preparation of Moist Chambers and Soil Suspension

Characterization and Identification of Myxomycetes

Data Evaluation

MATERIALS AND METHODS

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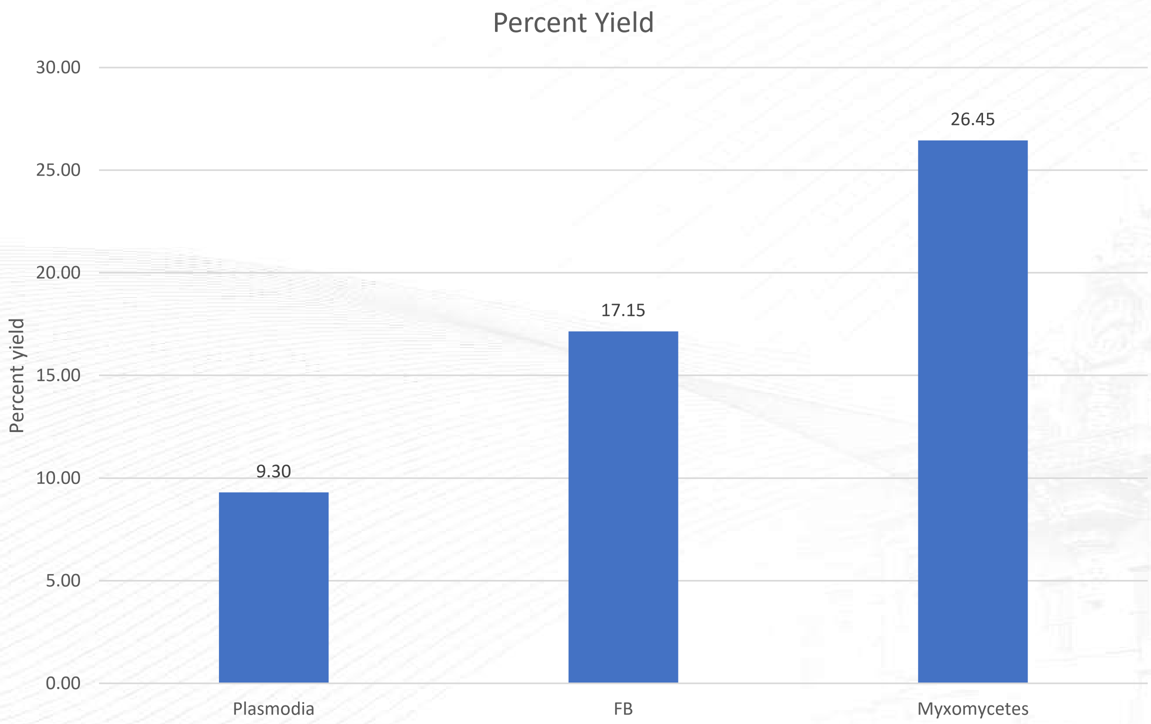
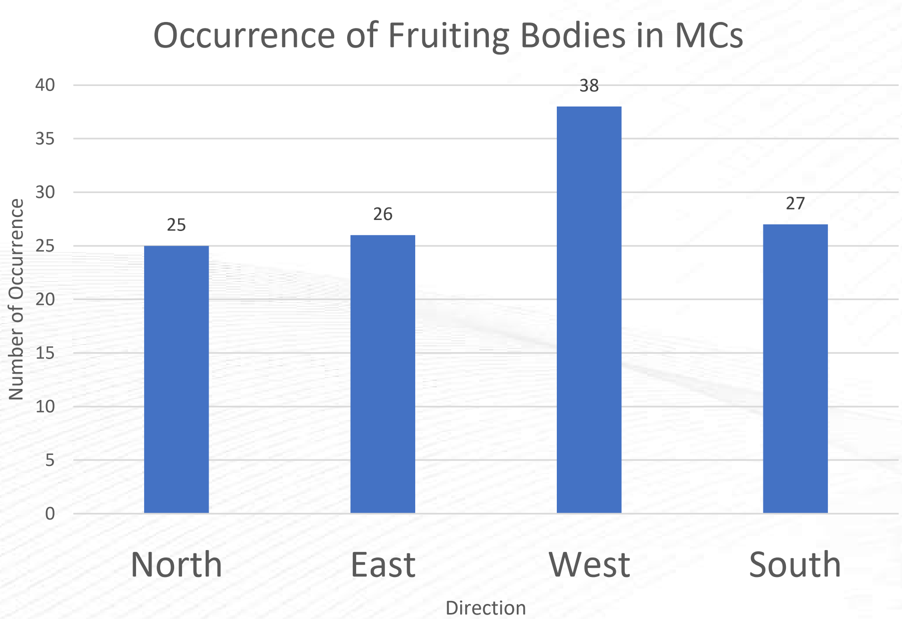
Records from the Moist Chambers

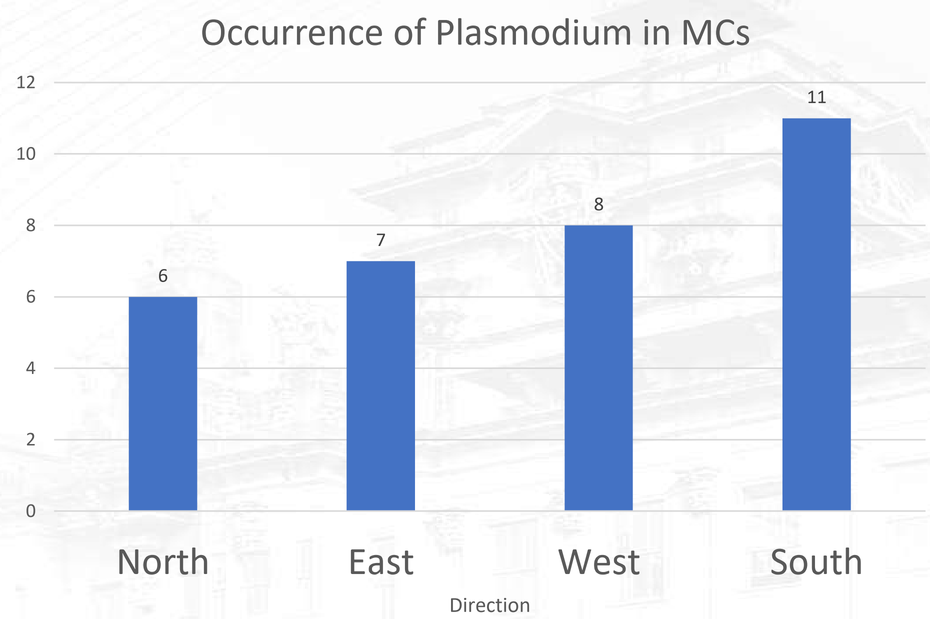


of the 344 MC we prepared,

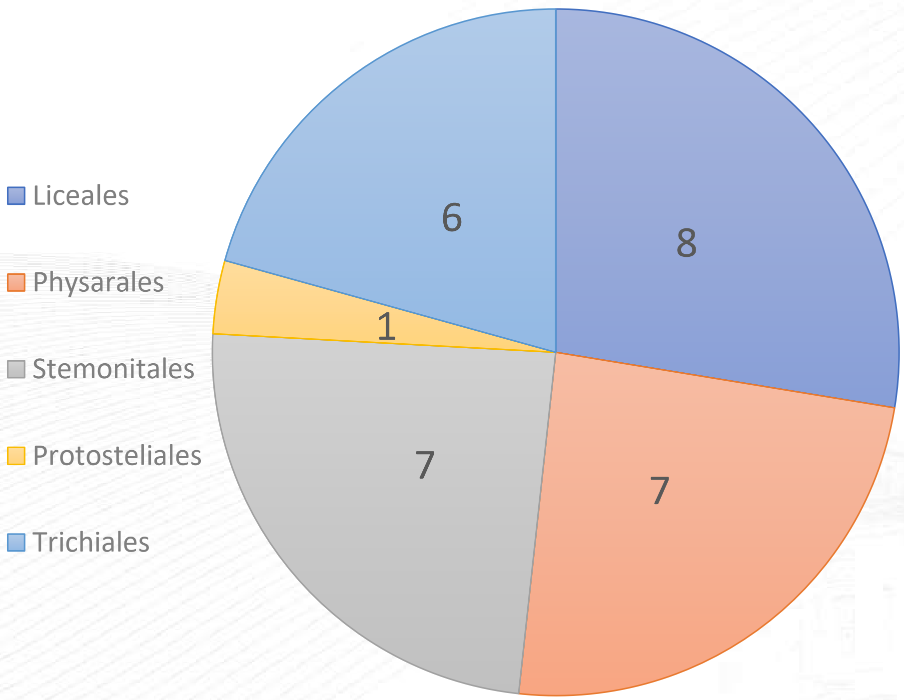
91 positive MC

Records from the Moist Chambers





Number of Myxomycetes recorded in the MC



From highest to lowest:

- Liceales
- Physarales & Stemonitales
- Trichiales
- Protosteliales

Number of MC with myxomycetes

Taxonomic Order	Number of MC (n= 340)	Number of Species	Number of Genera
Liceales	59	8	2
Physarales	32	7	3
Trichiales	14	6	3
Stemonitales	9	7	2
Protosteliales	2	1	1

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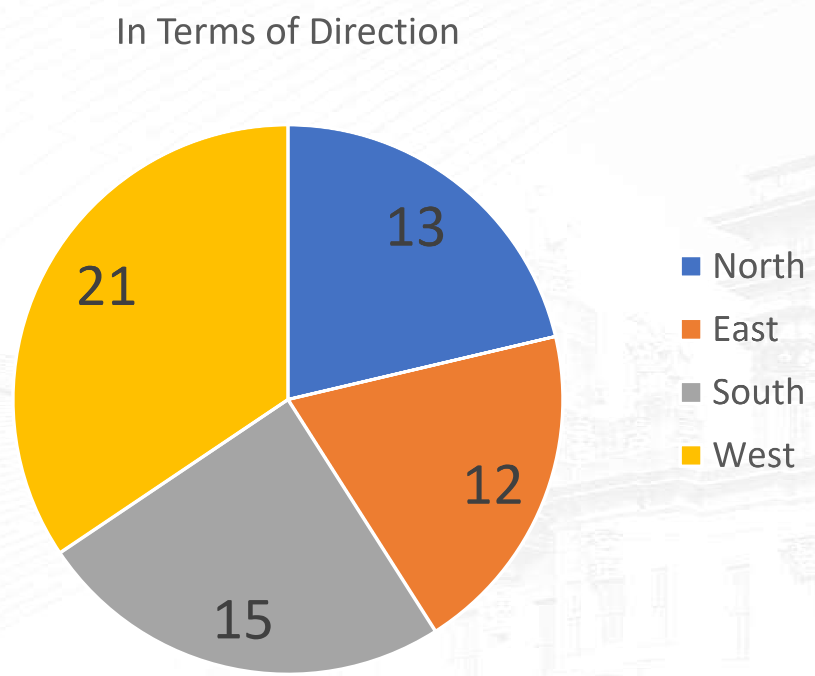
Number of Myxomycetes recorded in the MC



Number of myxomycetes in relation to direction

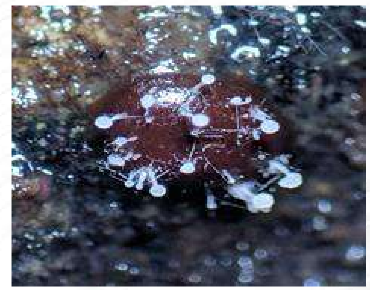
Taxonomic Order	North	East	South	West
Liceales	6	4	3	6
Physarales	3	4	6	8
Trichiales	3	1	5	3
Stemonitales	1	2	1	3
Protosteliales	0	1	0	1

Species associated with mahogany barks

- *Arcyria cinerea*
- *Ceratiomyxa fruticulosa*
- *Collaria arcyrionema*
- *Comatricha nigra*
- *Comatricha pulchella*
- *Cribraria microcarpa*
- *Cribaria violaceum*
- *Diderma hemisphaericum*
- *Didymium squamulosum*
- *Hemitrichia pardina*
- *Hemitrichia serpula*
- *Licea* sp. 1
- *Licea* sp. 2
- *Licea* sp. 3
- Licea *sp. 4*
- *Licea* sp. 5
- *Licea operculata*
- *Perichaena chrysosperma*
- *Perichaena pedata*
- *Physarum* sp. 1
- *Physarum* sp. 2
- *Physarum* sp. 3
- *Physarum album*
- *Physarum melleum*
- *Physarum lakhanpalii*

Species associated with mahogany barks

Licea sp. 1

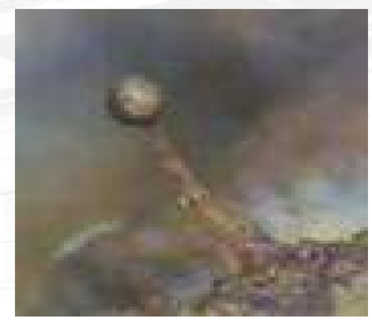


Licea sp. 2

Licea sp. 3

Licea sp. 4

Licea sp. 5



Licea operculata

Our take-home message:

Barks of *Swietenia macrophylla* (mahogany) harbors diverse species of corticolous myxomycetes.

West direction showed the highest number of species.

Future directions…

- Compare different barks on the presence of myxomycetes
  - *Swietenia macrophylla* (mahogany), *Samanea saman* (acacia), *Shorea contarta* (white lauan)
  - *Gmelina arborea* (gmelina), *Pterocarpus indicus* (narra), *Mangifera indica* (mango)
  - *Parkia javanica* (kupang), *Pinus* sp. (pine)
- Correlate the bark physico-chemical properties to the presence of myxomycetes

Acknowledgement…

- DOST-NSC-ASTHRDP Graduate Scholarship
- UST- Research Center for the Natural and Applied Sciences (RCNAS)
- The Management of the Angat Watershed Forest Reserve

Maraming Salamat po!

Proposal for an online monograph of the Neotropical Myxomycetes

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ICSEM 10
Costa Rica

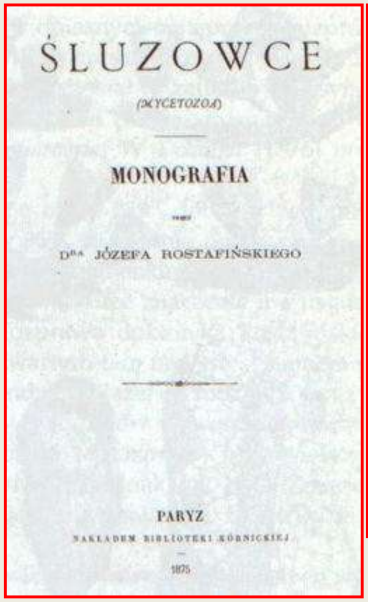
GOBIERNO DE ESPAÑA
MINISTERIO DE CIENCIA E INNOVACIÓN
CSIC
MYXOTROPIC

What is a monograph?

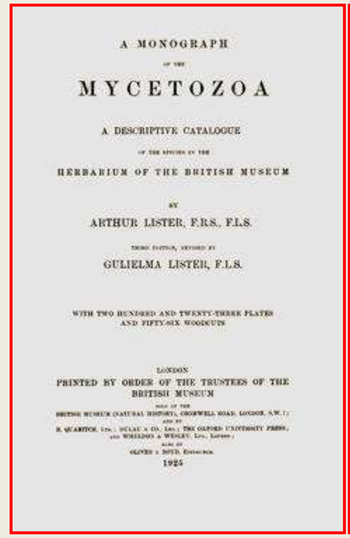
- Compendium and special treatise of a certain part of a science, or of a particular matter.
- in this case it is a taxonomic monograph of the Neotropical Myxomycetes.
- its purpose is to serve as a compendium of the taxonomic information available on the Myxomycetes of this biogeographic region.

Spermatozoa, en *Kunstformen der Natur (Haeckel, 1904, pl. 93)*

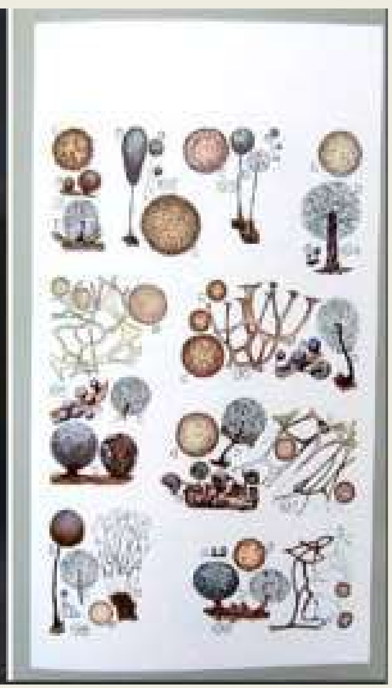
Monographs of Myxomycetes


ŚLUZOWCE
(MYCETOZOA)
MONOGRAFIA
Dra JÓZEFA ROSTAFIŃSKIEGO
PARYZ
NAKŁADEM BIBLIOTEKI KÓRNICKIEJ
1875

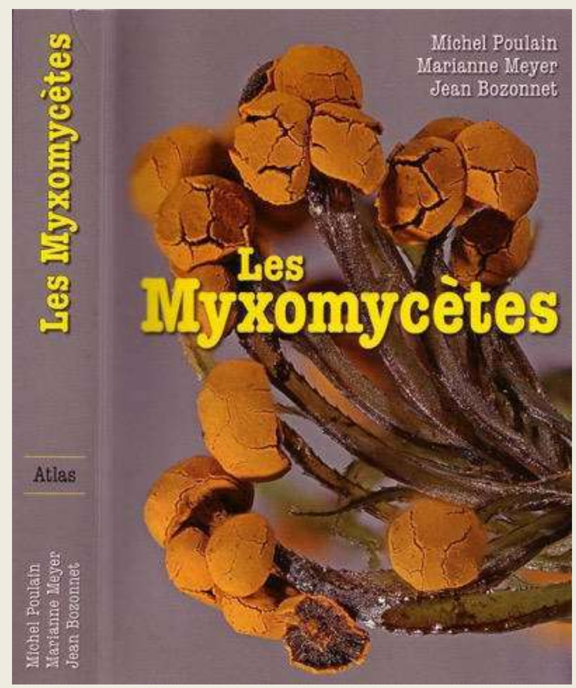
Josef T. Rostafinski (1850-1928)


A MONOGRAPH
OF THE
MYCETOZOA
A DESCRIPTIVE CATALOGUE
OF THE SPECIES IN THE
HERBARIUM OF THE BRITISH MUSEUM
BY
ARTHUR LISTER, F.R.S., F.L.S.
THIRD EDITION, REVISED BY
GULIELMA LISTER, F.L.S.
WITH TWO HUNDRED AND TWENTY-THREE PLATES
AND FIFTY-SIX WOODCUTS
LONDON
PRINTED BY ORDER OF THE TRUSTEES OF THE
BRITISH MUSEUM
1925

Arthur Lister (1830-1908) & Gulielma Lister (1860-1949)



George W. Martin (1886-1971) & C. J. Alexopoulos (1907-1986)



Michel Poulain et al. (2011)

Morphological Taxonomy

Hemitrichia serpula

Lycogala conicum

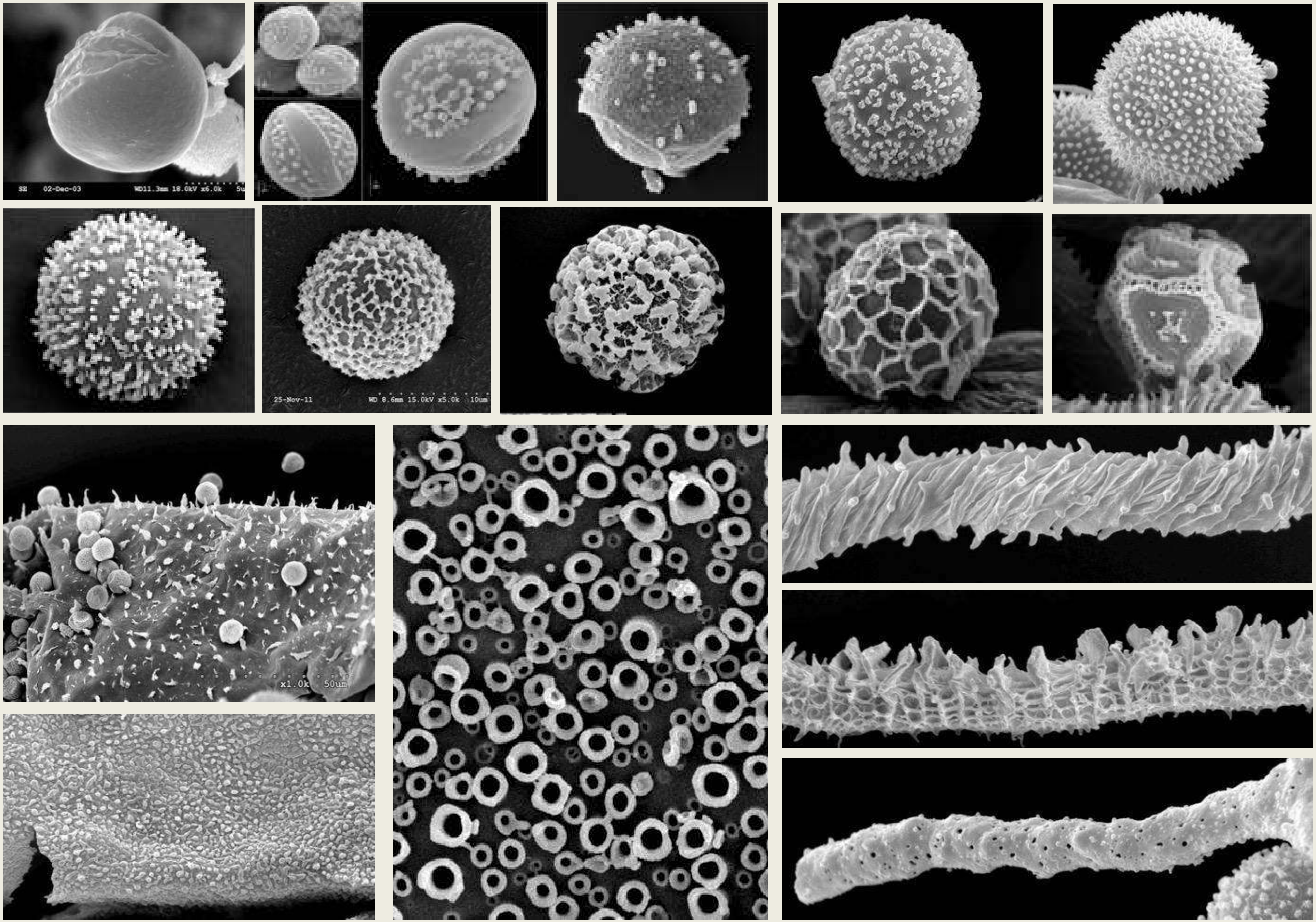
Tubifera microsperma

Arcyria affinis

Didymium minus

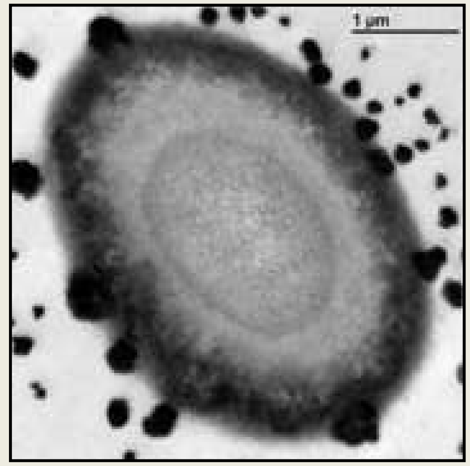
Badhamia foliicola

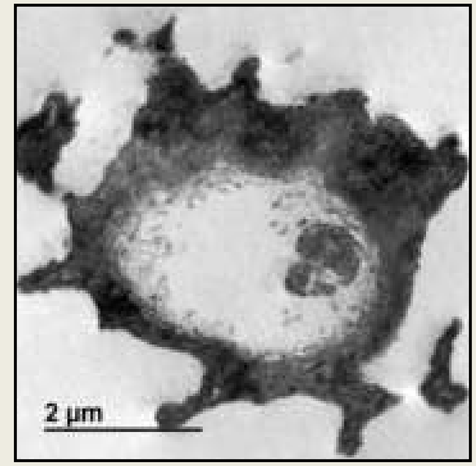
Morphological Taxonomy



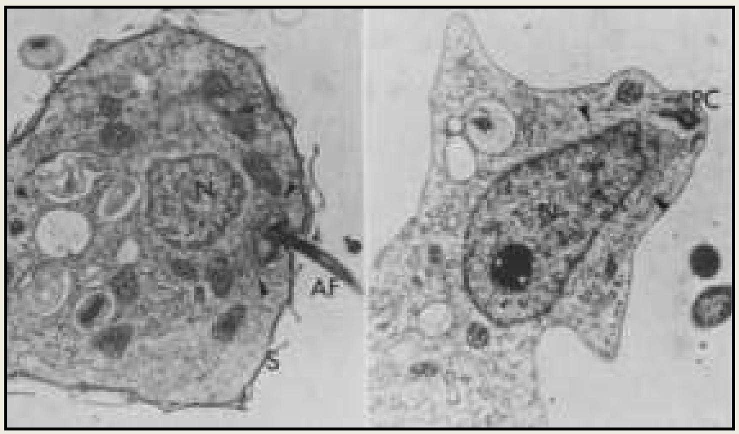
Ultrastructural Taxonomy

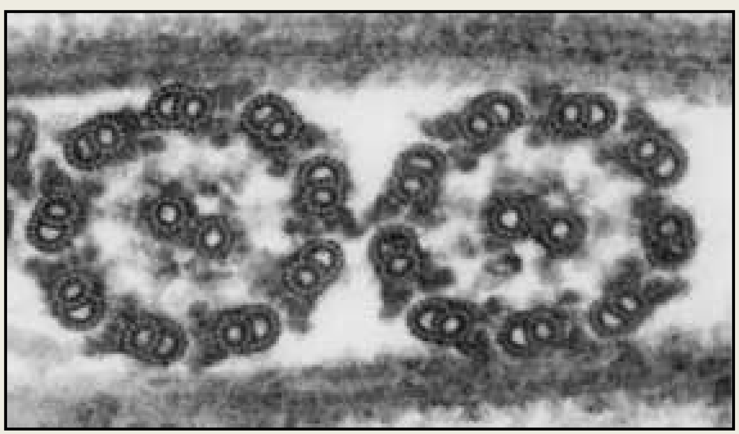
TEM micrographs of the solid (*Dianema succulenticola*) and hollow (*Arcyria ferruginea*) capillitial threads





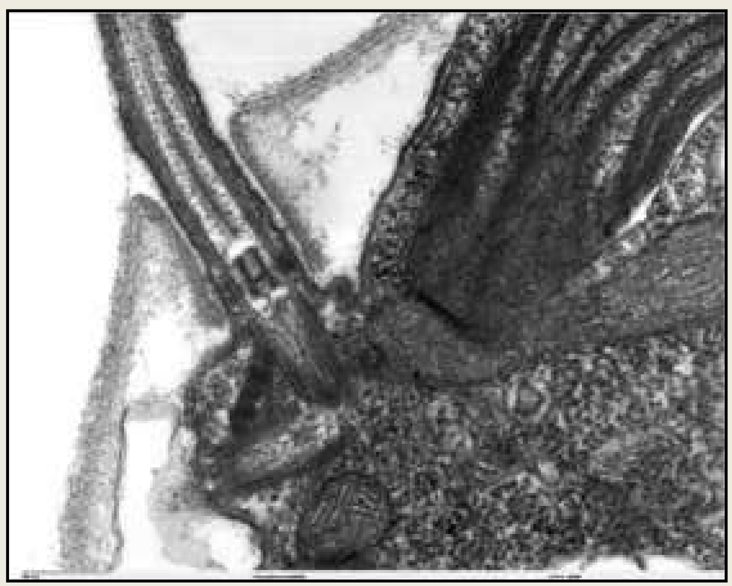
García, Estébanez & Lado (unpublished data)

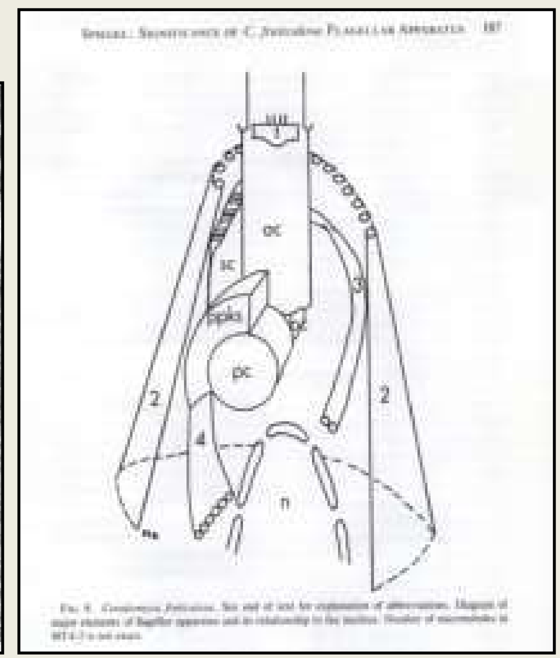




Spiegel (BioSystems 14: 491-499, 1981)

Flagellar apparatus and microtubules



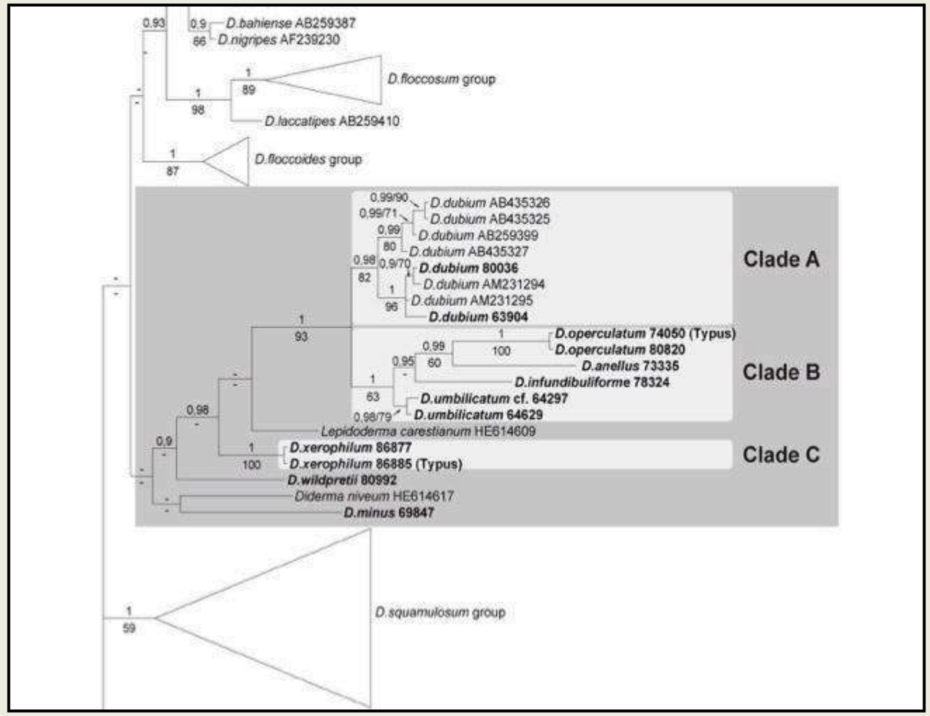


Spiegel (J. Elissa Mitchell Sci. Soc. 97: 183-189, 1981)

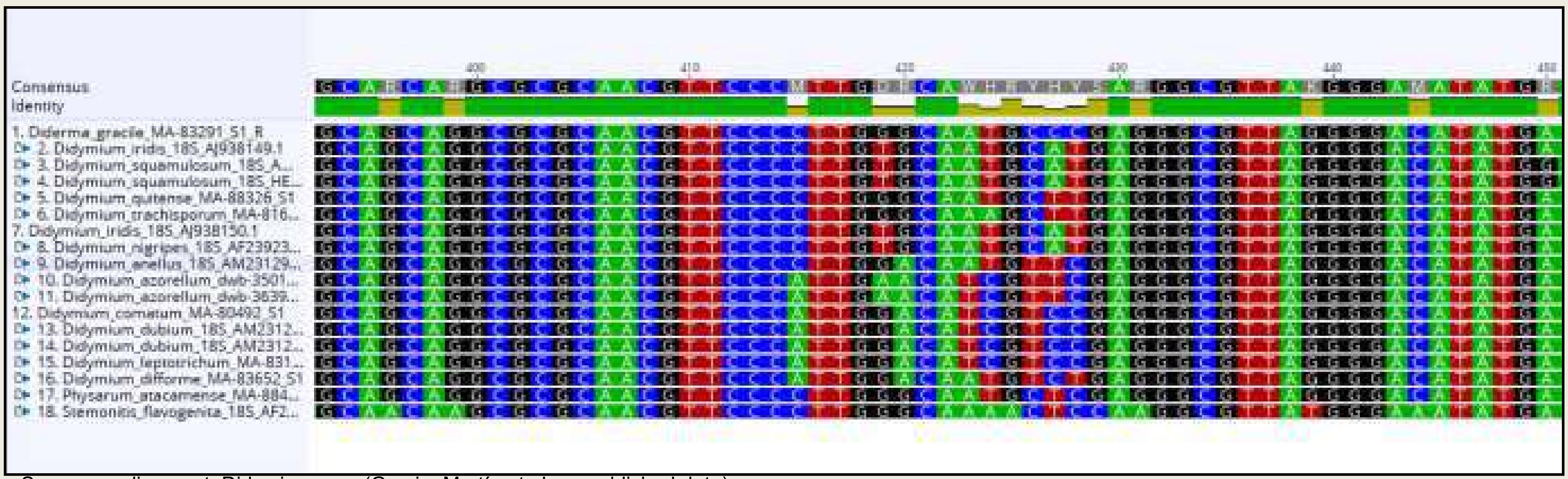
Molecular Taxonomy

Phylogeny
Barcode
Metagenomics
Transcriptomics
Next generation sequencing

Illumina HiSeq 3000 Sequencing System



Wrigley de Basanta et al. (Mycologia 107: 157-168, 2015)



Sequence alignment, Didymium spp. (Garcia_Martín et al., unpublished data)

Ecological data

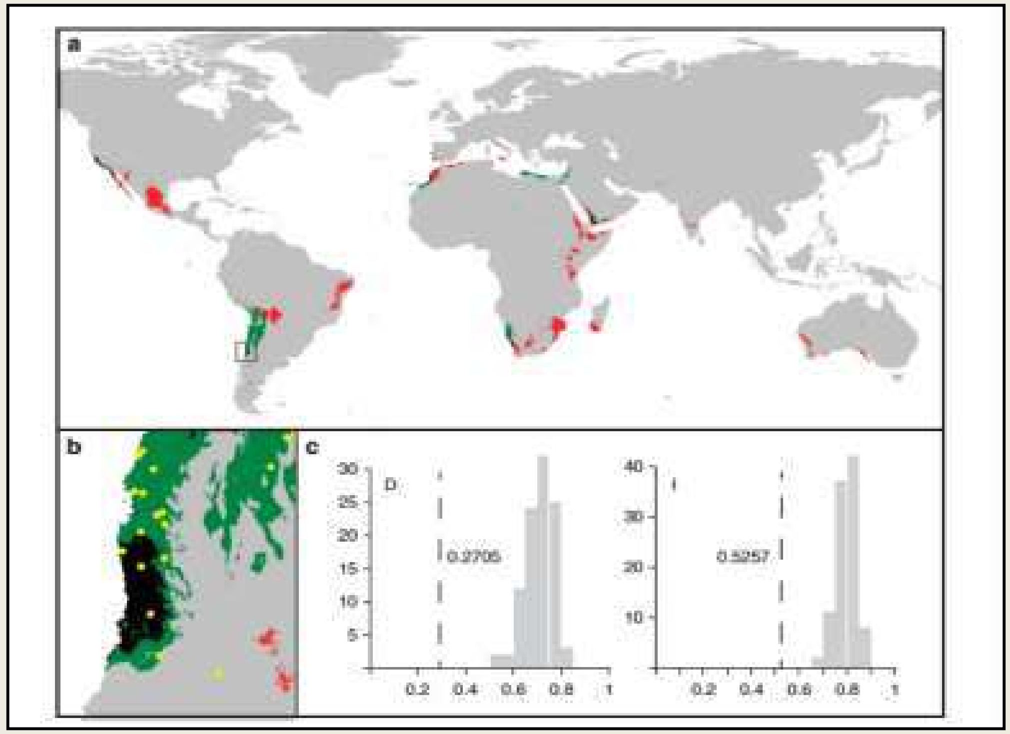
Extreme environments

Environmental niche models

Predictive niche models

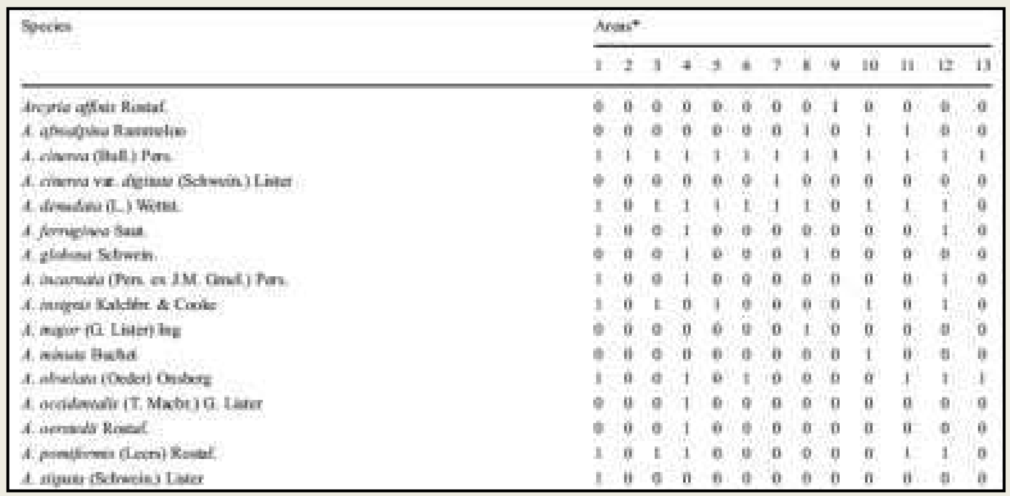
Biogeographic barriers

Endemicity



Predictive ecological models (Aguilar et al., The ISME Journal 8:737-745, 2014)

Extreme environments



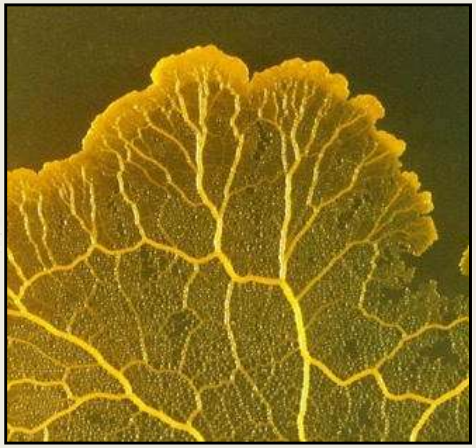
Species	Areas*												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Arcyria affinis Rostaf.	0	0	0	0	0	0	0	0	1	0	0	0	0
A. afroalpina Rammeloo	0	0	0	0	0	0	0	1	0	1	1	0	0
A. cinerea (Bull.) Pers.	1	1	1	1	1	1	1	1	1	1	1	1	1
A. cinerea var. *digitata* (Schwein.) Lister	0	0	0	0	0	0	1	0	0	0	0	0	0
A. denudata (L.) Wettst.	1	0	1	1	1	1	1	1	0	1	1	1	0
A. ferruginea Saut.	1	0	0	1	0	0	0	0	0	0	0	1	0
A. globosa Schwein.	0	0	0	1	0	0	0	1	0	0	0	0	0
A. incarnata (Pers. ex J.M. Gmel.) Pers.	1	0	0	1	0	0	0	0	0	0	0	1	0
A. insignis Kalchbr. & Cooke	1	0	1	0	1	0	0	0	0	1	0	1	0
A. major (G. Lister) Ing	0	0	0	0	0	0	0	1	0	0	0	0	0
A. minuta Buchet	0	0	0	0	0	0	0	0	0	1	0	0	0
A. obvelata (Oeder) Onsberg	1	0	0	1	0	1	0	0	0	0	1	1	1
A. occidentalis (T. Macbr.) G. Lister	0	0	0	1	0	0	0	0	0	0	0	0	0
A. oerstedii Rostaf.	0	0	0	1	0	0	0	0	0	0	0	0	0
A. pomiformis (Leers) Rostaf.	1	0	1	1	0	0	0	0	0	0	1	1	0
A. stipata (Schwein.) Lister	1	0	0	0	0	0	0	0	0	0	0	0	0

Endemicity analysis (Estrada-Torres et al. Fungal Diversity 59: 159-177, 2013)

Taxonomy of Myxomycetes

- New morphological hypothesis
- Development and life cycle studies
- Ultrastructural studies
- Genetic reproductive studies
- DNA phylogenetic studies
- Isozyme and DNA populations studies
- Ecological studies

→ Integrative Taxonomy



What is an e-monograph?

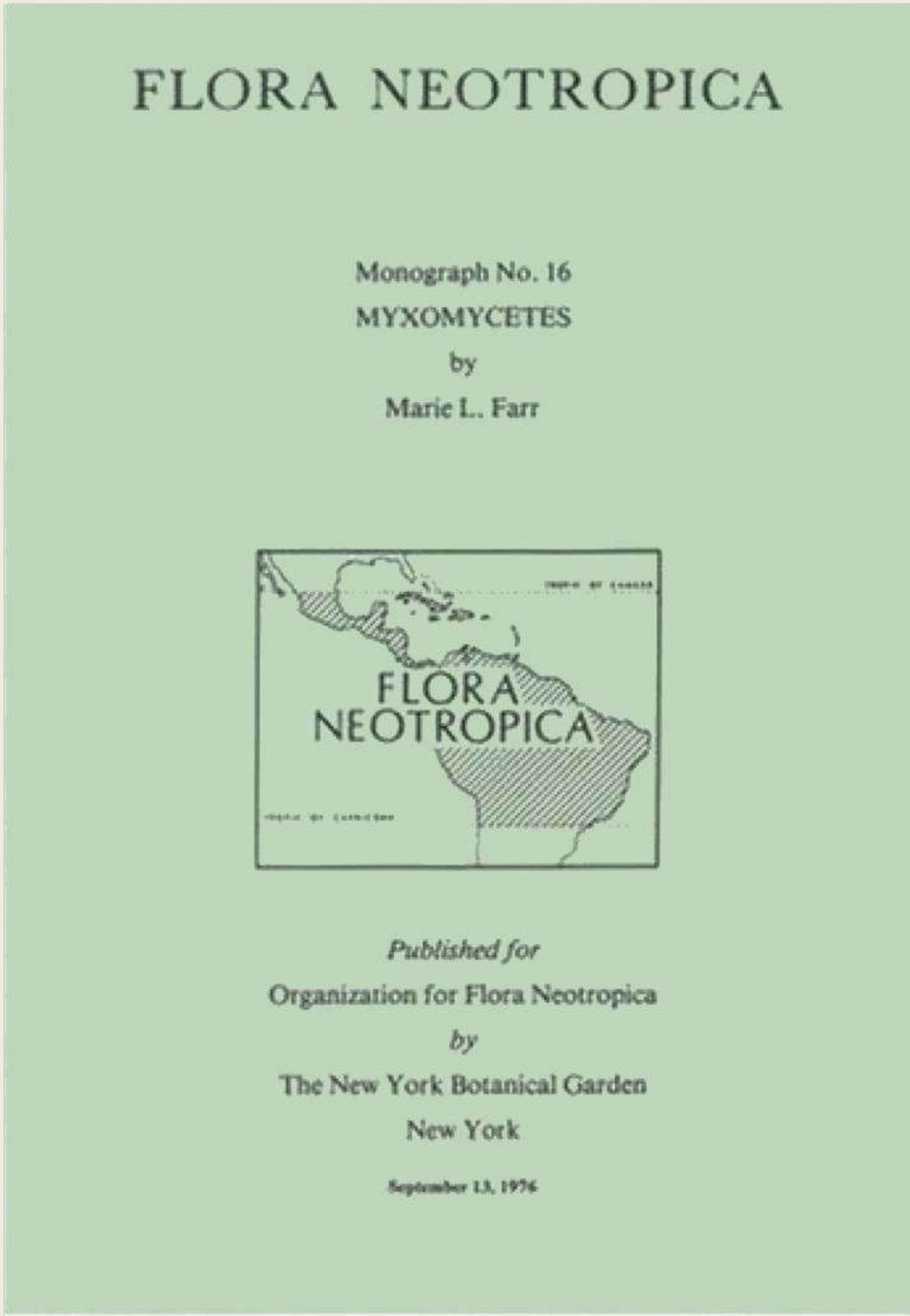
An e-monograph is a compendium of information, that takes advantage of the internet and other informatic programs or tools as a medium to update the contents rapidly.

These tools allow easy access to the information, allow the location of collections, also the current distribution of species, permit the generation of automatic descriptions or keys for the species, maps of distribution, etc.

Neotropical Bioregion

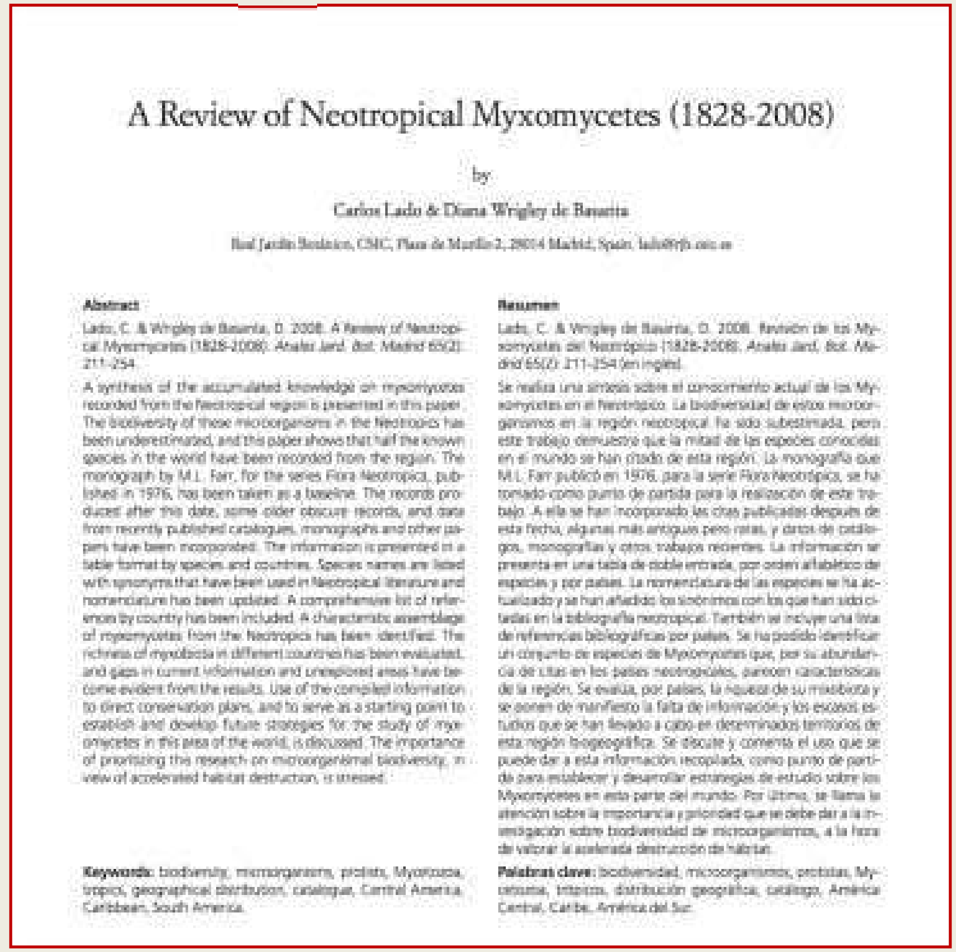
Seven hotspots:

- Madrean Pine-Oak Woodlands
- Mesoamerica
- Caribean
- Tumbes-Choco-Magdalena
- Tropical Andes
- Cerrado
- Atlantic Forest
- Chilean Winter Rainfall-Valdivian Forests



240 species described (1976)

431 species recorded (2008)



A Review of Neotropical Myxomycetes (1828-2008)

by

Carlos Lado & Diana Wrigley de Basanta

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Abstract

Lado, C. & Wrigley de Basanta, D. 2008. A Review of Neotropical Myxomycetes (1828-2008). *Anales Jard. Bot. Madrid* 65(2): 211-254.

A synthesis of the accumulated knowledge on myxomycetes recorded from the Neotropical region is presented in this paper. The biodiversity of these microorganisms in the Neotropics has been underestimated, and this paper shows that half the known species in the world have been recorded from the region. The monograph by M.L. Farr, for the series Flora Neotropica, published in 1976, has been taken as a baseline. The records produced after this date, some older obscure records, and data from recently published catalogues, monographs and other papers have been incorporated. The information is presented in a table format by species and countries. Species names are listed with synonyms that have been used in Neotropical literature and nomenclature has been updated. A comprehensive list of references by country has been included. A characteristic assemblage of myxomycetes from the Neotropics has been identified. The richness of myxobiota in different countries has been evaluated, and gaps in current information and unexplored areas have become evident from the results. Use of the compiled information to direct conservation plans, and to serve as a starting point to establish and develop future strategies for the study of myxomycetes in this area of the world, is discussed. The importance of prioritizing this research on microorganismal biodiversity, in view of accelerated habitat destruction, is stressed.

Keywords: biodiversity, microorganisms, protists, Myxozoa, tropics, geographical distribution, catalogue, Central America, Caribbean, South America.

Resumen

Lado, C. & Wrigley de Basanta, D. 2008. Revisión de los Myxomycetes del Neotrópico (1828-2008). *Anales Jard. Bot. Madrid* 65(2): 211-254 (en inglés).

Se realiza una síntesis sobre el conocimiento actual de los Myxomycetes en el Neotrópico. La biodiversidad de estos microorganismos en la región neotropical ha sido subestimada, pero este trabajo demuestra que la mitad de las especies conocidas en el mundo se han citado de esta región. La monografía que M.L. Farr publicó en 1976, para la serie Flora Neotrópica, se ha tomado como punto de partida para la realización de este trabajo. A ella se han incorporado las citas publicadas después de esta fecha, algunas más antiguas pero raras, y datos de catálogos, monografías y otros trabajos recientes. La información se presenta en una tabla de doble entrada, por orden alfabético de especies y por países. La nomenclatura de las especies se ha actualizado y se han añadido los sinónimos con los que han sido citadas en la bibliografía neotropical. También se incluye una lista de referencias bibliográficas por países. Se ha podido identificar un conjunto de especies de Myxomycetes que, por su abundancia de citas en los países neotropicales, parecen características de la región. Se evalúa, por países, la riqueza de su mixobiota y se ponen de manifiesto la falta de información y los escasos estudios que se han llevado a cabo en determinados territorios de esta región biogeográfica. Se discute y comenta el uso que se puede dar a esta información recopilada, como punto de partida para establecer y desarrollar estrategias de estudio sobre los Myxomycetes en esta parte del mundo. Por último, se llama la atención sobre la importancia y prioridad que se debe dar a la investigación sobre biodiversidad de microorganismos, a la hora de valorar la acelerada destrucción de hábitat.

Palabras clave: biodiversidad, microorganismos, protistas, Mycetozoa, trópicos, distribución geográfica, catálogo, América Central, Caribe, América del Sur.

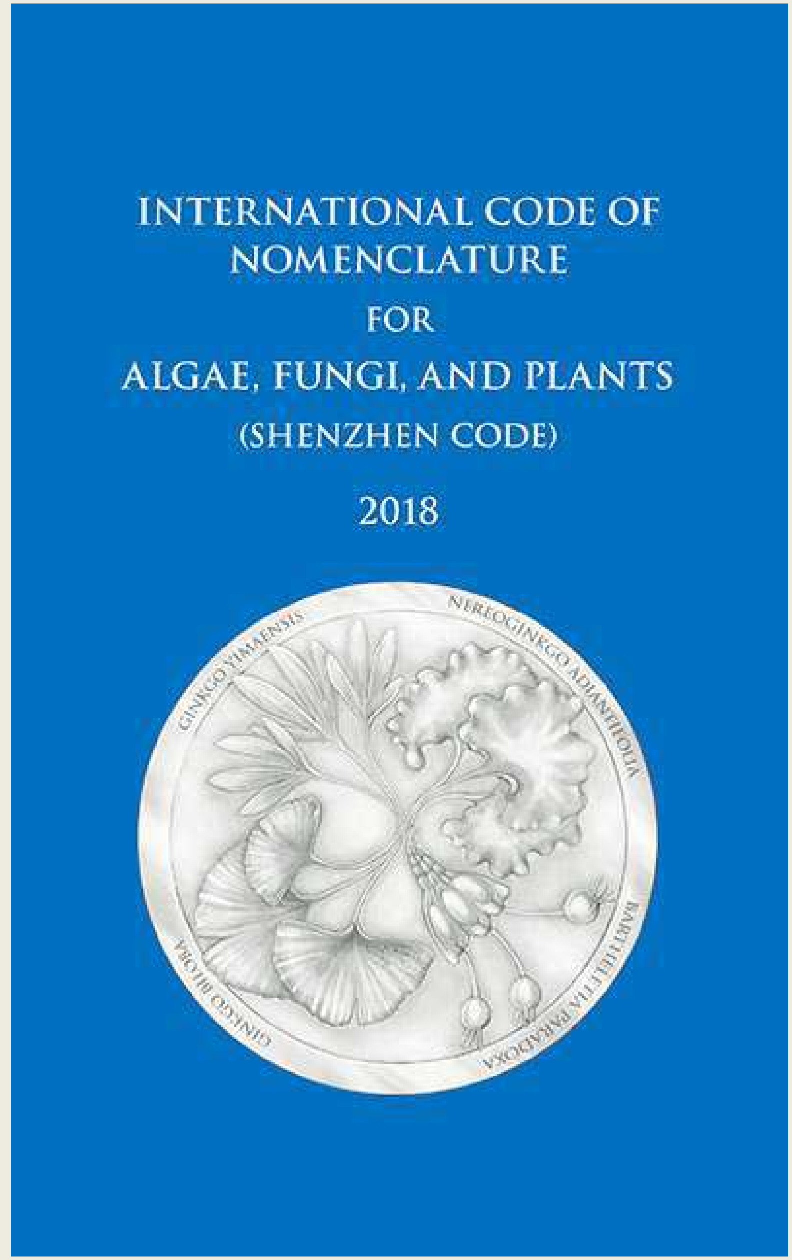
Structure of the proposed e-monograph

1. Nomenclature
2. Taxonomy
3. Images and illustrations
4. Distribution and habitat
5. Phylogeny
6. Observations
7. References

1. Nomenclature

•*International Code of Nomenclature for algae, fungi and plants* (ICN, Shenzhen Code, 2018).

•The current ICN covers, specifically, Myxomycetes (slime molds) as established in the "Preamble 8."



1. Nomenclature

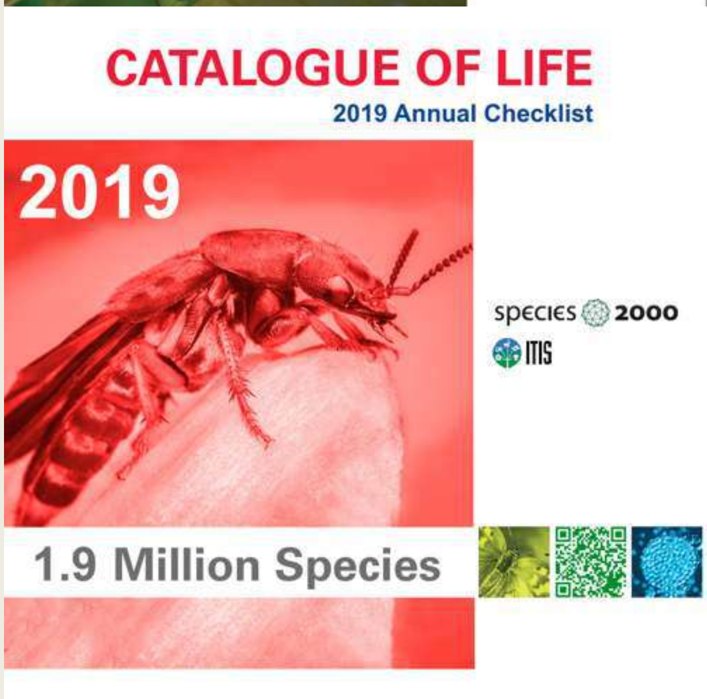
- Accepted name and synonyms.
- Information on the type collections.

https://eumycetozoa.com/data/index.php

1. Nomenclature

- Also periodical check of official repositories like Mycobank or Index Fungorum.
- Links to digital libraries or specialized literature.

2. Taxonomy: classification



2. Taxonomy: classification

- Terminology standardization.
- Descriptions: Use the same morphological structures and in the same order.
  - (from macro to micro)
  - (from out-side to in-side)
- Interactive Keys (DELTA System, INTKEY, NaviKey, Lucid, XID, ActKey, BIOKEYS, Meka, IdentifyIt, Pl@nt Net).
  - Dichotomous and diagnostic keys.
  - Also automatically generating descriptions.

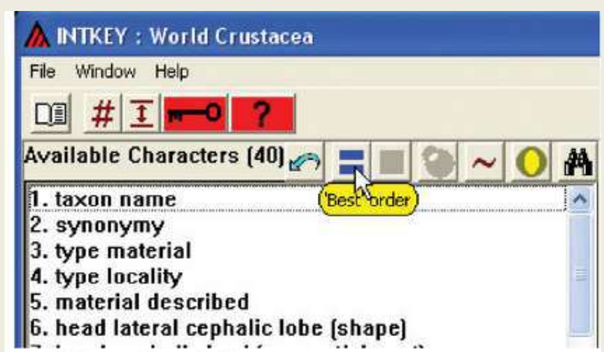
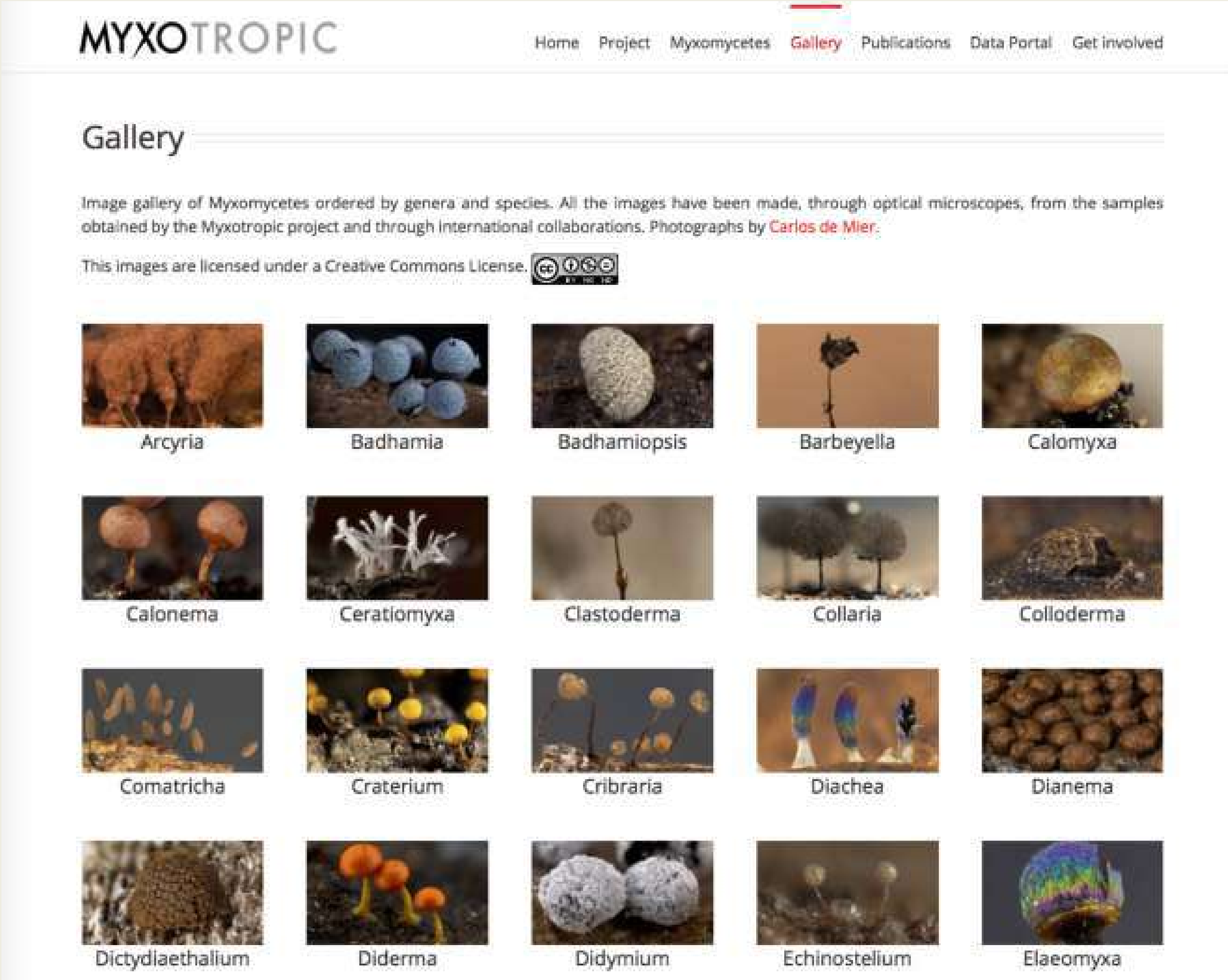


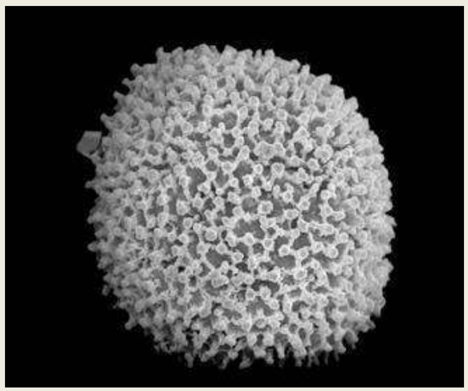
Figure 44. Selecting the *Best order* of characters.

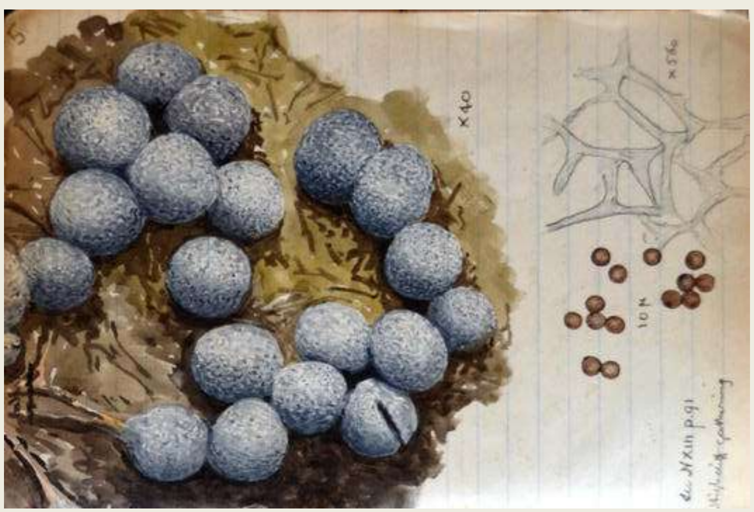
3. Images and illustrations

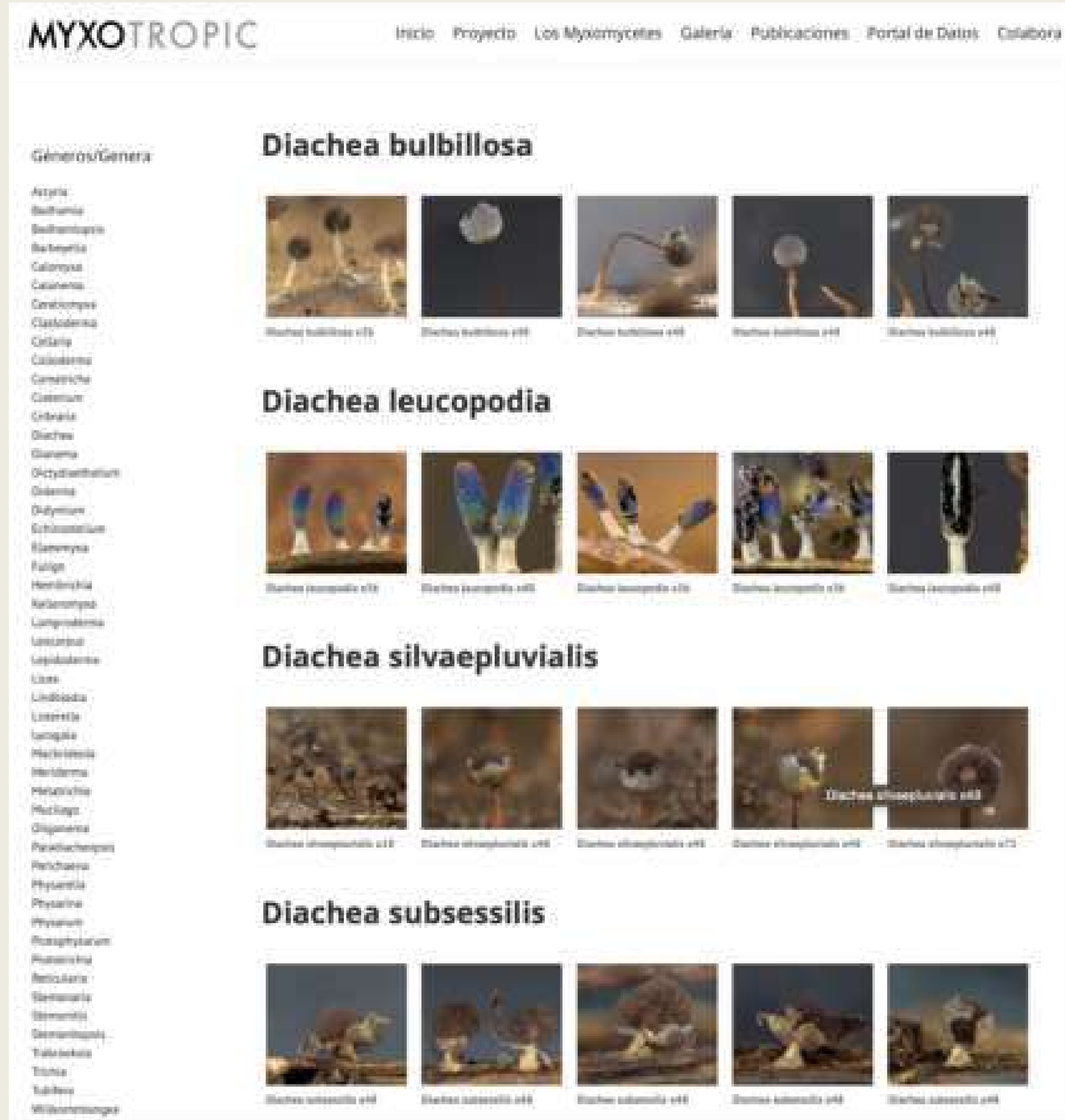


3. Images and illustrations

- Macro-photographs
- Micro-photographs
- SEM images
- Drawings

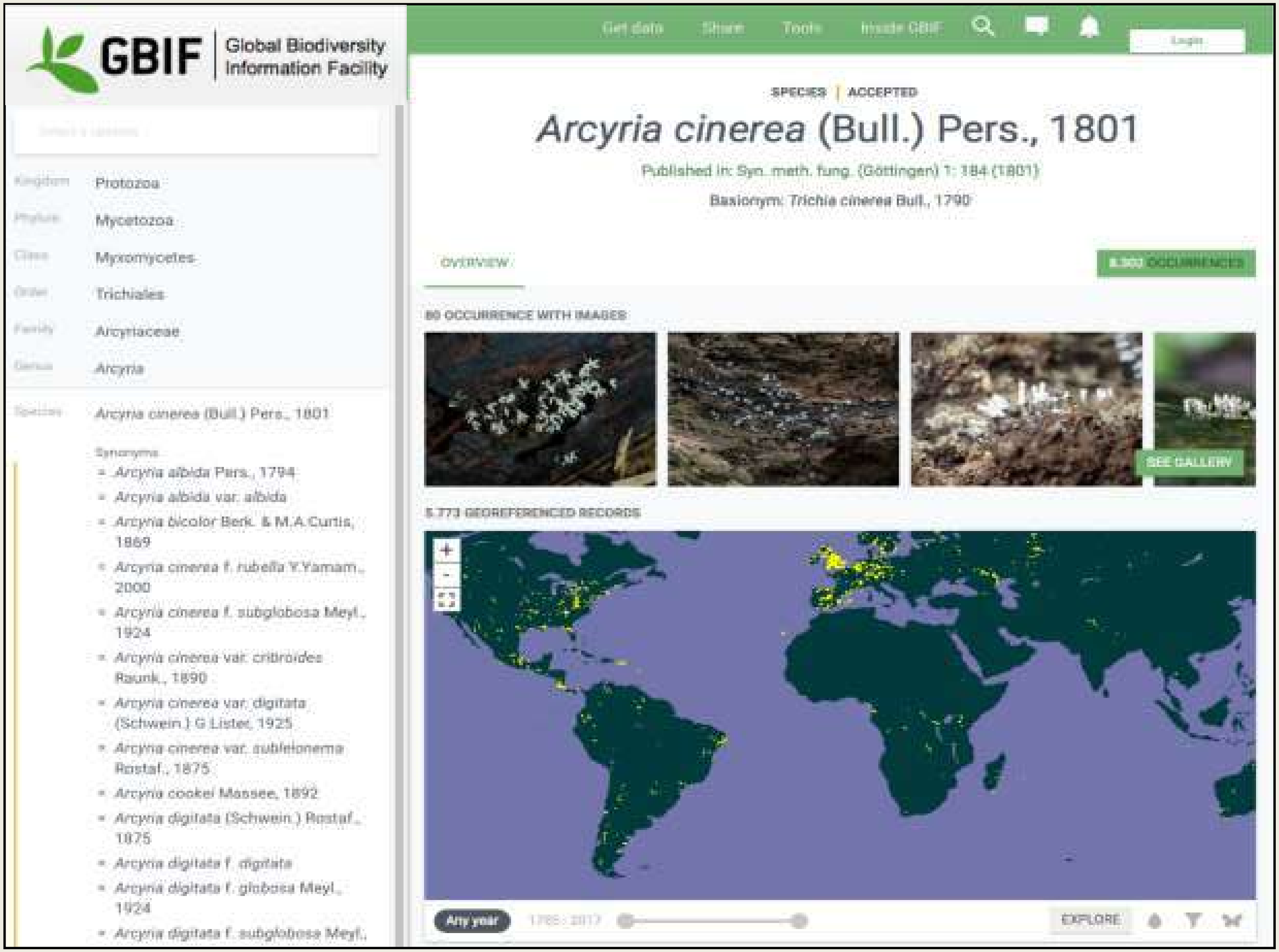






4. Distribution and habitats

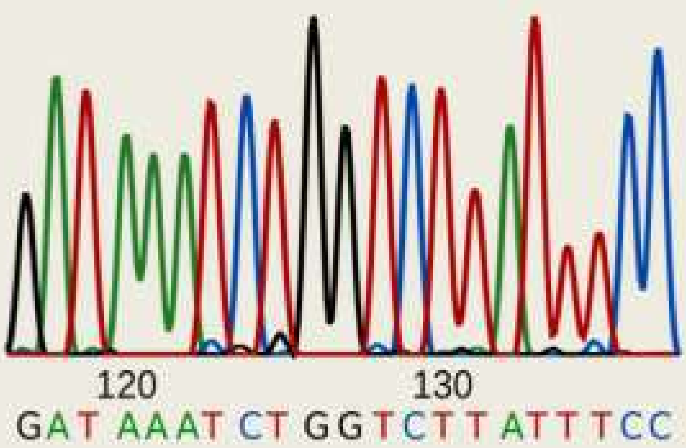
Links to databases and repositories of specialized information.

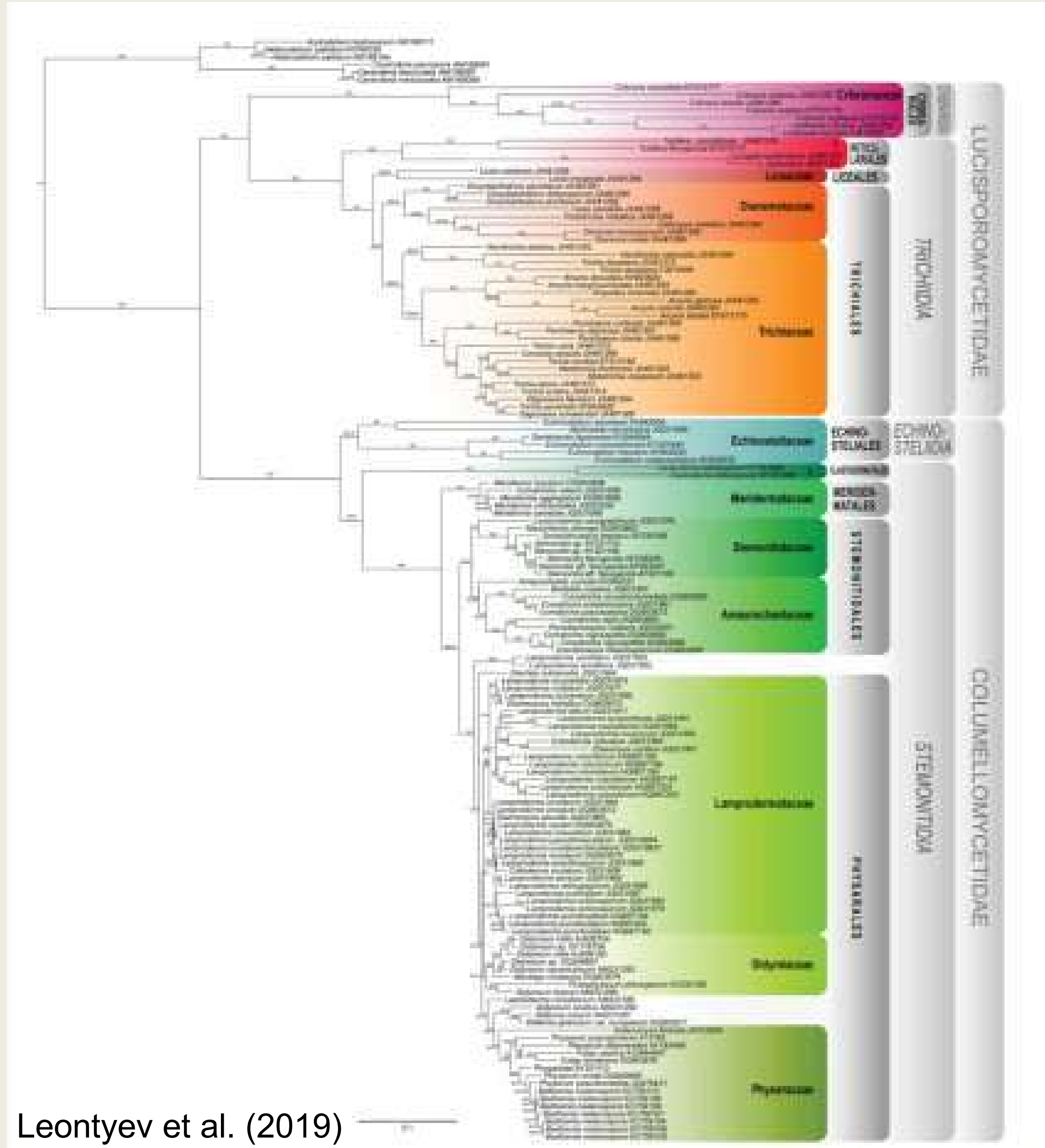


5. Phylogeny

Links to specialized repositories such as GenBank.

NCBI National Center for Biotechnology Information





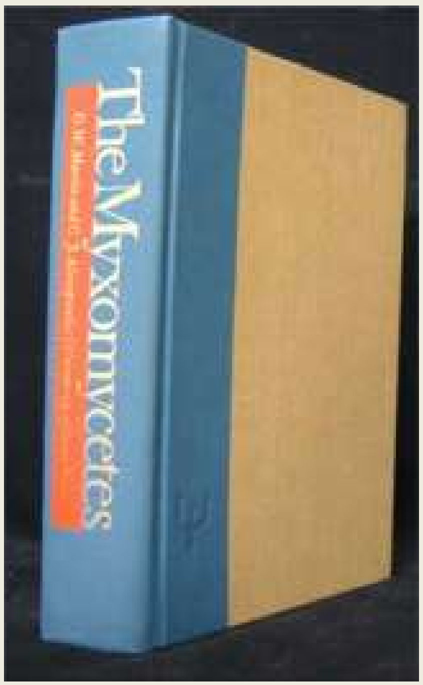
Leontyev et al. (2019)

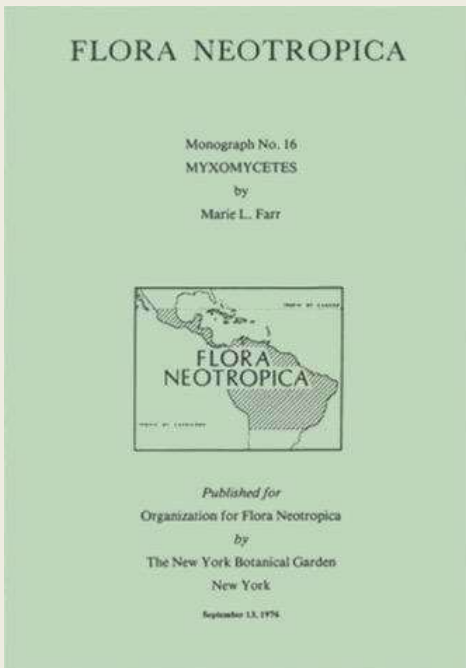
6. Observations

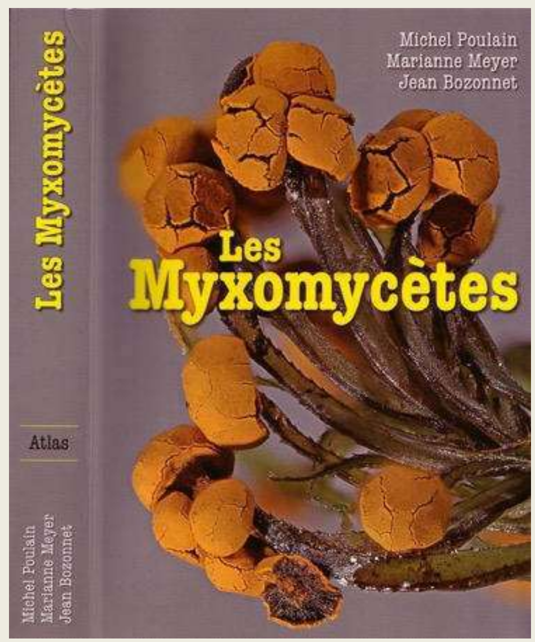
- Comments and notes (taxonomical, distributional, ecological, etc.).
- Links to international initiatives, webpages, etc. with complementary information.

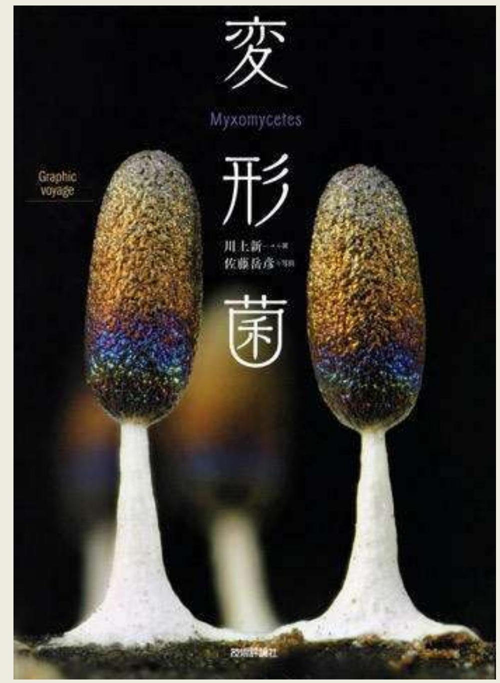
7. References

- Literature employed in the monograph (with link to the pdf file).
- Complementary references (with link to the pdf file).
- Links to other web pages.









Proposed e-Monograph of Myxomycetes

Summary

- Geographical scope: Neotropics.
- The prototype is currently under development.
- It is open to new ideas and improvements.
- It is conceived as a collaborative network.
- All specialists and people interested in Myxomycetes are welcome to participate.

Many thanks for your attention!

Photo E. Haritonoff

Yuri Novozhilov, Nadezhda Fedorova, Oleg Shchepin, Vladimir Gmoshinskiy, Nikki H. Dagamac, Alina Alexandrova, Eugene Popov, Martin Schnittler

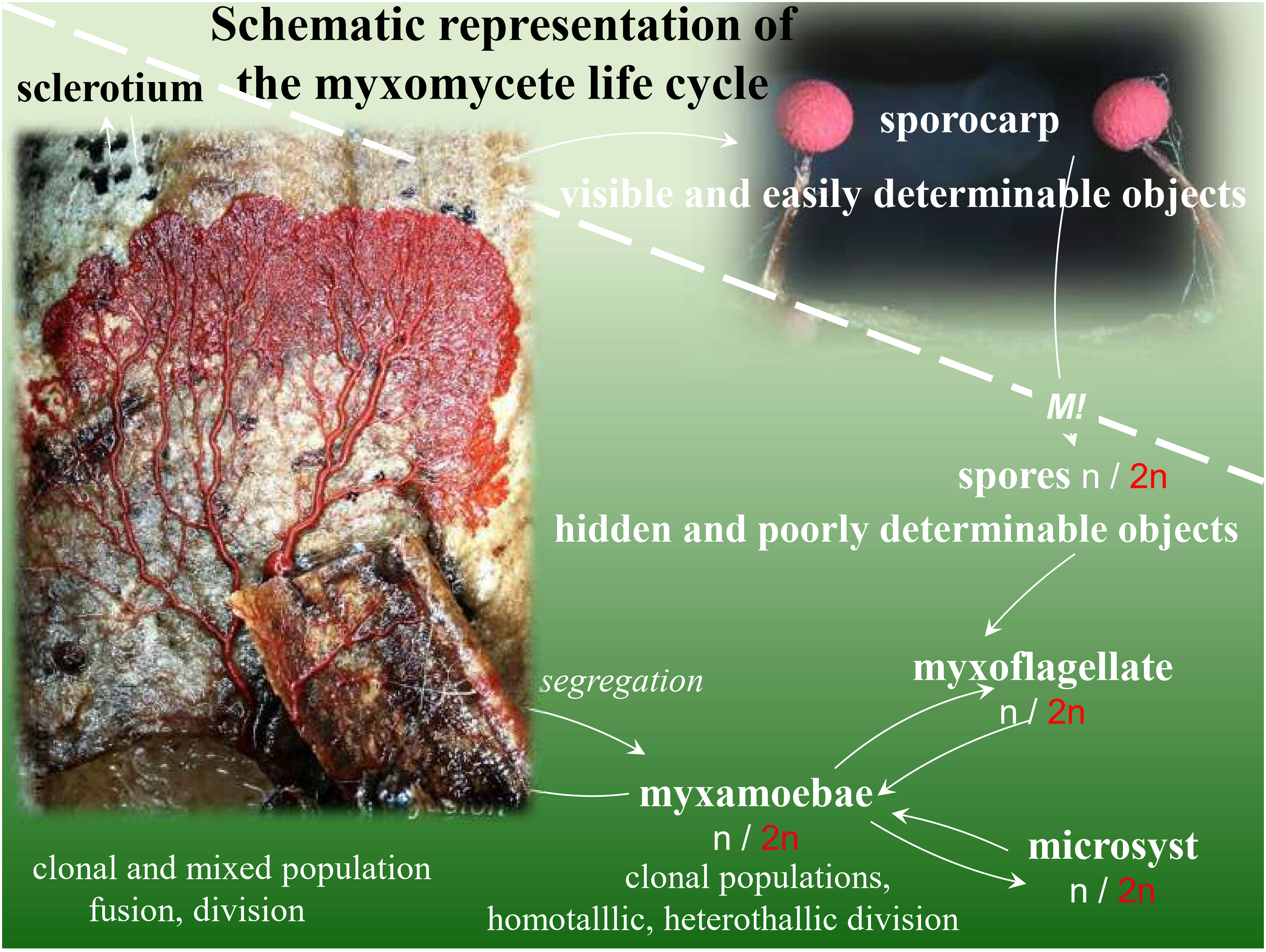
ICSEM 10
Costa Rica

Myxomycetes of tropical forests of Vietnam: what moist chamber cultures can reveal

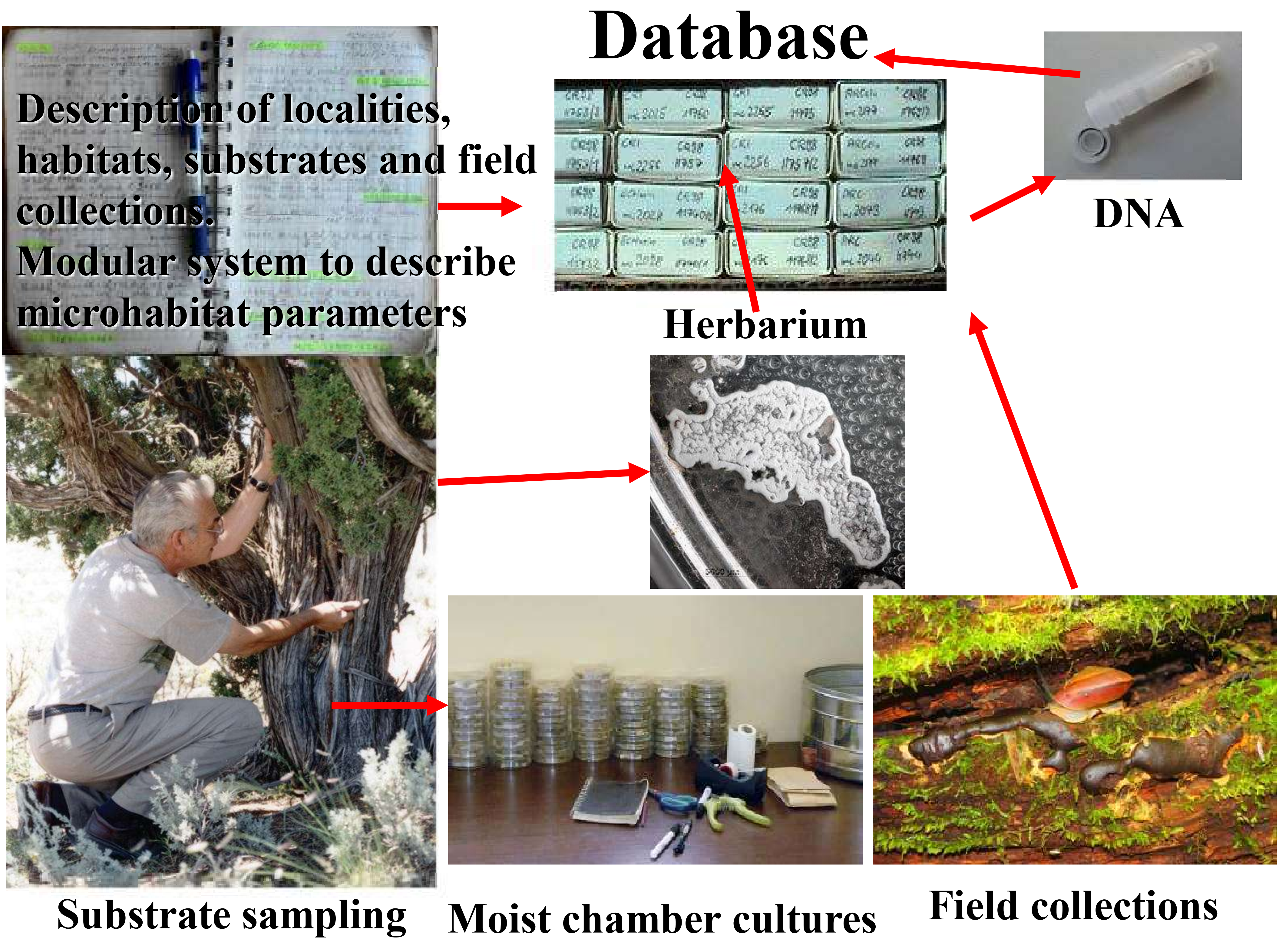
Ботанический институт
им. В.Л. Комарова
Российской академии наук

ERNST MORITZ ARNDT
UNIVERSITÄT GREIFSWALD

РФФИ


Schematic representation of
the myxomycete life cycle
sclerotium
sporocarp
visible and easily determinable objects
M!
spores n / 2n
hidden and poorly determinable objects
myxoflagellate
n / 2n
segregation
myxamoebae
n / 2n
clonal populations,
homotalllic, heterothallic division
microsyst
n / 2n
clonal and mixed population
fusion, division

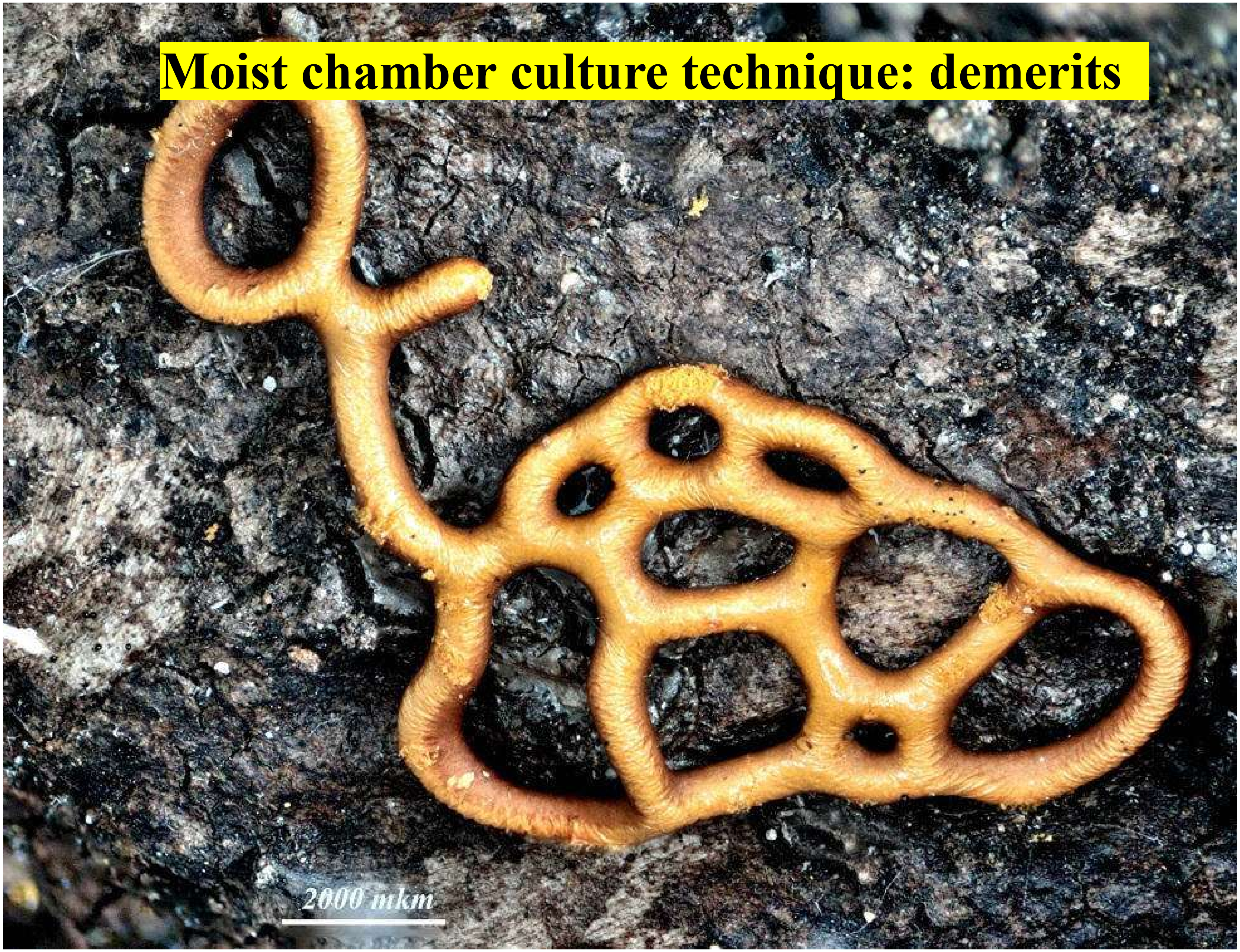



Database
Description of localities, habitats, substrates and field collections.
Modular system to describe microhabitat parameters
Herbarium
DNA
Substrate sampling
Moist chamber cultures
Field collections

Moist chamber technique: merits

- It helps overcome biases that appear due to the sporadic and ephemeral nature of myxomycete fruitings.
- This technique has a better resolution due to the use of a dissecting microscope. It allows better detection of species with minute fruiting bodies, such as corticolous (associated with the bark of living trees) or coprophilous (fimicolous) myxomycetes, which have fruiting bodies that are rarely encountered in the field.

Moist chamber culture technique: demerits



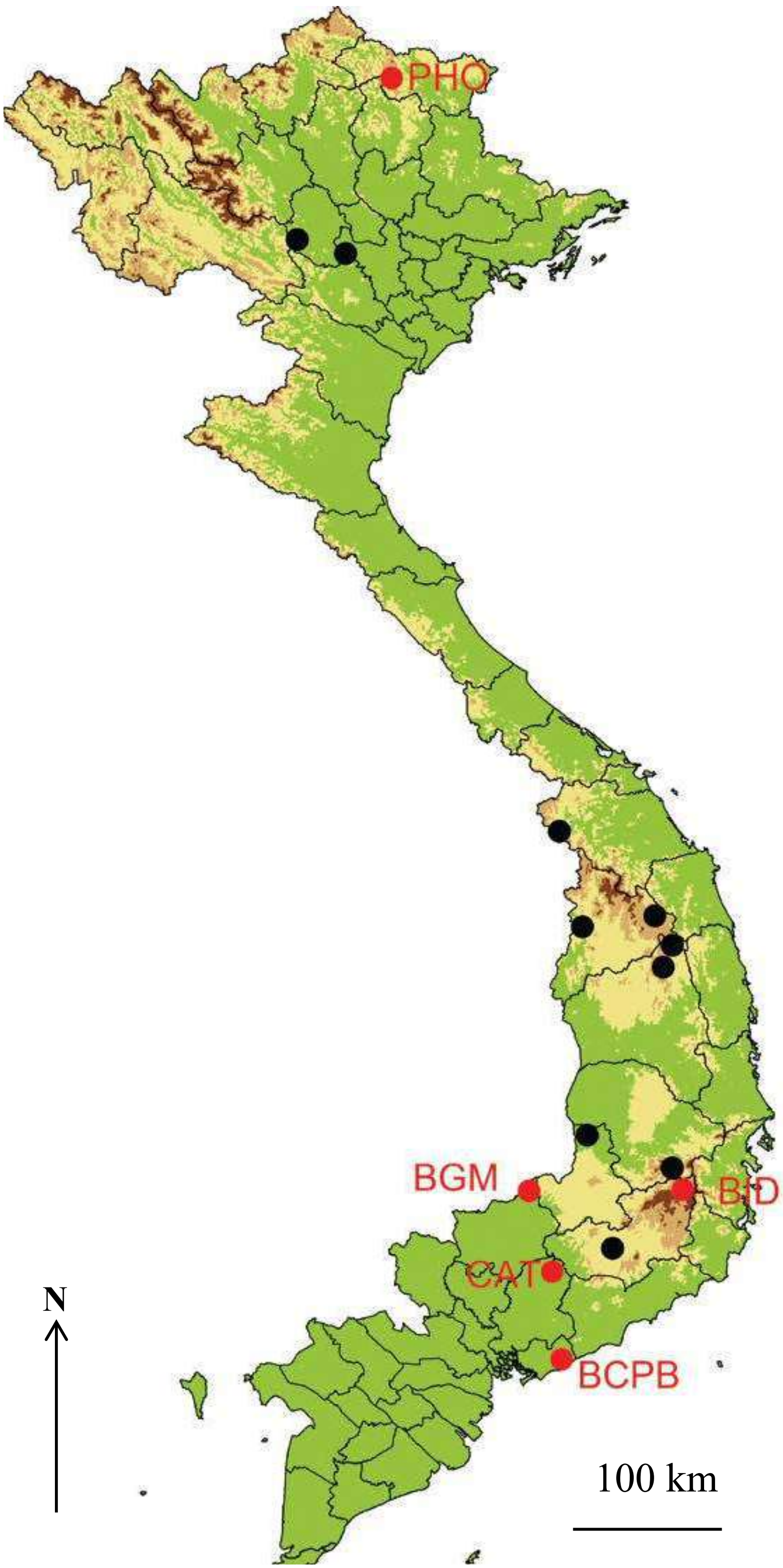
- Not very suitable for lignicolous myxomycetes with large fruit bodies. It can be time intensive, especially when trying to quantify the number of fruiting bodies and searching for minute species.

Objectives of the study

The primary objectives of this study were to:

1) understand the degree to which substrate cultures are capable of detecting a local myxomycete species richness in various forest and on various substrate types;

2) reveal any difference between assemblages of the species obtained from MCC in different forests and substrate types in the studied reserves.



In spite of studying myxomycetes in 15 reserves in Vietnam, we have chosen only five reserves where our efforts to reveal myxomycete diversity by moist chamber culture method were more or less even for analysis.

PHO = Phia Oắc National Park; mountain forests;
BID = Bidoup-Núi Bà National Park; mountain forests; (Novozhilov et al., 2019)
CAT = Cát Tiên National Park: lowland forests; (Novozhilov et al., 2017);
BCPB = Bình Châu-Phước Bửu Nature Reserve: dry dipterocarp coast forests;
(Novozhilov et al., unpublished);
BGM = Bù Gia Mập National Park; submontain forests (Novozhilov et al., unpublished)

Statistical data of moist chamber cultures for the 5 best studied reserves

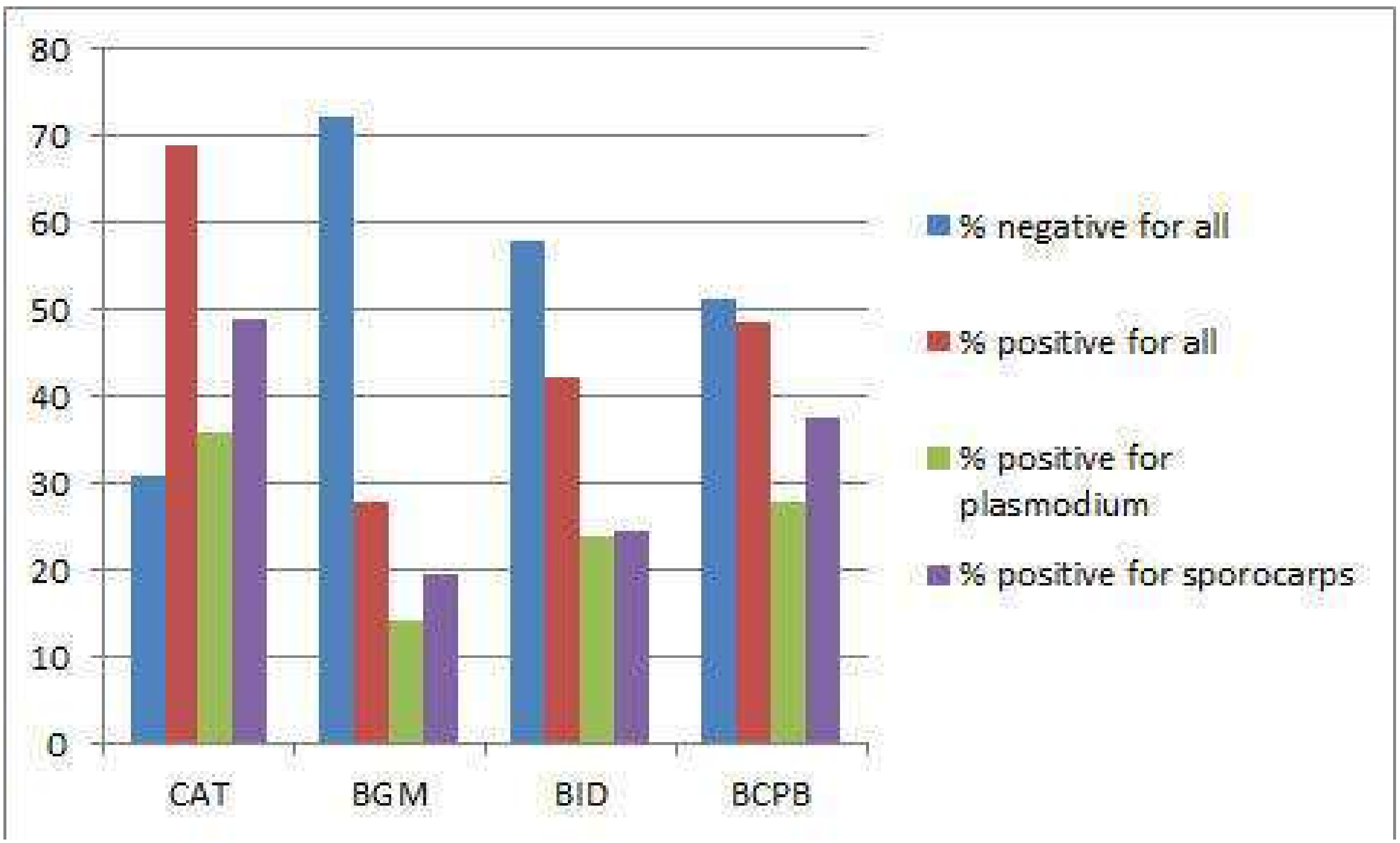
CAT - 954 mcs, 658 positive, 493 pos. for plasmodium, 466 pos. for sporocarps

PHO - 310 mcs, 177 positive, 71 pos. for plasmodium, 138 pos. for sporocarps

BCPB - 273 mcs, 133 positive, 76 pos. for plasmodium, 103 pos. for sporocarps

BID - 787 mcs, 332 positive, 188 pos. for plasmodium, 192 pos. for sporocarps

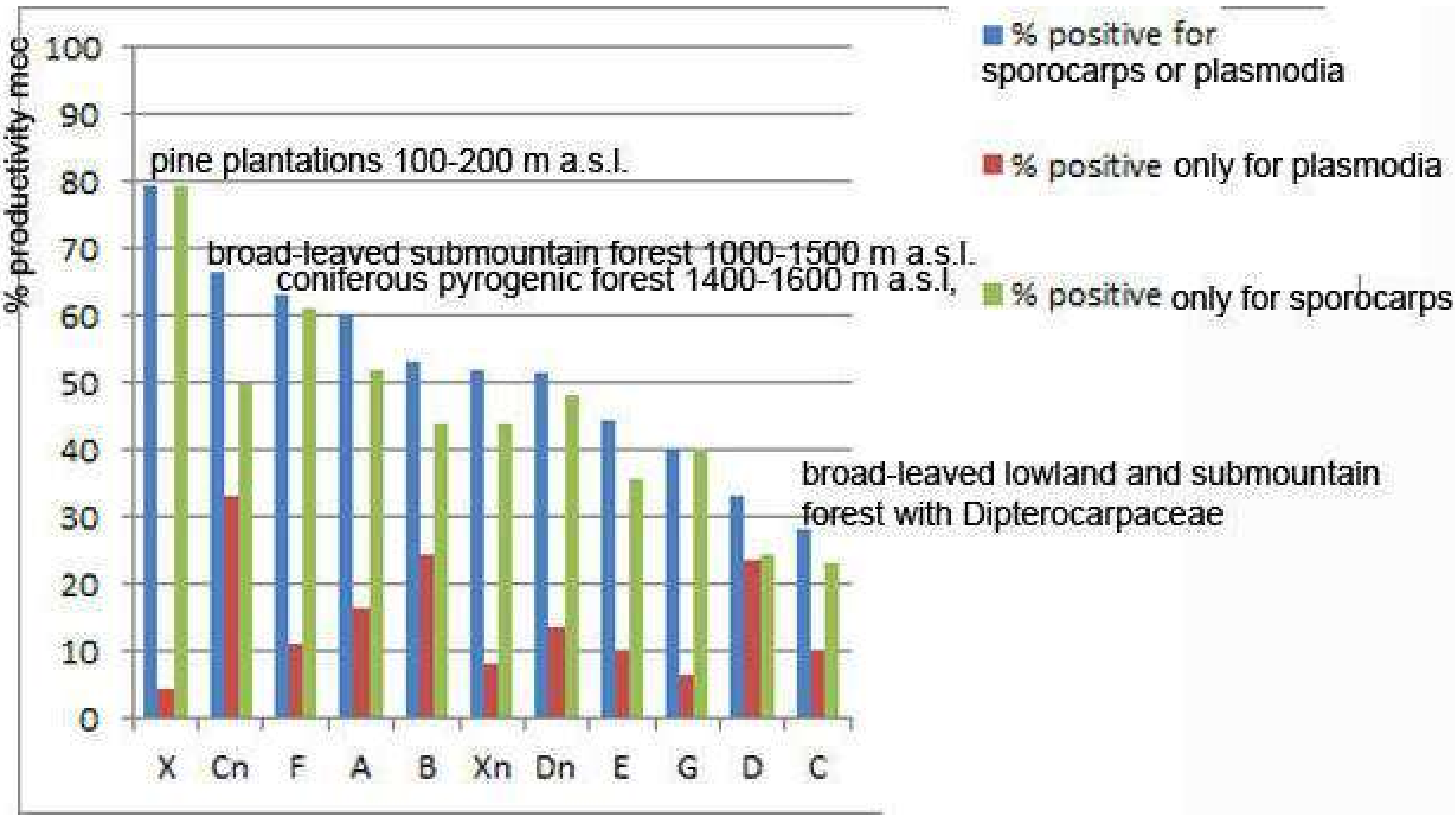
BGM - 382 mcs,
106 positive, 54 pos. for plasmodium, 75 pos. for sporocarps
192 pos. for sporocarps



Positive number of MCC for sporocarps 20-50%

Positive number of MCC for plasmodium 15-35 %

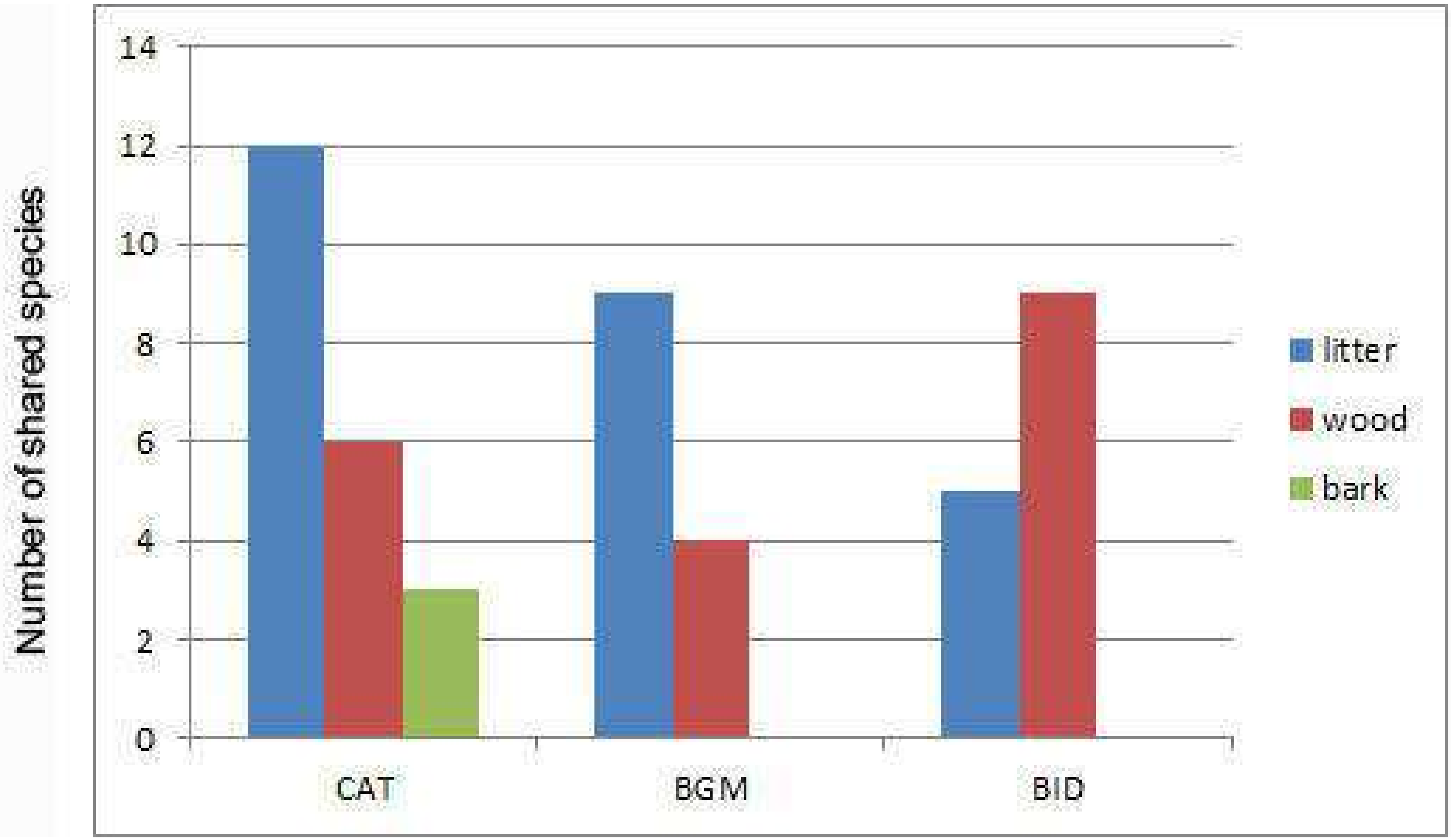
Productivity of moist chamber cultures with the bark for 11 studied vegetation types; positive number of MCC = 20-80%



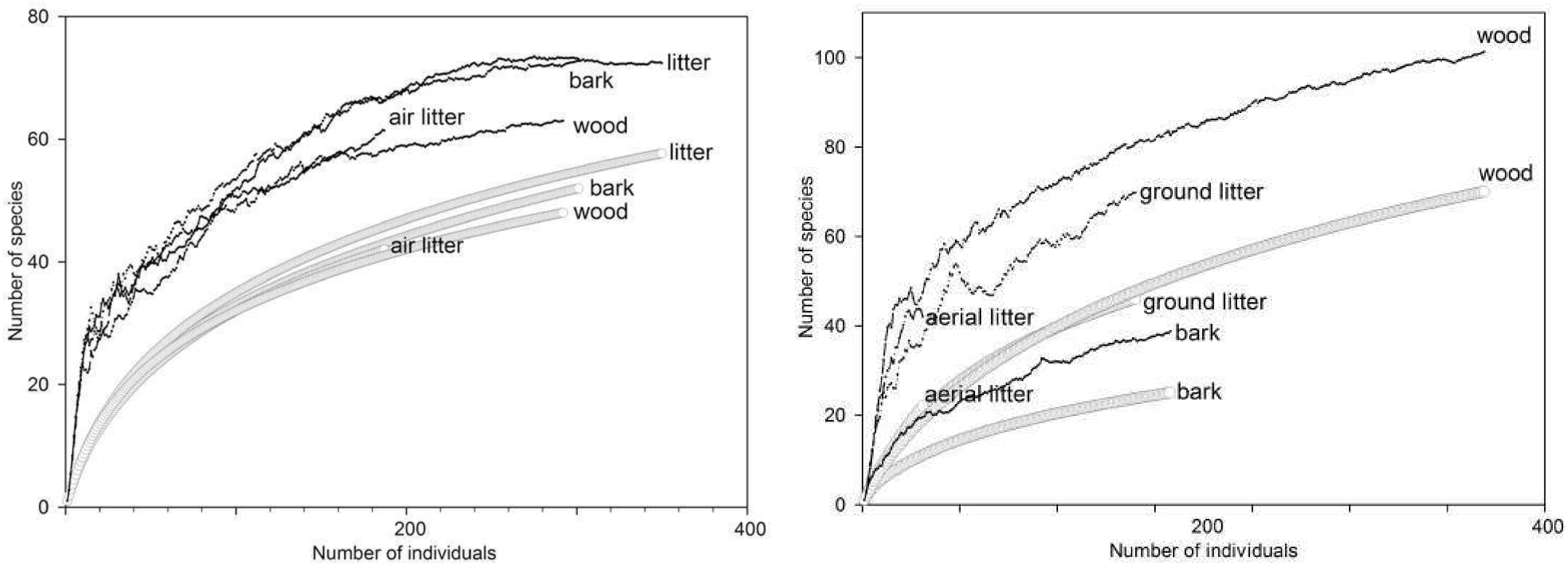
This difference is mainly caused by the high proportion of non-fruiting plasmodia in moist chamber cultures

Values of similarity of the data sets obtained from MCC and FC for the 3 best studied reserves in Vietnam

In the lowland semi-deciduous monsoon forests of Cat Tien Nat. Park maximal similarity was found for the litter, minimal - for the bark



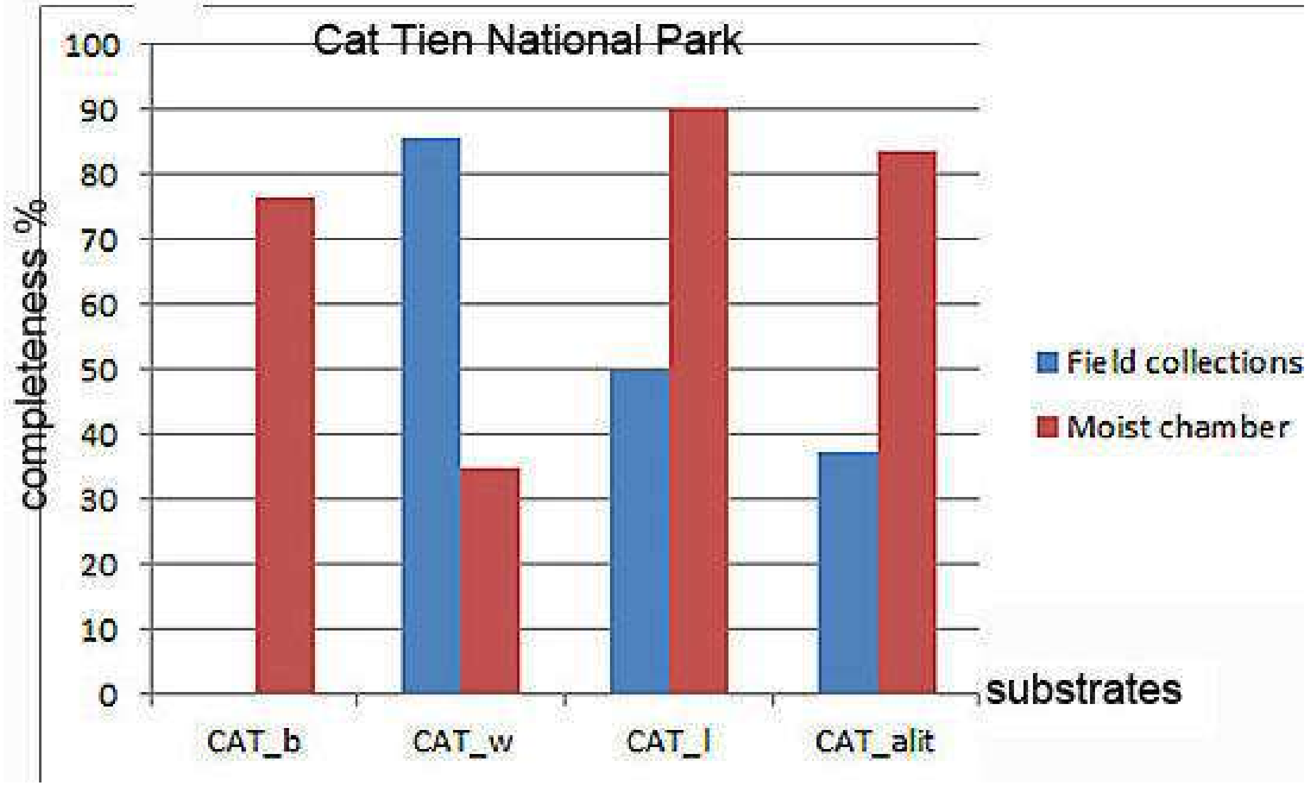
The completeness of different myxomycete assemblies for two National Parks



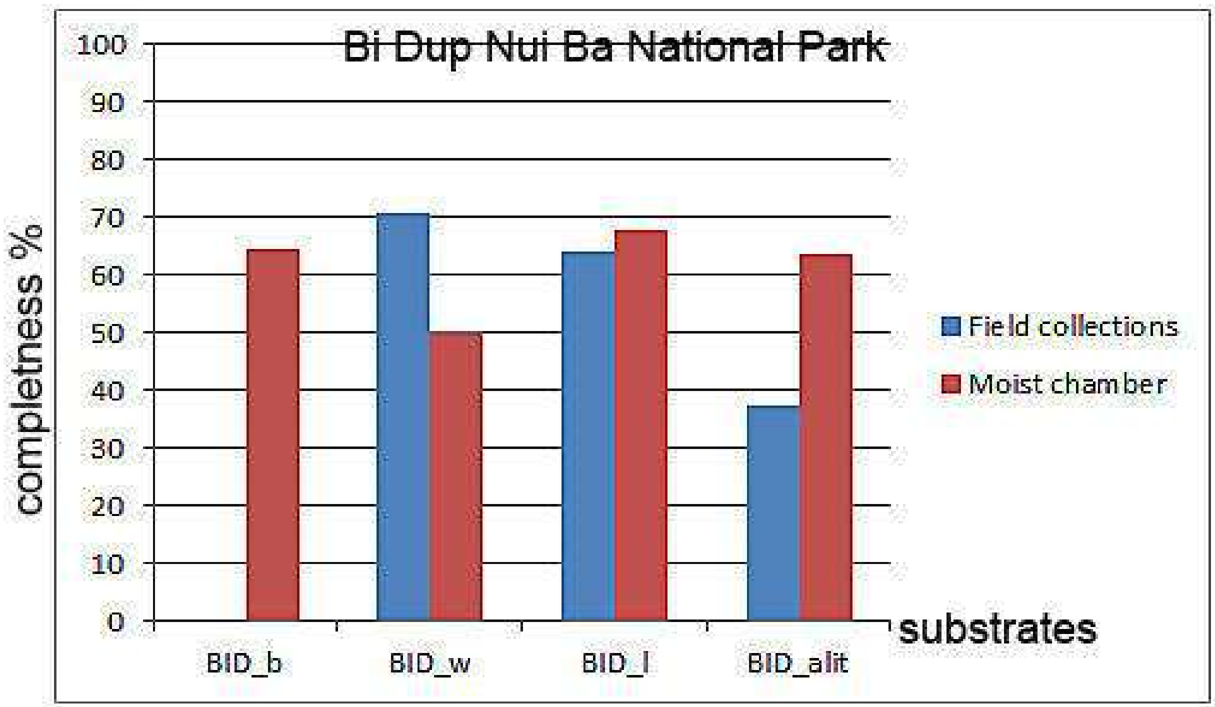
Cat Tien

Bi Dup Nui Ba

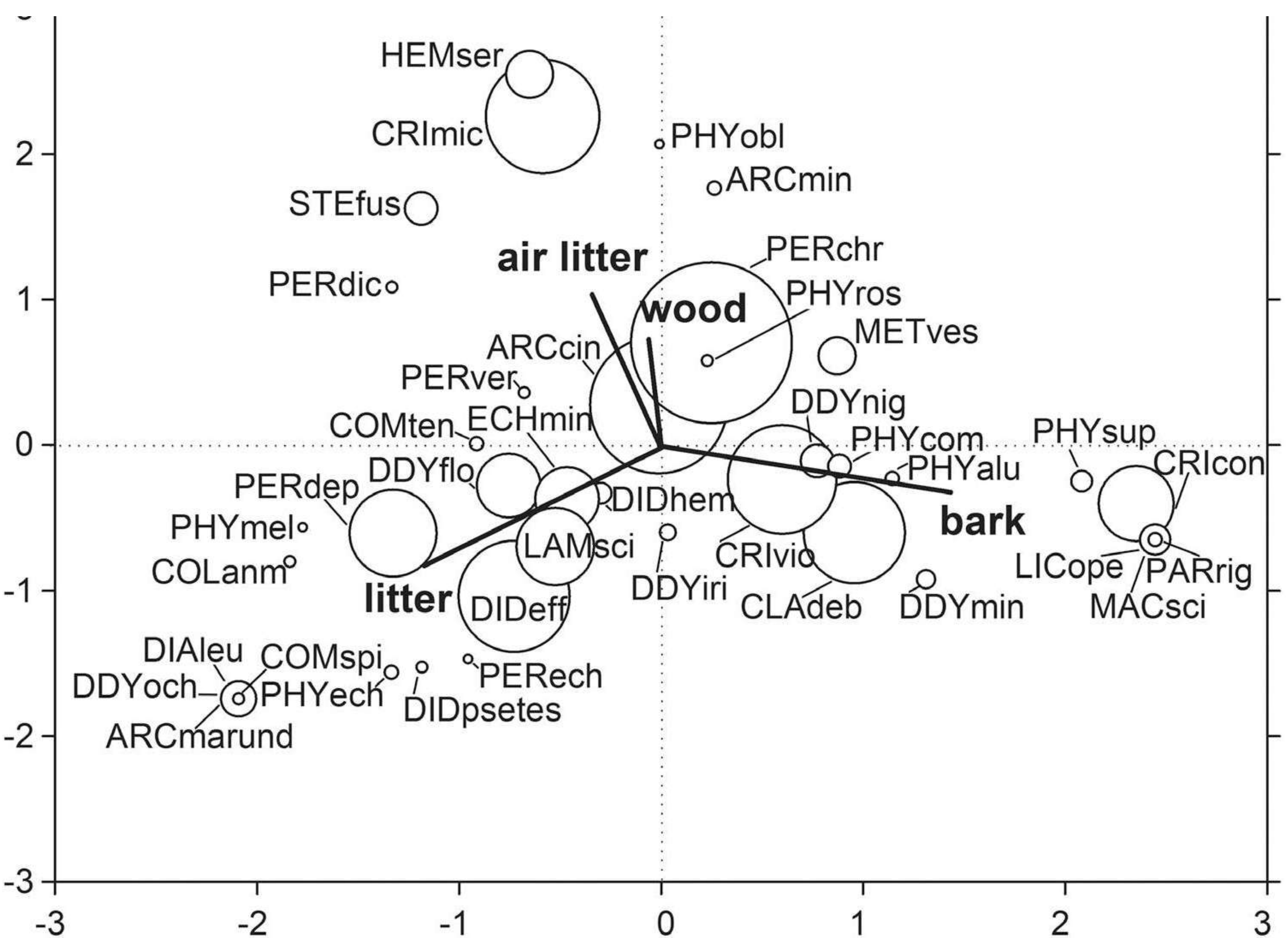
Individual-based species accumulation curves (thick lines) and the Chao 1 (mean) estimator (thin jagged lines) of expected morphospecies richness for 4 studied substrate types in 2 reserves



The completeness of different myxomycete assemblies depending on the collecting method

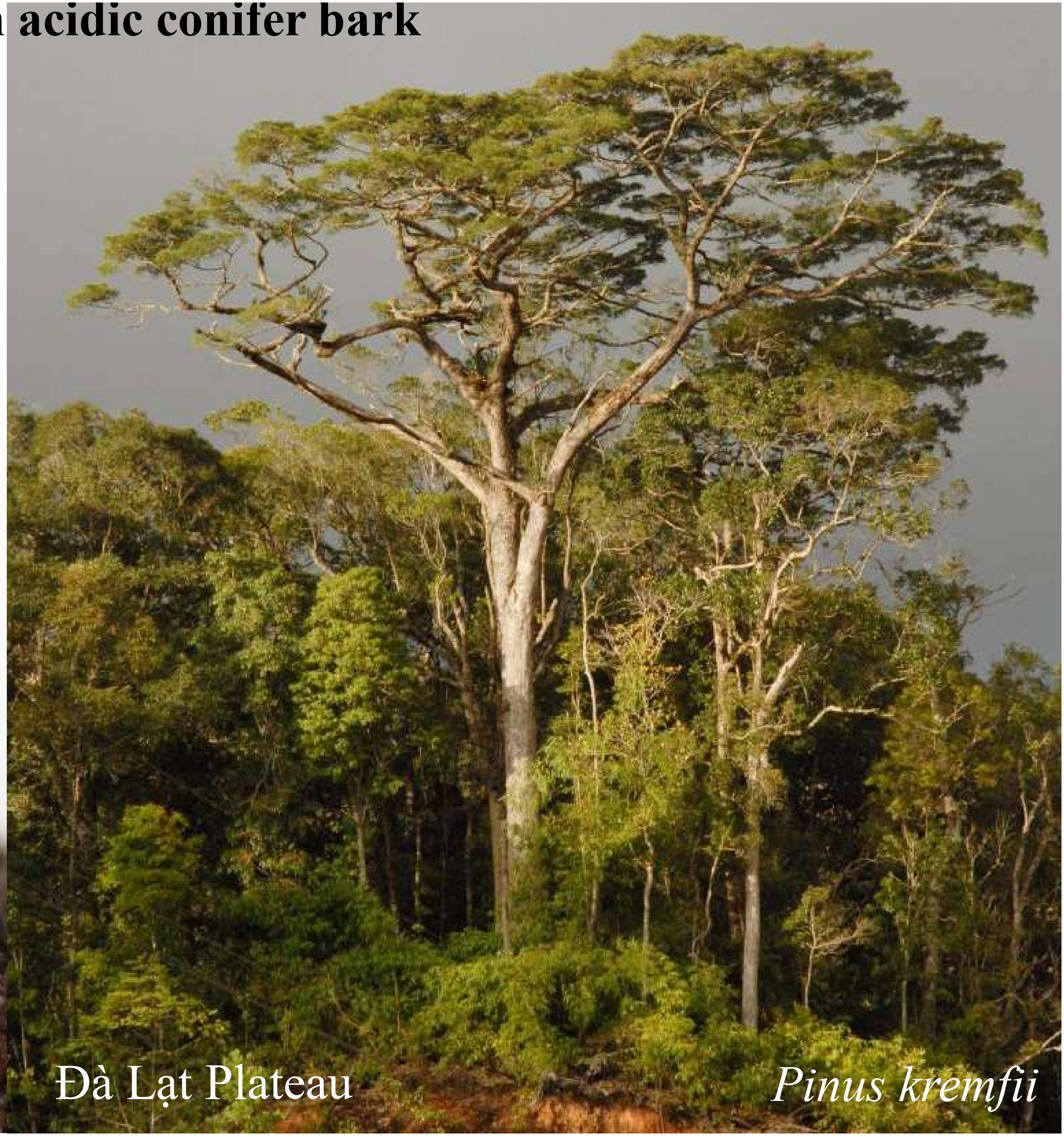


Microhabitats studied in Vietnam by moist chamber cultures

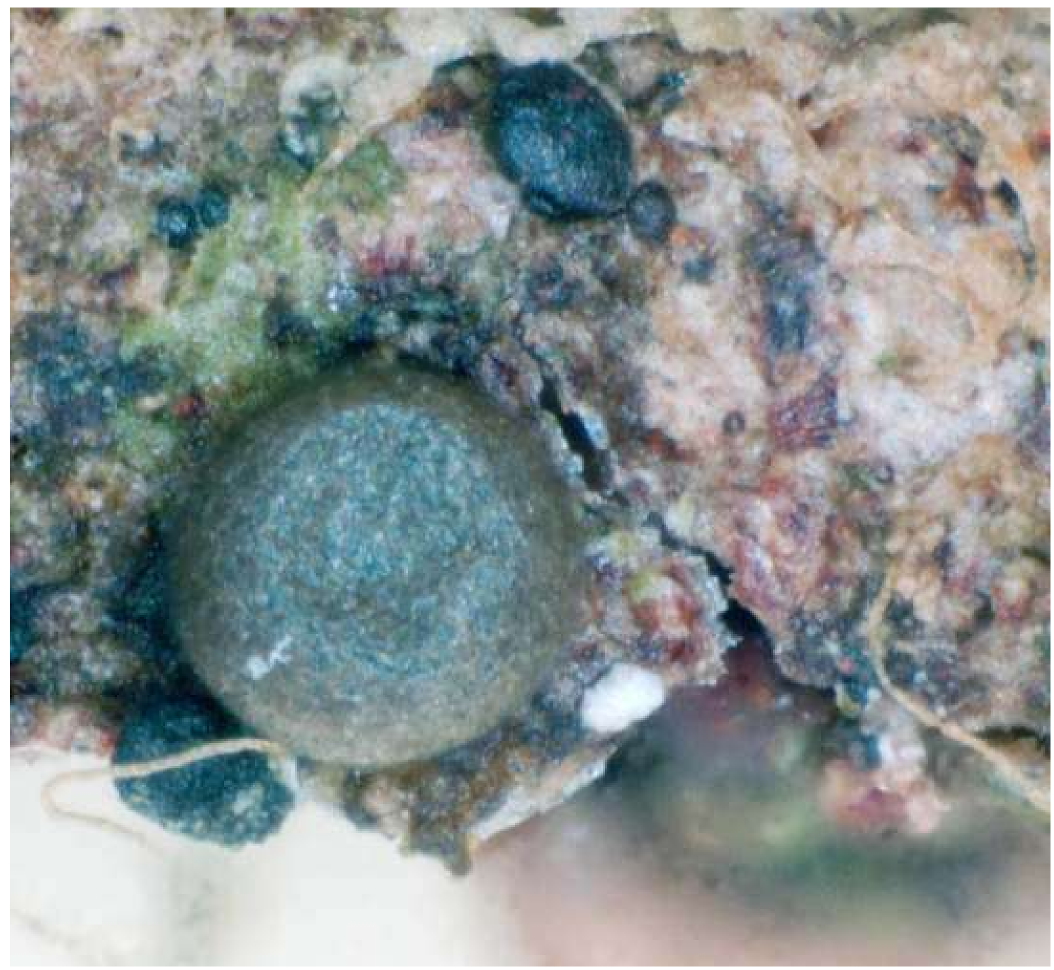


HEMser
CRImic
PHYobl
ARCmin
STEfus
PERdic
air litter
PERchr
wood
PHYros
METves
ARCcin
PERver
DDYnig
ECHmin
COMten
PHYcom
PHYsup
CRIcon
PHYalu
DDYflo
PERdep
DIDhem
bark
PHYmel
LAMsci
CRIvio
LICope
PARrig
COLanm
DDYiri
CLAdeb
DDYmin
MACsci
litter
DIDeff
DIAleu
COMspi
DDYoch
PHYech
PERech
DIDpsetes
ARCmarund
-3
-2
-1
0
1
2
3

Corticolous species on acidic conifer bark



Colloderma oculatum cf. – a rare species in the tropics was first found in Vietnam on the bark of a living tree of *Pinus massoniana*



Trichia ambigua cf. –
a corticolous myxomycete found in northern Vietnam in the artificial pine plantations on the bark of Pinus massoniana.

Schirmer P., Krieglsteiner L., Flatau L. Revision der Arten der Trichia botrytis-Gruppe mit besonderer Berücksichtigung von Trichia subfusca Rex //Zeitschrift für Mykologie. – 2015. – T. 81. – №. 2. – C. 431-450.

Arcyria cinerea "complex"-
the most common corticolous myxomycetes, occurring on all types of substrates

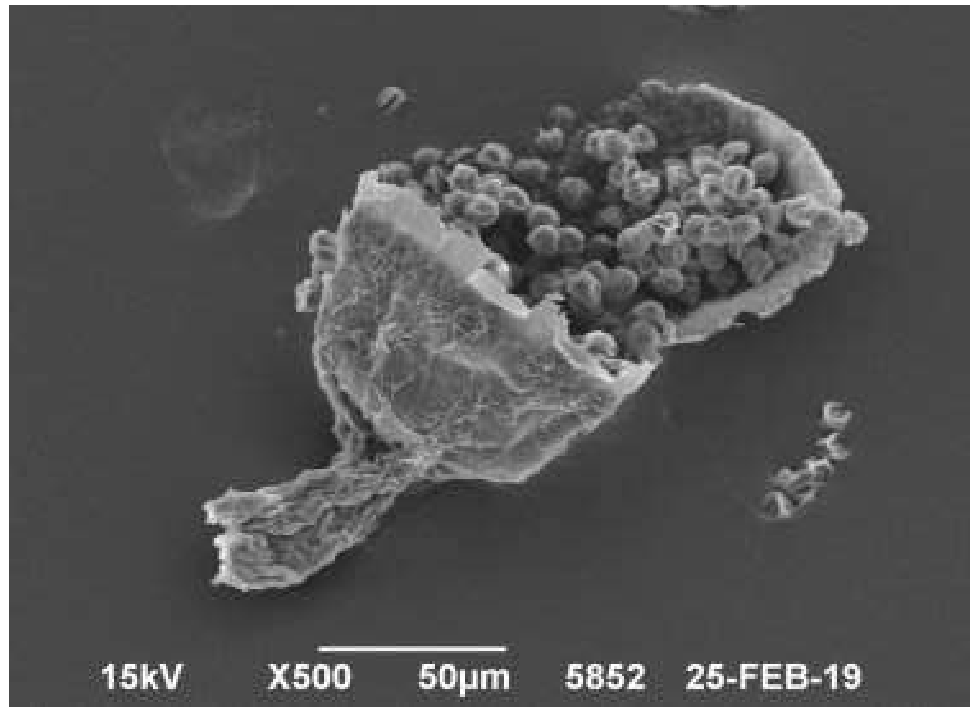

Ground litter

Perichaena chrysosperma “complex”
on surface of stems and aerial litter of bananas

Moist chamber cultures

The moist chamber culture technique remains an effective tool for identifying rare and new myxomycetes, especially among corticolous and litter-inhabiting taxa.

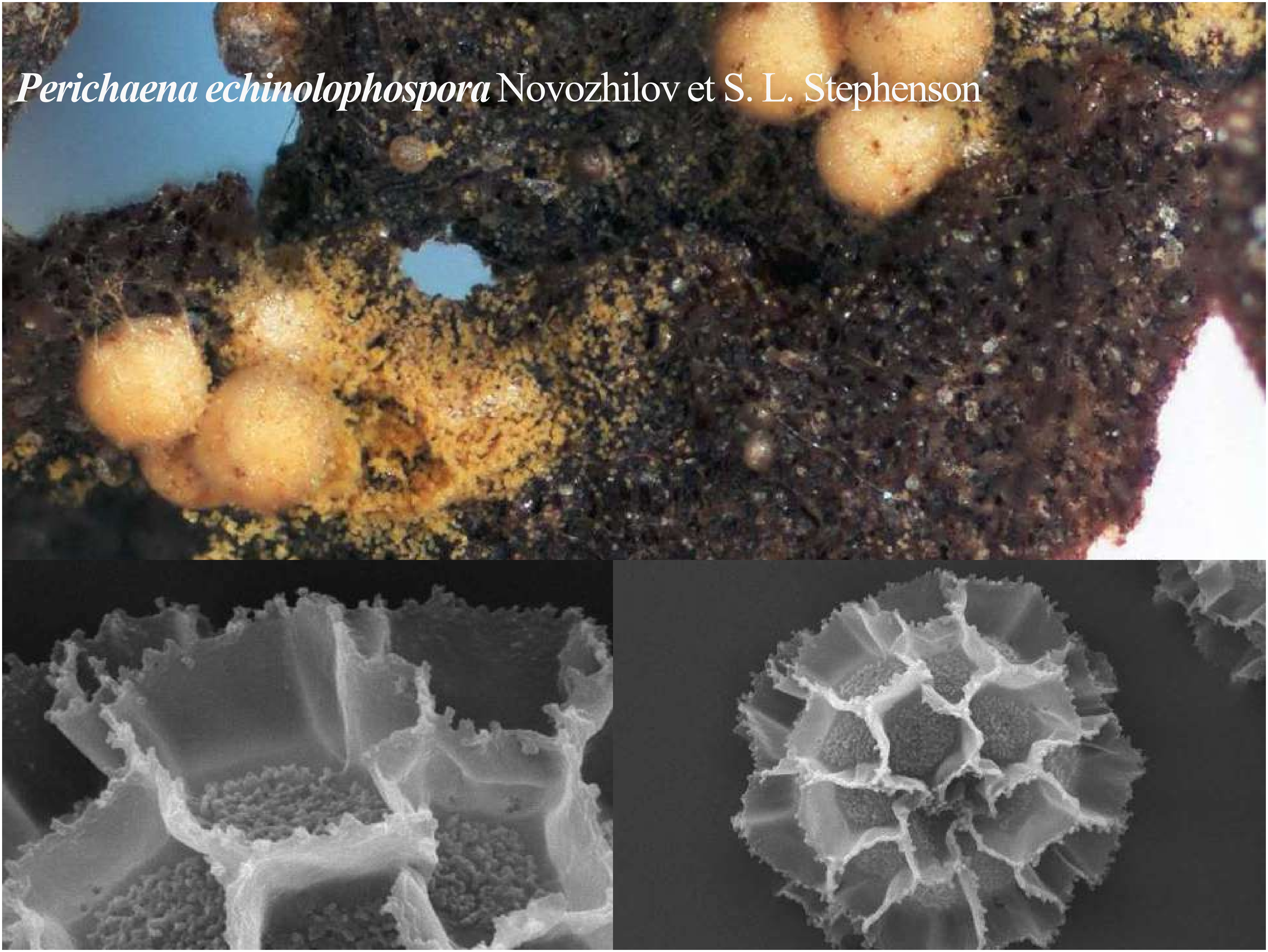
Rare and new taxa revealed by MCC in Vietnam

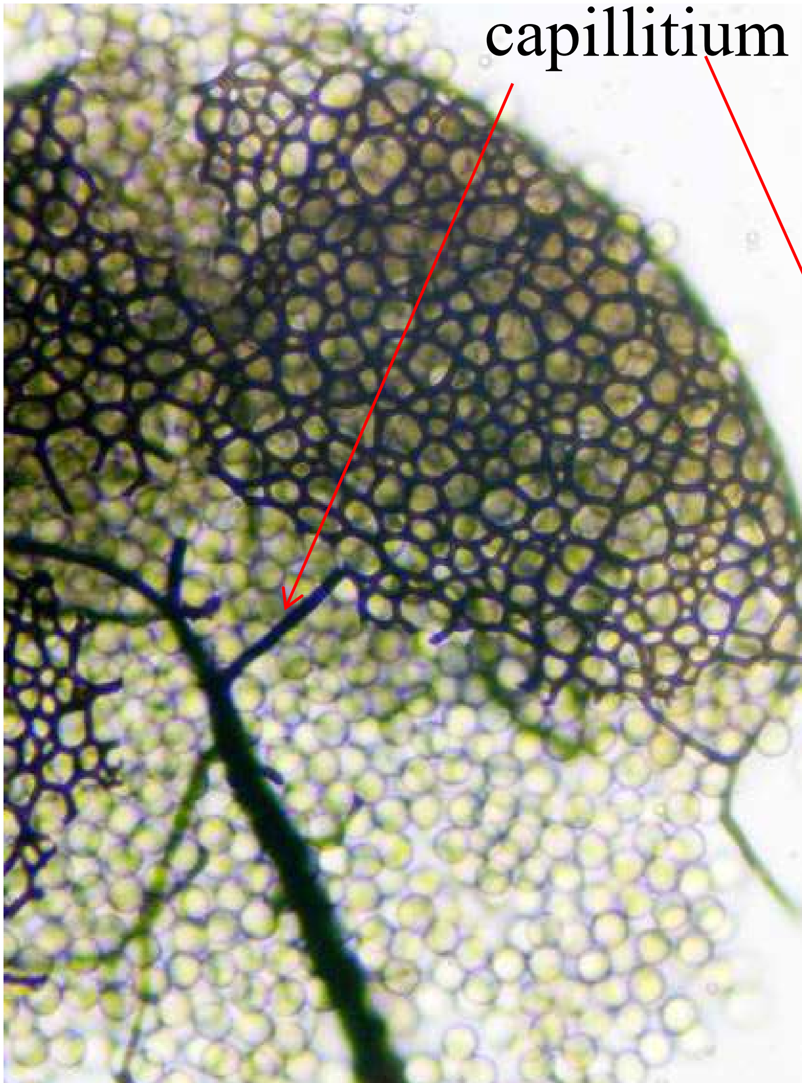


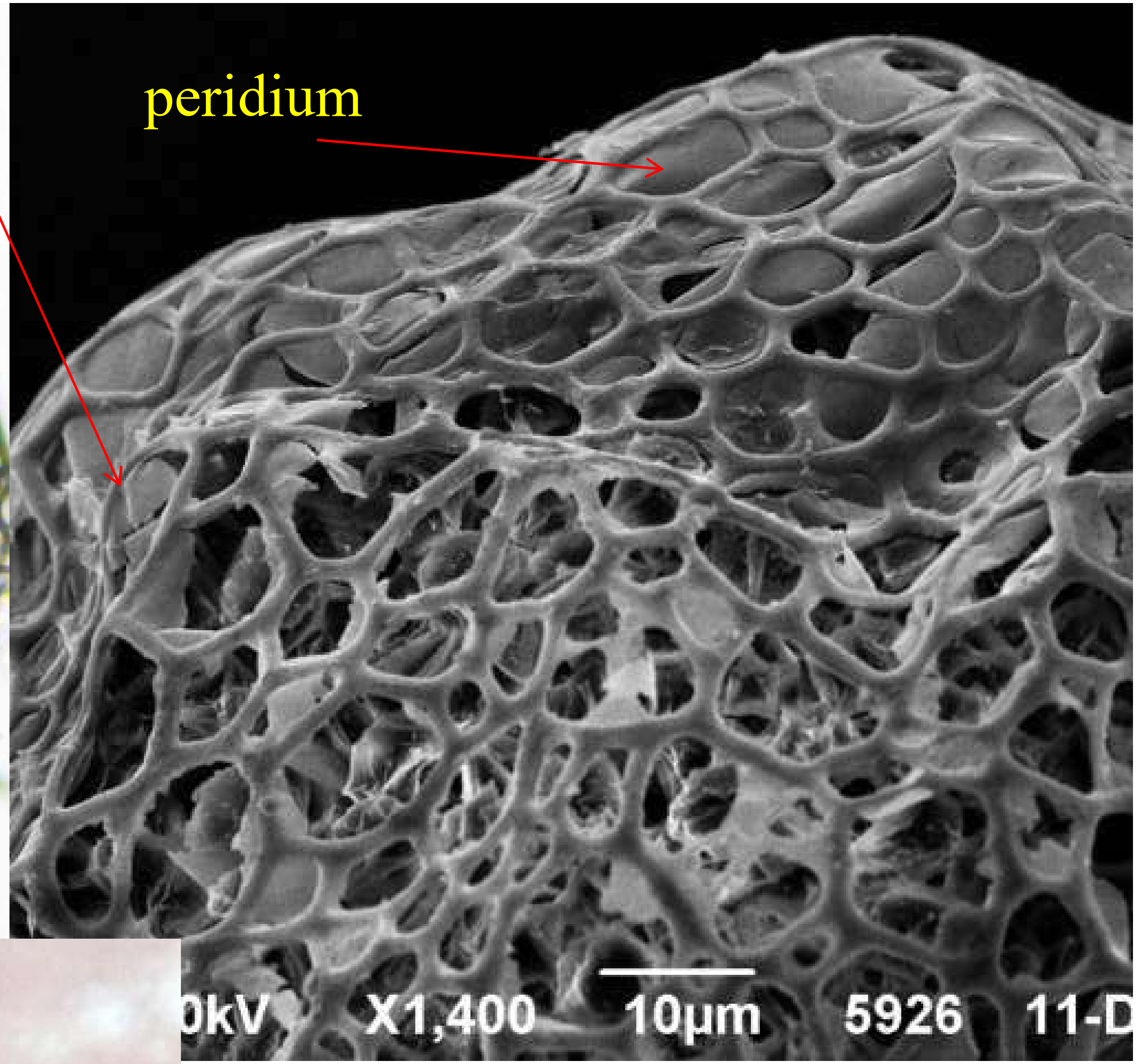
9 species of ***Licea***

4 species of ***Echinostelium***

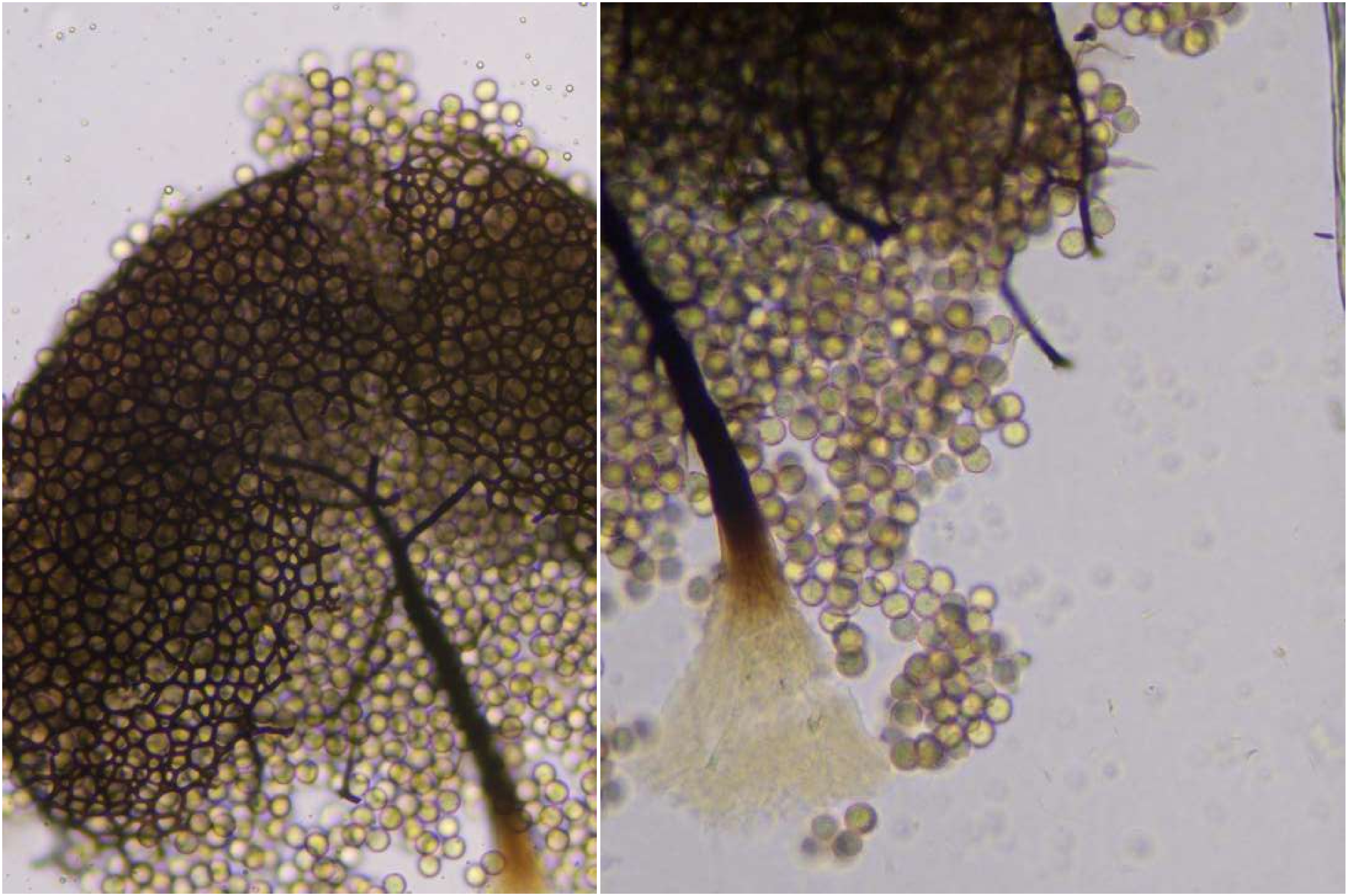
Perichaena echinolophospora Novozhilov et S. L. Stephenson

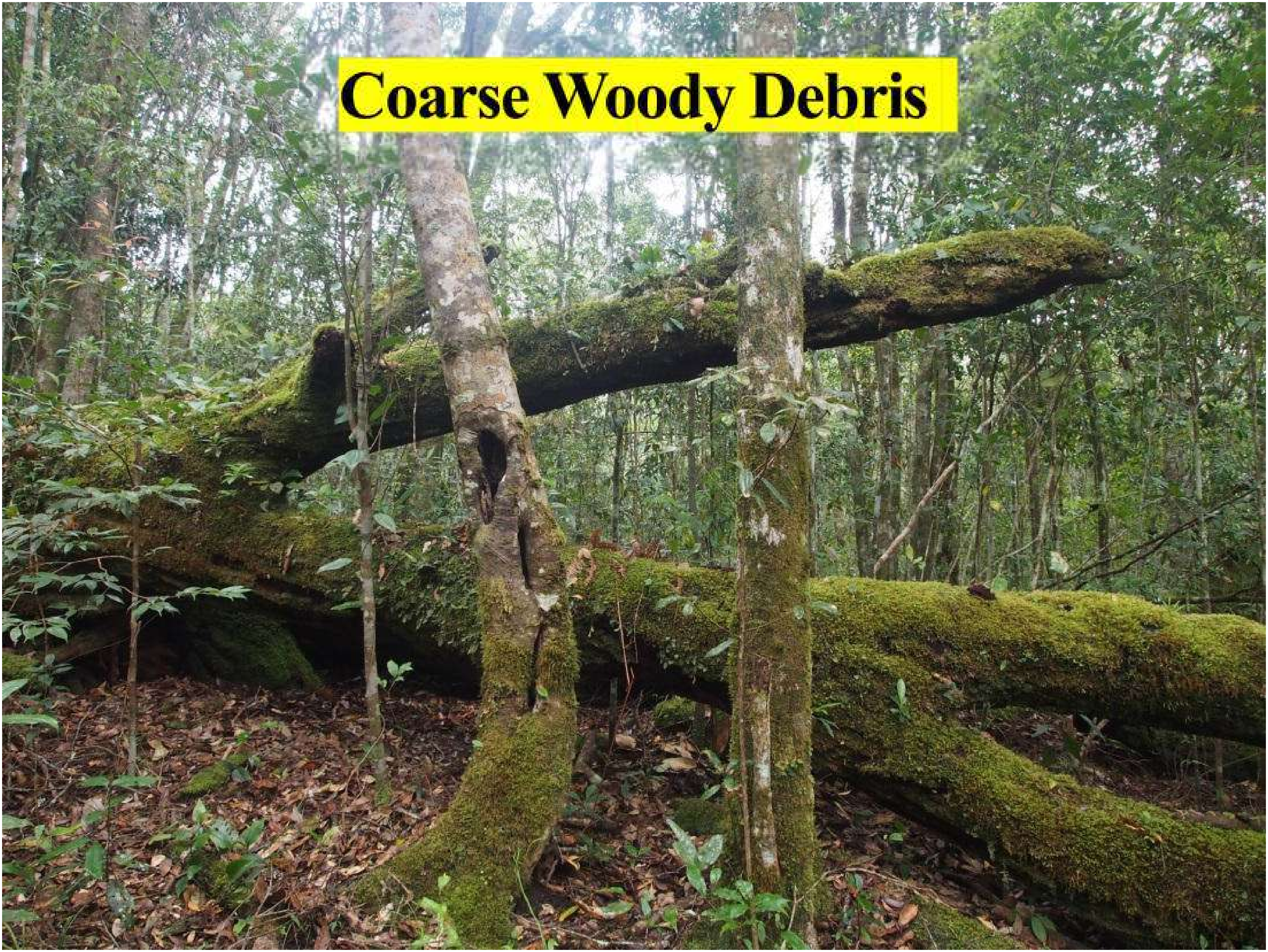






Paradiacheopsis cf. sp.
new taxa revealed by moist chamber cultures in Phia Oắc National Park




Coarse Woody Debris

Microhabitats in the tropics



In addition to woody remnants and ground litter, microhabitats in the tropics include:

- the aerial "canopy soil" associated with vascular and nonvascular epiphytes
- liane bark and the inflorescence of giant herbaceous plants, pH = 8-9, the residues of floral nectar or secretions from extrafloral nectaries provide the basic resource for a rapidly developing community of yeasts and bacteria
- foliicolous liverworts and lichens covering leaves of understory woody plants

Tropical lianas

Bark and woody remnants of lianas have near-neutral pH values (5.4–8.5) and high water retention for woody debris, which make them suitable for many species of myxomycetes.

A. cinerea, *Diderma hemisphaericum*, *D. squamulosum*, *Physarum pusillum*, and *S. fusca* var. *nigrescens* appear to be among the more consistently abundant and widespread members of the assembly of myxomycetes associated with

Bình Châu - Phước Bửu Nature Reserve: dry dipterocarp coast forest


Weathered Dung of Herbivorous Animals
in dry dipterocarp coast forests


Perichaena luteola (Kowalski) Gilert
200 µm

Conclusion

In spite of some delimitations the moist chamber culture technique remains an effective tool for identifying rare and new myxomycetes in the tropics, especially among corticolous and litter-inhabiting taxa.

Experiments using moist chamber cultures and ePCR connected with metabarcoding can be an important source of data on hidden diversity and may help visualize the real diversity of myxomycetes on different substrates.

Thank you for your attention!

Yuri Novozhilov, Nadezhda Fedorova, Oleg Shchepin and Eugene Popov acknowledges “Ecolan 1.2” (Russian-Vietnamese Tropical Centre) and AAAA-A19-119080990059-1 (Komarov Botanical Institute RAS) programs.

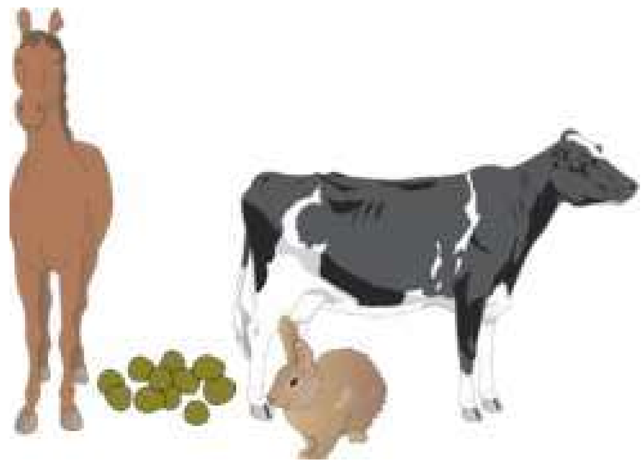
10th International Congress on the Systematics and Ecology of Myxomycetes

First reports of Fimicolous Myxomycetes from Brazilian Cerrado and Pantanal biomes

Francisco J. Simões Calaça, Izabel C. Moreira, Vanessa Basílio Tereza, Jéssica C. Araújo, **Solange Xavier-Santos**

University of Goiás State
Laboratory of Basic and Applied Mycology and Scientific Divulgation

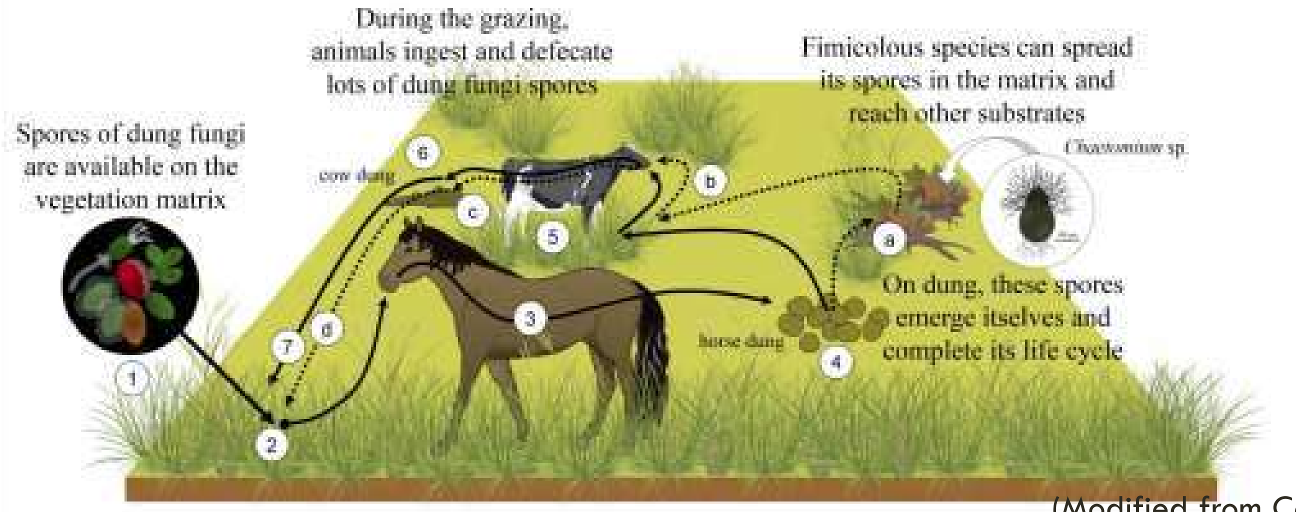
Dung: a favourable substrate to myxomycetes?



- high microbial content nutrients, moisture, alkaline-neutral pH
- different ecosystems
- specially advantageous in arid/desertic regions where the decomposition is slow -> dungs represent a package with favorable conditions

(Hudson 1986; Stephenson 2011, Novozhilov et al. 2017)

ARE THEY OPPORTUNISTICS?



(Modified from Calaça et al. 2020)

Contrary to coprophilous fungi (colonization of dung/feces is a required in life cycle), myxomycetes are **secondary and facultative inhabitants** of these substrates and the establishment on dung does not require animal ingestion and it is mediated by biotic vectors (Ex. insects) or by abiotic factors (Ex.: wind). Most, perhaps all, species found on dung may occasionally occur on other substrata (Eliasson and Keller 1999) (Eliasson & Lundqvist 1979, Eliasson & Keller 1999).

Doveri (2004) suggested that the term **fimicolous** is more suitable for organisms that live on dung but do not depend on it; **coprophilous** denotes dependency.

-> Fimicolous Myxomycetes

Myxomycetes Fimicolous

- oldest record: early 1800s -> *Physarum fimetarium* (Schumacher, 1803)
- first global review -> 80 species (Eliasson & Lundqvist, 1979)
- updating and adding a dichotomous key for species with exclusive occurrence on dung-> 99 species (Eliasson & Keller, 1999)
- updating ecological niches and microhabitats, adding 15 species (114) (Eliasson, 2013)

- **Fimicolous myxomycetes: overview of the global distribution and scientometrics**

(Calaça et al. *in press*)

- 1900-2017
- 98 papers/50 journals
- 503 occurrences
- 125 morphospecies

- Despite the increase of publications on fimicolous myxomycetes, most aspects related to their biology and biogeography are still undocumented (Novozhilov et al. 2017)

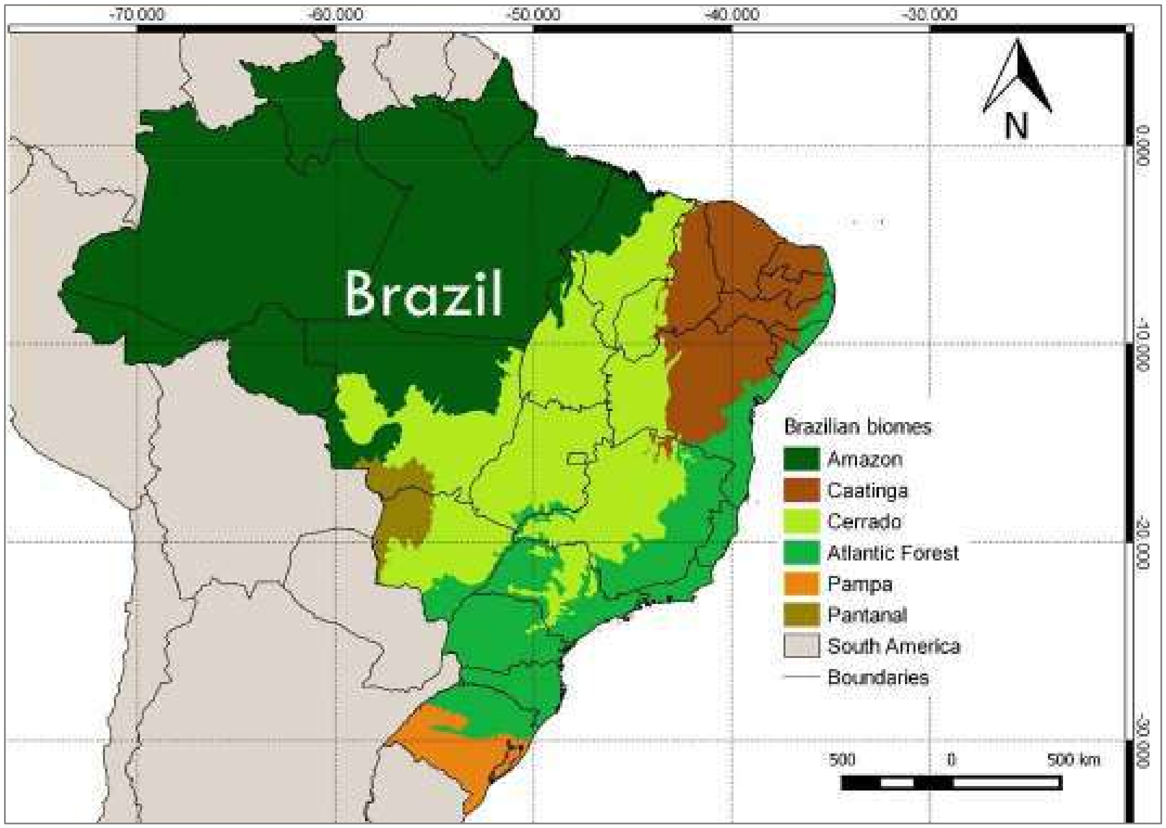
In Brazil

- about 250 species of myxomycetes
- distributed in all geographical regions of the country
- mainly on vegetal substrates
- few reports about myxomycetes occurring as fimicolous
- 10 species (*Arcyria cinerea, Cribraria cancellata, C. microcarpa, C. violacea, Comatricha mirabilis, Hemitrichia minor, Licea tenera, Metatrichia vesparia, Physarum cinereum, P. roseum*).
- All in the Northeast region
- Brazilian studies focused on fimicolous myxomycetes:
  - Bezerra et al. (2008) -> Coprophilous myxomycetes of Brazil: first report. Rev. Mex. Micologia 27:29–37
  - Parente & Cavalcanti (2017) -> *Arcyria cinerea* (Bull.) Pers. (Myxomycetes, Trichiaceae,) found on dung of rock cavy (Kerodon rupestris Wied-Neuwied, 1820, Rodentia: Caviidae). Revista Ouricuri 7:1–11.

- We present herein records of fimicolous myxomycetes from Central Brazil, in two biomes: Cerrado and Pantanal.

Introduction | **Material & Methods** | Results | Discussion | Final Considerations

- Study areas: Brazilian biomes **Cerrado** and **Pantanal**



- **Cerrado** (Brazilian Savanna): predominant in highland Central Brazil, 2nd largest biome, different vegetation types, from fields to forest, hotspot to biodiversity conservation.

- **Pantanal** (Tropical wetland): smallest Brazilian biome (2% territory), the largest floodplain on the planet, vegetation : grass field-forest and aquatic vegetation.

View of the Poconé Pantanal landscapes. Image: L. Leonardo-Silva.

View of the Poconé Pantanal landscapes. Image: S. Xavier-Santos.

View of the Poconé Pantanal landscape (a typical wetland). In the center of the image, a broad-snouted caiman (*Caiman latirostris*: Alligatoridae), known as *jacaré-de-papo-amarelo,* rests in the sun. Image: L. Leonardo-Silva.

Jacaré-de-papo-amarelo. Image: S. Xavier-Santos.

Animal footprint on the sand. Image: S. Xavier-Santos.

View of the Cerrado landscapes (*campo sujo*, grassland formation). Image: F. Calaça.

View of the Cerrado landscapes (*typical cerrado*, savanna formation). Image: F. Calaça.

View of the Cerrado landscapes (*cerradão,* forest type formation). Image: F. Calaça.

- **Sampling: fiel and Laboratorial procedures**

- Dung samples collection: between 2017-2018
- Moist chambers: ± 27°C, 4 months
- Monitoring: 2x weeks
- Characterization, taxonomic identification and photographic records
- Vouchers in Herbarium HUEG, Anápolis, Goiás, Brazil – Collection of Myxomycetes

Collecting in field

Moist chamber culture

Microscopic analysis

Collection in HUEG

Our data present first records of fimicolous myxomycetes:

- from Brazil Central
- Cerrado biome (Brazilian Savanna)
- Pantanal biome
- fimicolous habitat to some species (in Brazil and world)

(Table 1)

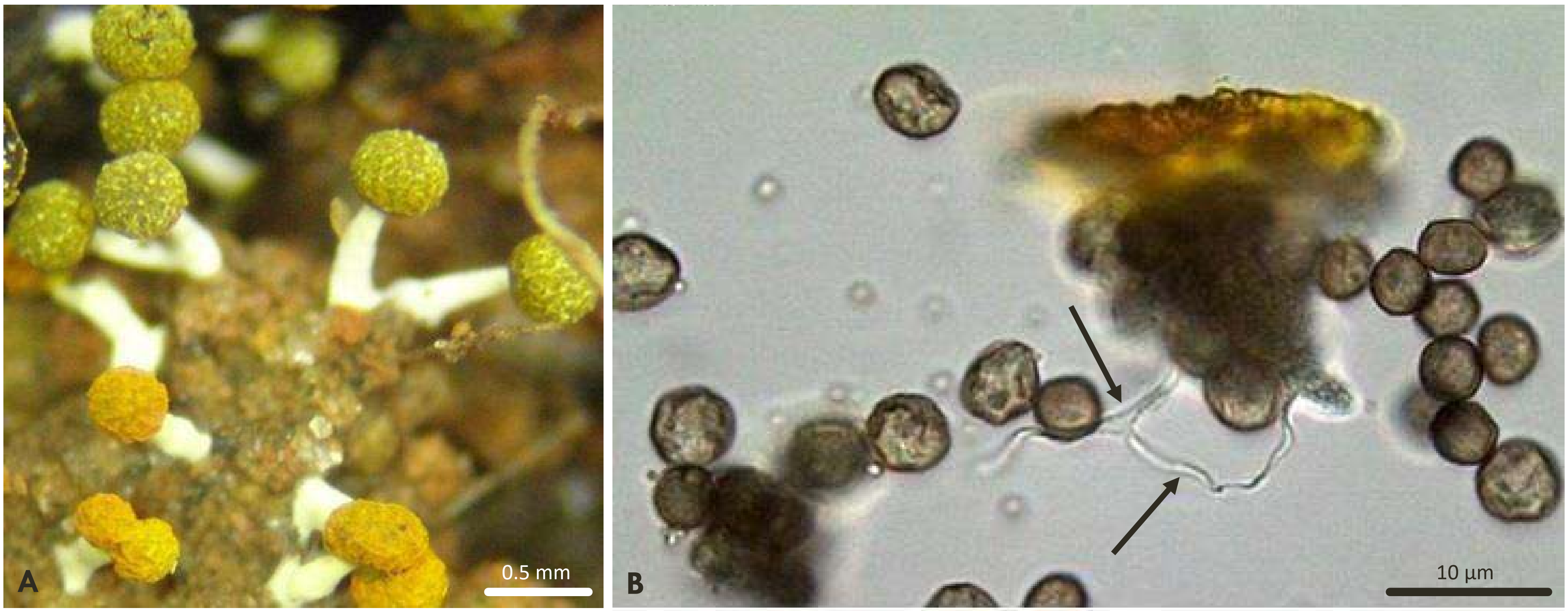
Table 1. Fimicolous myxomycetes recorded from Central Brazil.

Species	Biome	Location	New record	
			as fimicolous	to location
Arcyria cinerea (Bull.) Pers.	Cerrado	Anápolis and Pirenópolis (GO)	-	-
Physarum melleum (Berk. & Broome) Massee	Cerrado	Porangatu (GO)	First in Brazil Second in world	-
P. viride (Bull.) Pers.	Cerrado	Anápolis (GO)	First in world	Centro-Oeste region
P. cinereum (Batsch) Pers.	Cerrado	Goiás (GO)	-	
Perichaena corticalis (Batsch) Rostaf.	Pantanal	Poconé (MT)	First in Brazil	Centro-Oeste region

Arcyria cinerea

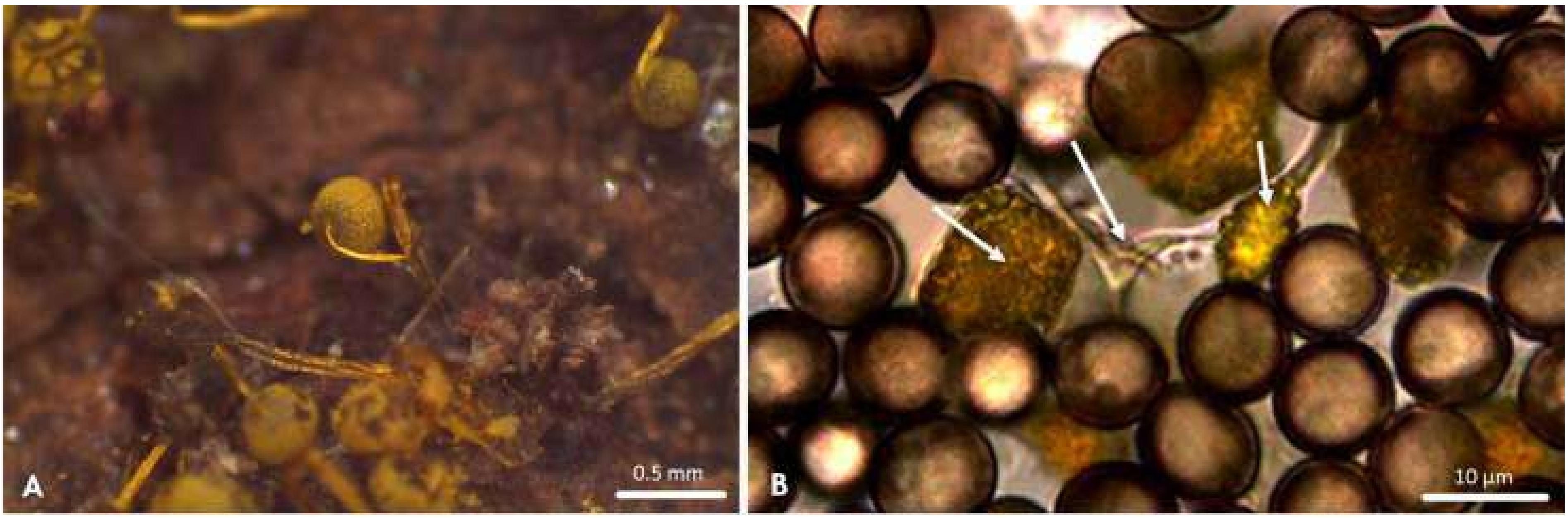
Arcyria cinerea on dung. **A** – Sporophores. **B** – Capillitium. **C** – Spores. Images: F.J.S. Calaça

Physarum melleum



Physarum melleum on dung. **A** – Sporophores. **B** – Spores and capillitium (arrow). Images: I.C. Moreira

Physarum viride



Physarum viride on dung. **A** – Sporophores. **B** – Spores and capillitium with calcium granules (arrow). Images: I.C. Moreira

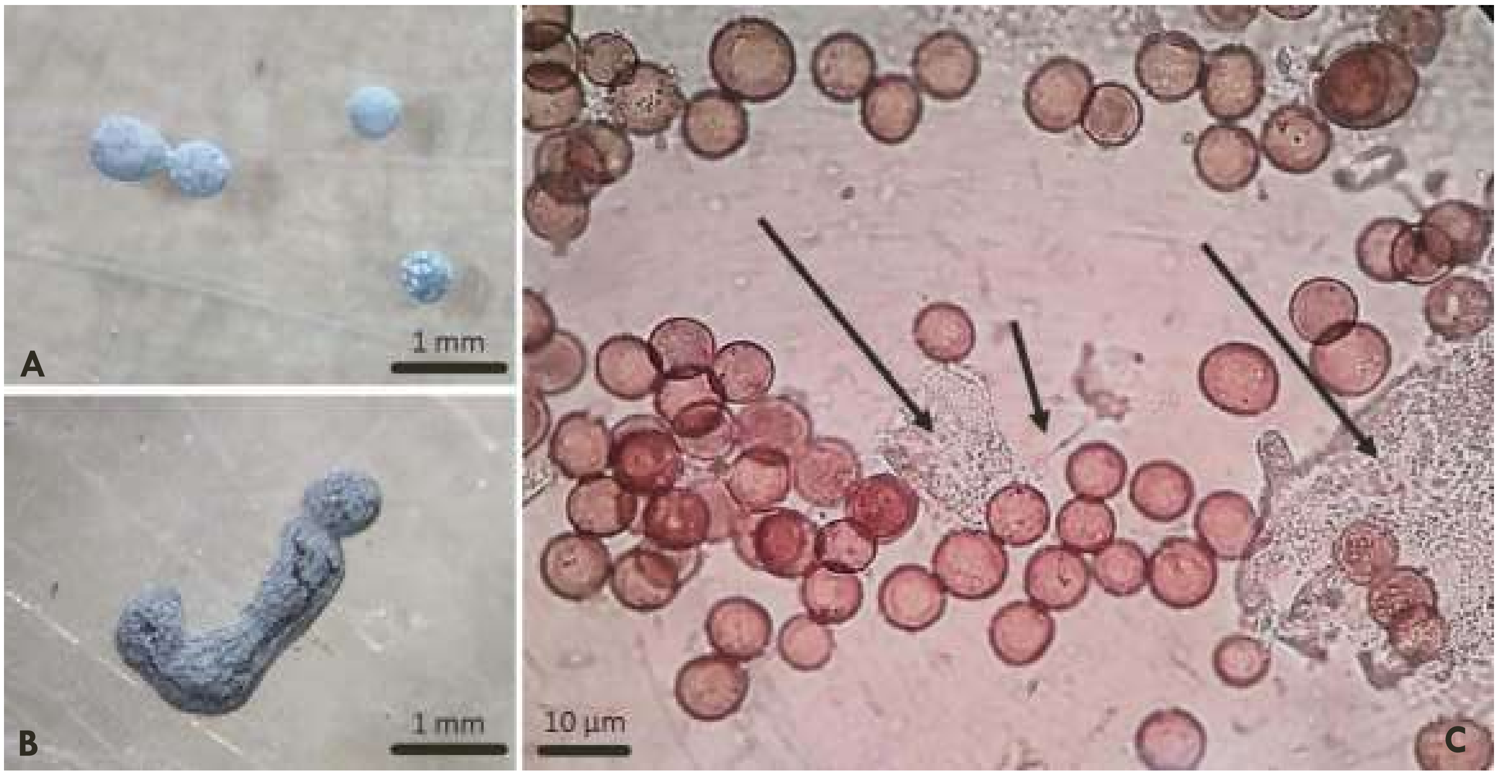
Physarum cinereum

Dung sample in moist chamber

Plasmodium (arrow) growing on the inner plastic bottle surface

Sporangia fomed on the inner plastic bottle surface

Physarum cinereum



Physarum cinereum. **A-B** – Sporophores (plasmodiocarp). **C** – Spores and remains of capillitium (arrow). Images: F.J.S. Calaça

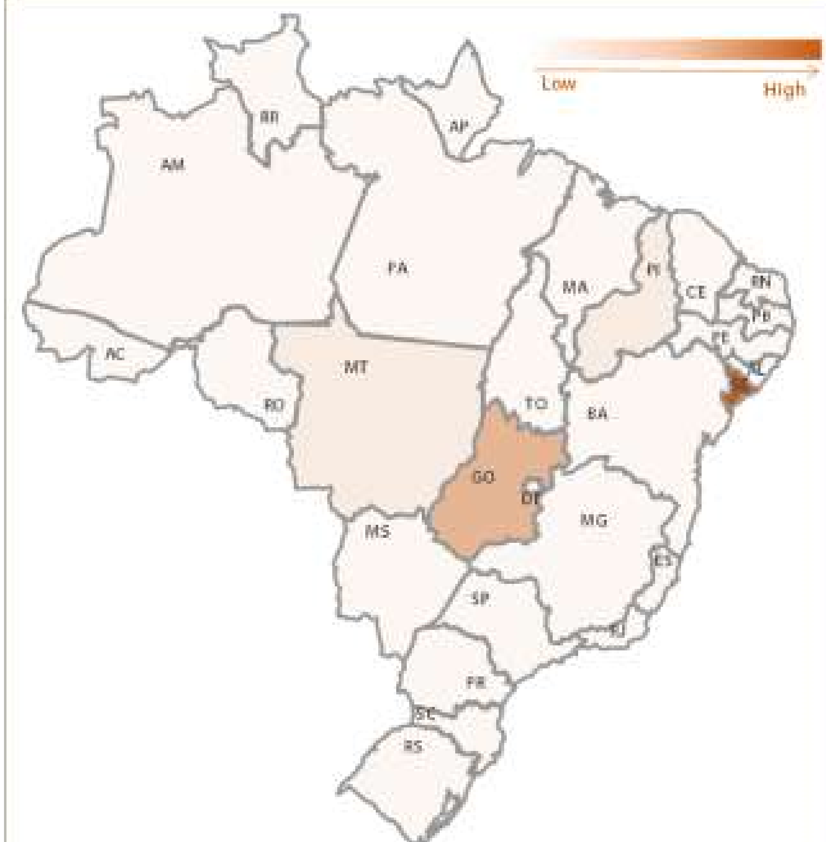
Perichaena corticalis

Perichaena corticalis. **A** – Sporophores. **B** – Peridium (arrow). **C** – Spores. Images: F.J.S. Calaça

Introduction | Material & Methods | Results | Discussion | Final Considerations

Distribution of fimicolous mixomycetes records in Brazil

- Sergipe: 9
- Goiás: 4
- Mato Grosso: 1
- Piauí: 1



Occurrence of Fimicolous Myxomycetes

Introduction | Material & Methods | Results | Discussion | **Final Considerations**

This work is part of the doctoral project "Biology of Coprophilous Fungi of Central Brazil" of the Postgraduate Program in Natural Resources of the Cerrado, within the scope of the "Dung Fungi from Brazil" project.

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The authors:

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Izabel Moreira

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Jéssica Araújo

Solange Xavier-Santos

Fung Lab

Micologia básica, aplicada e divulgação científica

https://micologiaueg.wixsite.com/fungilab

Thank you!

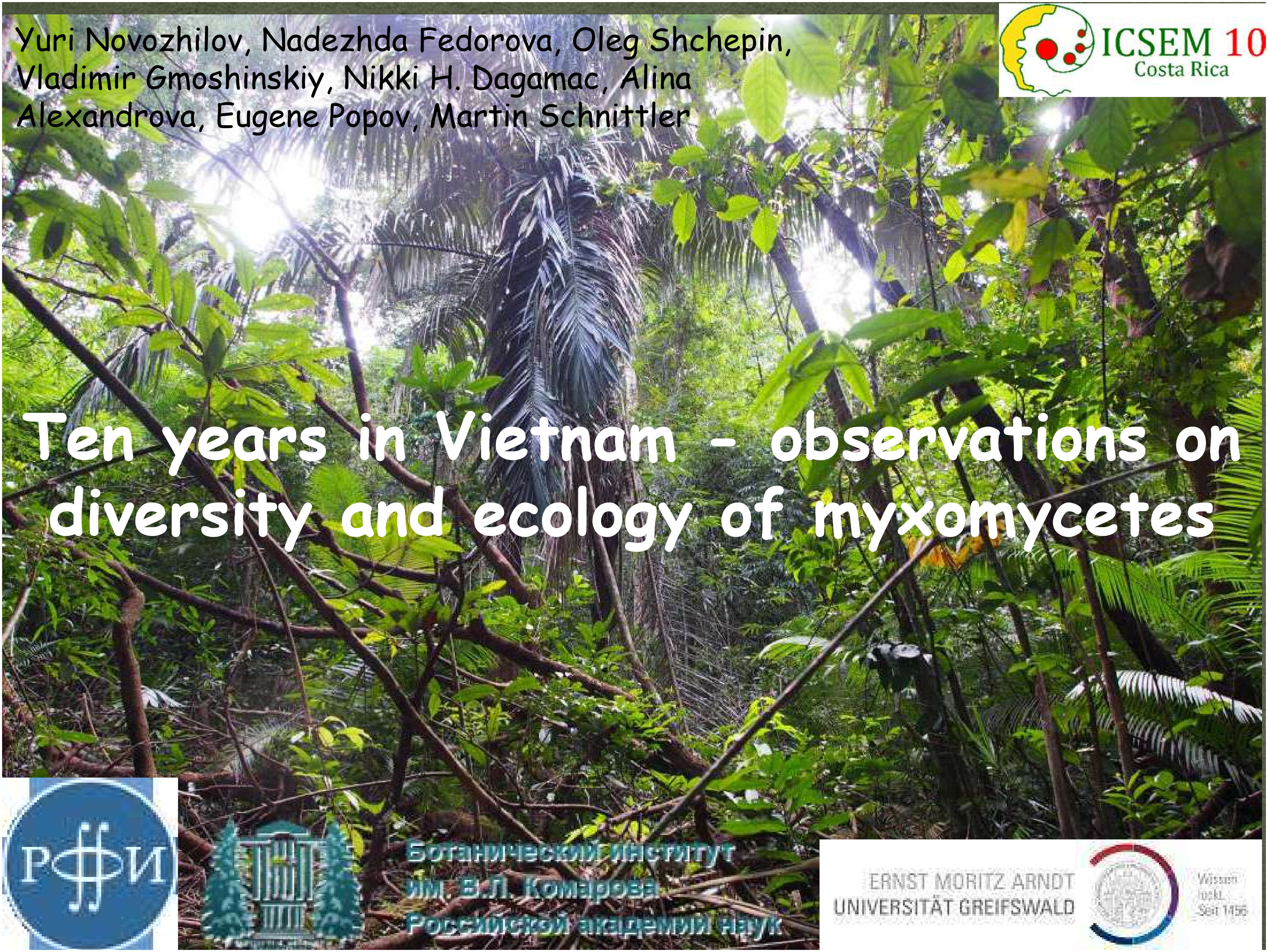
species most commonly encountered on dung (Novozhilov et al, 2003)
Badhamia apiculospora,
B. spinispora,
Licea alexopouli
Perichaenaliceoides
P. luteola

thick-walled spores - > adaptation to passing through the intestinal tract of a herbivore ? (Eliasson 2013)
Licea alexopouli,
Kelleromyxa fimicola
Trichia brunnea

Yuri Novozhilov, Nadezhda Fedorova, Oleg Shchepin, Vladimir Gmoshinskiy, Nikki H. Dagamac, Alina Alexandrova, Eugene Popov, Martin Schnittler

ICSEM 10
Costa Rica

Ten years in Vietnam - observations on diversity and ecology of myxomycetes



РФФИ

Ботанический институт им. В.Л. Комарова Российской академии наук

ERNST MORITZ ARNDT UNIVERSITÄT GREIFSWALD

Wissen lockt. Seit 1456

15 studied reserves

Five reserves, where intensive studies have been conducted:

CAT = Cat Tien National Park and adjacent Vinh Cuu Nature Reserve;

BCPB = Binh Chau-Phuoc Buu Nature Reserve

BGM = Bu Gia Map National Park

BID = Bidup-Nui Ba National Park

PHO = Phia Oak Reserve

CMR = Chư Mom Ray National Park

CYS = Chu Yang Sin National Park

KCR = Kon Chư Răng Nature Reserve

KKK = Kon Ka Kinh National Park

KPPF = Kon Plông Protected Forest (Thạch Nham)

XSN = Xuân Sơn National Park

YDN = Yok Đôn National Park

BA = Ba Vi National Park

XSN = Xuân Sơn National Park

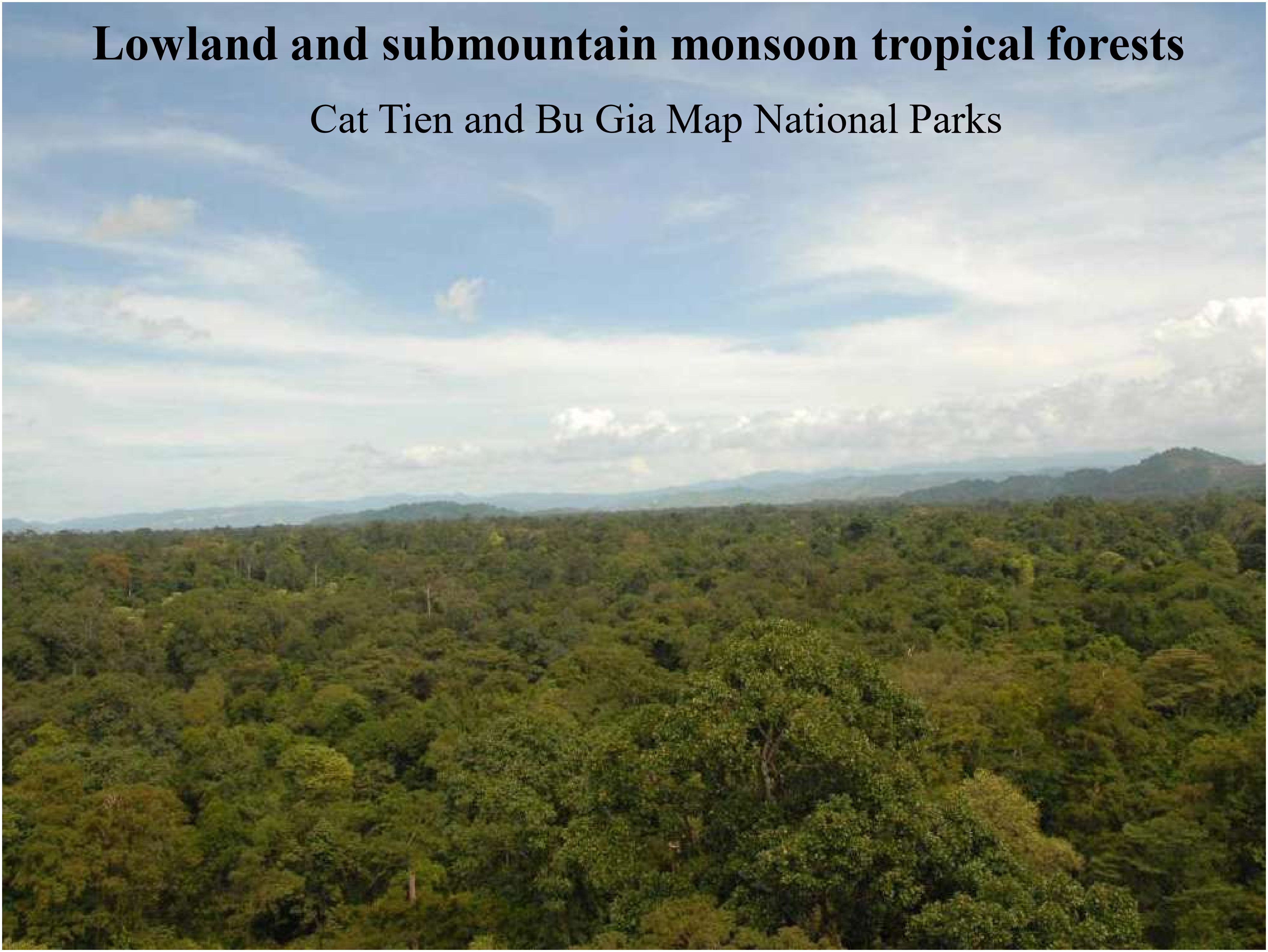
BAO = Bao Loc

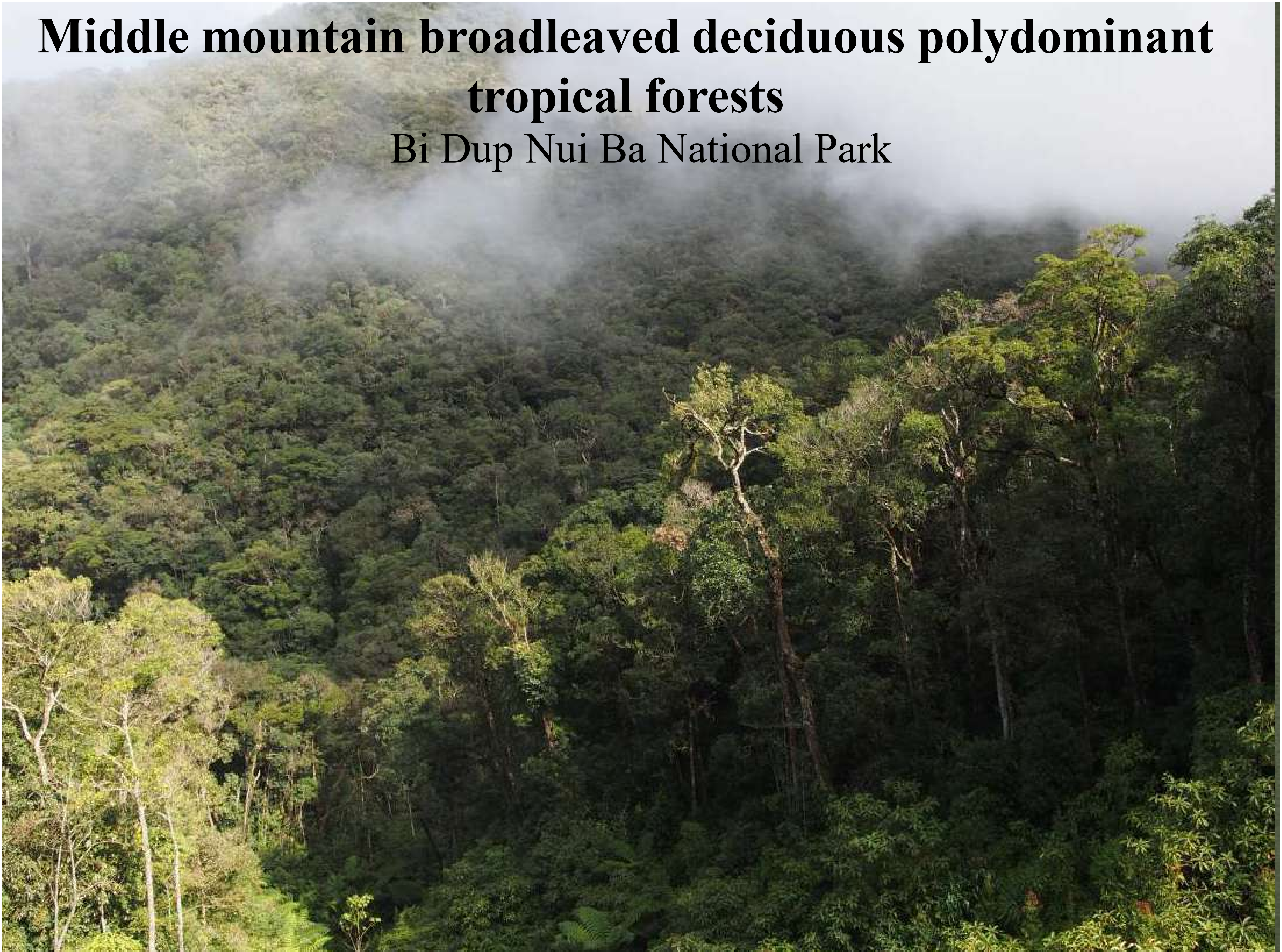
ST = Song Thanh Nature Reserve

Climate

The study area is subjected to a tropical monsoon climate with two distinct seasons.

The seven climatological regions of Vietnam


Lowland and submountain monsoon tropical forests
Cat Tien and Bu Gia Map National Parks

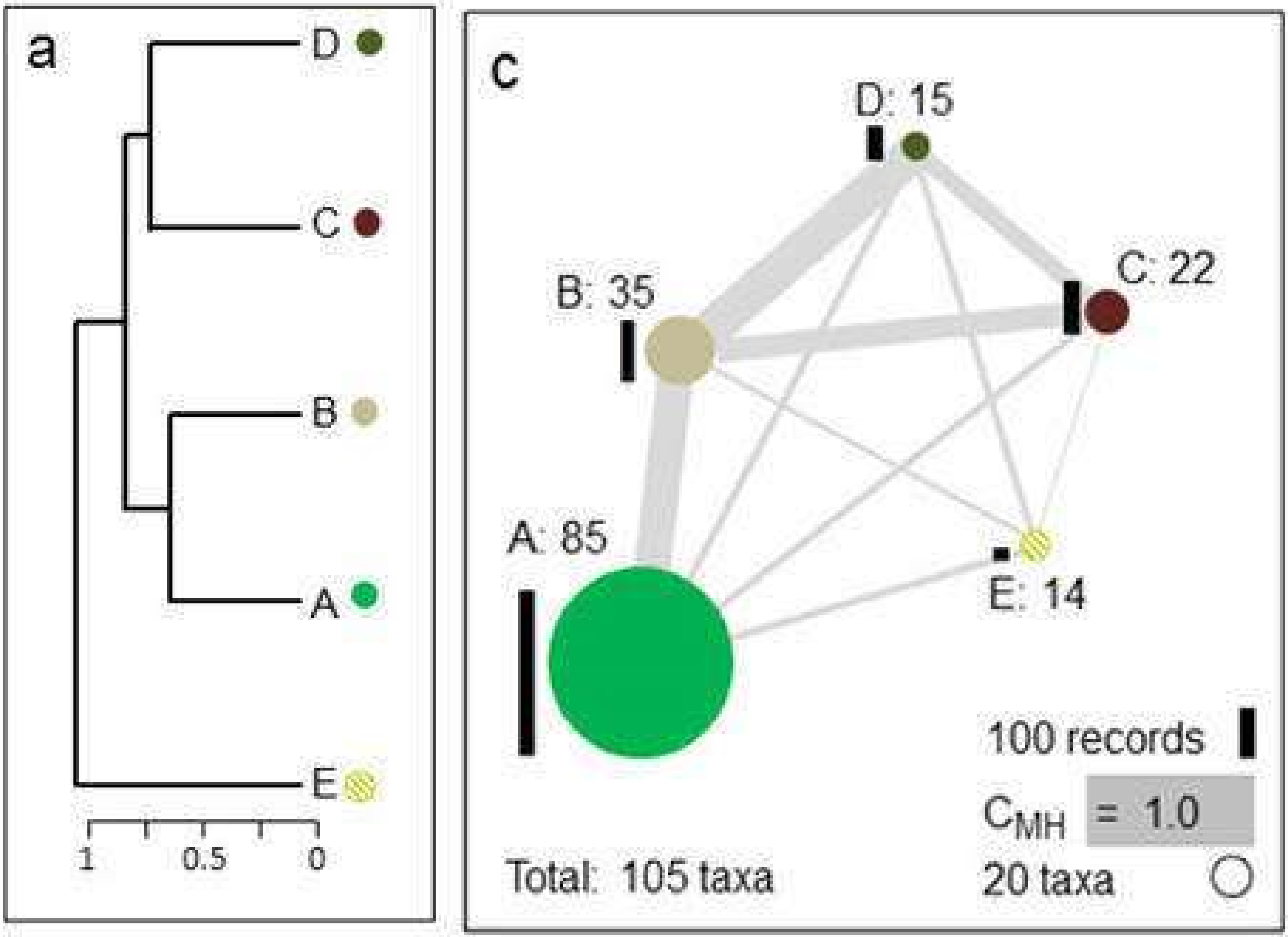

Middle mountain broadleaved deciduous polydominant tropical forests
Bi Dup Nui Ba National Park

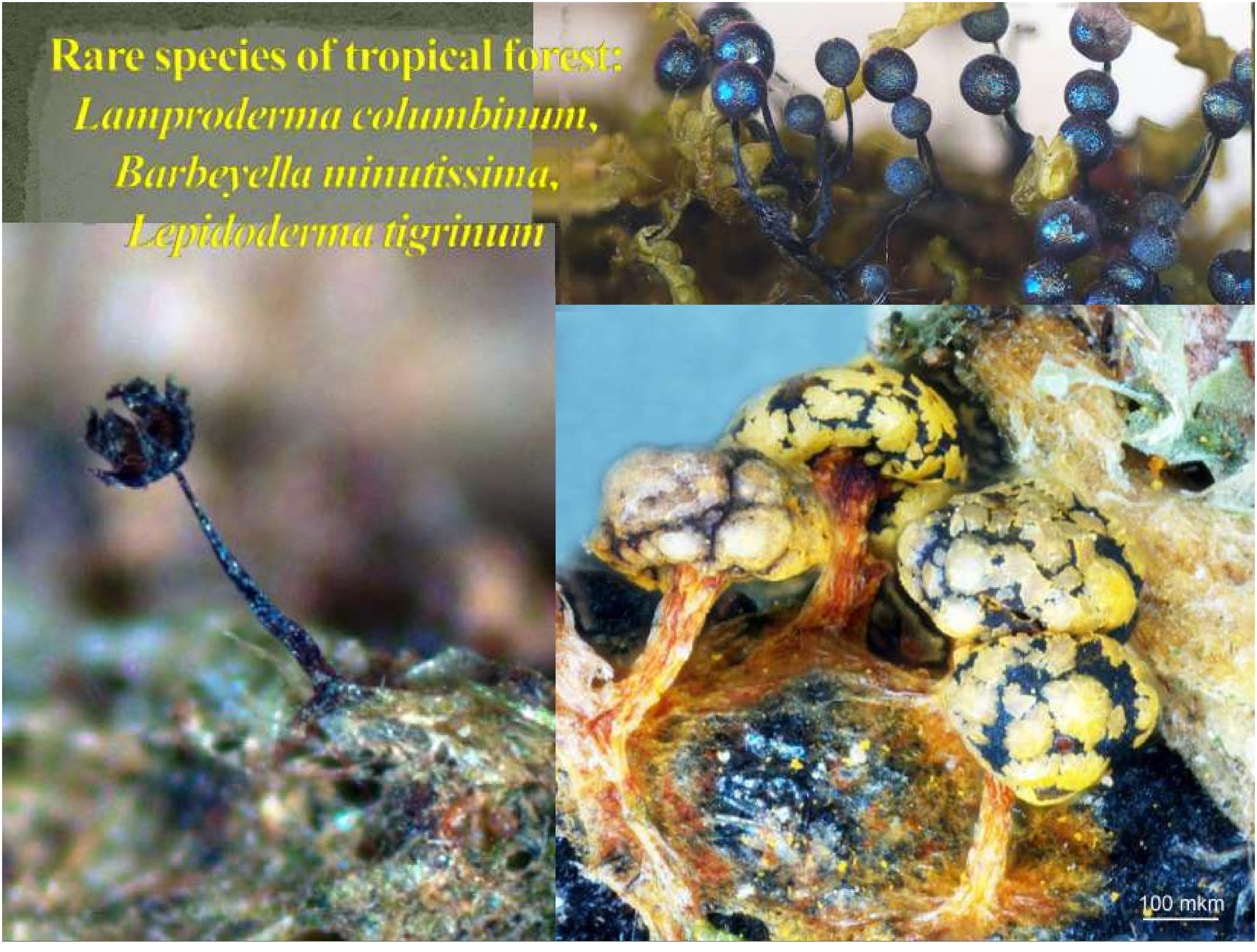

Mixed broadleaved-coniferous forests
Bi Dup Nui Ba National Park


Middle mountain open pyrogenic coniferous forest


High mountain cloud forest 1800-2500 m a.s.l.
Bi Dup Nui Ba and Phia Oak National Parks

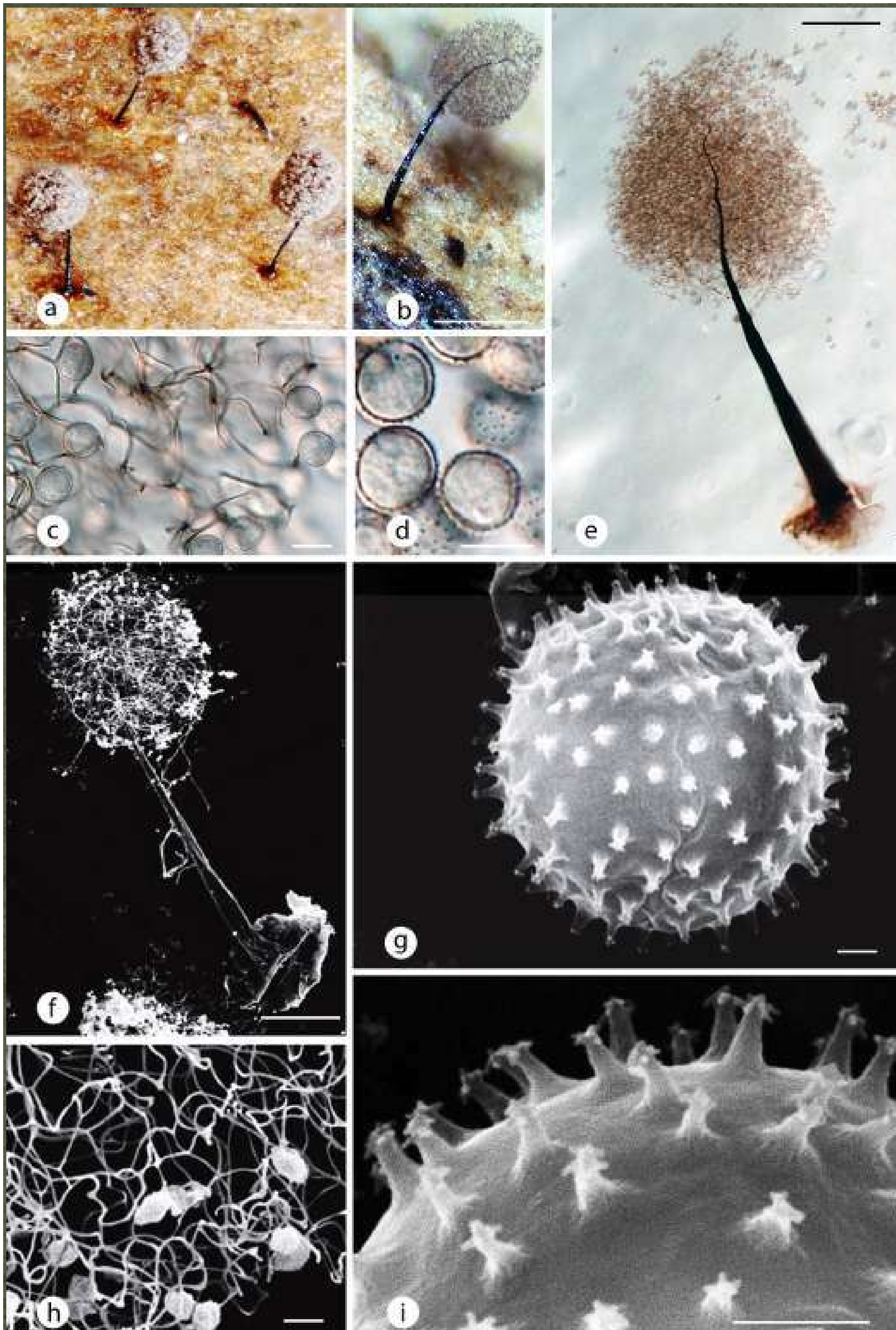
The degree of similarity varies among the five vegetation types




Rare species of tropical forest:
Lamproderma columbinum,
Barbeyella minutissima,
Lepidoderma tigrinum
100 mkm

Siphoptychium cf. *reticulatum* Leontyev, Schnittler et S.L. Stephenson

Indicator species for the high mountain cloud forest *Comatricha spinispora* and *Arcyria marginoundulata*



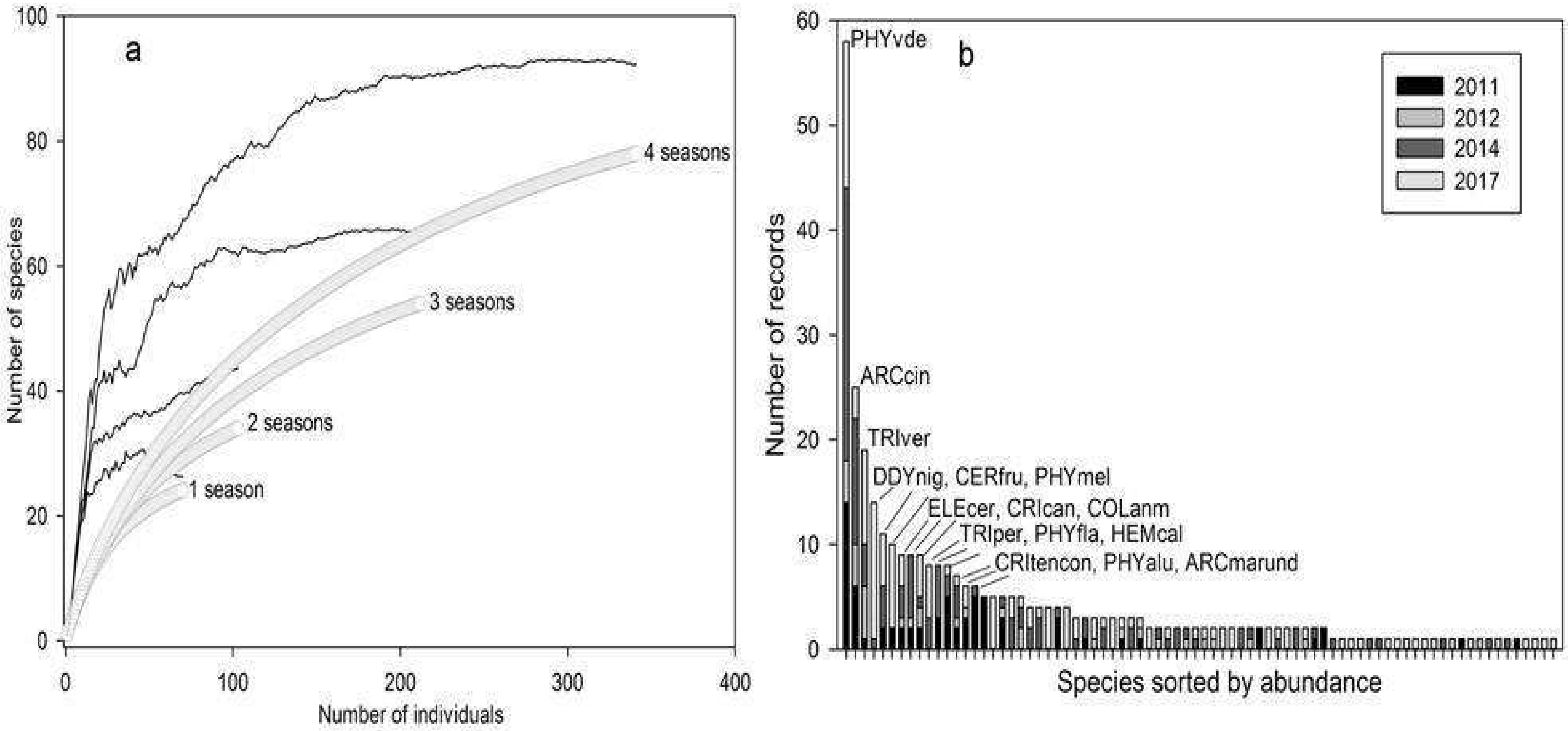
Comatricha spinisporum Novozhilov & D.W. Mitch. ad interim

Indicator species for the middle mountain open pyrogenic coniferous forest *Cribraria minutissima* and *Echinostelium minutum*

Indicator species for the the banana plantations - *Hemitrichia pardina*, *Perichaena chrysosperma*, *Physarum melleum* and *Diderma deplanatum*.

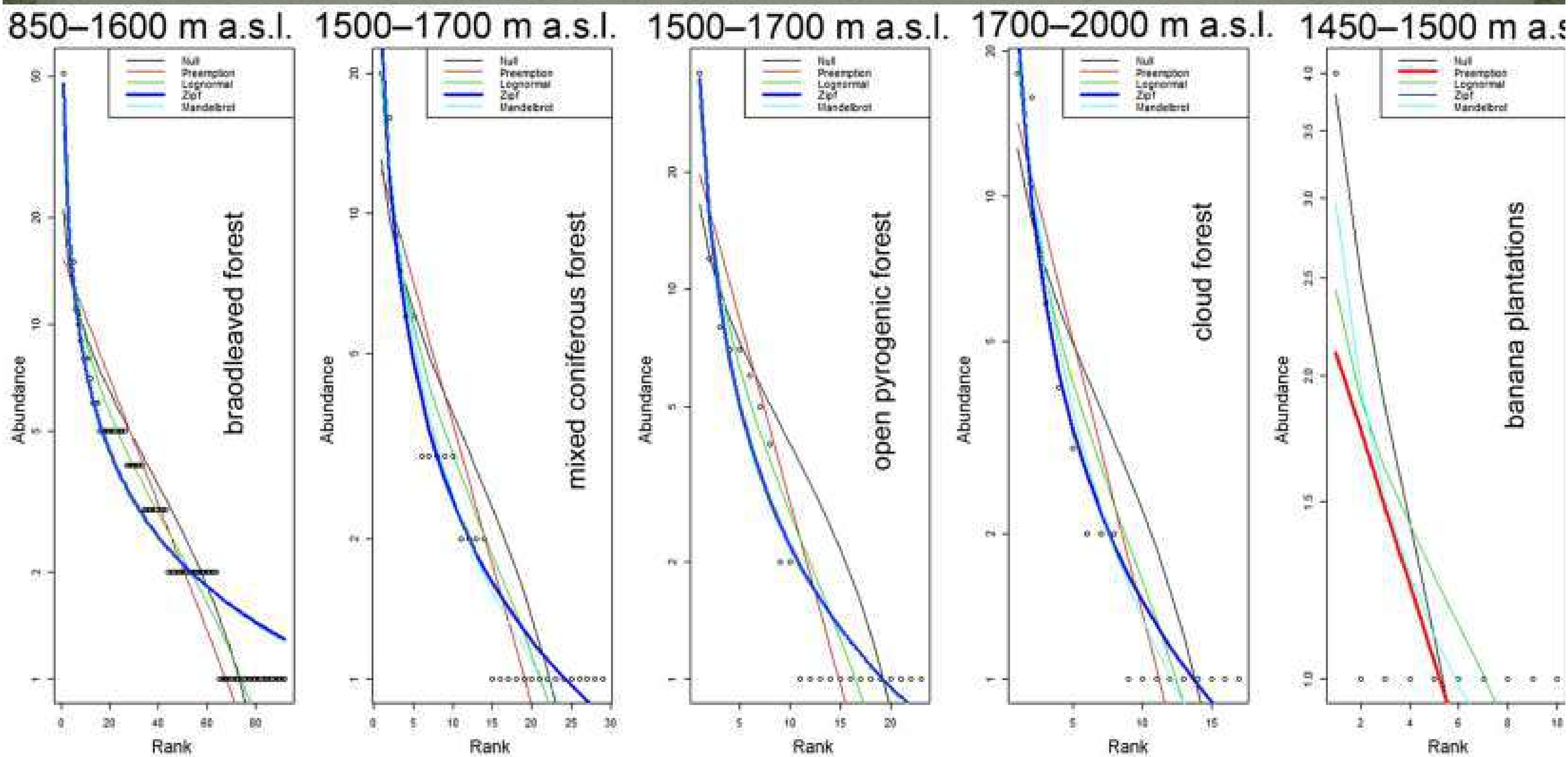
•

Individual-based species accumulation curves (thick lines) and the Chao 1 (mean) estimator (thin jagged lines) of expected morphospecies richness constructed for different number of sampling seasons based on 341 determinable field specimens of myxomycetes (78 taxa) collected in November-December (2010, 2012, 2014, 2017) in Bi Dup Nui Ba Nat. Park

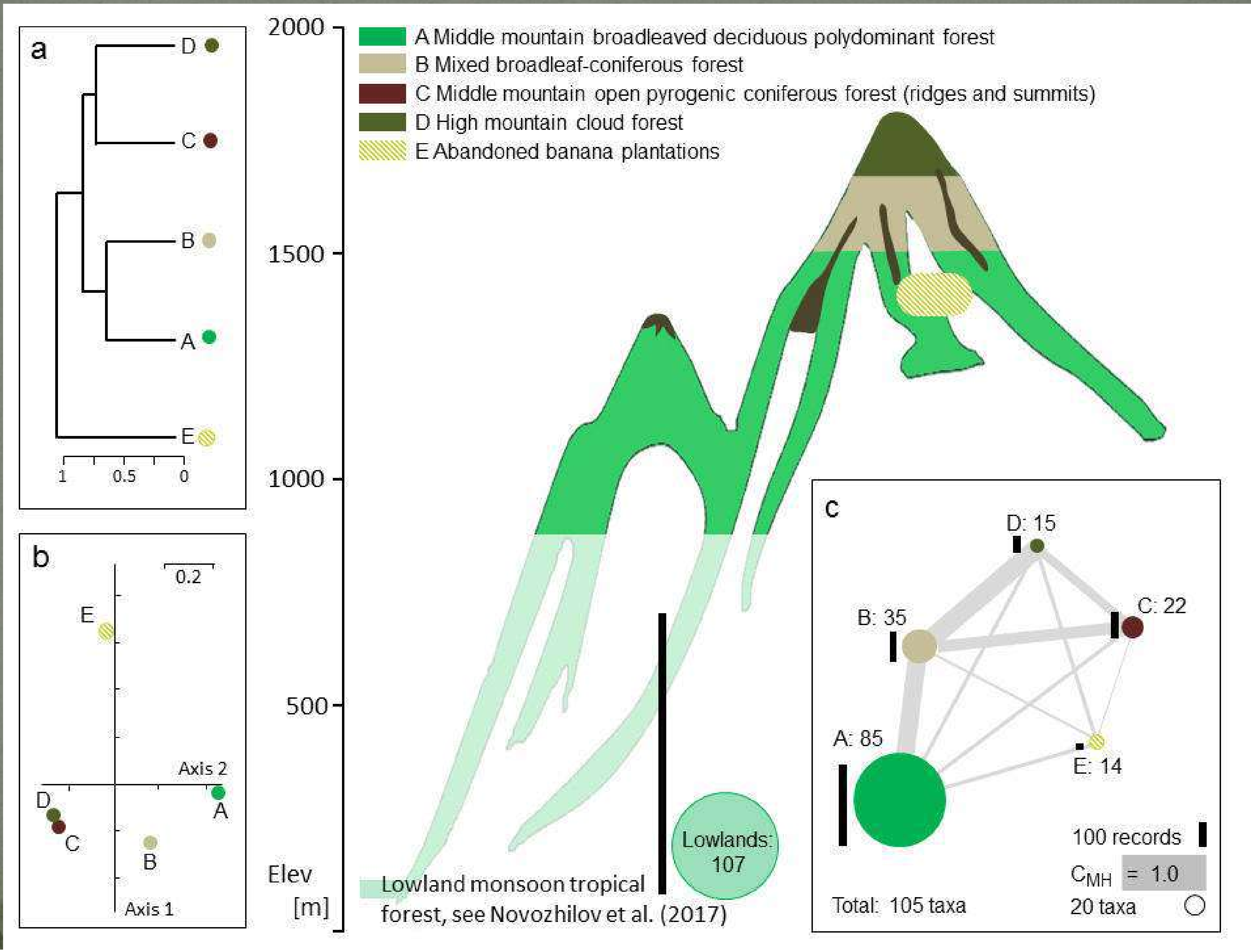


"Flagship" species, *Trichia verrucosa* and *Elaeomyxa cerifera* of the mountain tropical forests of Vietnam

Modelling species abundance distribution in different vegetation types



Characteristics of the investigated myxomycete assemblages, showing schematically the distribution of the five vegetation types



Difference between lowland and mountain myxomycete assemblages is the higher diversity and abundance of some bright-spored genera in the latter.

Lycogala epidendrum vs. *Lycogala exiguum* cf.

Conclusion

In general, lignicolous myxomycetes, an ecological guild where bright-spored taxa prevail, are more diverse in mountain forests (compared with lowland forests).

Some lignicolous taxa frequently found in this study, like *Trichia verrucosa* and *Elaeomyxa cerifera*, have never been found in lowland monsoon forests.

In contrast, some lignicolous species frequently occurring in the lowlands (*Arcyria denudata*, *Diderma cattiense*, and *Stemonitopsis typhina* var. *similis*; all with a frequency >3%) have been found in mountain forests but occur less frequently (<1.0%).

Interestingly, one of the most abundant and widely distributed lignicolous species of boreal and temperate forests in the world, *Lycogala epidendrum*, is very rare in lowland monsoon forests of southern Vietnam and mountain forests.

The overall high species richness and diversity of myxomycete biota in the Dalat Plateau may be explained by the very heterogenic habitats carrying distinct vegetation over the altitudinal gradient, which is different to that of monsoon lowland tropical forests in southern Vietnam.

Thank you for attention!

Yuri Novozhilov, Nadezhda Fedorova, Oleg Shchepin and Eugene Popov acknowledges the programs "Ecolan 1.2" (Russian-Vietnamese Tropical Centre) and the program AAAA-A19-119080990059-1 (Komarov Botanical Institute RAS).

Myxomycetes from Africa, an update

Myriam de Haan[a], Renato Cainelli[b],

Petra Ballings[a], Anna Maria Fiore-Donno[c], George G. Ndiritu[d]

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Myxomycetes from Africa, an update

Part 1 Myriam

- Published survey(s)
- Website
- Mauritania
- Malawi

Part 2 Renato

- SouthAfrica
- Namibia
- Tanzania
- Mauritania

Myxomycetes of Tropical Africa in digital format

https://www.ffta-online.org/ficac8-9/

Flore illustrée des Champignons d'Afrique centrale

Fascicules 8-9

Trichiales (Myxomycètes)

par J. Rammeloo (novembre 1981) : 133-170, pl. 23-31

https://www.ffta-online.org/ficac11/

Flore illustrée des Champignons d'Afrique centrale

Fascicule 11

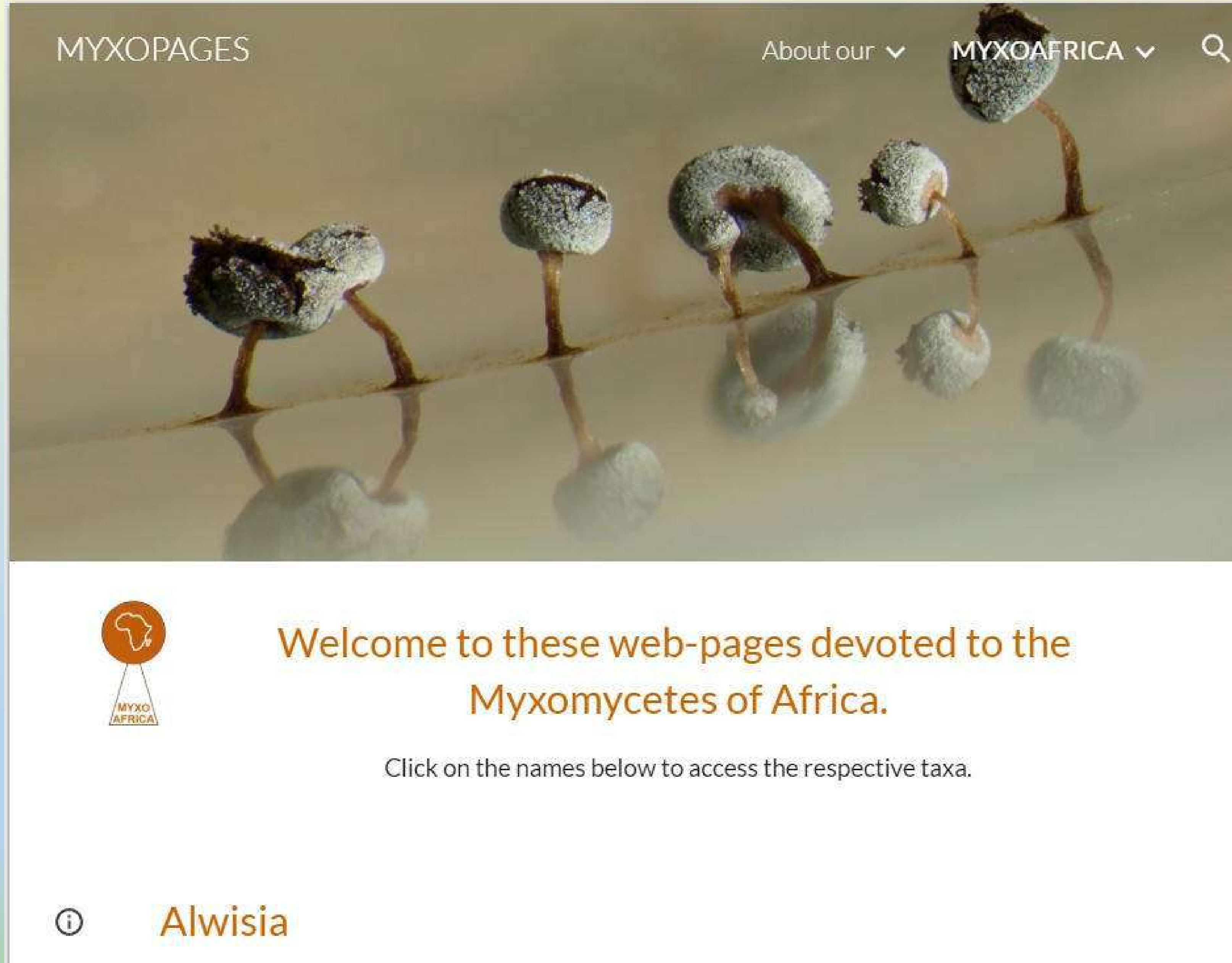
***Diderma* (Physarales, Myxomycetes)**

par B. Buyck (octobre 1983) : 201-213, pl. 36-38

Echinosteliales & Stemonitales (Myxomycetes)

par J. Rammeloo (octobre 1983) : 214-244, pl. 39-43

Website Myxomycetes of Africa



***Clastoderma debaryanum* A. Blytt**

Bot. Zeitung (Berlin) 38: 343 (1880)

https://eumycetozoa.com/data/report.php?busca=clastoderma&por=gensi&numr=106&tipo=Rtax

Description

Sporocarps stalked, 1-1.5 mm TH, globose, 0.1-0.2 mm diam., ochraceous or clay-coloured, often in large, densely populated groups, occasionally scattered. **Stalk** erect, tapering, hollow, below filled with granular matter up to a distinct amber-like, translucent ovoid swelling, from there on keratinoid and translucent, up to 1.4 mm long, often with fine parallel, longitudinal groves, orange brown, dark brown to almost black. **Hypothallus** inconspicuous or absent. **Peridium** brown with silvery reflec-tions, partly disappearing early on, partly remaining as a thin collar around the stalk and as small platelets attached to the ends of the capillitium threads. **Capillitium** branching from the top of the columella or stalk apex two to three times before reaching the peridium, sometimes forming a surface net. **Columella** short or absent. **Spores** beige to dark brown in mass, pale rosy to pale reddish brown in TL, minutely warted, 8-12 µm diam.

Ecology: on dead wood.

General distribution: cosmopolite.

African distribution: Egypt, D. R. Congo, Equatorial Guinea, Madagascar, Malawi, Mayotte (FR), Reunion (FR), Rwanda, Sey-chelles.

Revised specimens:

-MdH-DRC-MYX038A (BR), Democratic Republic of the Congo, Tshopo prov., Yafake, N 0° 49' 48", E 24° 18' 54", 6 MAY 2010, on dead fallen tree trunk in primary tropical lowland rainforest with dominant tree species, *Gilbertiodendron dewevrei* (De Wild) Leonard.

-MdH-DRC-MYX077 (BR), Democratic Republic of the Congo, Mongala prov., Kona, Kona woodland, N 02° 02' 27.5", E 22° 47' 17.0", 367 m alt., 13 MAY 2010, on rotten wood in secondary tropical lowland rainforest.

-MdH-YA-MYX290 (BR), Democratic Republic of the Congo, Tshopo prov., Yangambi Man and Biosphere Reserve, N 0°47'21.76", E 24° 31'2.81", 479 m alt., substrate fragments of dead wood (groud litter) collected on 11 NOV 2013 in regrowth forest, recorded in MC on 25 MAR 2015.

Ceratiomyxa morchella A.L. Welden

Mycologia 46(1):94 (1954)

https://eumycetozoa.com/data/report.php?busca=ceratiomyxa&por=gensi&numr=456&tipo=Rtax

Description

Sporophores usually in large colonies, globose to polyhedric on a cylindrical stalk, 2-5 mm diam., up to 7 mm TH, melting away like ice when crushed, watery white or cream coloured. **Stalk** broad cylindrical, up to 3 mm long, transparent, colour-less to milky white. **Spores** on individual, hyaline stalks, up to 10 µm long, 2-3 µm diam., densely distributed over the surface of the sporophores, colourless, smooth, more or less globose or slightly ovoid, 6-8 x 8-10 µm diam.

Ecology: typically on rotten wood with pH 4-5.

General distribution: Tropical regions.

African distribution: D.R. Congo, Madagascar, Mayotte (FR), Zimbabwe.

Revised specimens:

-MdH-YA-MYX061 (BR), Democratic Republic of the Congo, Tshopo prov., Yangambi Man and Biosphere Reserve, N 0°52'5.81'', E 24° 27'23.57'', 450 m alt., 31 OCT 2013, on rotten wood in small remnant of primary tropical lowland rainforest with dominant tree species, *Gilbertiodendron dewevrei* (De Wild) Leonard.

-MdH-YA-MYX187 (BR),), Democratic Republic of the Congo, Tshopo prov., Yangambi Man and Biosphere Reserve, N 0°47'47.64", E 24° 29'52.17'', 439 m alt., 9 NOV 2013, on rotten wood in primary tropical lowland rainforest with dominant tree species, *Gilbertiodendron dewevrei* (De Wild) Leonard.

-MdH-DRC-MYX036 (BR), Democratic Republic of the Congo, Tshopo prov., Yafake, N 0° 49' 48'', E 24° 18' 54'', 6 MAY 2010, on dead fallen tree trunk in primary tropical lowland rainforest with dominant tree species, *Gilbertiodendron dewevrei* (De Wild) Leonard.

Plate [illegible]

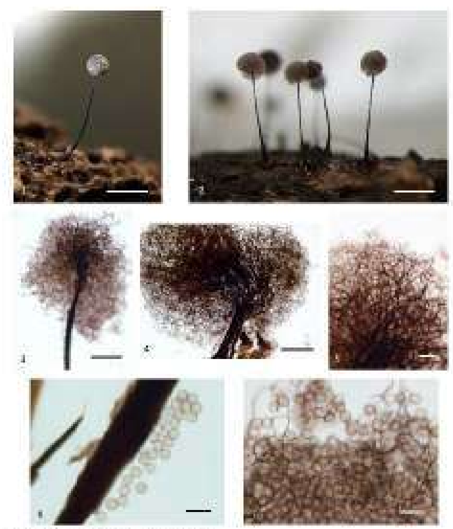
1 Fresh aethalia (1 mm), 2 spores (LM, 20 µm), 3 dried aethalia (1 mm), 4 dried aethalia (1 mm), 5 detail of cortex scales (LM, 100 µm), 6 detail of cortex scales (200 µm), 7 dried aethalia (1 mm), 8 detail of cortex scales (200 µm)

Measurements between () represent the scale bars.

Plate Lycogala epidendrum (L.) Fr.

1 fresh aethalia (1 cm), 2 spores (LM, 20 µm), 3 detail of cortex scales (200 µm), 4 dried aethalia (1 mm), 5 dried open aethalium (1 mm), 6 detail of cortex scales (LM, 100 µm), 7 detail of cortex scales (LM, 50 µm)

Measurements between () represent the scale bars.



Myxomycetes from Africa, an update

Number of species

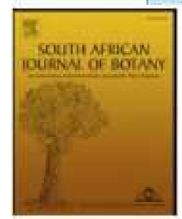
388 ⟶ 399

South African Journal of Botany 124 (2019) 402–413

Contents lists available at ScienceDirect

South African Journal of Botany

journal homepage: www.elsevier.com/locate/sajb



Myxomycete biodiversity revealed in the Namib desert

S.L. Stephenson [a], D. Wrigley de Basanta [b,*], C. Lado [b], A. Estrada-Torres [c], R. Darrah [d]

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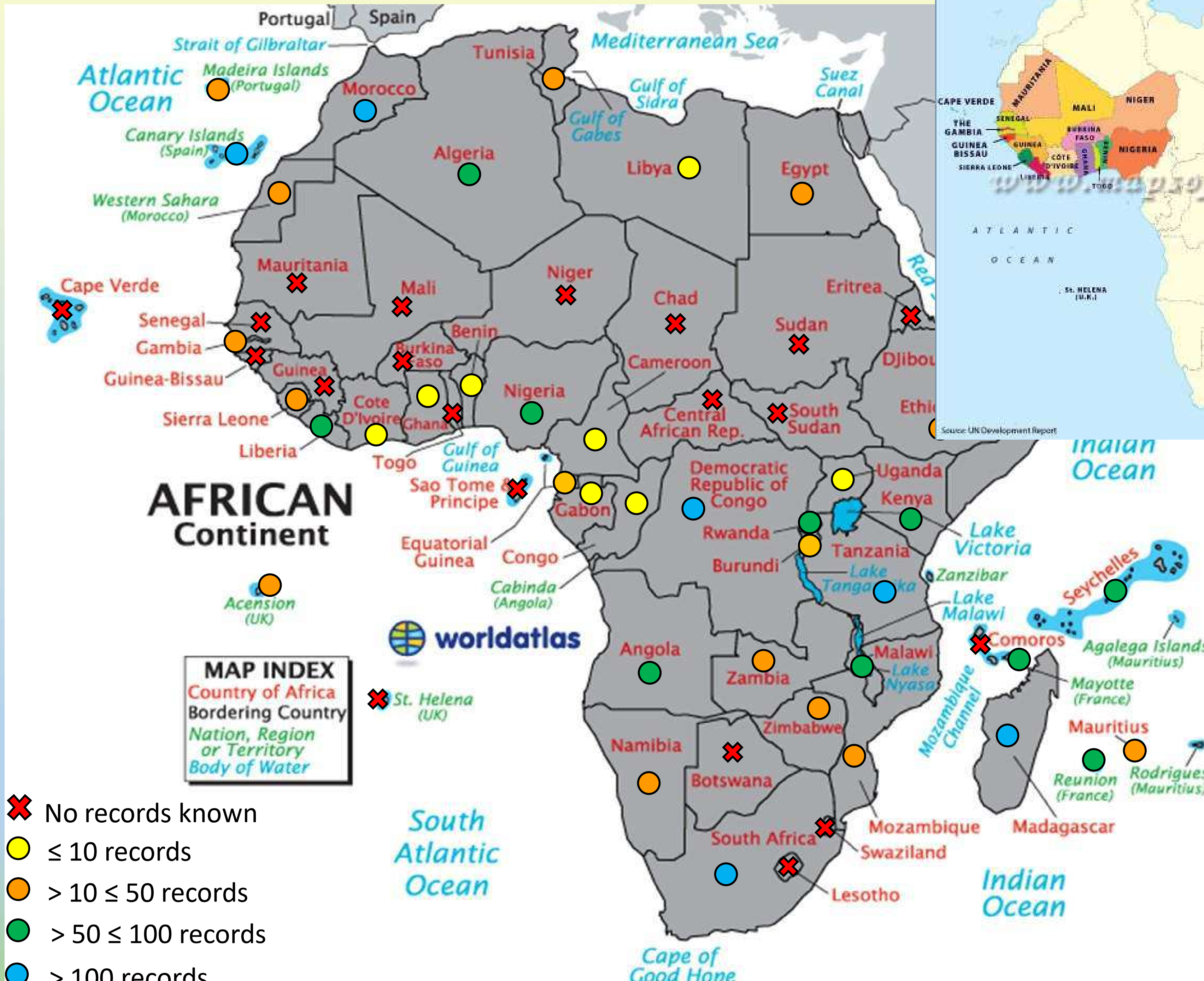
[d] Box 391. Anderson street, Farmington, WV, USA

43 taxa

8 new records for Africa

Portugal
Spain
Strait of Gilbraltar
Mediterranean Sea
Atlantic Ocean
Madeira Islands (Portugal)
Morocco
Tunisia
Gulf of Sidra
Suez Canal
MIDDLE EAST
Gulf of Gabes
Canary Islands (Spain)
Algeria
Libya
Egypt
Persian Gulf
Western Sahara (Morocco)
Saudi Arabia
Red Sea
Mauritania
Niger
Cape Verde
Mali
Chad
Eritrea
Sudan
Yemen
Senegal
Benin
Gulf of Aden
Gambia
Burkina Faso
Cameroon
Djibouti
Guinea-Bissau
Guinea
Somalia
Nigeria
Central African Rep.
South Sudan
Ethiopia
Sierra Leone
Cote D'Ivoire
Ghana
Liberia
Gulf of Guinea
Togo
Uganda
Indian Ocean
Democratic Republic of Congo
Kenya
Sao Tome & Principe
AFRICAN Continent
Gabon
Rwanda
Lake Victoria
Equatorial Guinea
Congo
Tanzania
Burundi
Lake Tanganyika
Zanzibar
Seychelles
Cabinda (Angola)
Acension (UK)
Lake Malawi
worldatlas
Comoros
Agalega Islands (Mauritius)
Angola
Malawi
Lake Nyasa
Zambia
Mayotte (France)
MAP INDEX
Country of Africa
Bordering Country
Nation, Region or Territory
Body of Water
St. Helena (UK)
Mozambique Channel
Zimbabwe
Mauritius
Namibia
Botswana
Reunion (France)
Rodrigues (Mauritius)
Mozambique
Madagascar
South Africa
Swaziland
South Atlantic Ocean
Lesotho
Indian Ocean
Cape of Good Hope
No records known
≤ 10 records
> 10 ≤ 50 records
> 50 ≤ 100 records
> 100 records

Mauritania



Portugal
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Mauritania
Mali
Niger
Chad
Sudan
Eritrea
Cape Verde
Senegal
Gambia
Guinea-Bissau
Guinea
Burkina Faso
Benin
Cameroon
Nigeria
Sierra Leone
Liberia
Cote D'Ivoire
Ghana
Togo
Gulf of Guinea
Central African Rep.
South Sudan
Djibouti
Ethiopia
AFRICAN Continent
Sao Tome & Principe
Gabon
Equatorial Guinea
Congo
Democratic Republic of Congo
Uganda
Kenya
Rwanda
Burundi
Tanzania
Lake Victoria
Lake Tanganyika
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MAP INDEX
Country of Africa
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Botswana
Madagascar
Reunion (France)
Rodrigues (Mauritius)
South Atlantic Ocean
South Africa
Mozambique
Swaziland
Lesotho
Indian Ocean
Cape of Good Hope
No records known
≤ 10 records
> 10 ≤ 50 records
> 50 ≤ 100 records
> 100 records

AFRICA
Western Region
EUROPE
ASIA
MAURITANIA
MALI
NIGER
CAPE VERDE
SENEGAL
THE GAMBIA
GUINEA BISSAU
GUINEA
BURKINA FASO
NIGERIA
SIERRA LEONE
LIBERIA
COTE D'IVOIRE
GHANA
TOGO
BENIN
ATLANTIC OCEAN
INDIAN OCEAN
St. HELENA (U.K.)
www.mapsofworld.com
Source: UN Development Report
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90% Saharan desert

7% steppes

3% water mass

Between Atar and Chinguitti

Grande Dune between Lemhaissat and Nouamghar

Grande Dune

Between Atar and Chinguitti

Camelus dromedarius

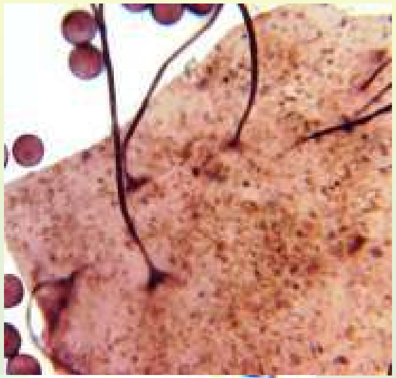
Grande Dune
Nucularia perrinii
Chenopodiaceae

Substrates

Between Atar and Chinguitti
Panicum turgidum
Poaceae

Acacia sp.
Leguminosae

Cassia sp.
Leguminosae

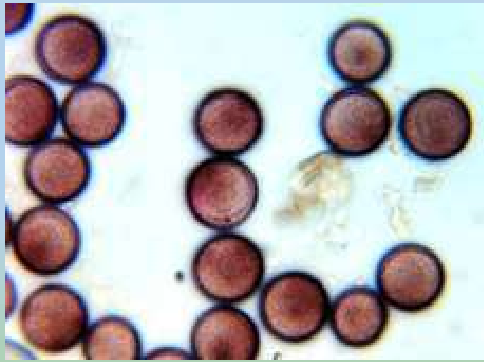


Didymium bahiense

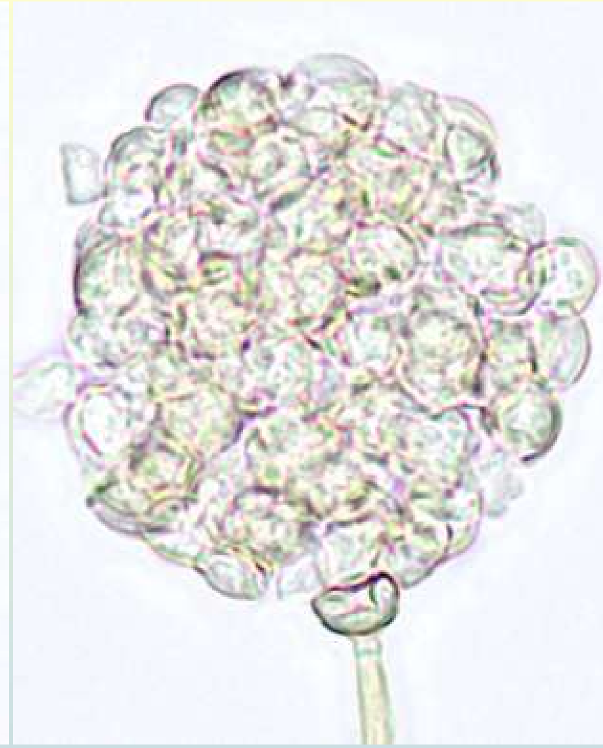
Didymium difforme

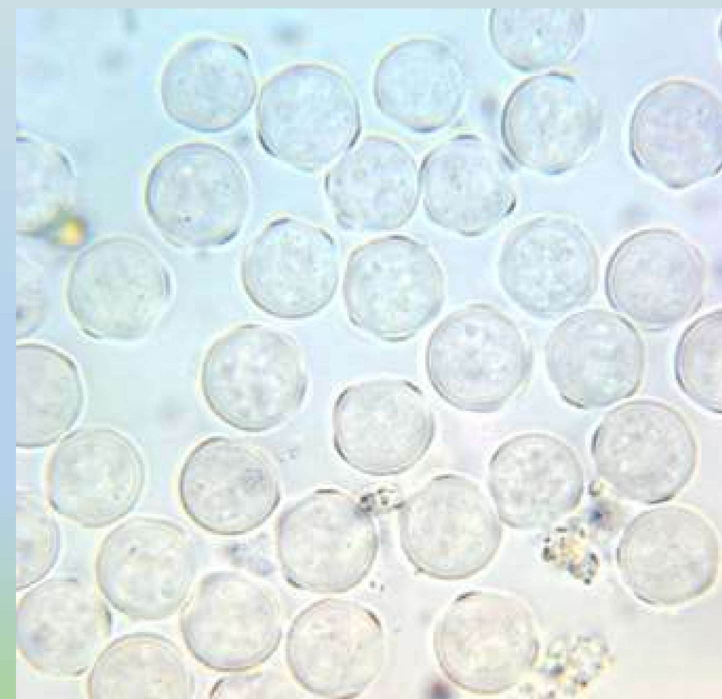
Physarum compressum

Physarum cf. gravidum



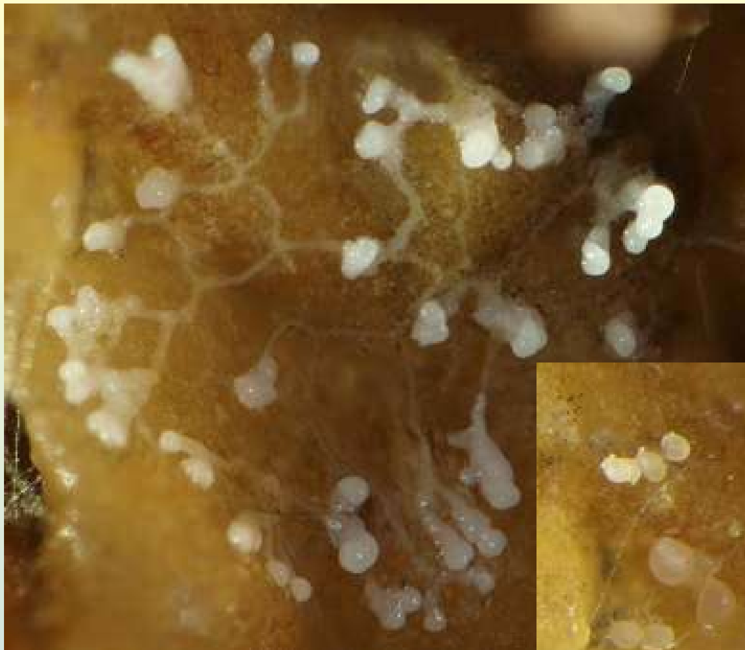
Echinostelium coelocephalum

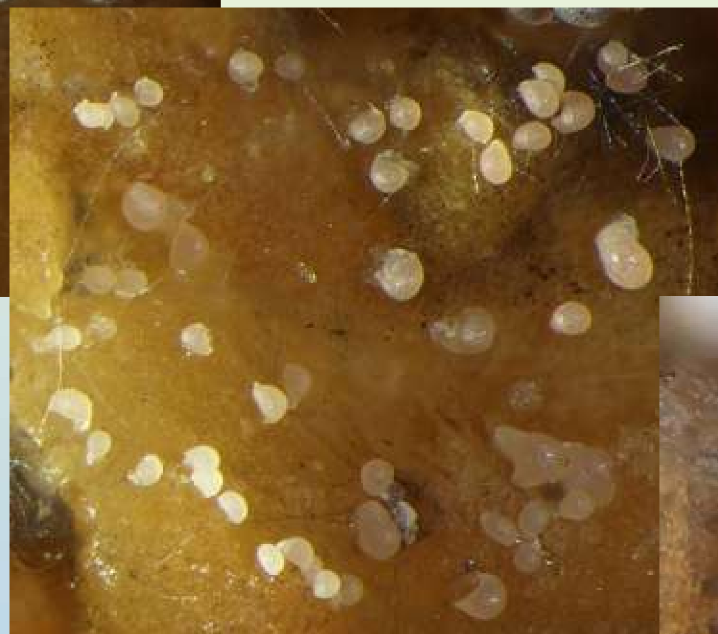


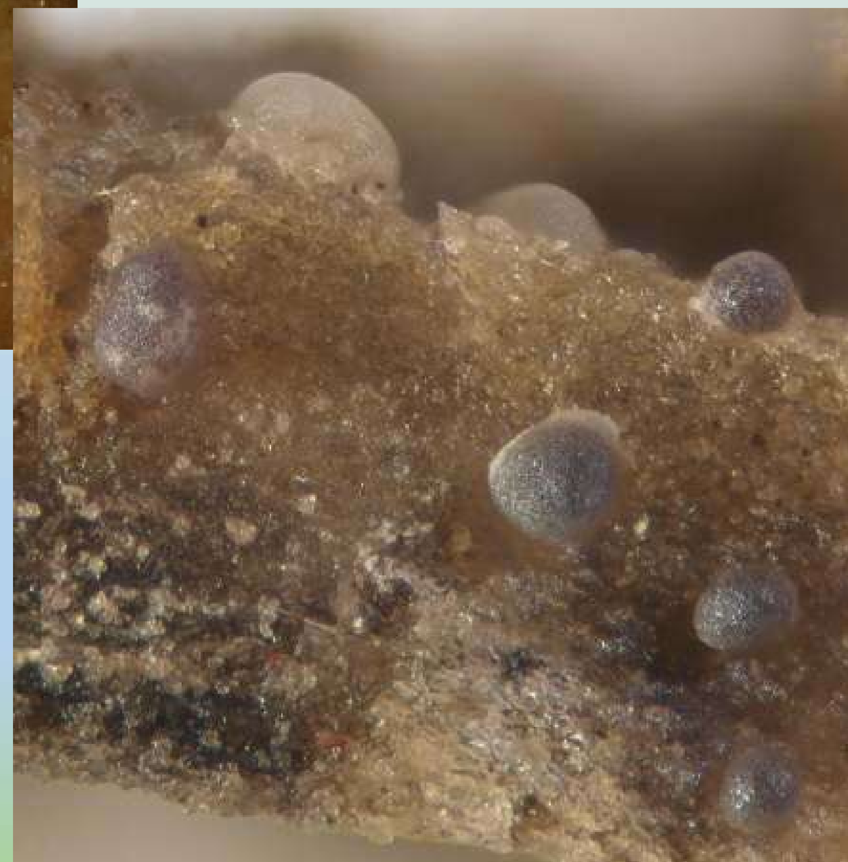


Spores 9-11 µm
With pads at points of spore-to-spore contact

Didymium sp.



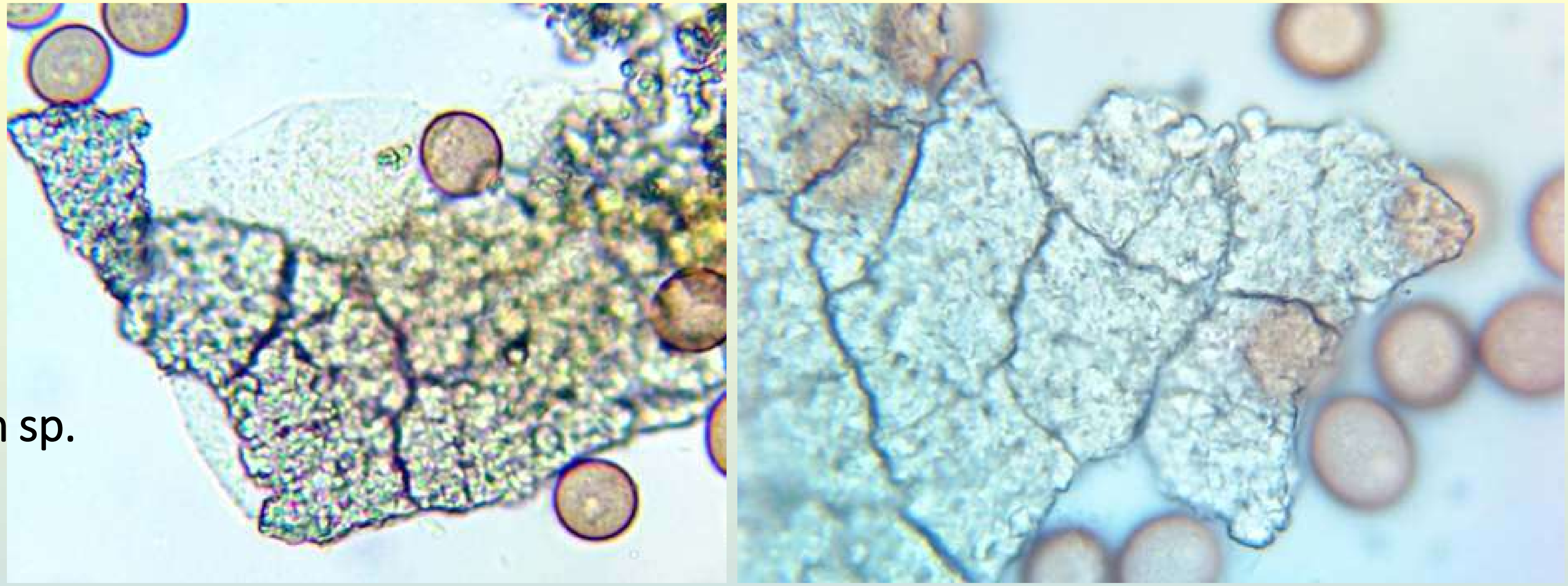


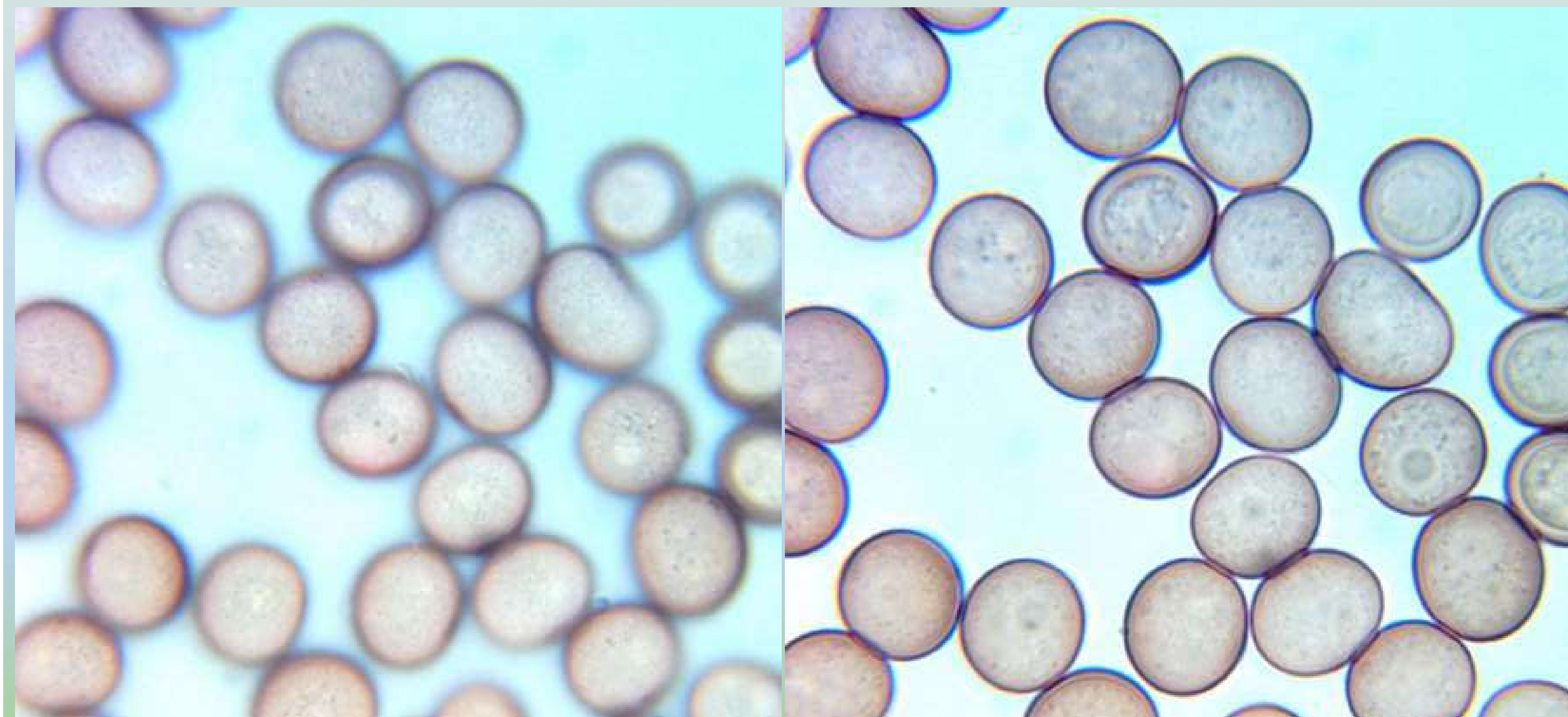


Didymium sp.

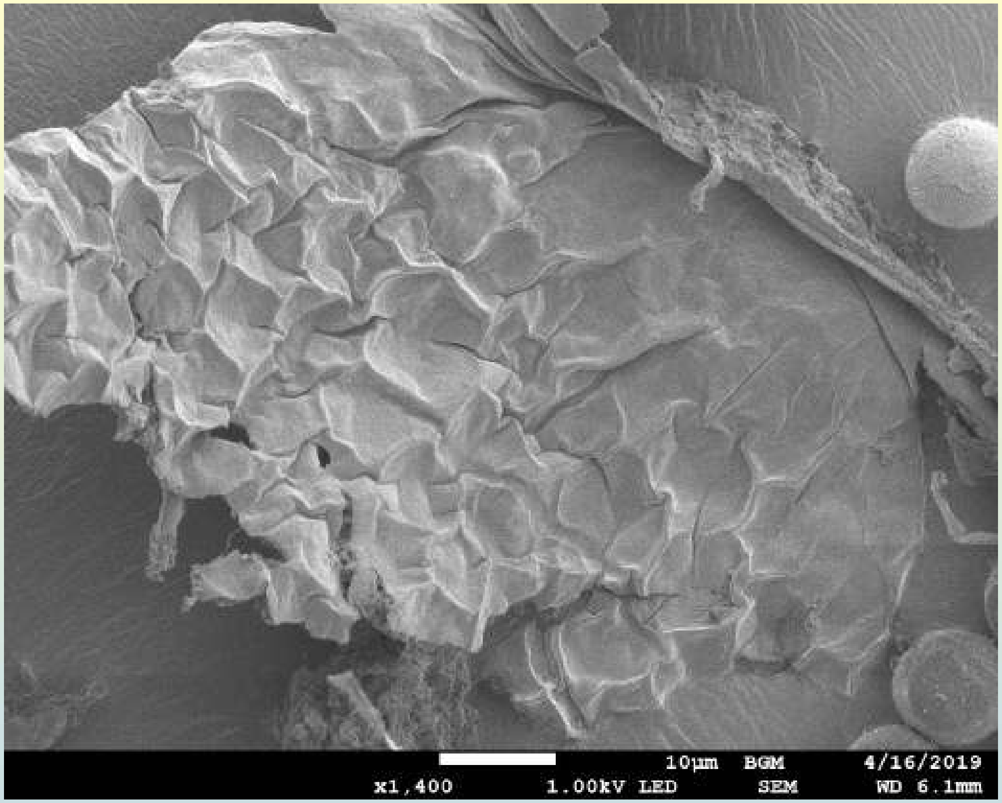
Double peridium

Didymium sp.





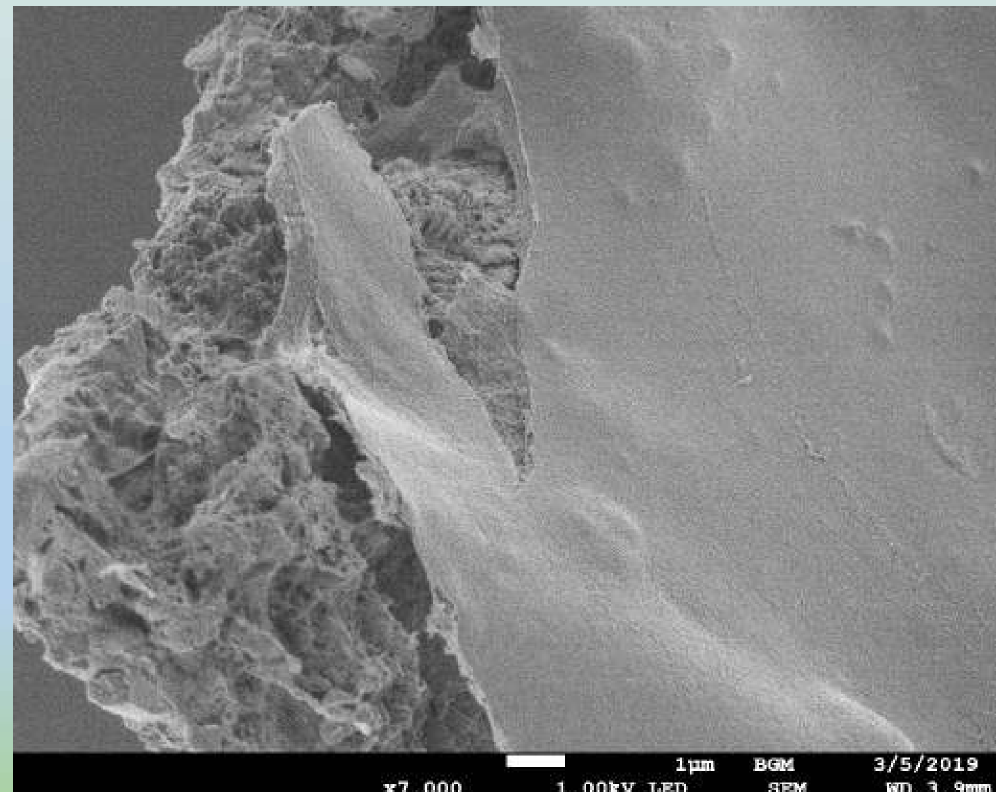
Spores 12-14 µm



Didymium sp.

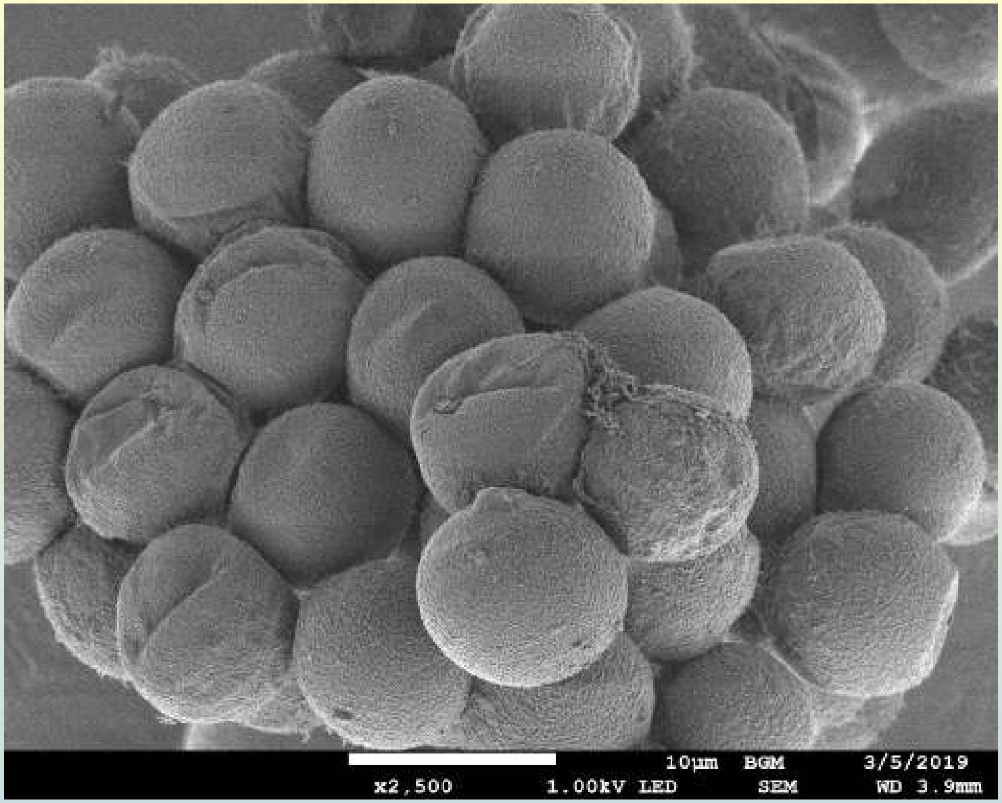
Scanning Electron Microscopy

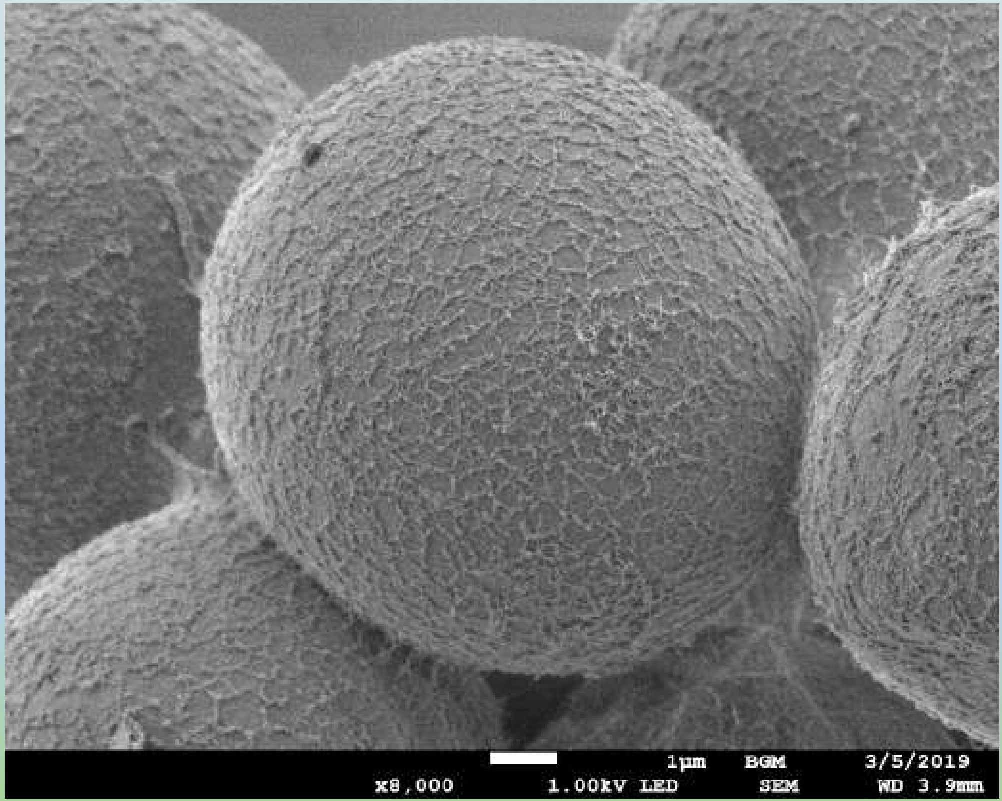
Inner peridium is smooth



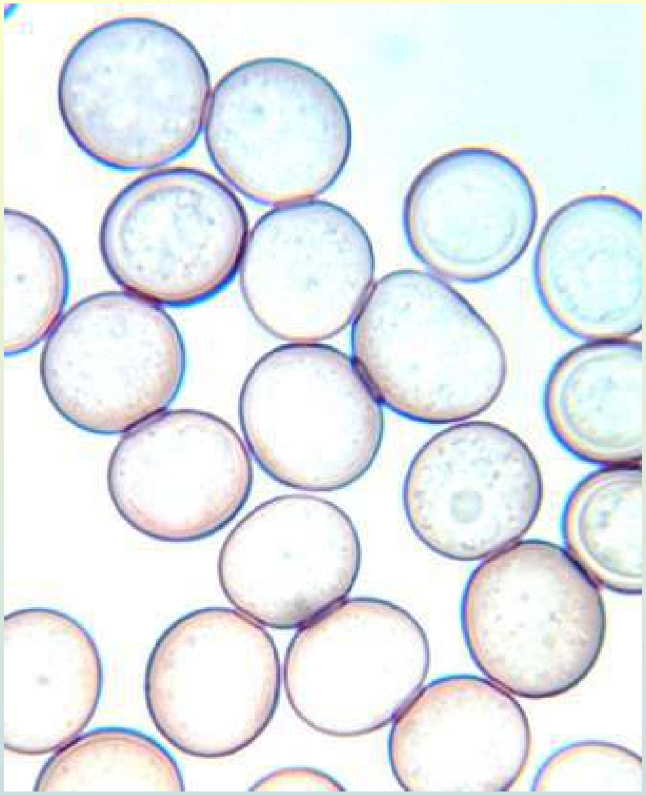
Didymium sp.

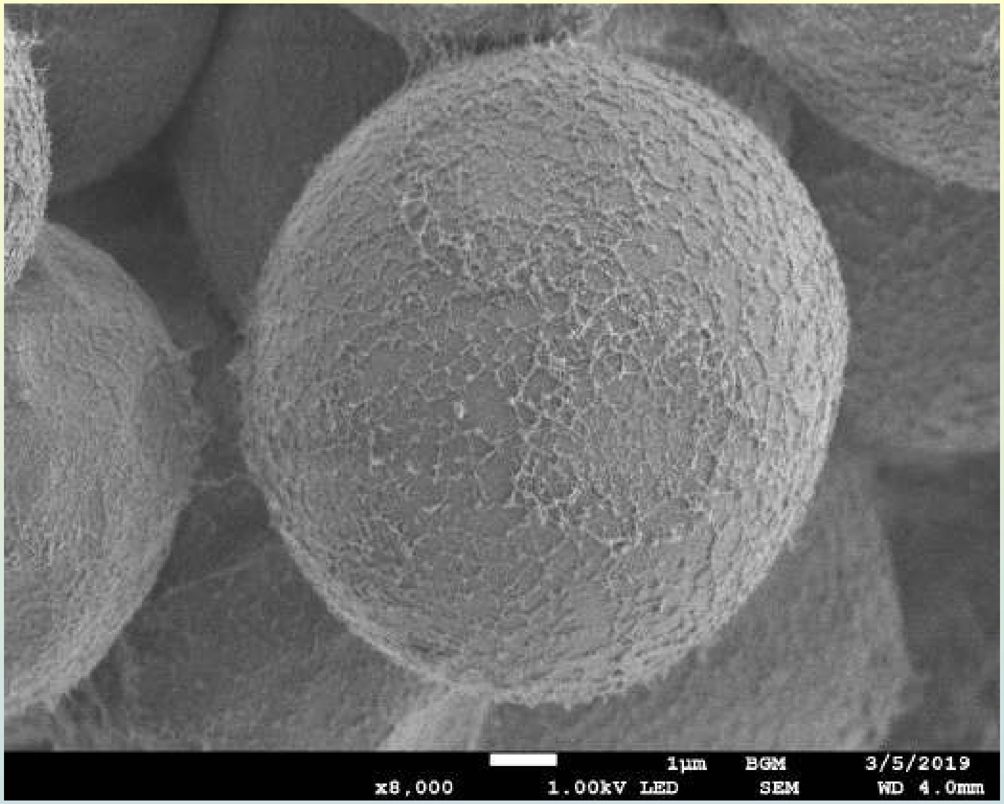
Scanning Electron Microscopy





Spore ornamented with a fine reticulum?

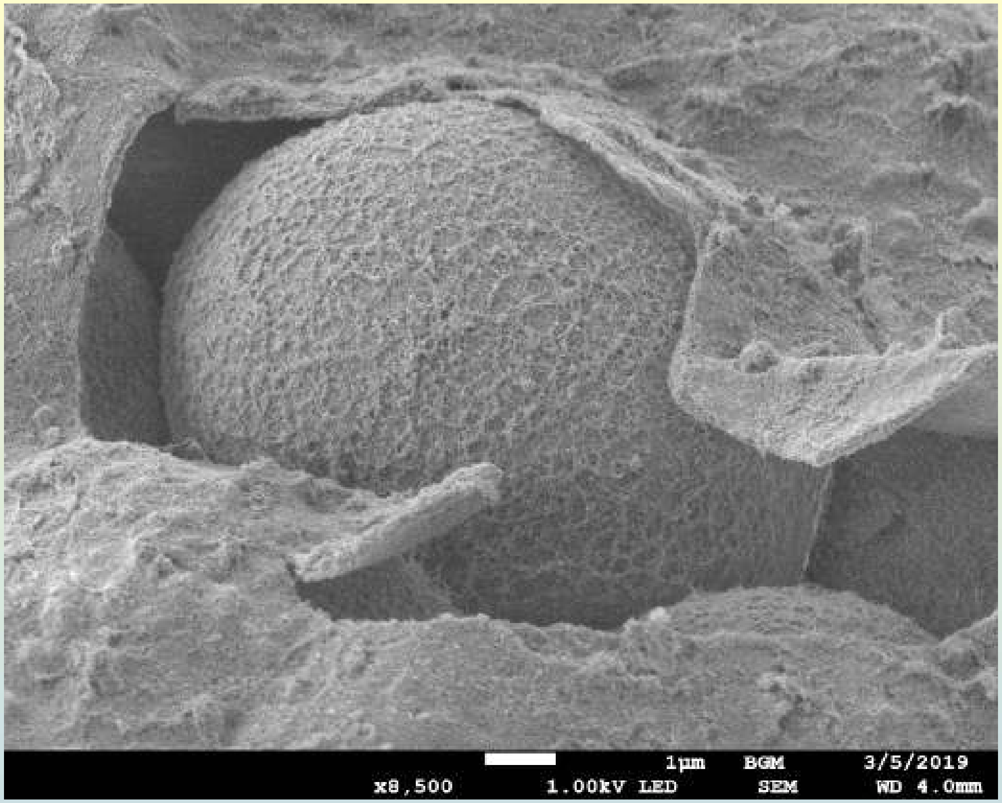




Didymium sp.

Scanning Electron Microscopy

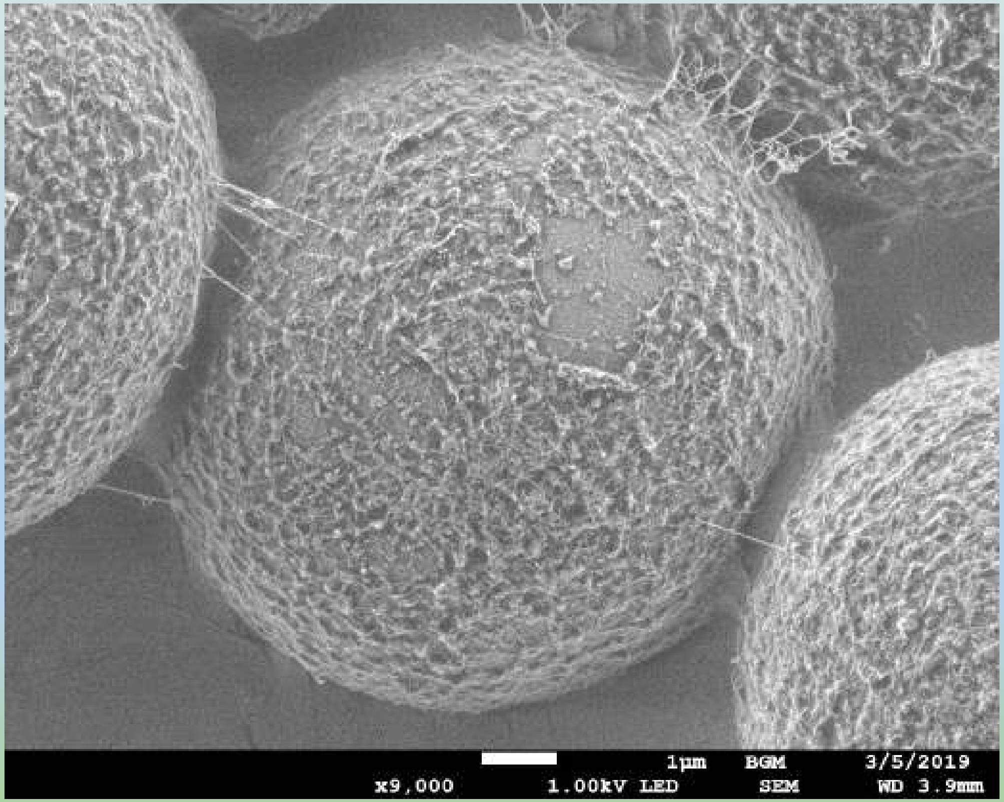
Spores seem to be
“connected”?



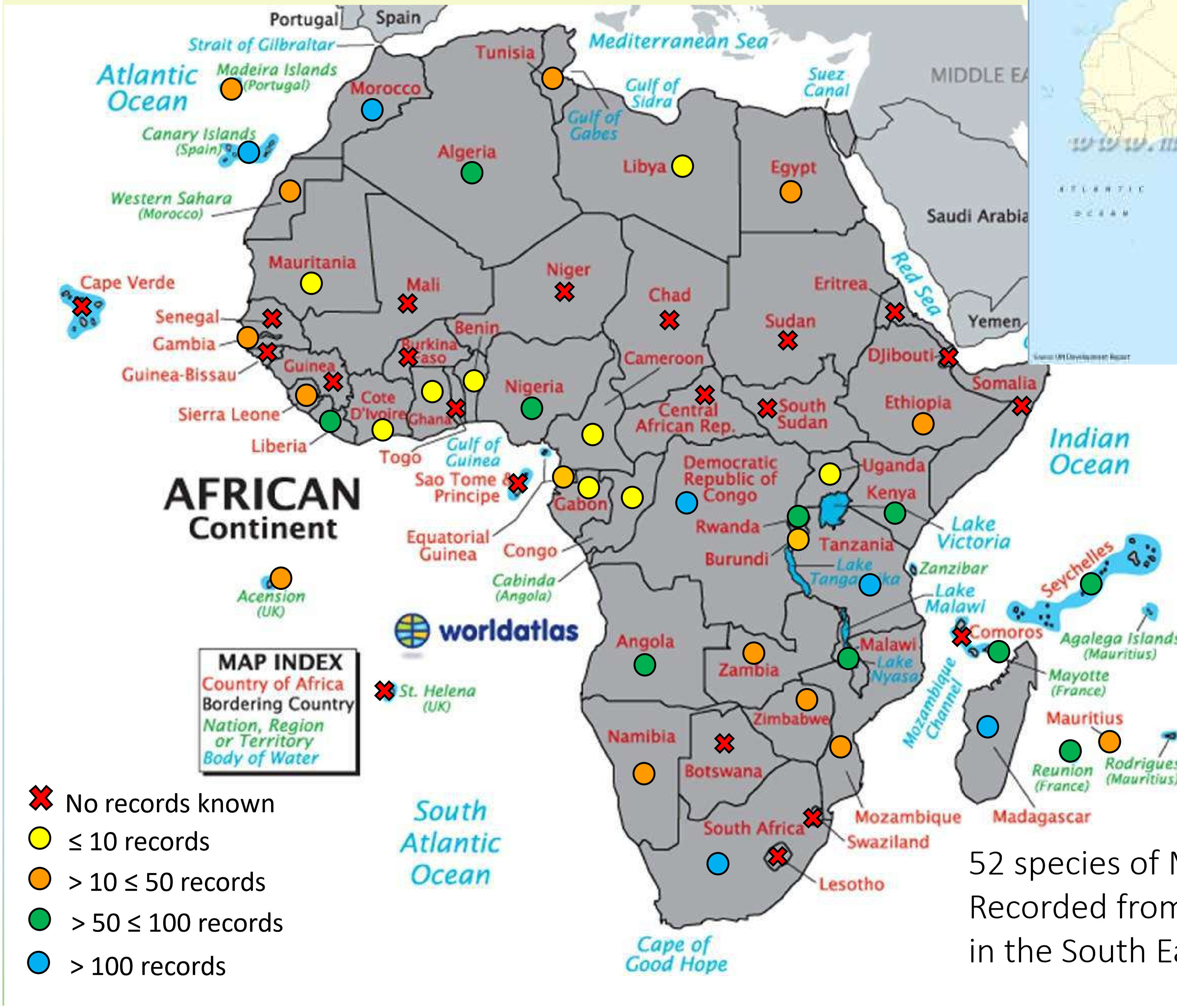
Didymium sp.

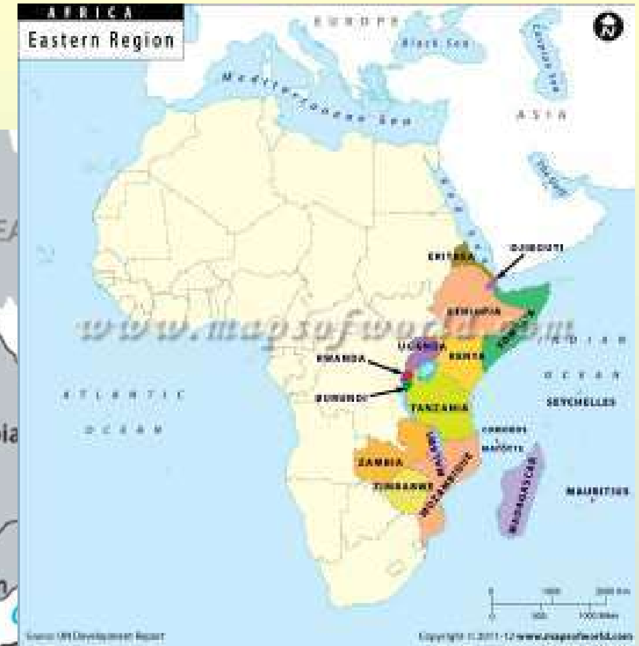
Scanning Electron Microscopy

Spore ornamented with a fine reticulum?



Malawi

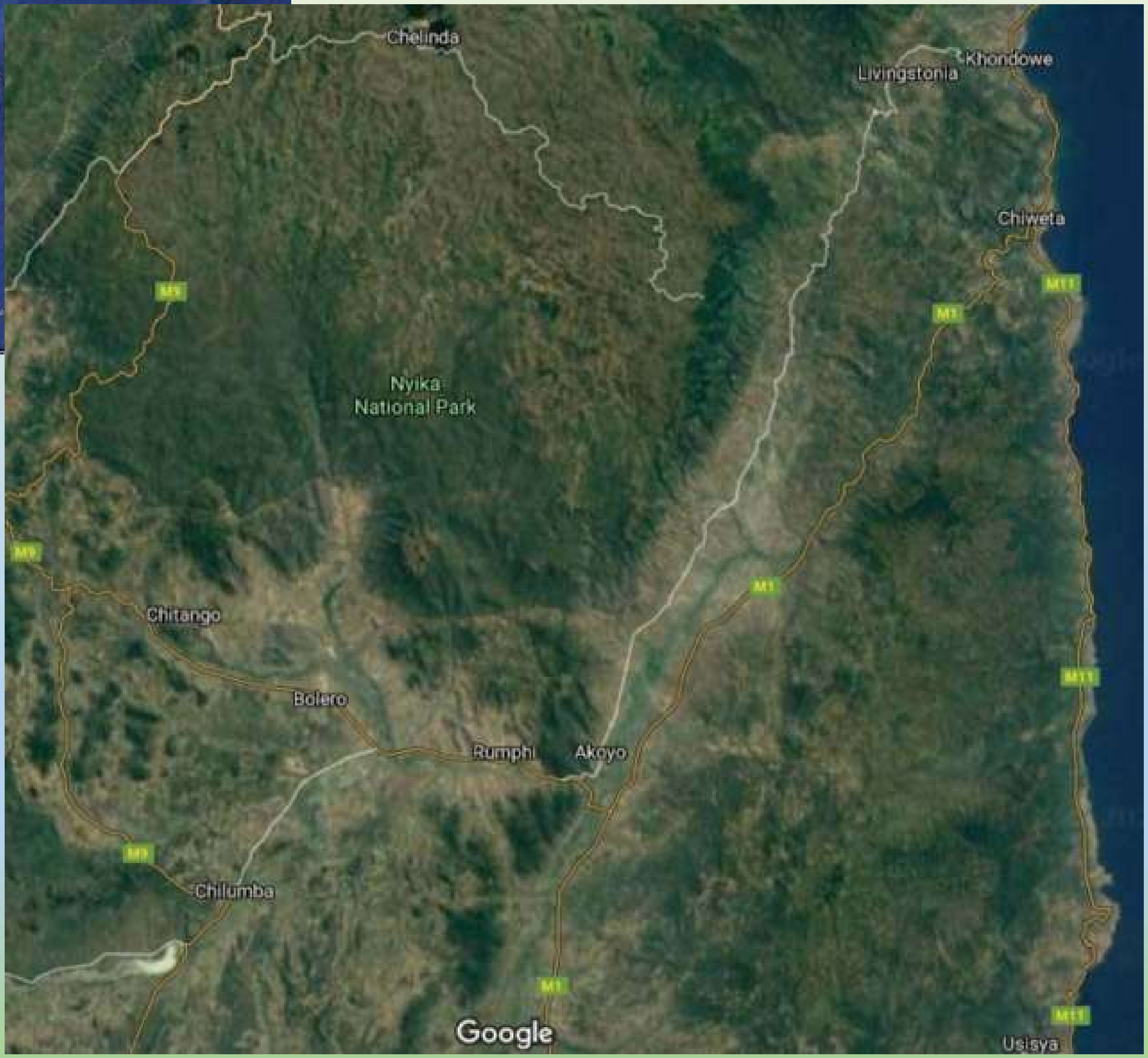




52 species of Myxomycetes Recorded from Mulanje Massif in the South East

Malawi

Nyika National Park



Montane grasslands,
Submontane evergreen forest,
Miombo woodlands

Malawi Nyika National Park

Chelinda camp with pine plantations

Chisanga falls

Arcyria marginoundulata = new for Africa

Comatricha pulchella = new for Malawi

Craterium concinnum

Diderma effusum = new for Malawi

Didymium bahiense

Didymium difforme = new for Malawi

Didymium squamulosum

Hemitrichia minor = new for Malawi

Hemitrichia pardina = new for Malawi

Lamproderma scintillans

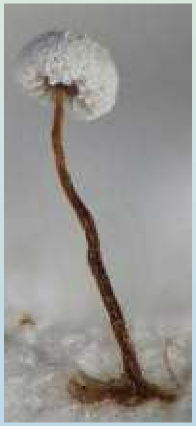
Perichaena brevifila = new for Africa

Perichaena chrysosperma

Perichaena madagascariensis = new for Malawi

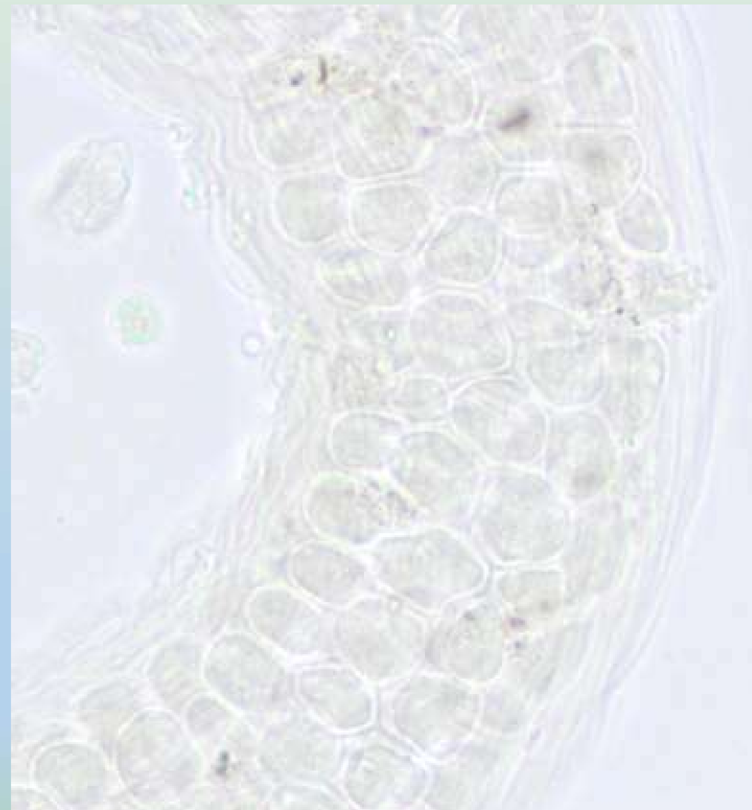
Trichia flavicoma = new for Malawi



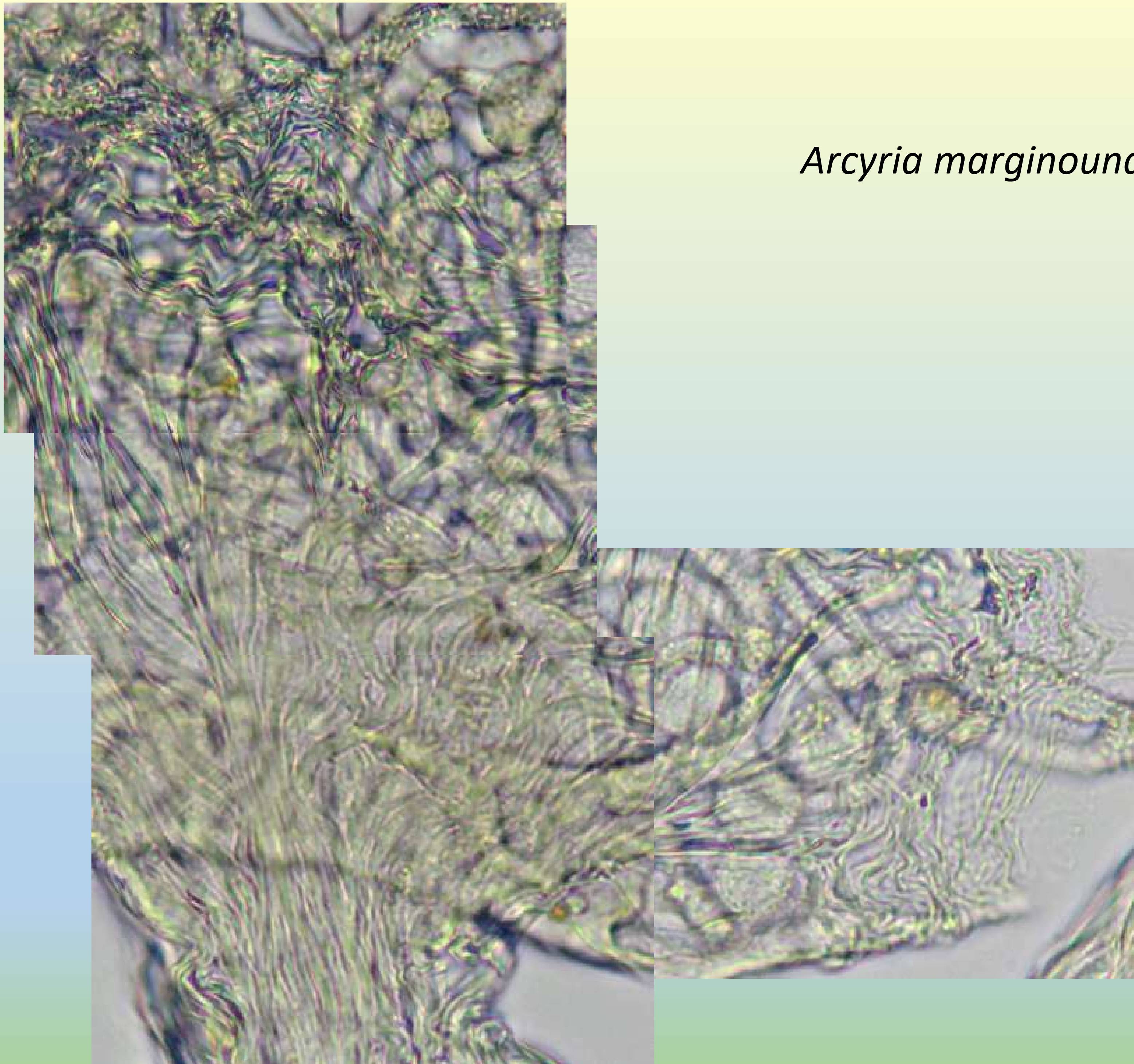


Arcyria marginoundulata



Arcyria marginoundulata

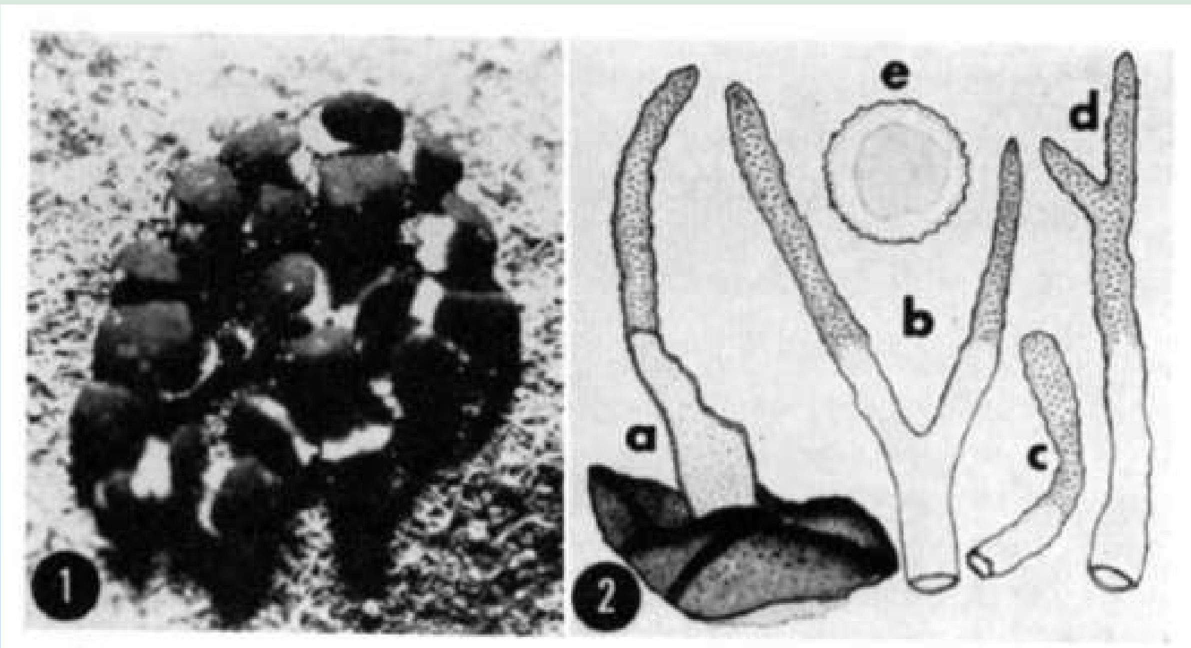
Arcyria marginoundulata



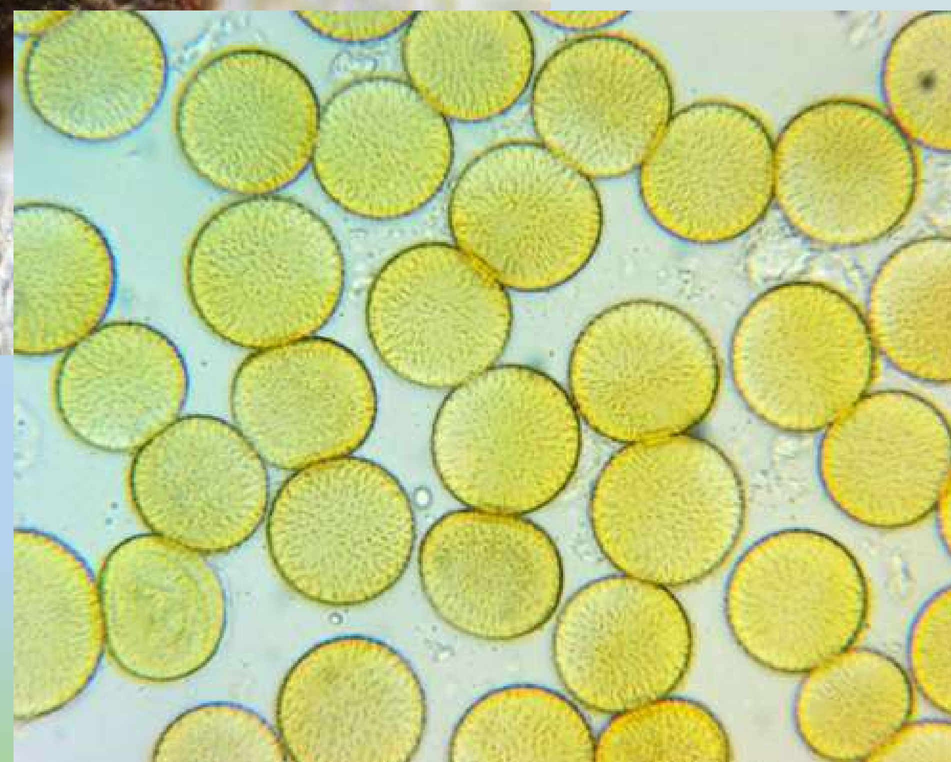
Arcyria marginoundulata

Perichaena brevifila

Perichaena brevifila



From: Keller & Brooks, Mycologia 63(3):657 (1971)



Perichaena madagascariensis

Myxomycetes from Africa, an update

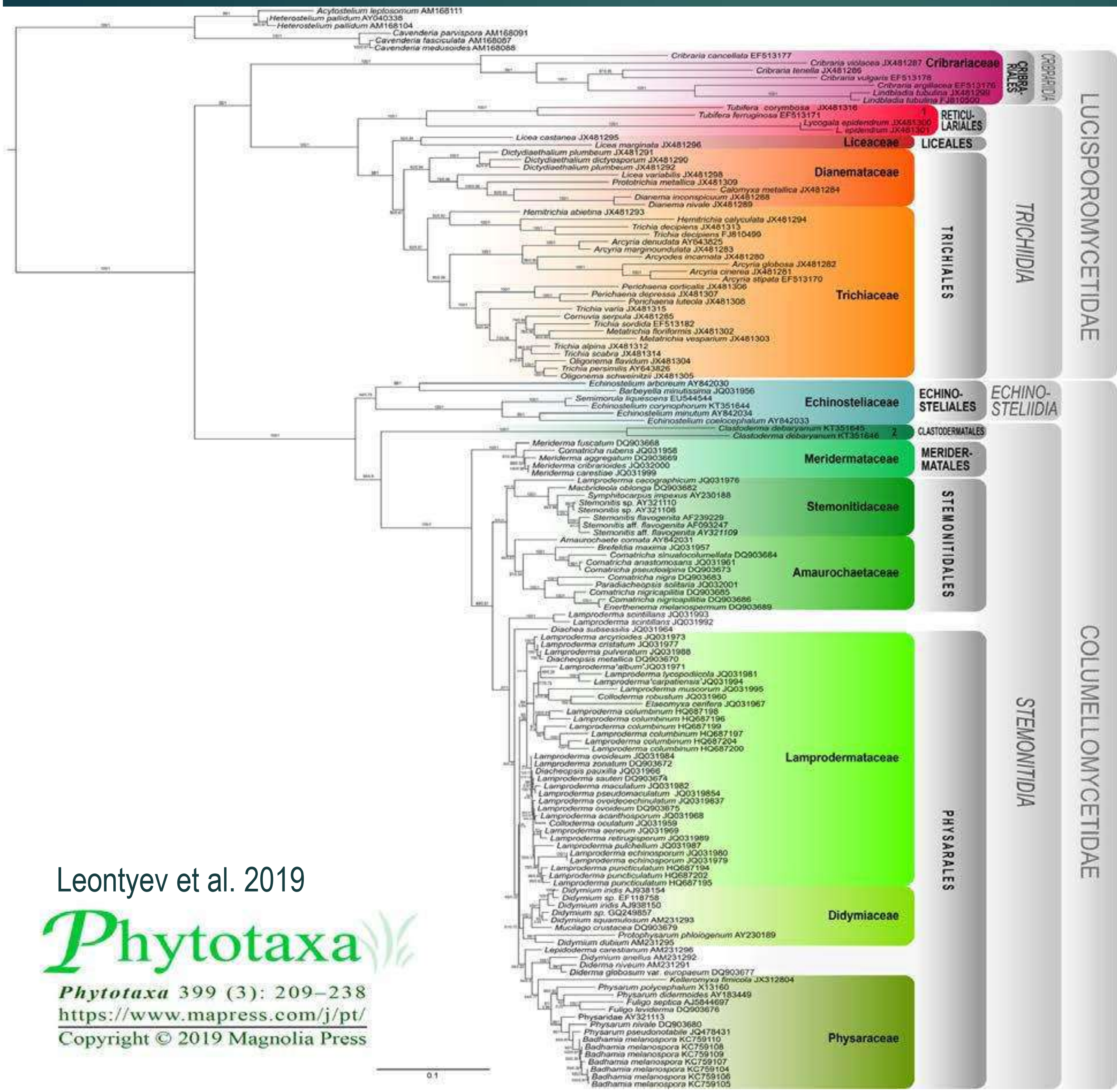
Part 2 Renato

- SouthAfrica
- Namibia
- Tanzania
- Mauritania

SECONDARY CAPILLITIUM, TERTIARY STALK AND FALSE COLUMELLA

Prof. Dr. Dmitry Leontyev
H.S. Skovoroda Kharkiv National Pedagogical University
Kharkiv, Ukraine

Recent phylogenetic studies disclosed the general consequence of evolutionary steps, which led to the formation of major myxomycete taxa...



Leontyev et al. 2019

Phytotaxa

Phytotaxa 399 (3): 209–238
https://www.mapress.com/j/pt/

2019: first phylogenetically-based classification of myxomycetes

2 subclasses
all new
4 'superorders'
all new
9 orders
3 new
1 re-erected
13 families
1 new
2 re-erected

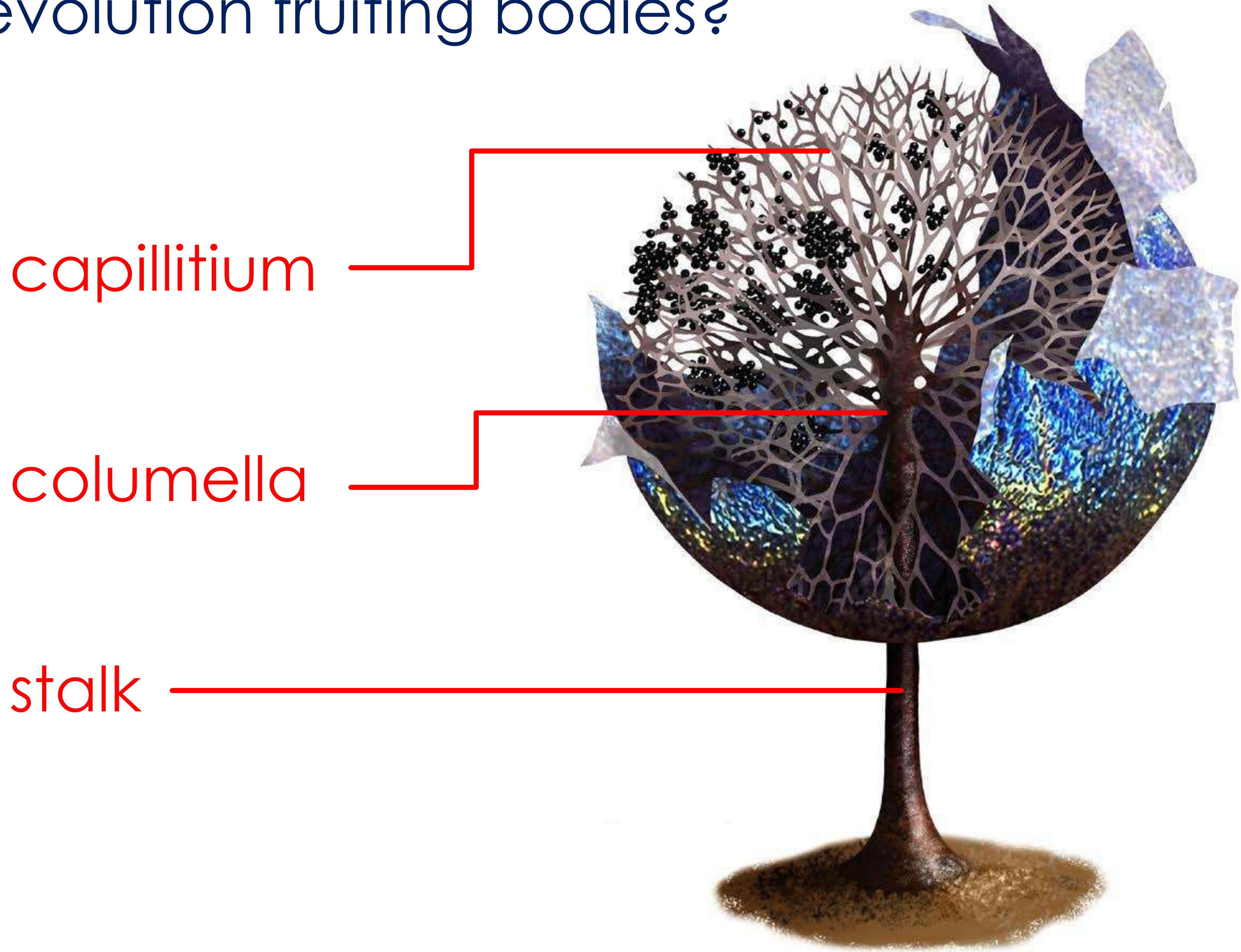
Lamprodermataceae – to Physarales
Clastodermatales – to Stemonitidia

As the myxomycete genealogy emerges from the fog of time, we receive more and more opportunities to analyze the natural history of morphological structures in different groups of these organisms.

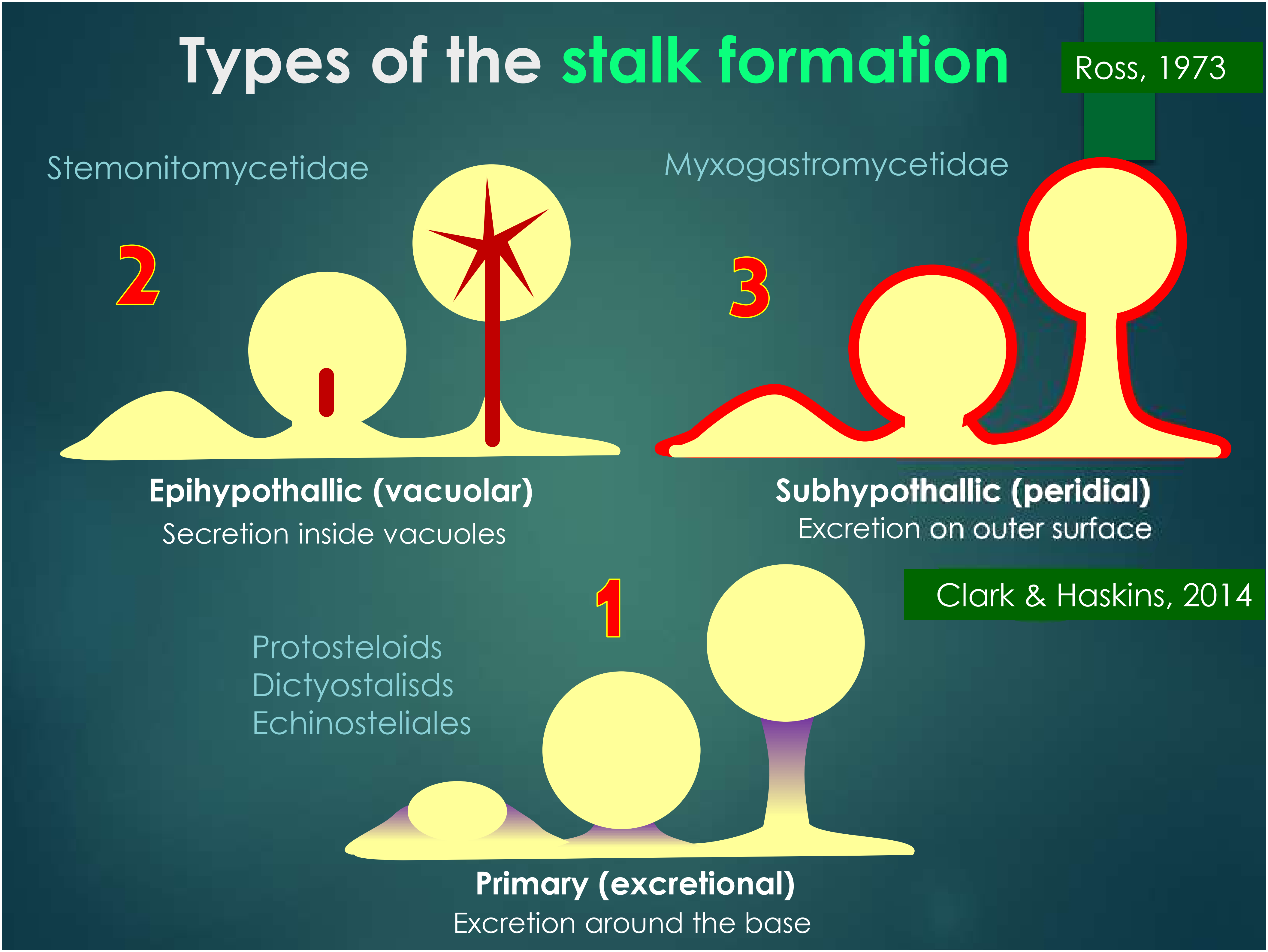
- XIX-XX – putative evolution of morpho traits served as the basis for revealing evolution of taxa

- XXI – disclosed evolution of taxa provides data about evolution of morpho traits

What can molecular phylogeny data improve in our understanding of the evolution fruiting bodies?



D. Leontyev for S. Stephenson's book, 2019


Types of the stalk formation
Ross, 1973
Stemonitomycetidae
Myxogastromycetidae
2
3
Epihypothallic (vacuolar)
Secretion inside vacuoles
Subhypothallic (peridial)
Excretion on outer surface
1
Clark & Haskins, 2014
Protosteloids
Dictyostalisds
Echinosteliales
Primary (excretional)
Excretion around the base

4

Hypothallic stalk

Secretion around the base

Re-erection of the primary stalk?

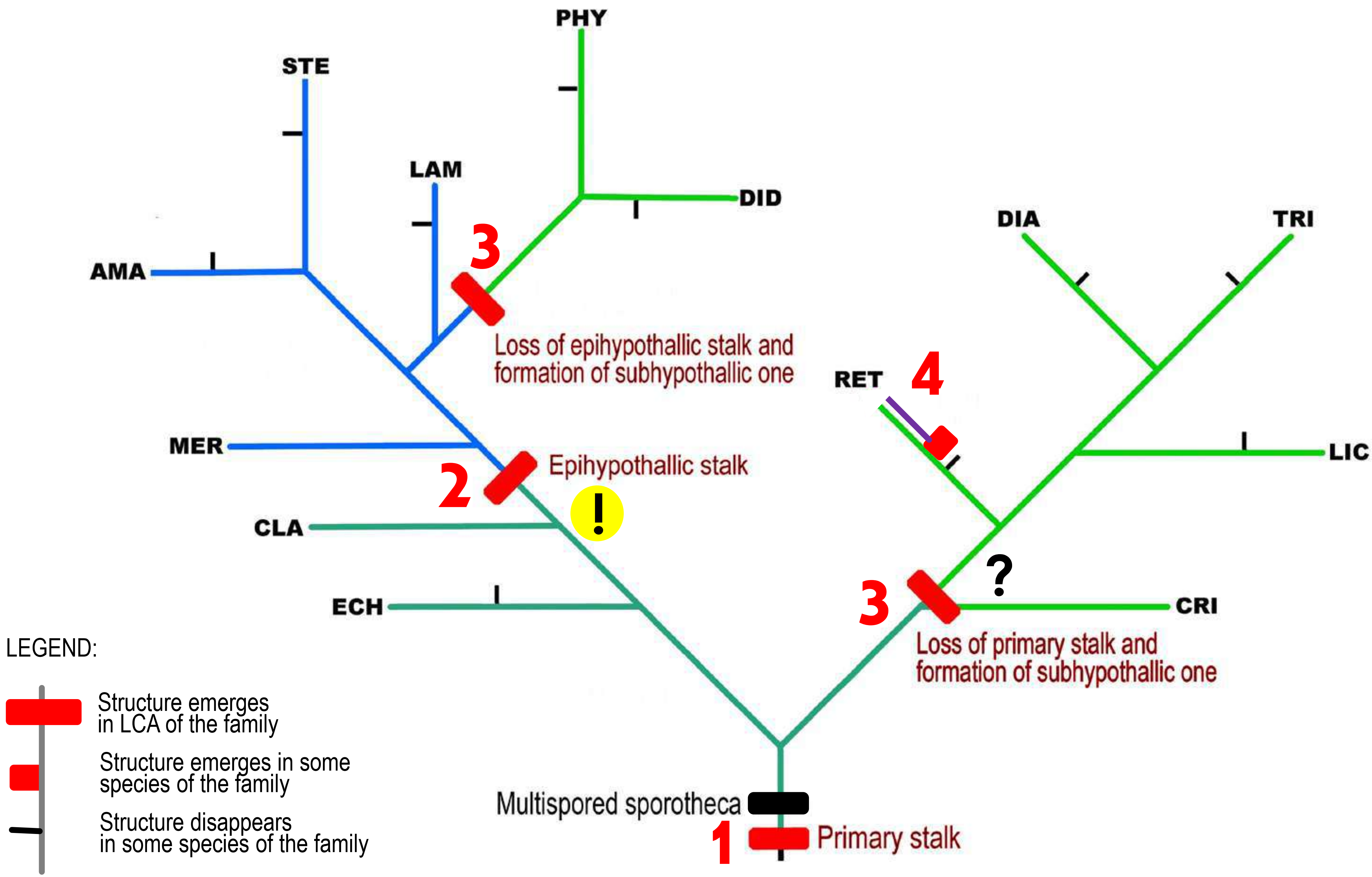
Tubifera microsperma

Myxotropic.org

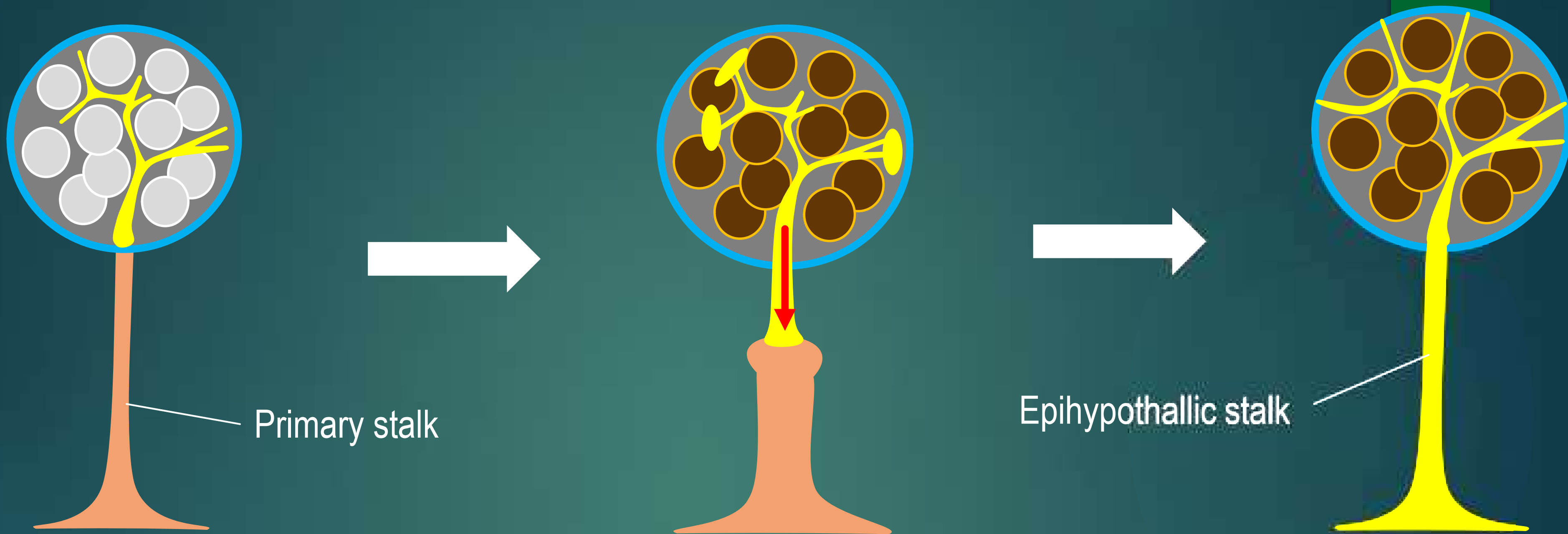
Tubifera ferruginosa subsp. acutissima

Leontyev unpubl.

Evolution of the stalk



Clastoderma: transition between primary and secondary stalk

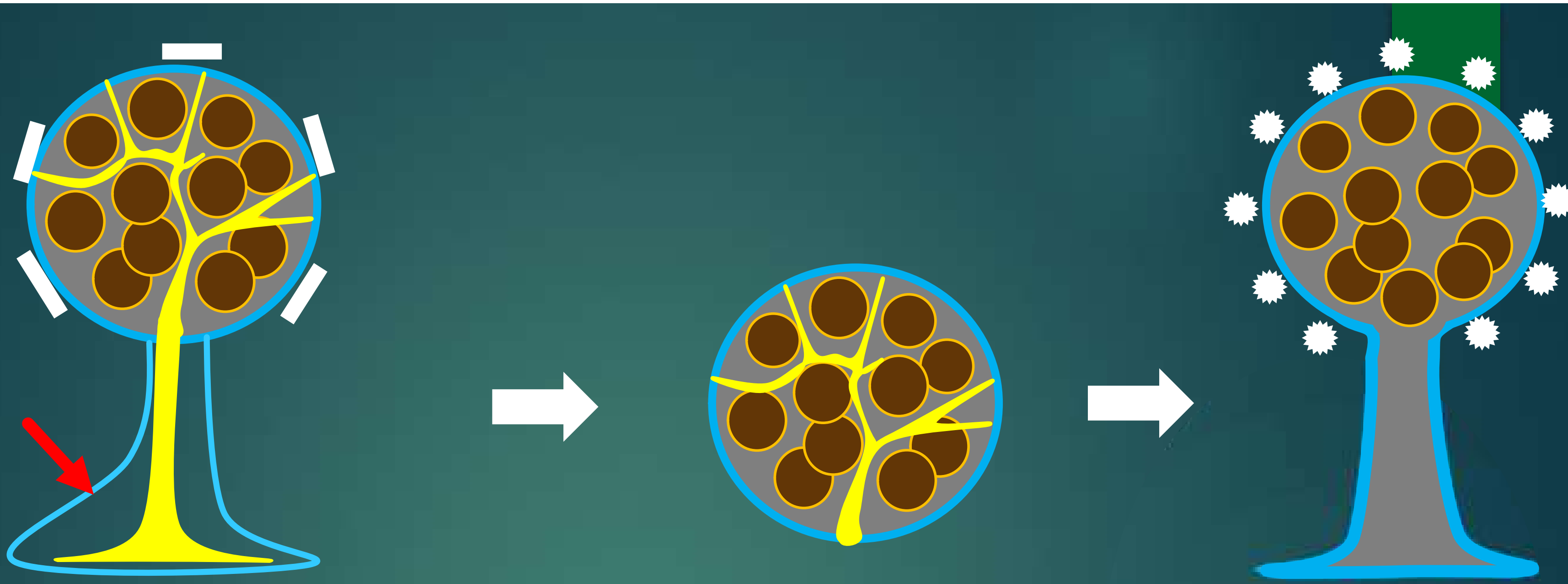


Echinostelium minutum

Clastodema debaryanum

Meriderma carestiae

Images taken from D. W. Mitchell's DVD "The Myxomycetes" (2011)

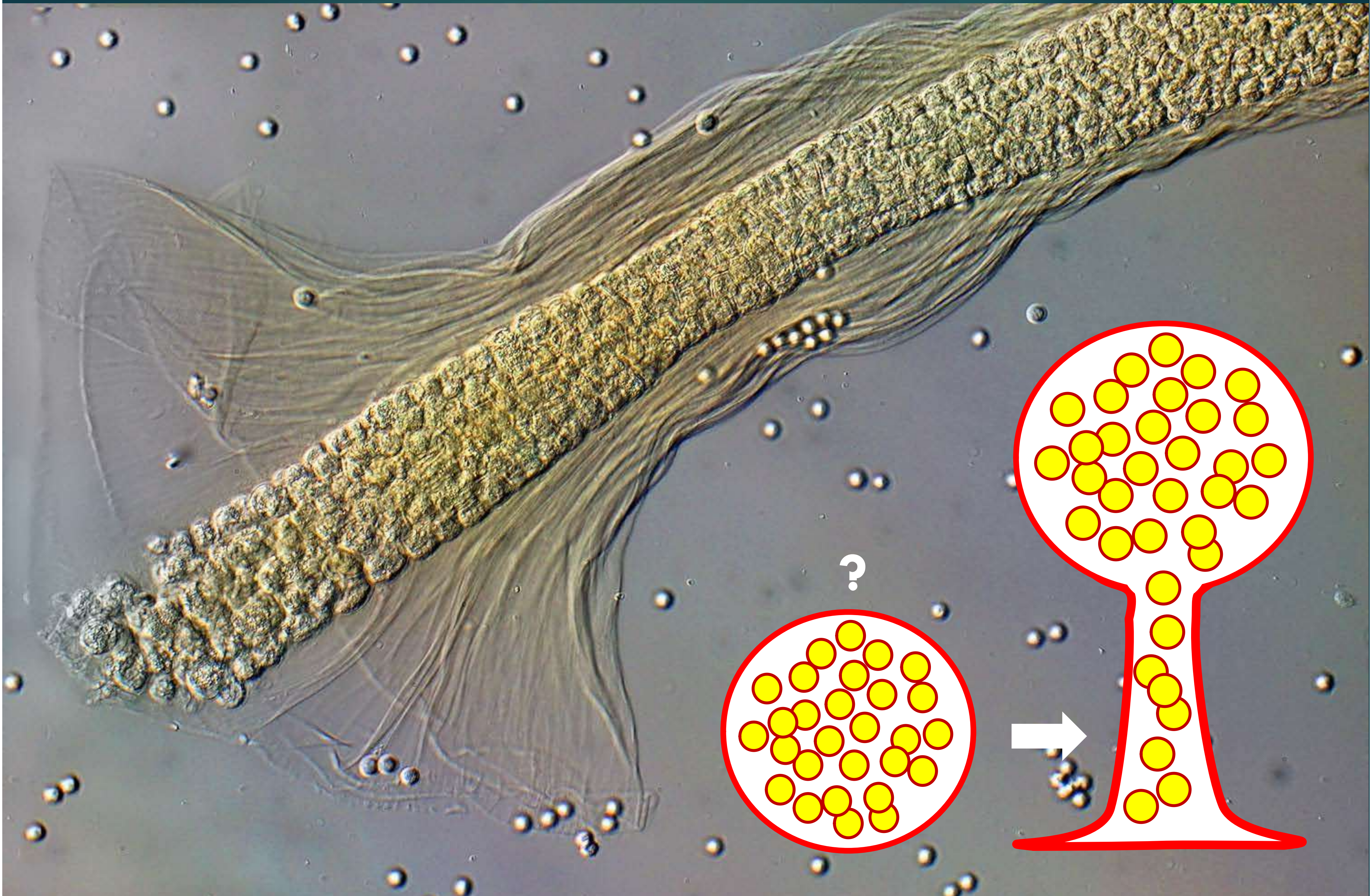


Lamproderma retirugisporum

Diacheopsis metallica

Physarum flavicomum

Images taken from D. W. Mitchell's DVD "The Myxomycetes" (2011)

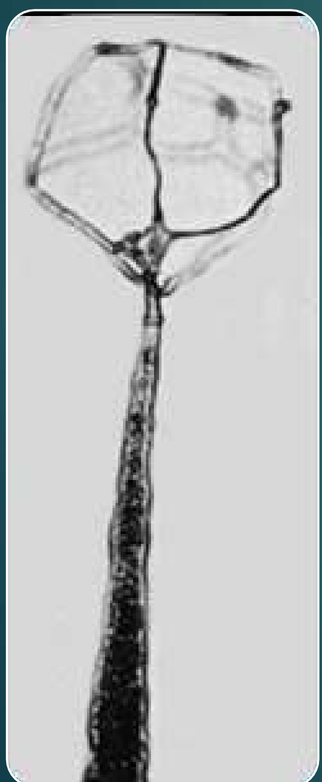


Leontyev unpubl.

Types of the capillitium

1

– Solid
– Attached to the columella
– Attached or not to the peridium
– Never contains lime

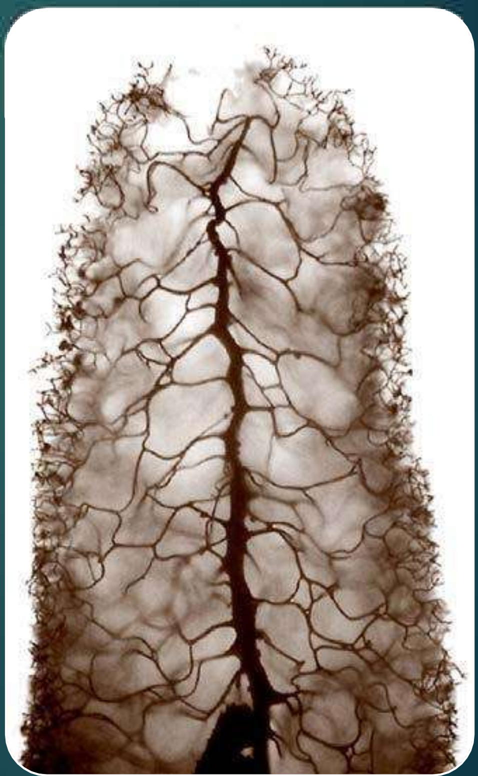


E. cribrarioides

Macbrideola cornea

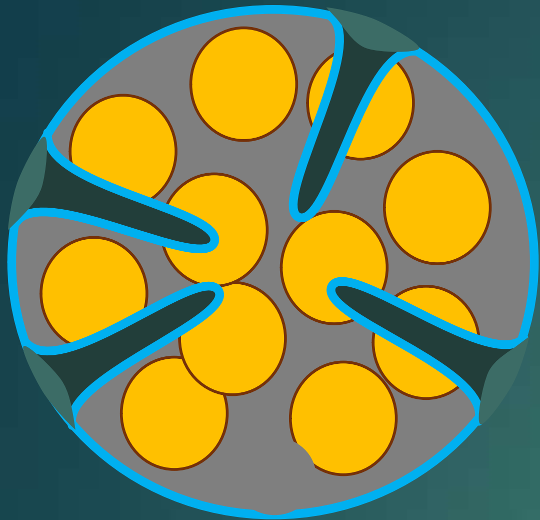
Meriderma cribrarioides

Stemonitopsis typhina



Images taken from D. W. Mitchell's DVD "The Myxomycetes" (2011); A.V. Kochergina (unpubl.)

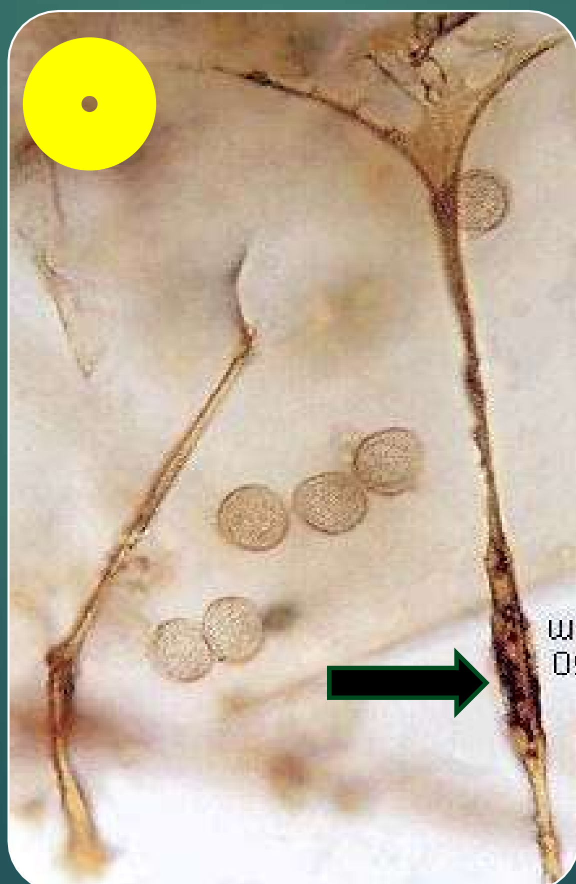
2



– Tubular
– Often merged to the peridium
– May not be attached to the columella
– May contain lime

Alwisia bombarda

Dianema mongolicum



Badhamia gigantospora

Images taken from D. W. Mitchell's DVD "The Myxomycetes" (2011) and Leontyev et al. (2014)

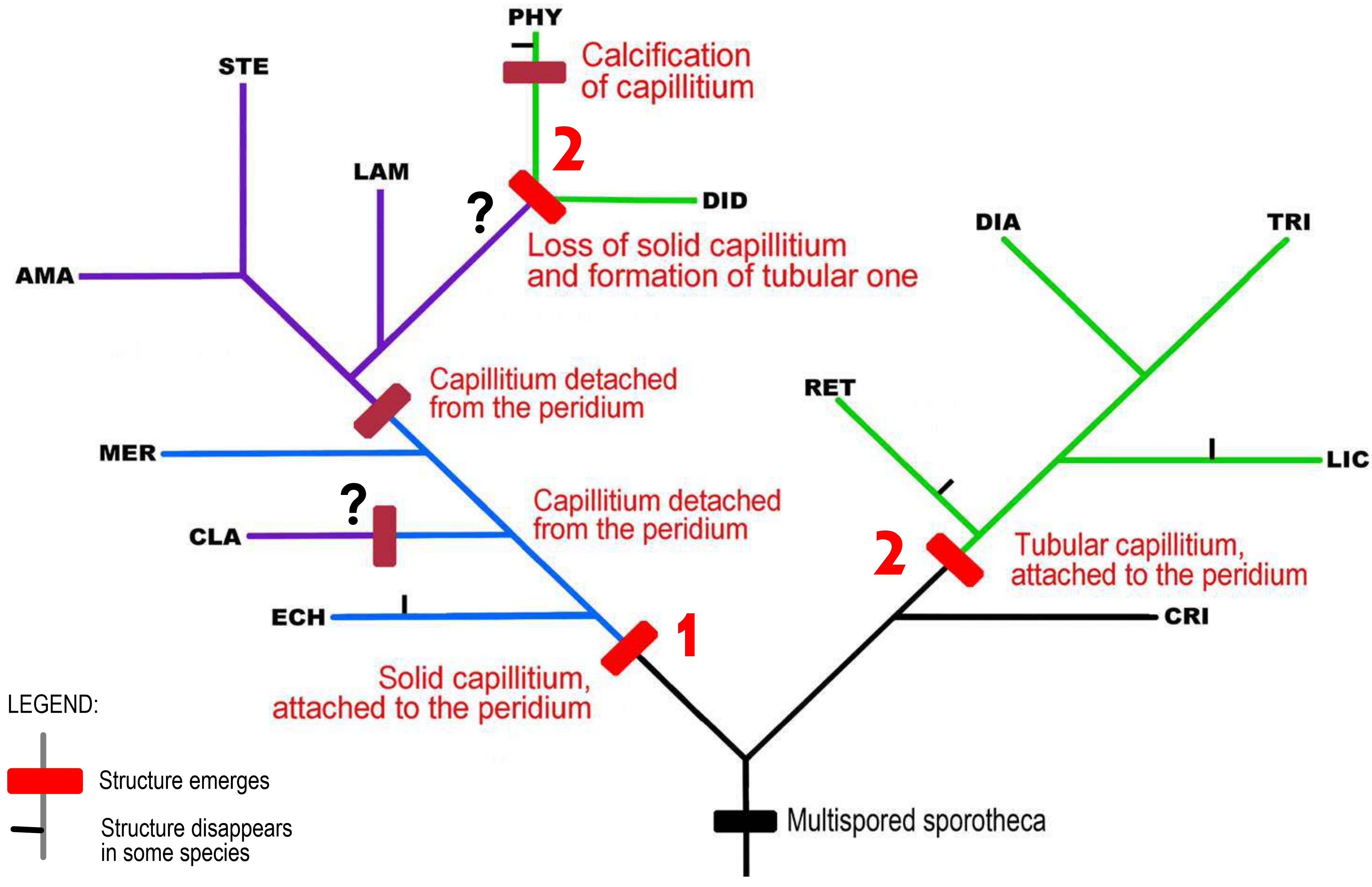
Lycogala epidendrum

Alwisia lloydiae

Arcyria versicolor

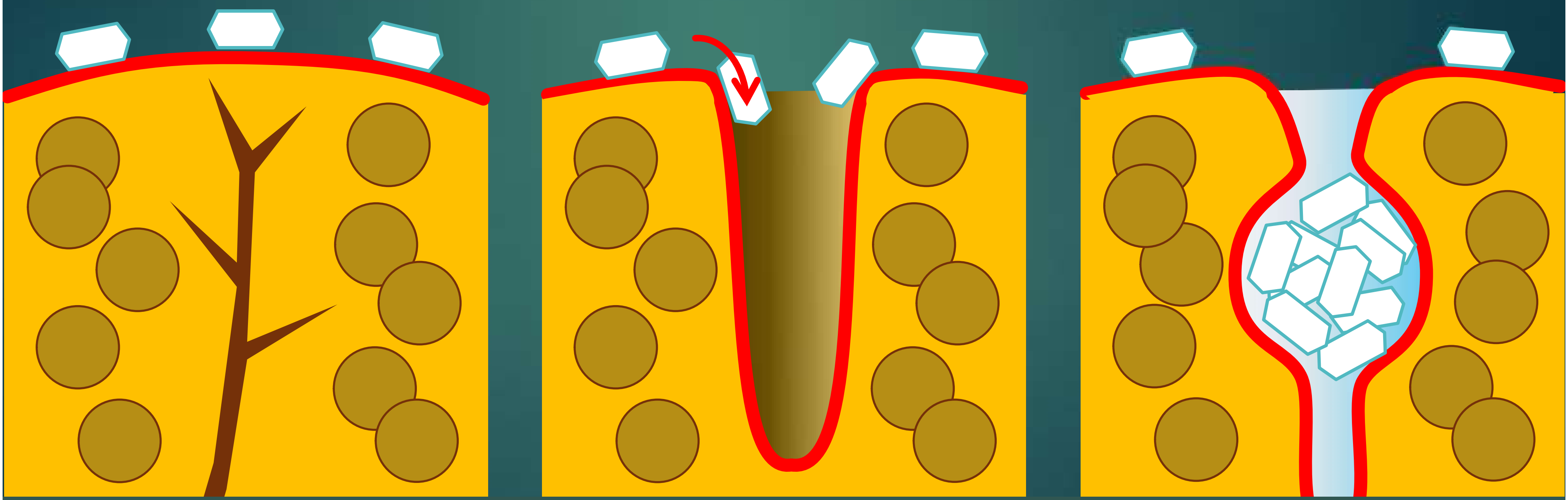
Images taken from D. W. Mitchell’s DVD “The Myxomycetes” (2011) and Leontyev et al. (2014)

Evolution of the capillitium



Lime and type of capillitium

Only tubular capillitium, ontogenetically derived and mechanically connected to the peridium, may accumulate lime.



Capillitium in Didymiaceae

Primary?

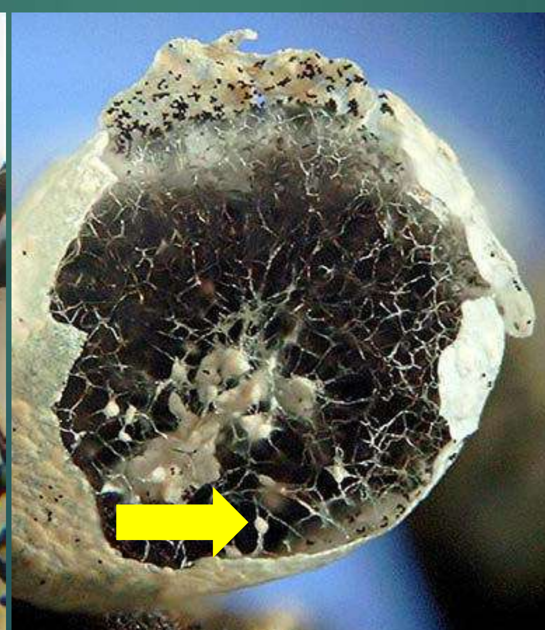
- Thin, solid (?)
- May be melanized
- Usually doesn't contain lime

Secondary?

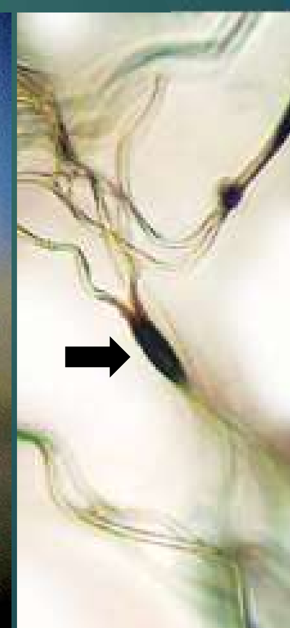
- Contain nodes, filled from inside
- Partial calcification from inside (*D. brooksii*)
- May be merged to the peridium

Lamproderma sauteri

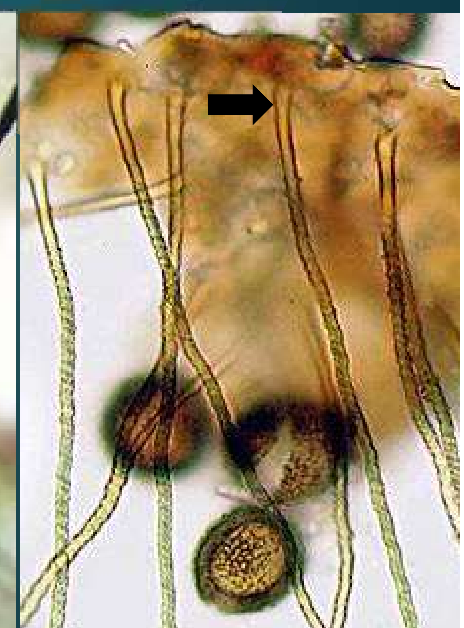
Lamproderma peyerimhoffii



Diderma brooksii



Diderma alpinum

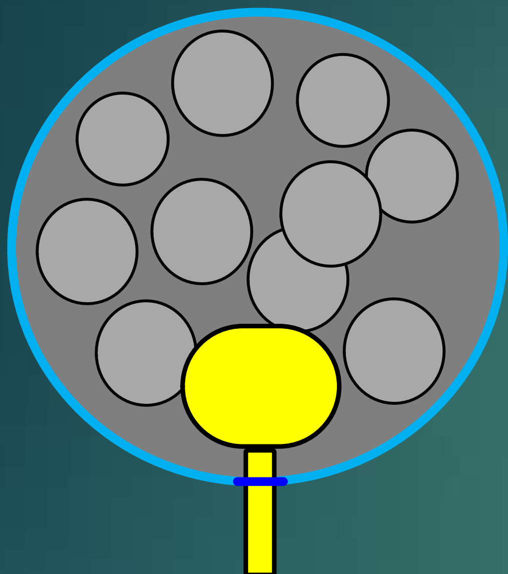


Didymium decipiens

Images taken from D. W. Mitchell's DVD "The Myxomycetes" (2011)

Types of the columella

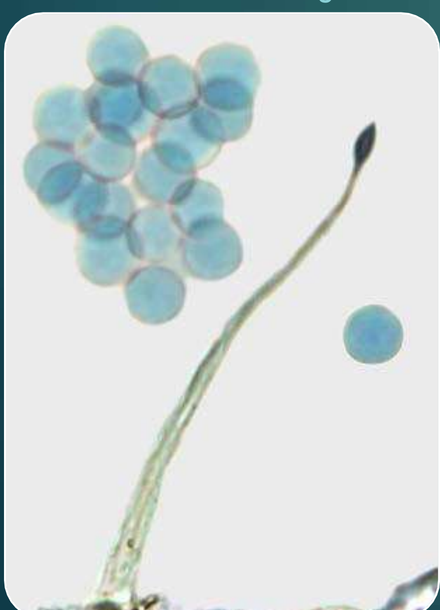
0



"Protocolumella"

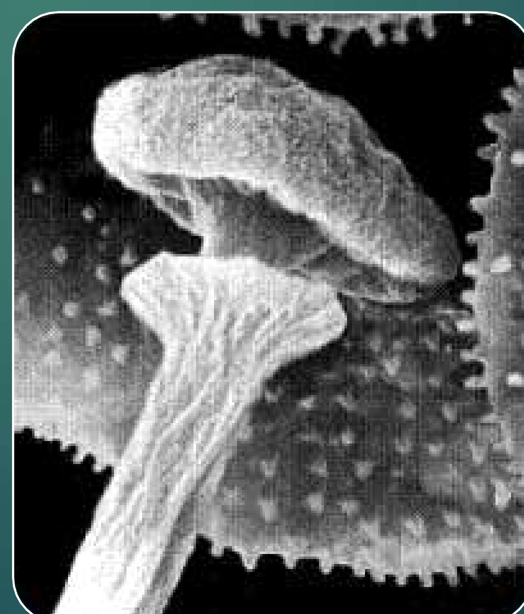
– Solid, ± isodiametric
– Originates from the primary stalk
– Not identical with the spore, attached to the stalk

Echinostelium fragile

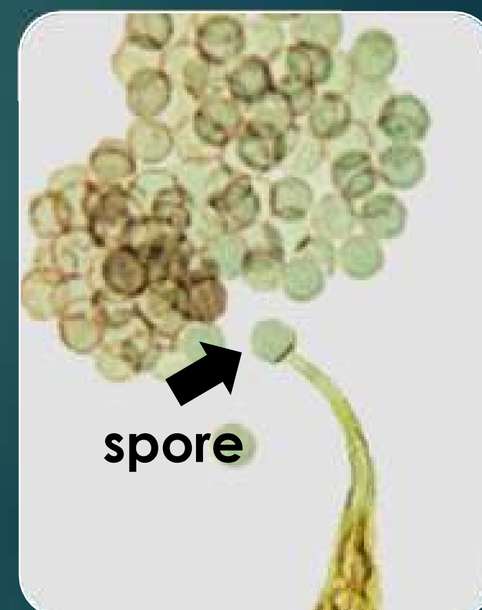


Echinostelium brooksii

Echinostelium brooksii



Echinostelium vanderpoelii

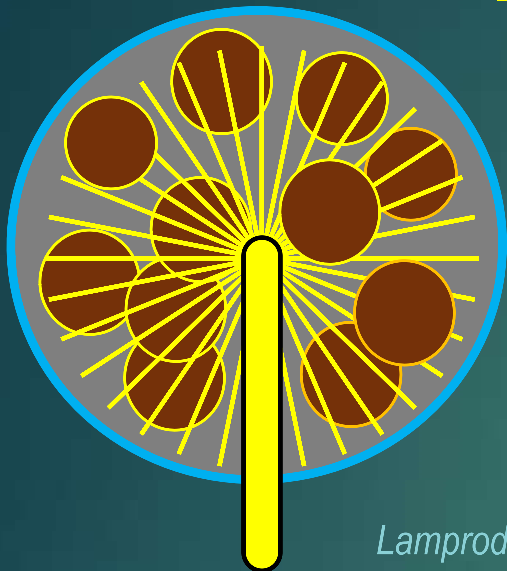


Images taken from D. W. Mitchell's DVD "The Myxomycetes" (2011)

'True columella'

Poulain et al. 2011

1

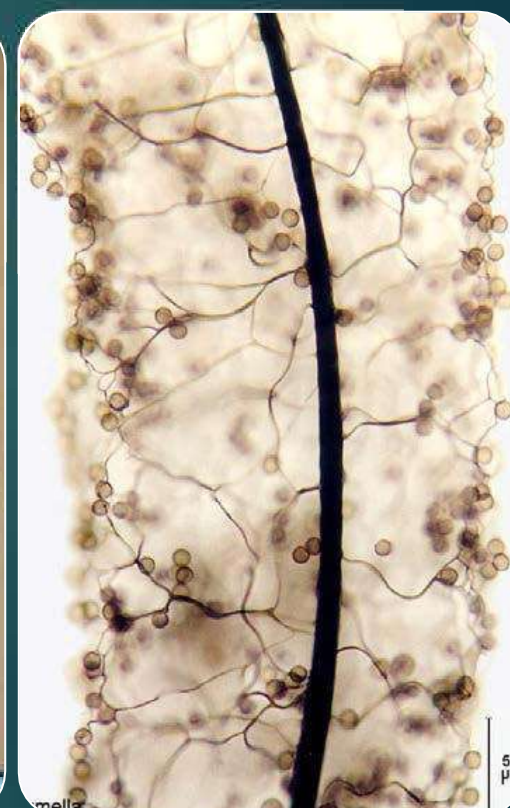


– Solid
– Connected to the primary or epihypothallic stalk
– Base of the solid capillitium

Echinostelium arboreum

Lamproderma echinosporum

Comatricha pulchella



Stemonitis axifera

Images taken from D. W. Mitchell's DVD "The Myxomycetes" (2011)

2 Basal/Secondary/Hypocolumella

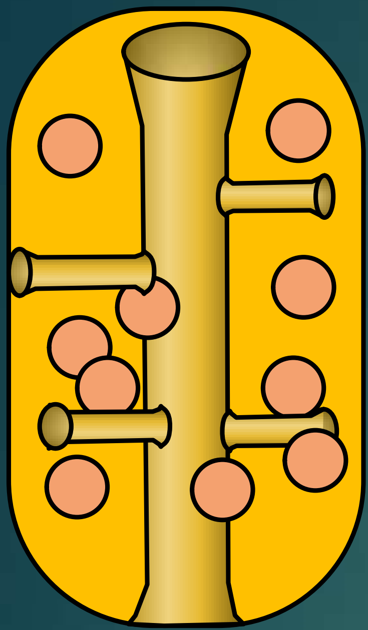
Poulain et al. 2011

- Hollow or filled with lime
- Derived from subhypothallic stalk and peridium
- Not connected to the capillitium

'secondary columella' 'hypocolumella'

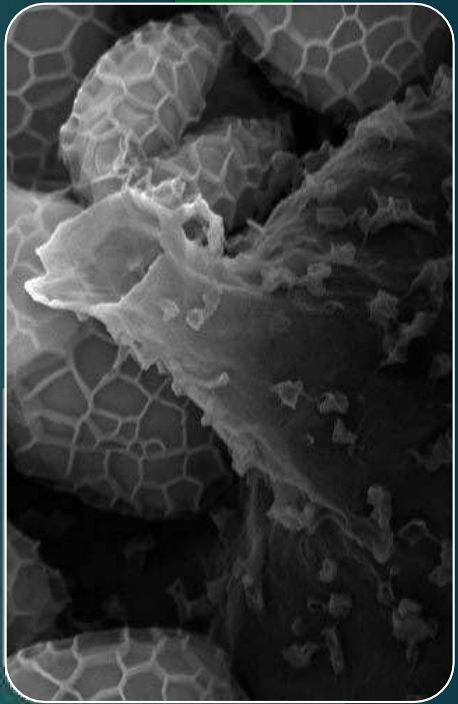
Didymium rubropus *Diachea leucopodia* *Didymium megaloporum* *Didymium squamulosum*

3



'False columella' of capillitial origin

– Tubular
– Not connected to the stalk (?)
– Structural unity with the tubular capillitium



Siphoptychium casparyi

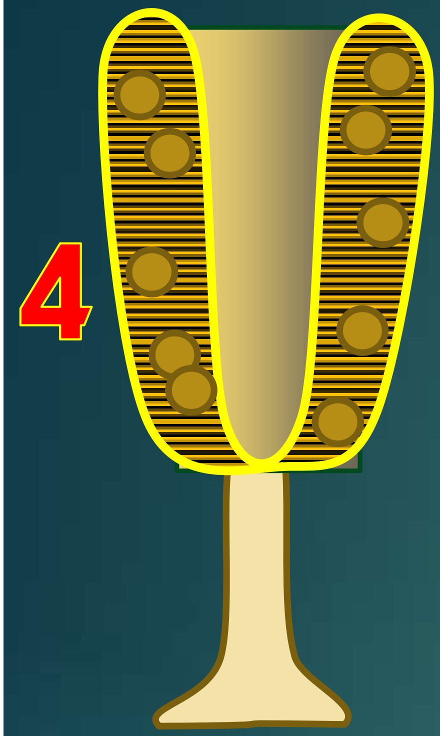
Images taken from Leontyev et al. 2019

'Capillitial columella' does not always remain opened to outer space

Siphoptychium violaceum

Siphoptychium reticularum

Images taken from Leontyev et al. 2019



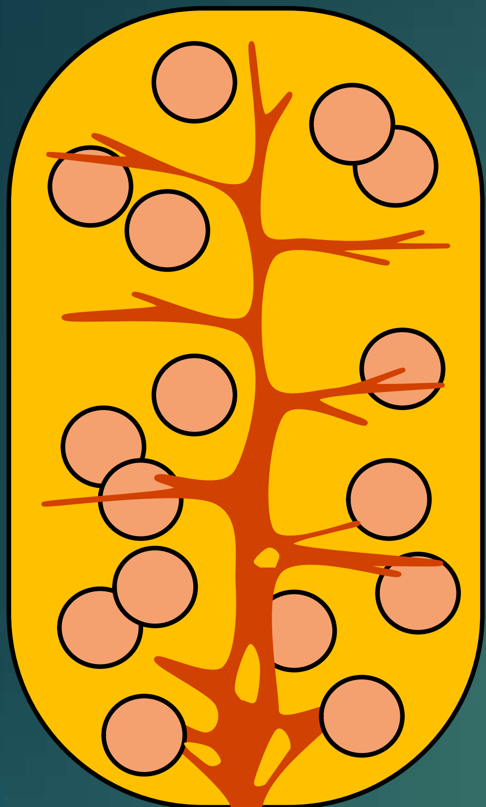
‘False columella’ of peridial origin

- Tubular
- Not connected to the stalk (?)
- No structural unity with the tubular capillitium

Physarella oblonga

Images taken from Myxotropic.org and https://atrium2.lib.uoguelph.ca/xmlui/handle/10214/7183

5



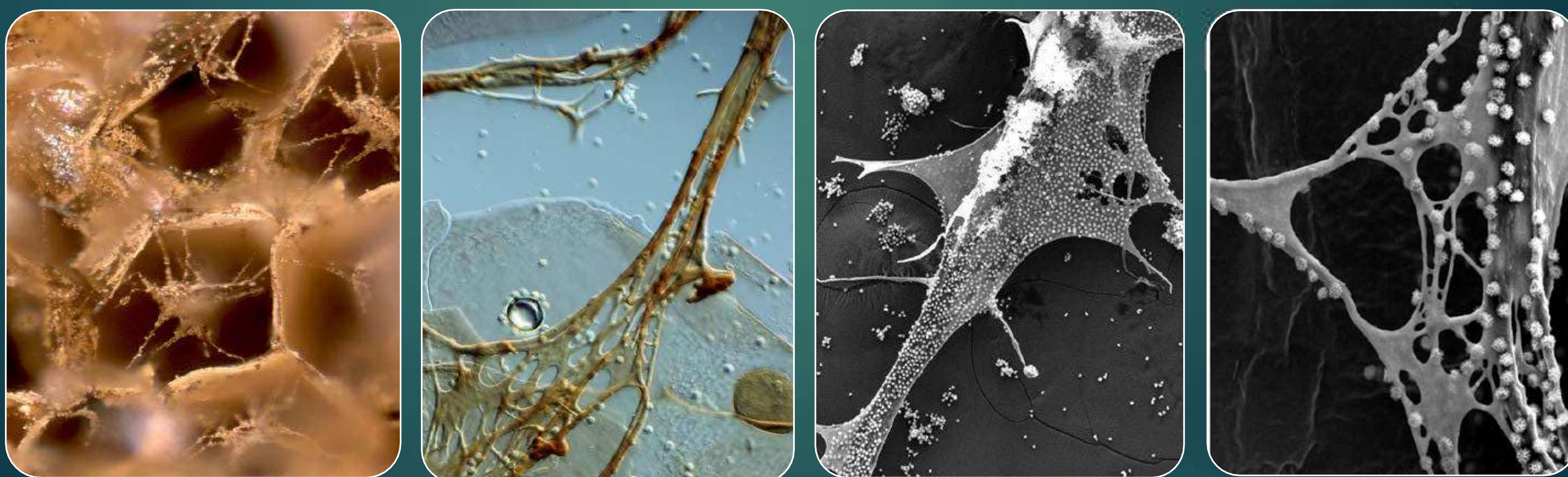
‘Fibrose columella’

Poulain et al. 2011

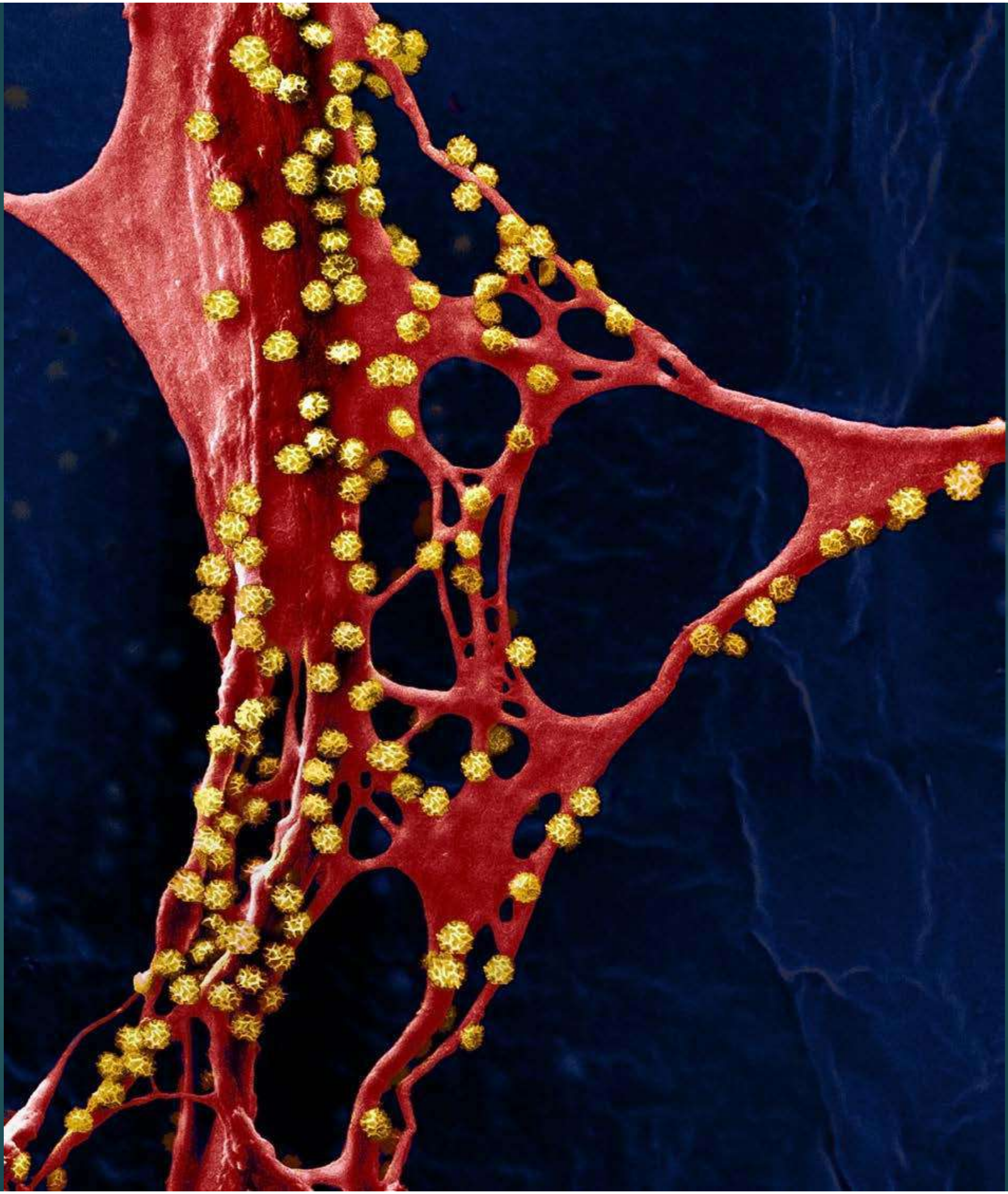
– Fibrose, solid
– Not connected to the stalk
– Structural similarity to the primary columella and primary capillitium

Re-erection of the true capillitium-columella system?

Thecotubifera dictyoderma

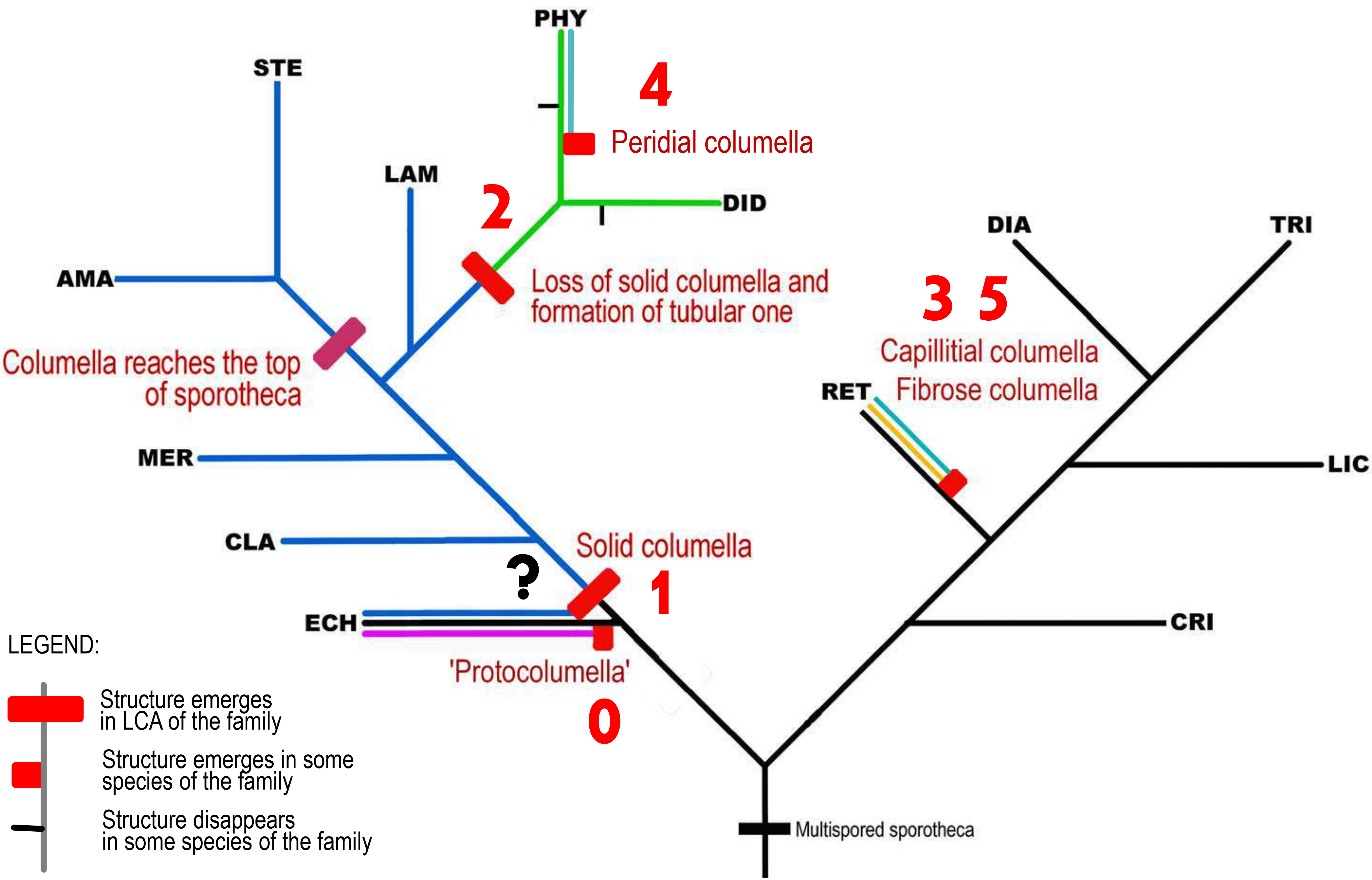


Images from Leontyev et al. 2019



D. Leontyev, cover
of 'Mycologia', #6, 2019

Evolution of the columella



Conclusions (very preliminary...)

- Any element of the fruiting body may simply disappear: only on mutation may cause a complete lass of the structures
- Structures evolve again, when they become necessary again, but on another structural basis
- Exception is possible for the cases of 'reinvention' of the structure on similar structural basis (hypothallic stalk, fibrose columella)
- Specific terms are necessary to distinguish superficially similar, but ontogenetically different structures
- We are still at the most beginning of the understanding of morphological evolution in myxomycetes


Дякую за увагу!
Thermo
Thanks for attention!

Molecular Diversity in nivicolous Myxomycetes: Long-term study German Alps 2013-2019

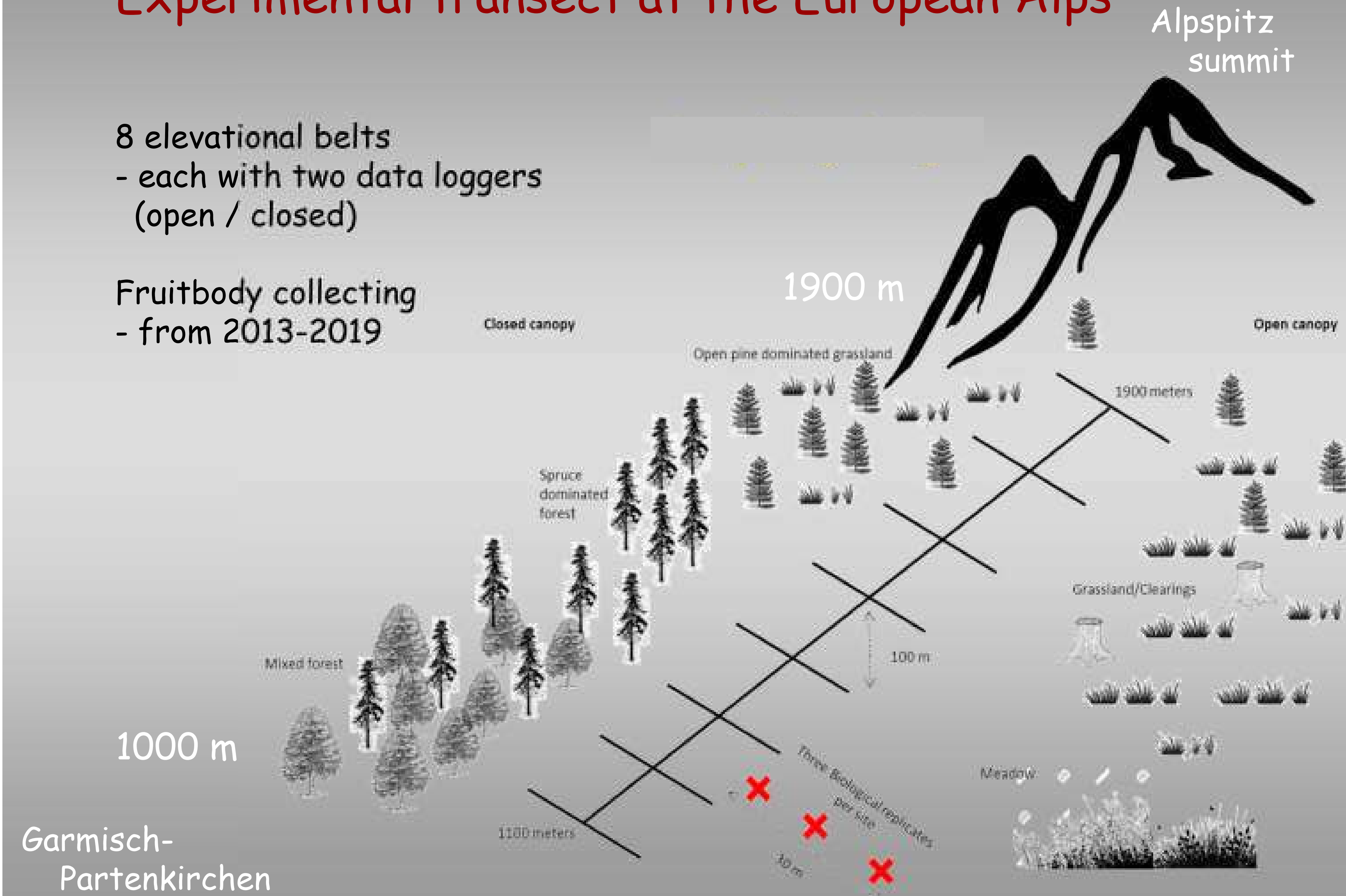
Martin Schnittler, Oleg N. Shchepin, Mathilde Borg Dahl, Nikki H. Dagamac, Jan Woyzichovski, Yuri K. Novozhilov

reSPONse
Deutsche Forschungsgemeinschaft DFG
ERNST MORITZ ARNDT UNIVERSITÄT GREIFSWALD
Wissen lockt. Seit 1456

Experimental transect at the European Alps

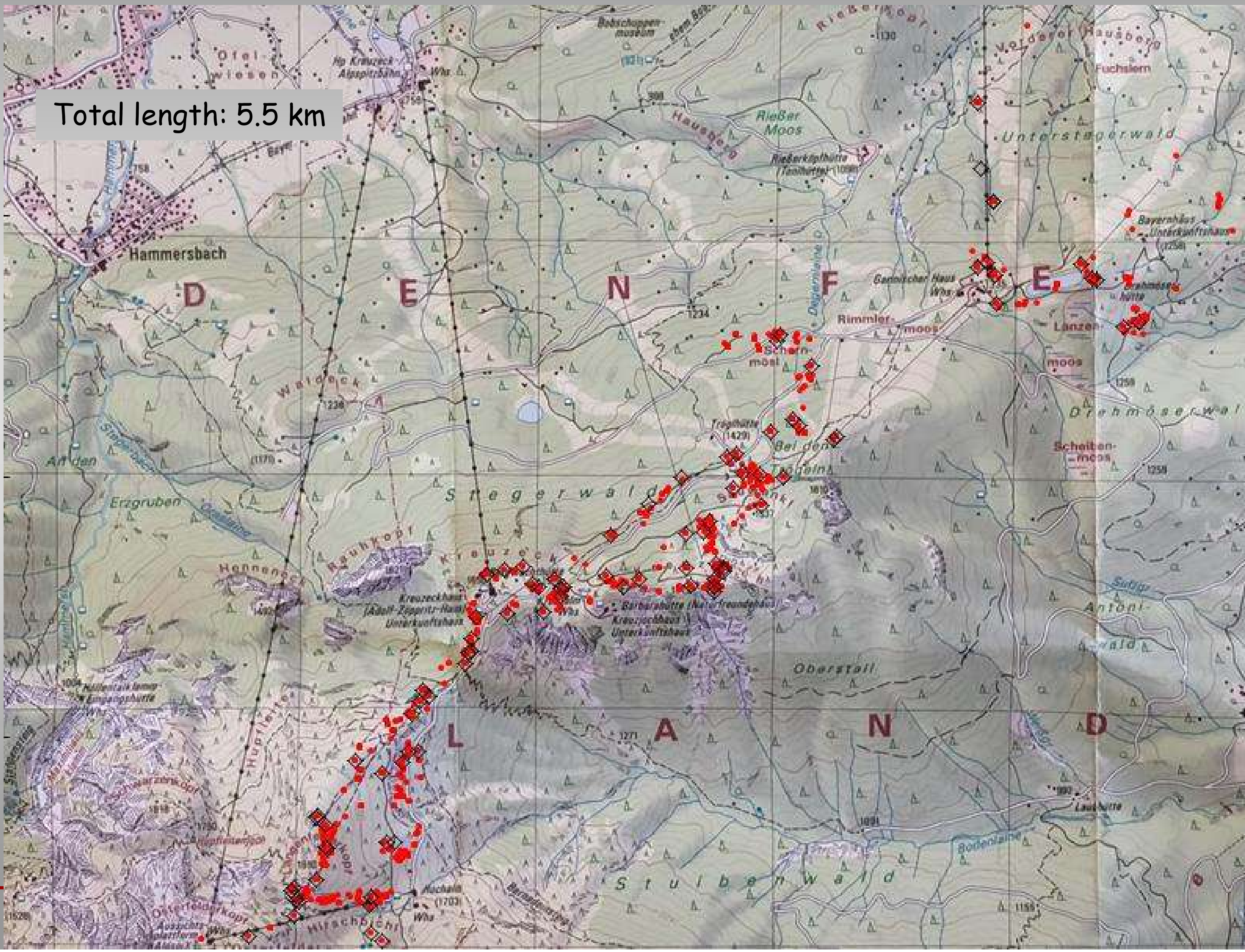
8 elevational belts
- each with two data loggers (open / closed)

Fruitbody collecting
- from 2013-2019



Borg Dahl, M., et al. (2018): Sci. Rep. 8: 11662

Collections



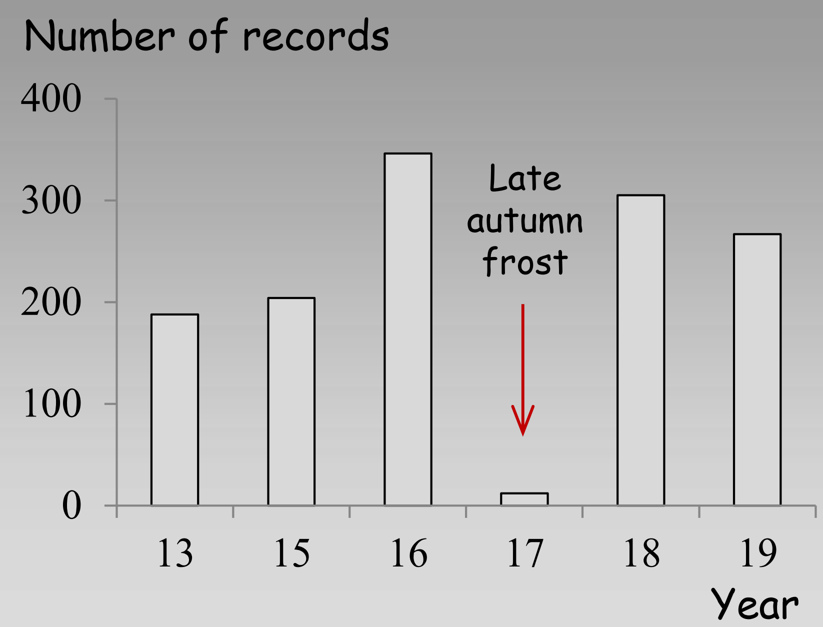
What has been done?

Five seasons collecting
1322 records
1009 sequenced (76%)
1291 records det. to species

37 taxa („morphospecies")
35 of these dark-spored

99 different ribotypes obtained

Most common (<50 records):
Lamproderma ovoideum agg. (250)
Diderma meyeri (170)
Lamproderma sauteri agg. (161)
Diderma alpinum (89)
Diderma europaeum (94)
Lamproderma aeneum (52)

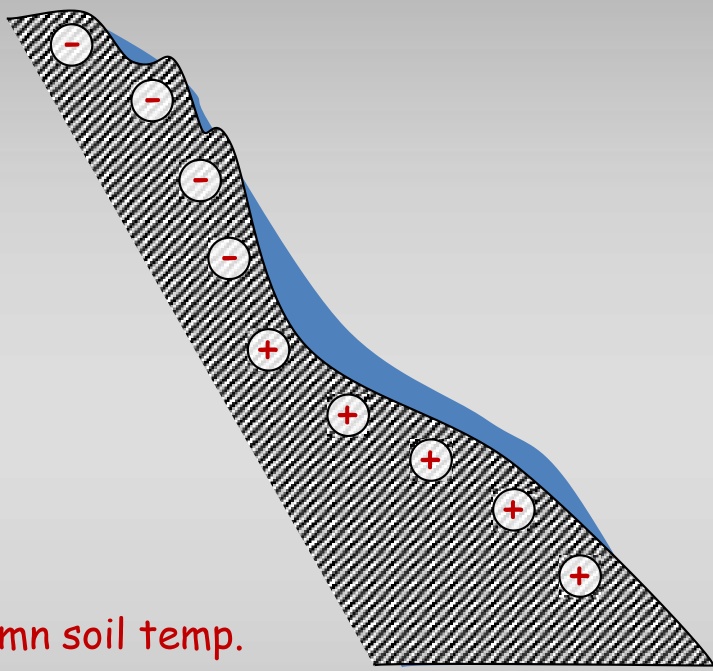


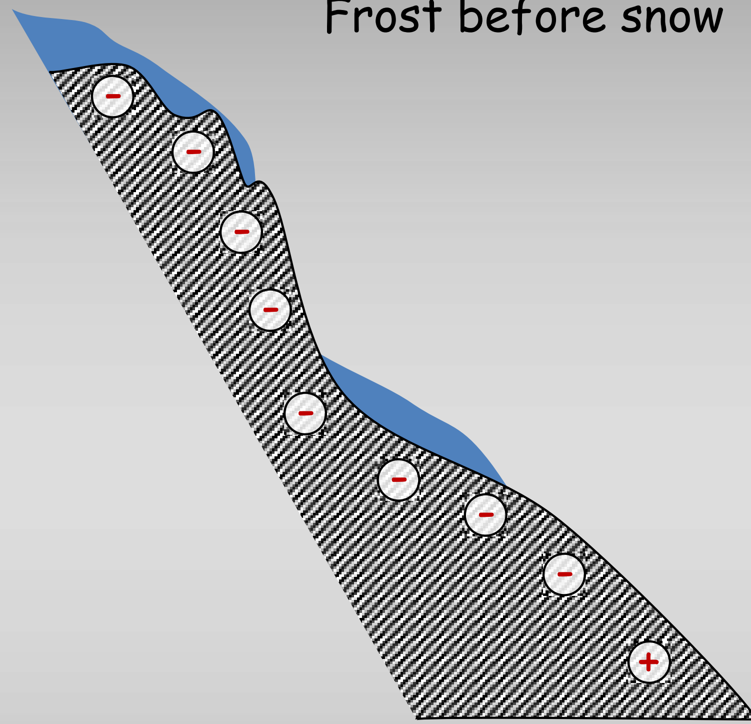
Year	Coll	Seq	% seq
13	188	105	55.9
14			
15	204	150	73.5
16	346	266	76.9
17	12	12	100.0
18	304	257	84.5
19	268	168	62.7 +

Steadiness of fruiting

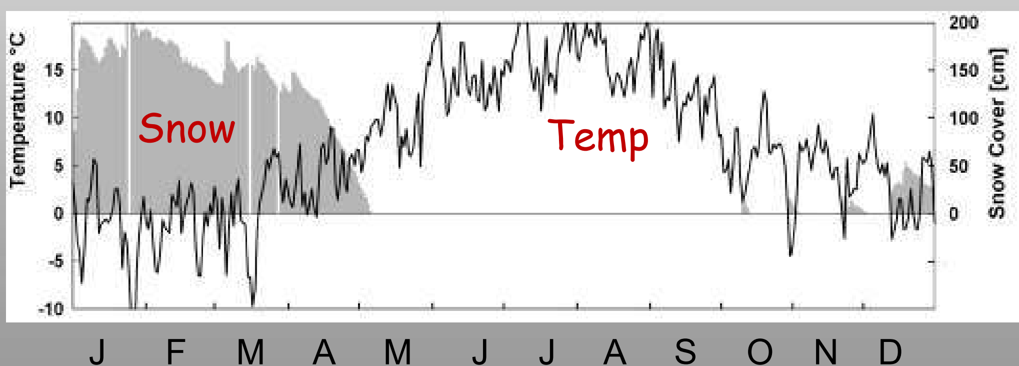
Good year:
Snow before frost

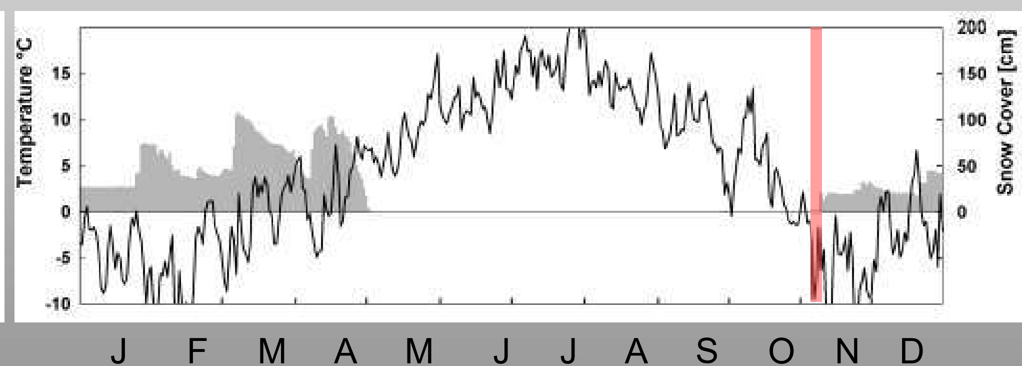
Bad year:
Frost before snow





Autumn soil temp.





Questions

1. Does barcoding reliably identify species?
- what is the relation morphospecies - (groups of) ribotypes

1. Is there an ecological (elevational) zonation in
- morphospecies?
- ribotypes?
- if yes, is it more pronounced for ribotypes?

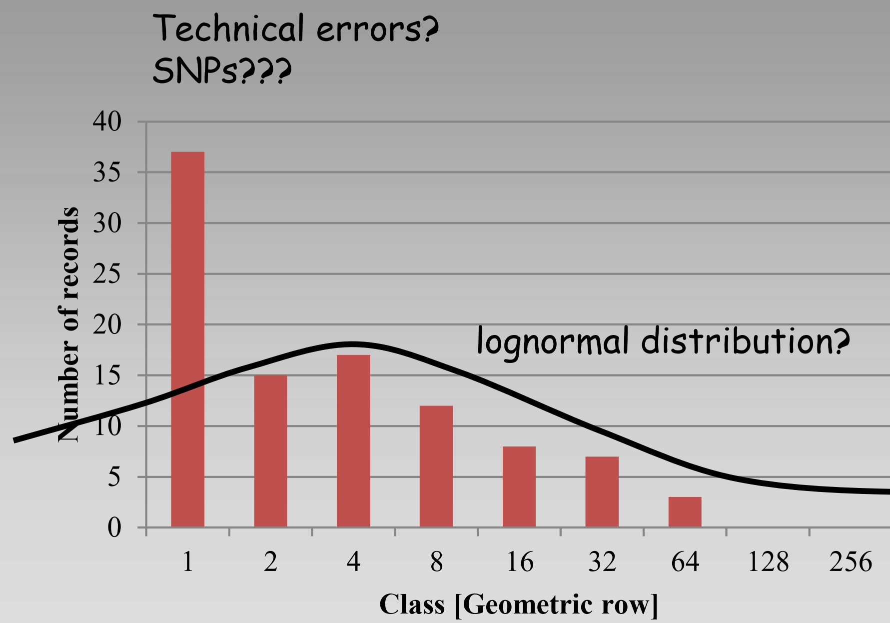
2. Will ribotypes be constant over years
- is the probability to refind a ribotype higher if it has been found already at this locality?
  (In other words, will amoebae persist? - This would help to survive variations in snow cover)

Ribotype diversity

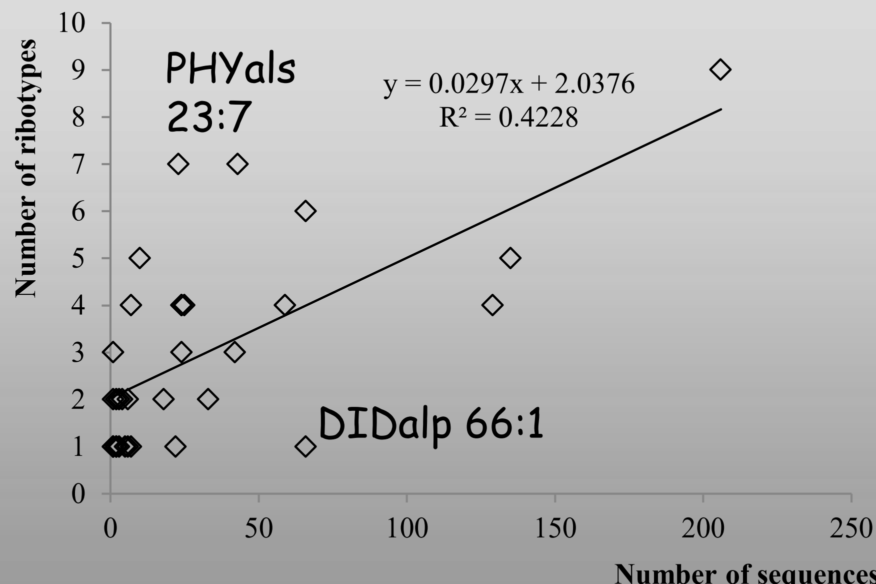
1009 sequences evaluated
99 ribotypes

>1/3 are singletons
(=37 ribotypes)

abundance of genera and species comparable between years (not shown)



No good correlation between Number of sequences and number of ribotypes for a morphospecies

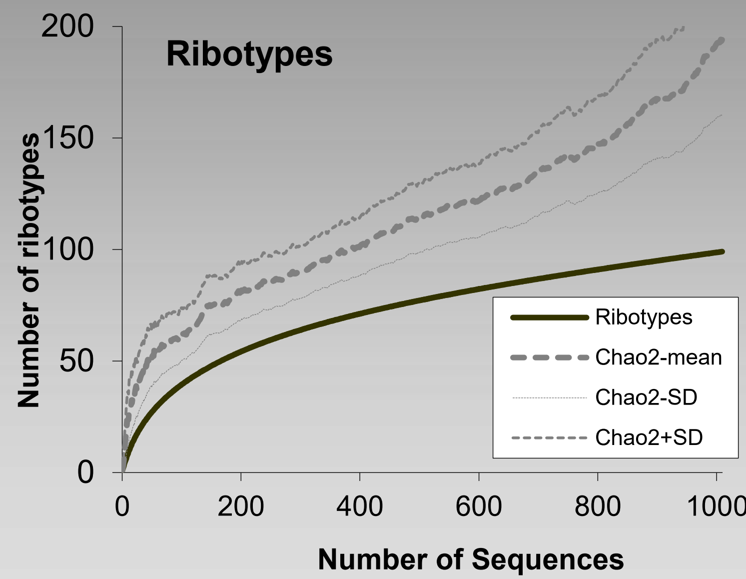


Ribotypes

1009 sequences evaluated
  99 ribotypes

Chao 2 mean: 194.09

51.0 % completeness



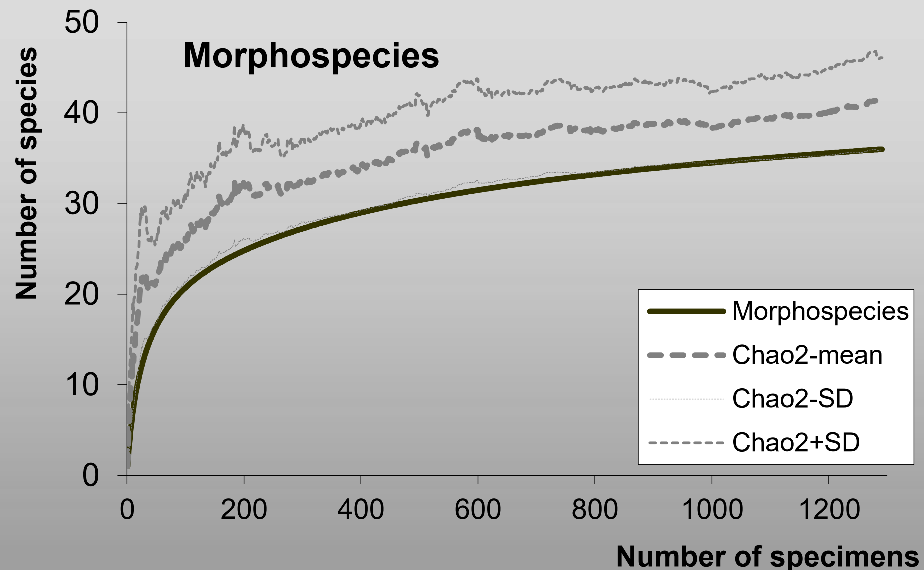
Again:
Technical errors?
SNPs???

Morphospecies

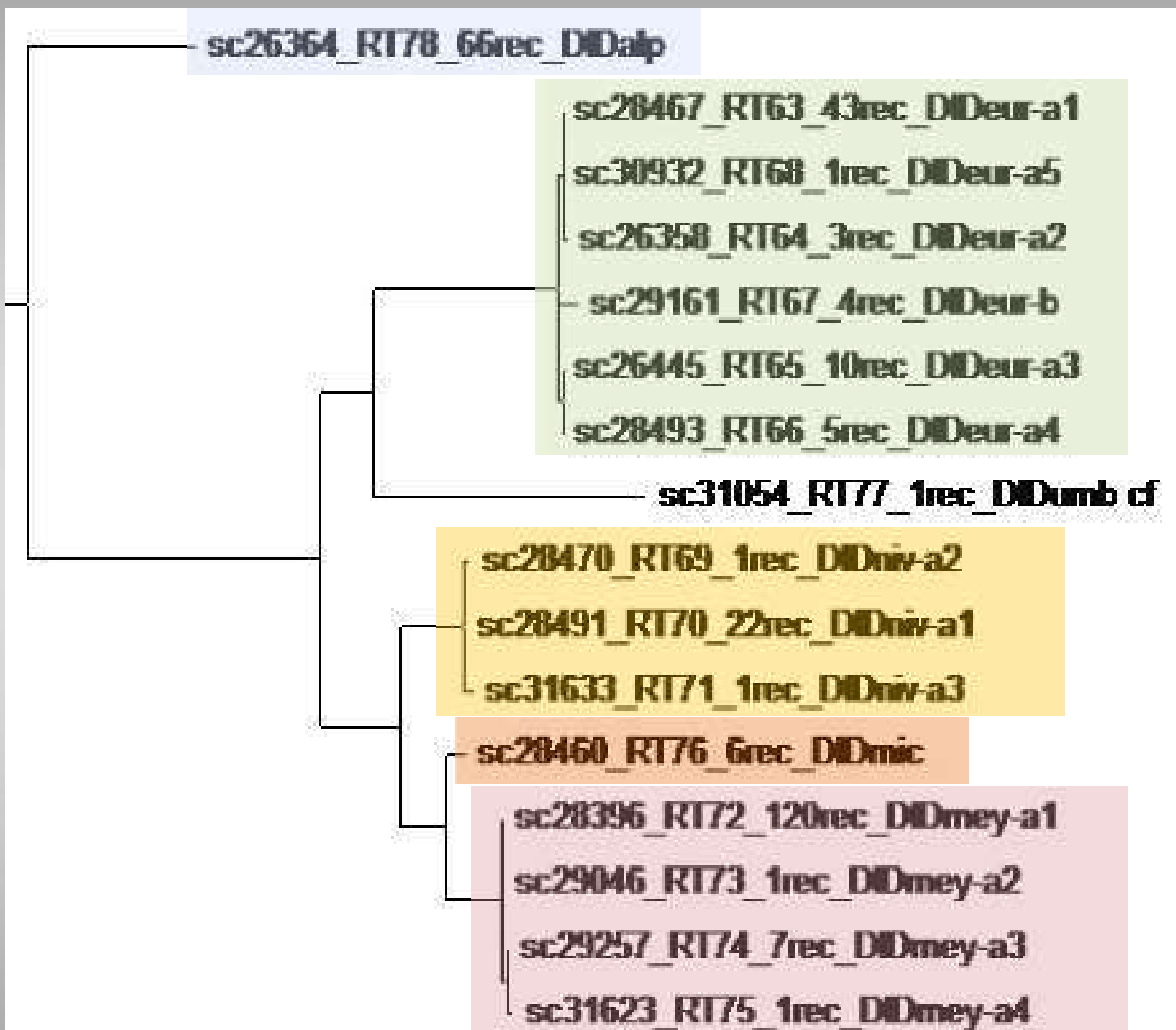
1291 determinable specimens
  36 morphospecies

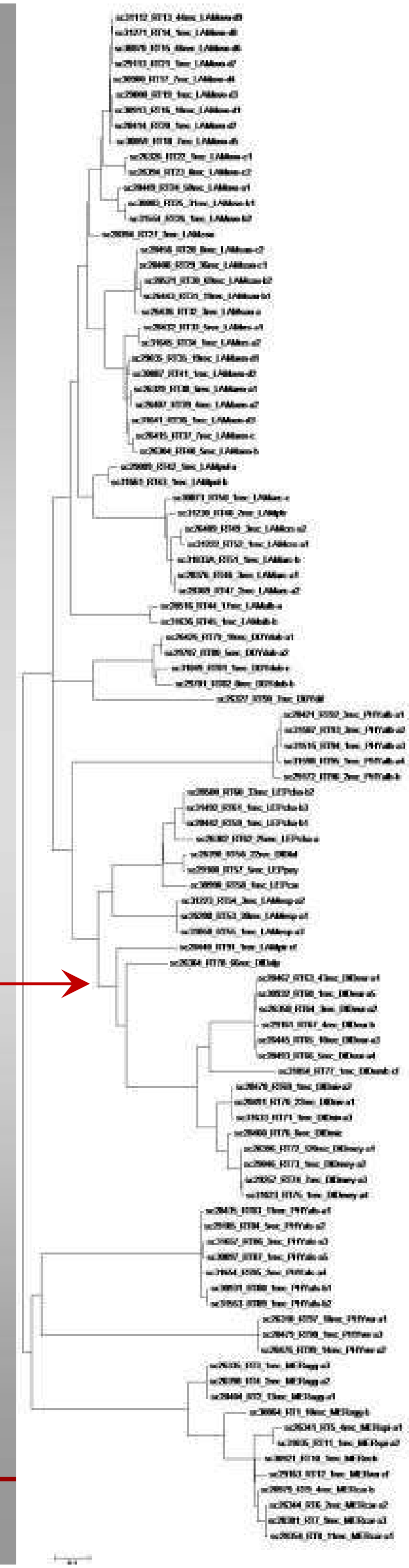
Chao 2 mean: 41.38

87.0 % completeness



Ribotypes and morphospecies





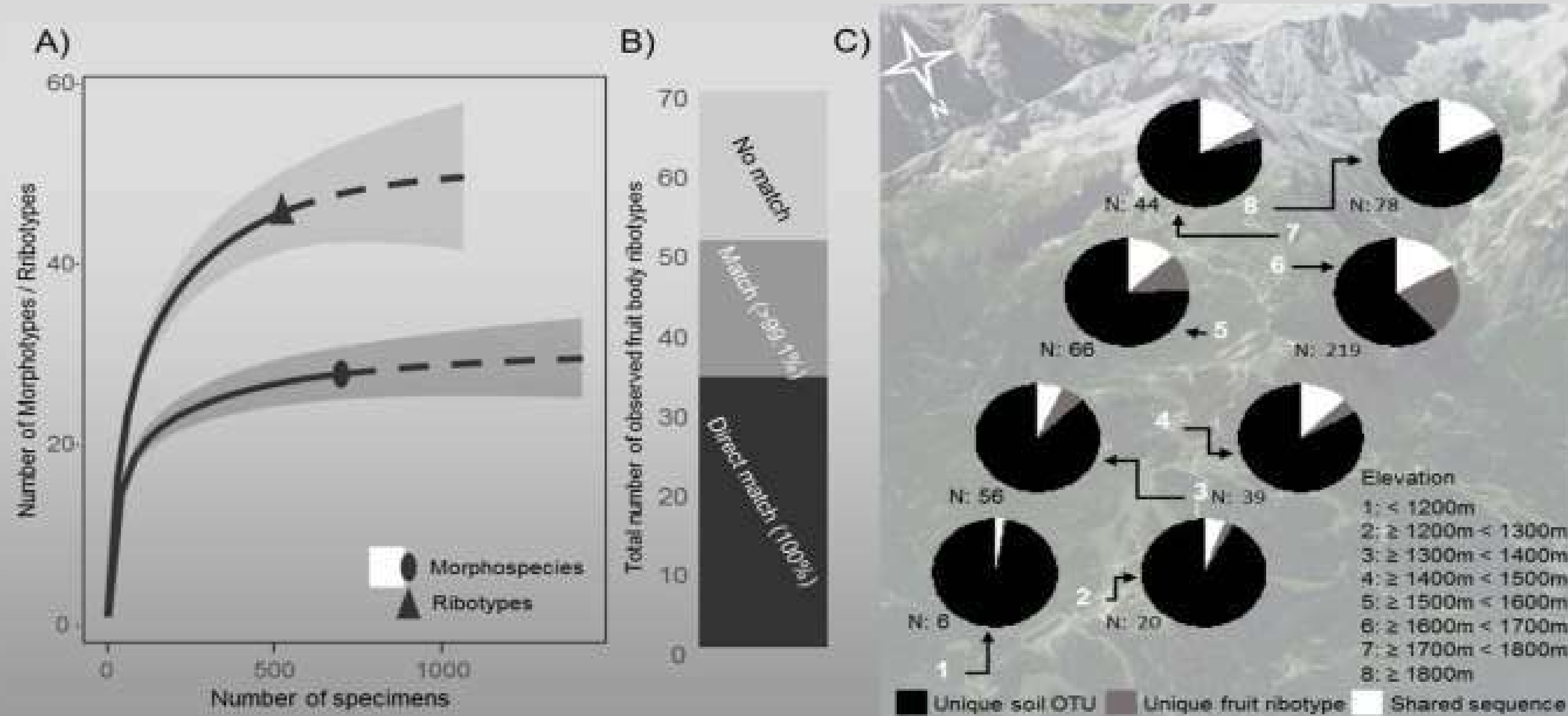
Metabarcoding of dark-spored soil myxomycetes (2018)

A More ribotypes than morphologically discernible species were found within the transect.

B Most sequences from fruit bodies matched those from metabarcoding (53 of 70), but not all sequences found from metabarcoding were found as fruit bodies (245 of 503 OTUs, threshold 99.1%).

C At lower elevations (instable snow cover) less OTUs from soil matched sequences from fruit bodies, and fruiting was less abundant.

We only find a fraction of all ribotypes as fruit bodies



Borg Dahl, M., et al. (2018): Sci. Rep. 8: 11662

Hidden and "real" diversity…

Comparison of OTUs (ribotypes from soil) and survey (ribotypes from fruit bodies)

Left: ML phylogeny of partial 18S rDNA
- all soil OTUs >5% frequency in any two samples (84 OTUs = 64,8% of all 838 553 reads)
- all fruitbody sequences (70 ribotypes from 537 collections, 2013-2016)

Fruit: relative abundance in survey

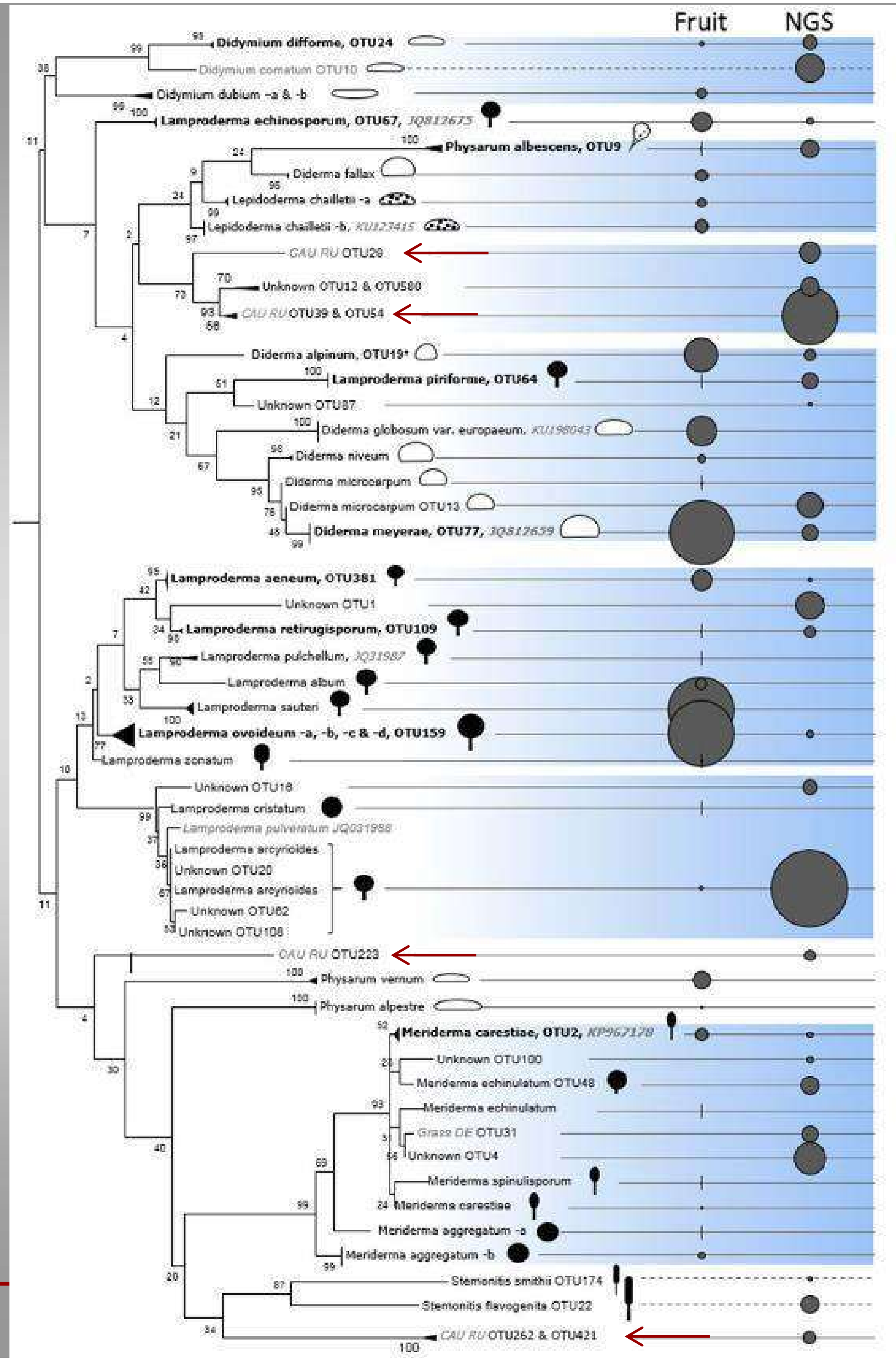
NGS: relative abundance in soil

Taxa in Bold: exact match Fruit = NGS
Lines - - - - - non-nivicolous myxomycetes (not surveyed yet)

Soil sampling: May 2016

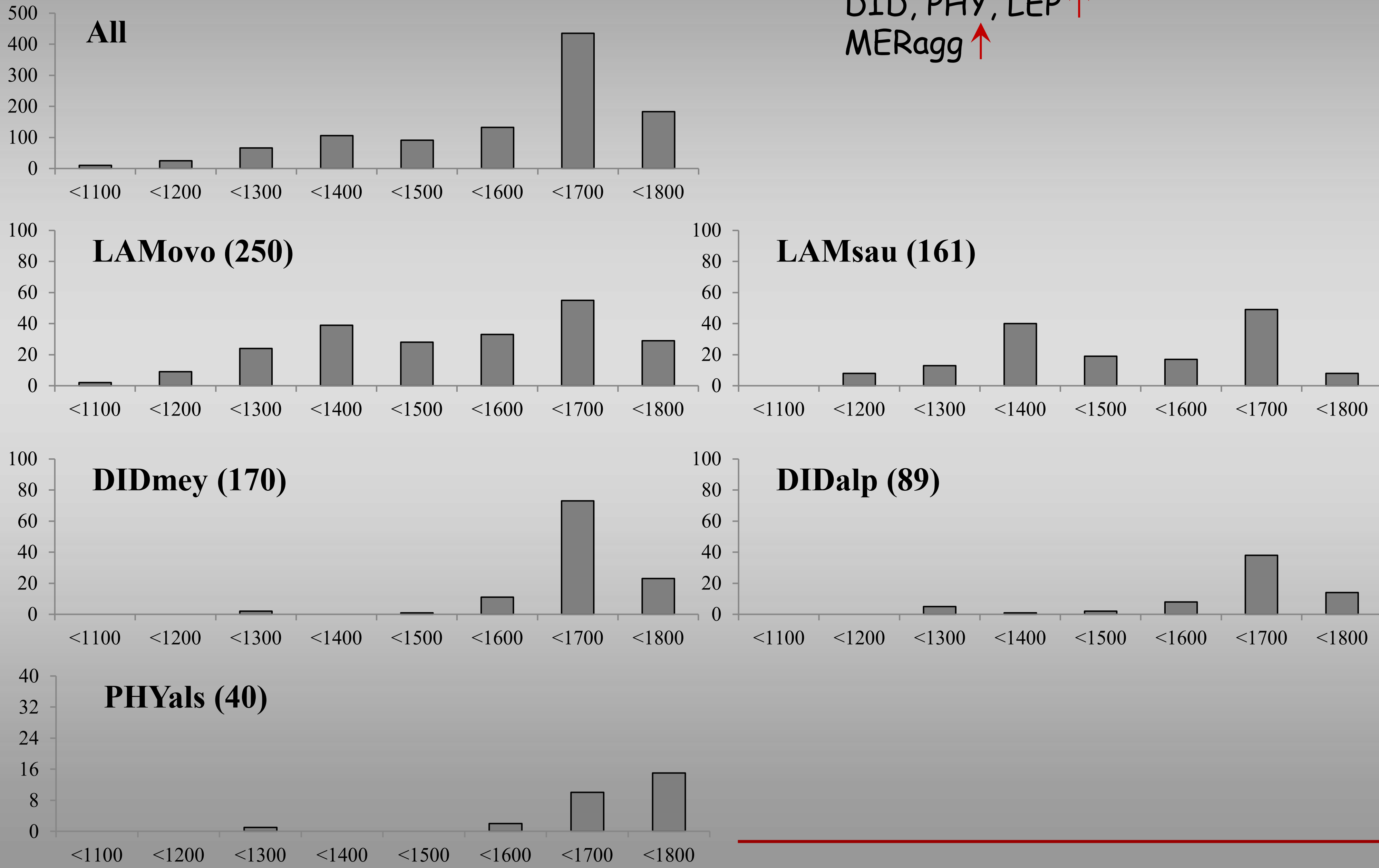
Schematic drawings: Fruit body size & shape

⟵ OTUs found with metabarcoding as well in the northern Caucasus fruitbodies unknown



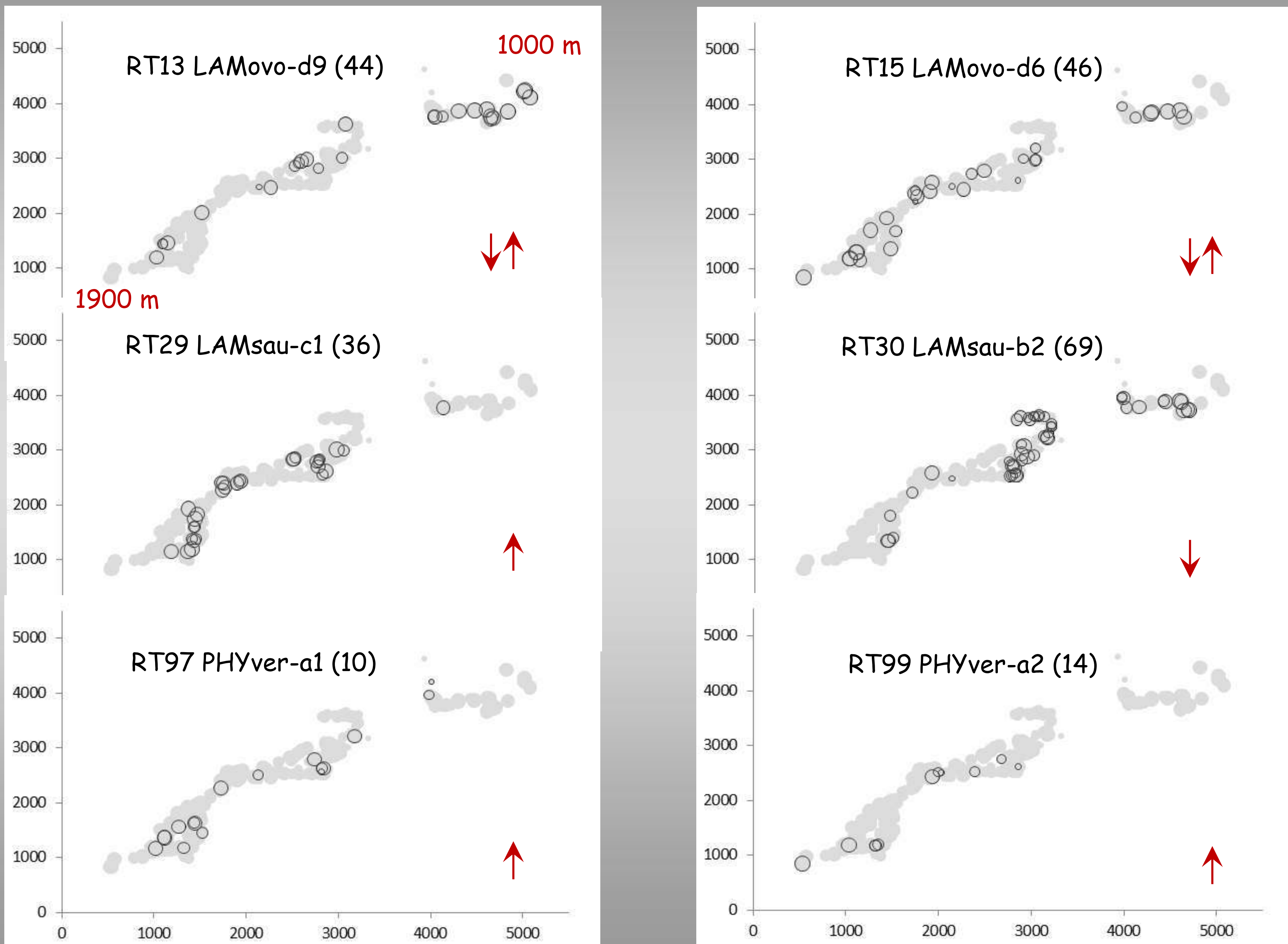
Zonation in morphospecies

LAMovo, LAMsau ↓
other LAM ↑
DID, PHY, LEP ↑
MERagg ↑



Zonation in ribotypes

Often no clear zonation ↓↑

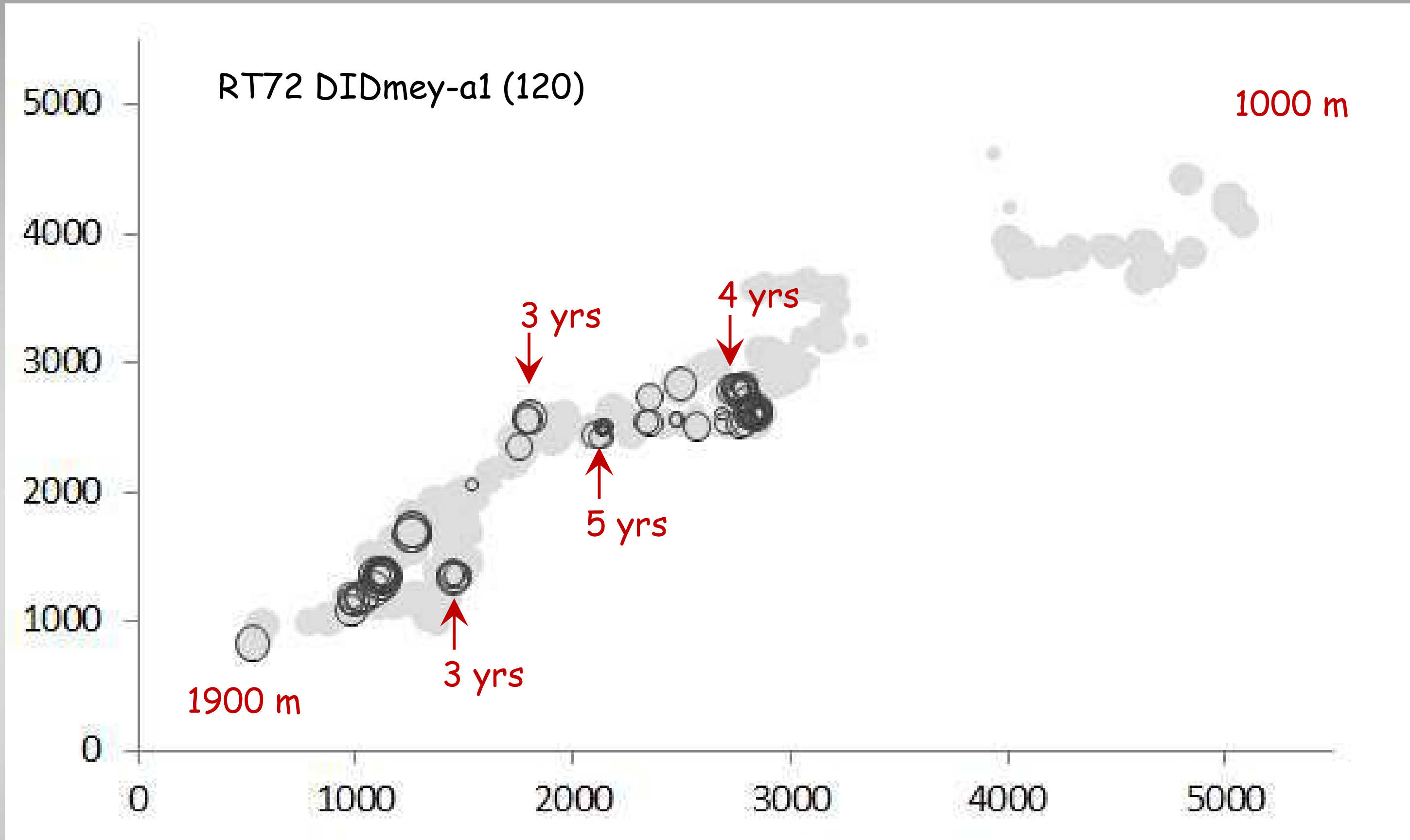


one biospecies ?

two biospecies ?

one biospecies ?

Steadyness of ribotypes



Ribotypes seem to be steady, but: are these the same genotypes?
Conclusion: we need high-resolving markers t ansqer this question!

Summary

1. Barcoding works - clear-cut clades for most, but not all morphospecies
- some with several putative morphospecies

2. We need a barcoding treshold - mutations are constantly at work!
- suggestion: Borg Dahl et al. 2018b: 99.1%

3. Comparison with metabarcoding results: there are sequences found only in soil (as amoeabae)
- mostly unknown but a significant proportion related to nivicolous species (especially *Lamproderma* spp.)

4. Zonation between morphospecies, but not between similar ribotypes (these belong to the same biospecies and mix)

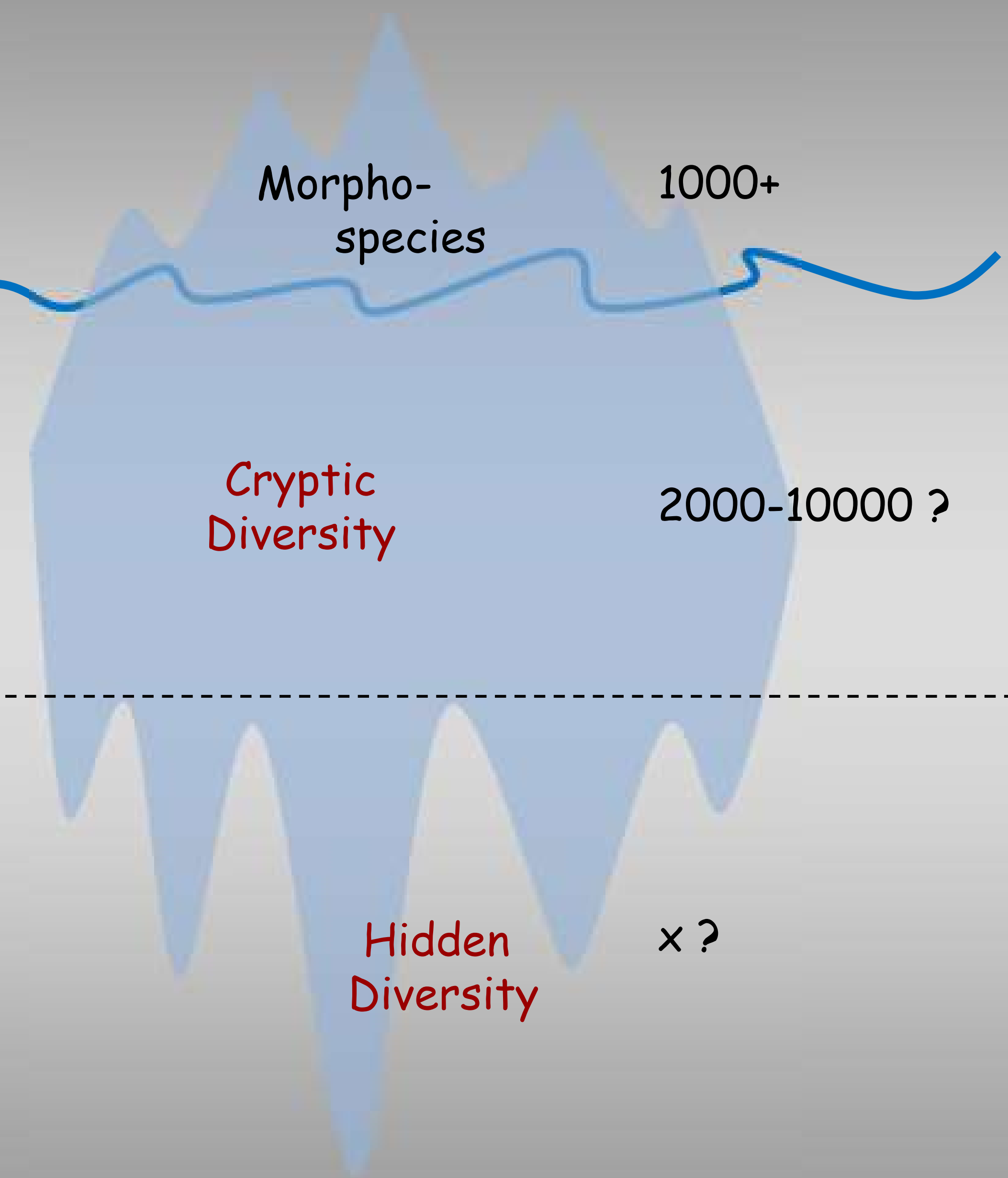
5. Morphospecies seem to occur year after year at the same place (and sometimes with the same ribotype)
But what about genotypes?

The tip of the iceberg?

- morphologically discernible species

- biological, i.e. reproductively isolated, biospecies
- a part of it is:

- species that may have lost the ability to fruit (and to reproduce sexually ?)




Thanks for your
attention

Additional slides

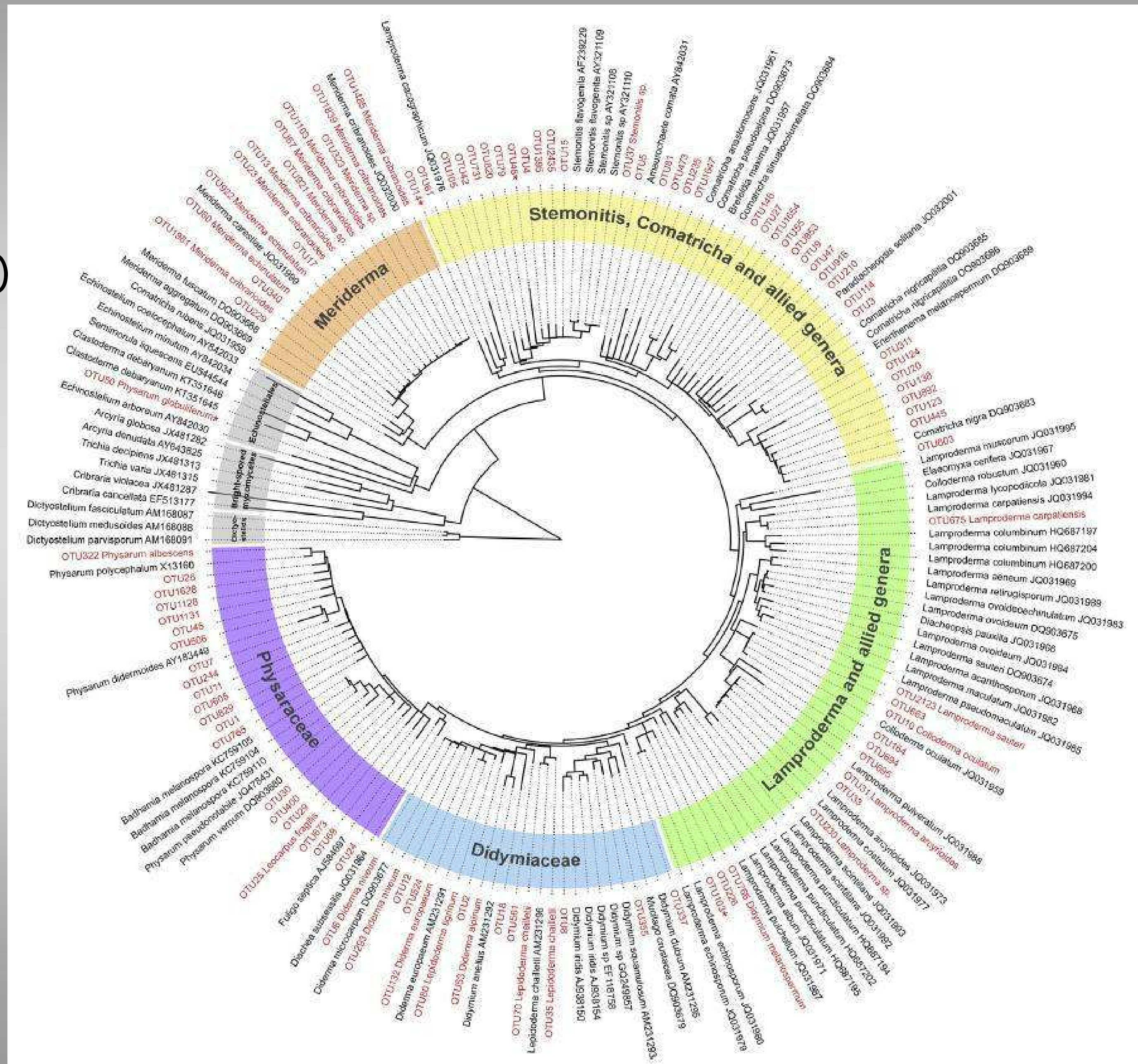
Myxomycetes not known as fruit bodies?

Comparison

Red names
metabarcoding survey from lowland forests (Russia, Leningrad region)

Black names
Sequences known from Fruit bodies

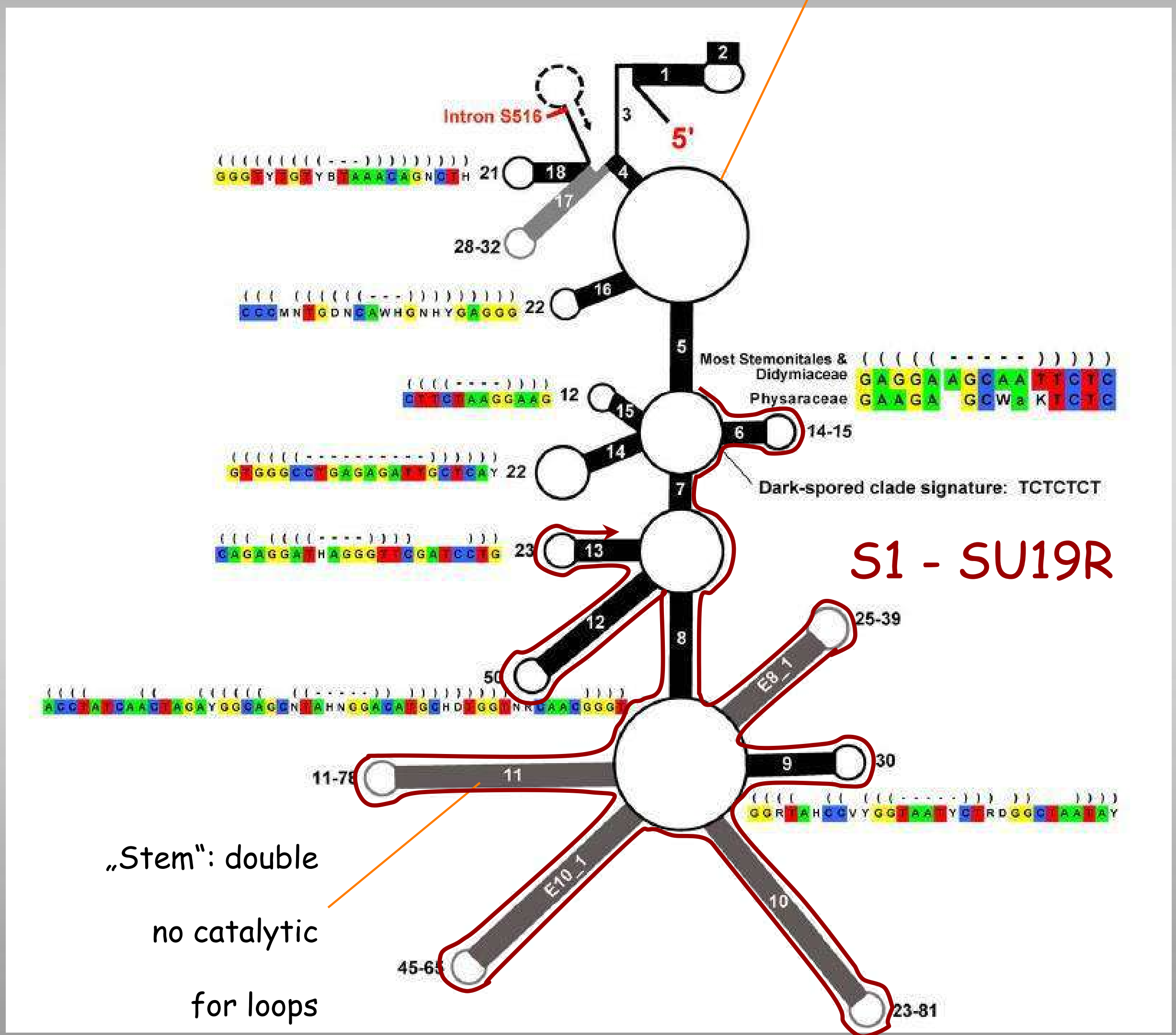
OTUs here clustered with 98% similarity



Shchepin et al. 2019, Fungal Ecology 39: 80-93

Secondary structure of the SSU

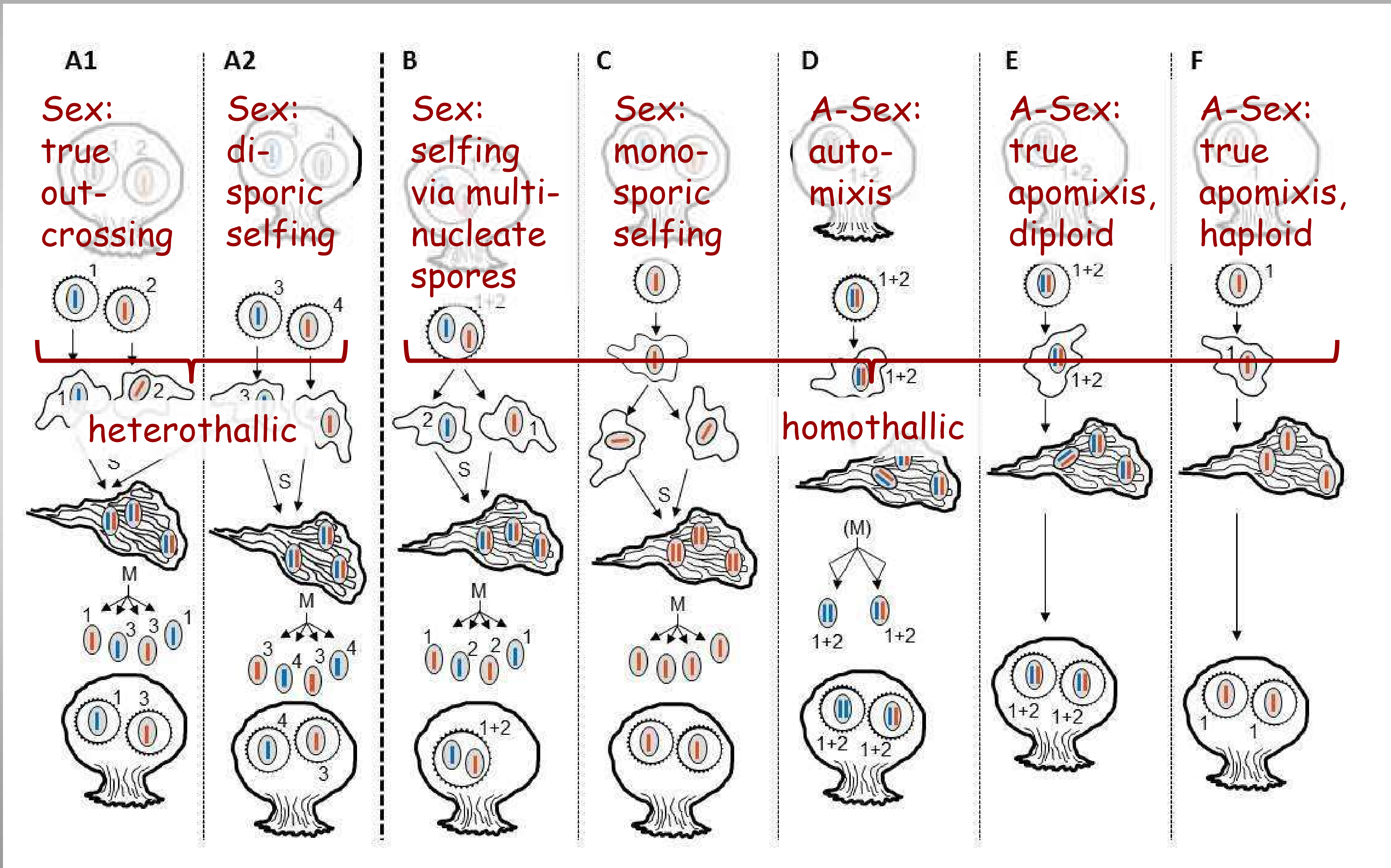
Schematic secondary structure of the first part of the SSU rRNA (after de Wyts et al. 2001), encompassing the first 18 helices and part of the 19th, up to the first intron insertion site. Helices (paired strands) common to all domains of life are represented by black rectangles and numbered (E8_1, E10_1 are unique to eukaryotes), lengths are given next to the loops. Single-stranded segments are indicated by thin lines. For helices whose length is conserved, a 95% consensus is shown. Helices whose length is variable are in grey and the length range is given. Consensus sequences of the helices are shown in the Stockholm format (parentheses = stem, hyphens = loop, blank = no paring); lower-case characters indicate a base that is not present in all sequences of the group.



Fiore-Donno et al. 2012, PloS One 7(4): e35359. doi:10.1371/journal.pone.0035359

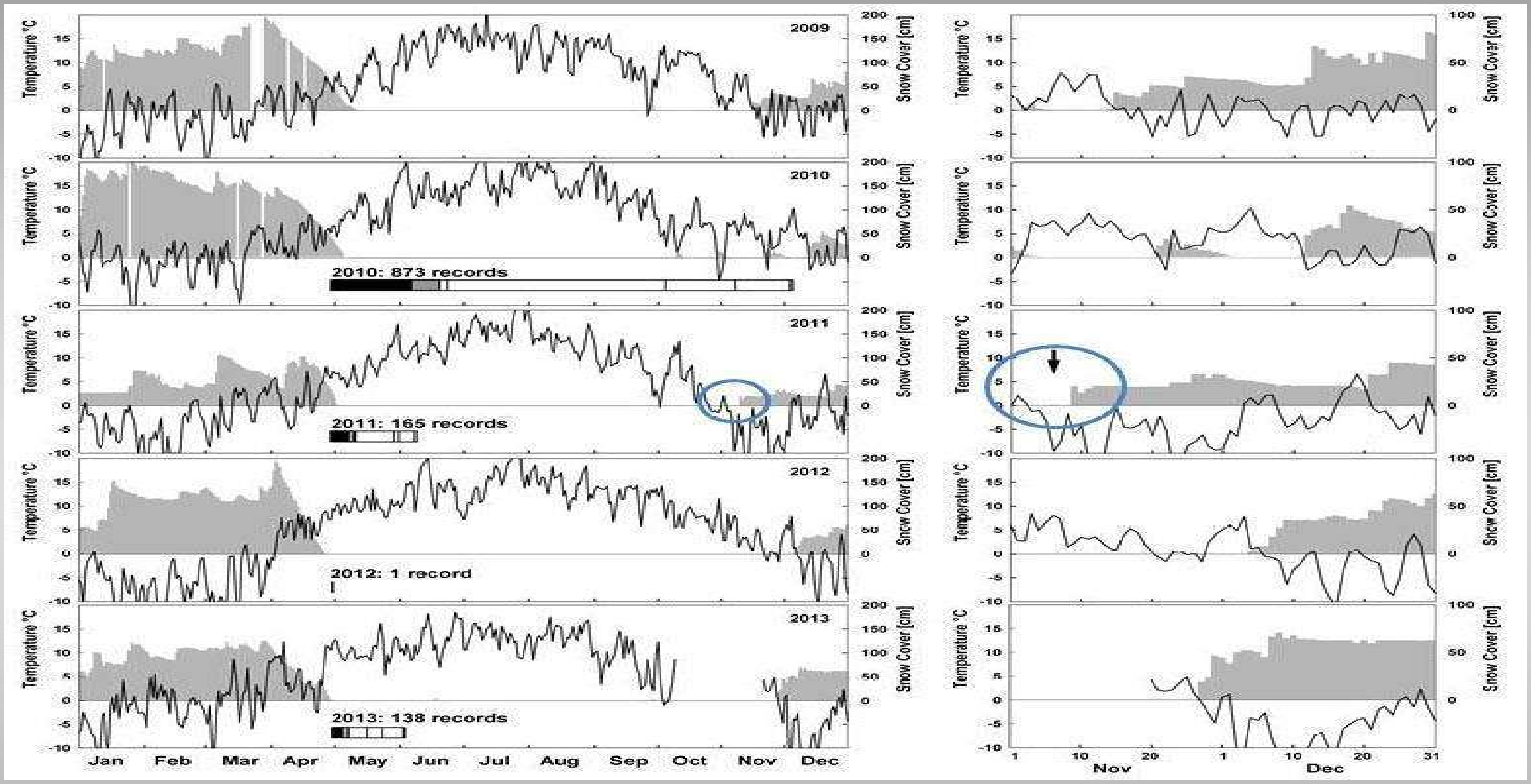
S = syngamy; M = meiosis; 1,2,--- mating types, red, blue = different genomes

Reproductive options in myxomycetes



Feng et al. 2016, Protist 167: 234-253.

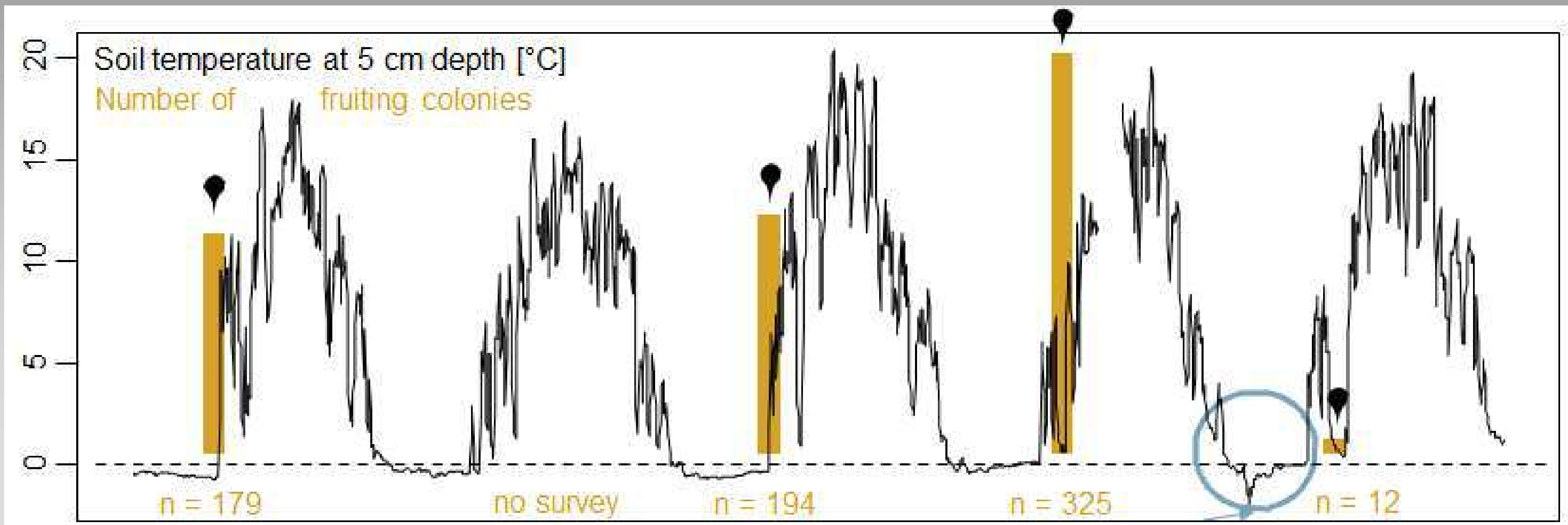
Weather and fructification propensity: Caucasus Mts.



Northern Caucasus, 2009-13: Plots of mean daily temperature (black line) and snow cover (grey bars, Klukhor pass weather station).
Horizontal bars: number of myxomycete colonies recorded in the years 2010–2013, with the genera *Lamproderma* as black, *Meriderma* as grey (both Stemonitales) and *Didymium*, *Diderma*, *Lepidoderma*, *Physarum* (all Physarales) as white sections. Right panel: Enlarged plots showing the months Oct / Nov of the respective year. Blue circles indicate frost events before the first snow falls.

Schnittler et al. 2015, Fungal Ecology 21: 16-23

Weather and fructification propensity: German Alps



German Alps, 2014-17: Soid temperature (black curve) at 5 cm height (weather station of the TU Munich, (German Alps, Garmisch-Partenkirchen, Kreuzeck, 1500 m)

Yellow bars: number of fructification found in the spring survey (Apr / May)

PUTTING OUR SLIMIES ON A PREDICTIVE MAP

Applying species distribution models on myxomycete research

Nikki Heherson A. Dagamac, Oleg Shchepin, Jan Woyzichovski
Yuri Novozhilov & Martin Schnittler

Russian Academy of Sciences

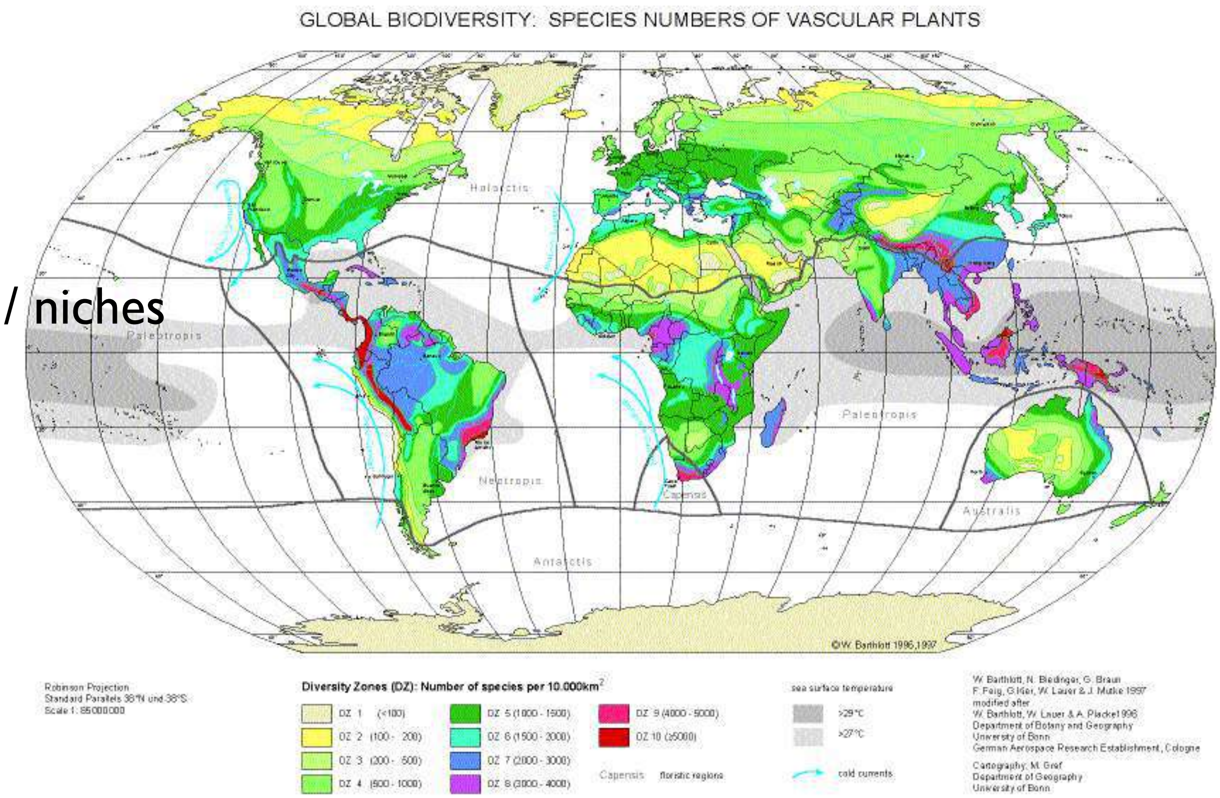
reSPONse

So what is this talk going to be about?

MAPS

But with a little twist

Shows potential distribution / niches
Shows range dynamics
Shows prediction



At the end…

we can discuss how reliable models can be on the light of experiential knowledge of myxomycete experts like you!

WHY DO MODELLING???

Besides feeding our curiosity and boredom…

- Know the range of the distribution of species
- Predict where a particular species can occur
- Information about organism – environment relationship

IN RESPONSE TO…

- ❑ Increasing rate of habitat loss
- ❑ Incomplete information (spatial & temporal) of distribution of large number of taxa
- ❑ Climate change

Species Distribution modeling...

Uses computer algorithms to identify putative areas within a landscape that have “**similar**“ environments to areas where a species has been previously reported

Species Distribution modeling…

Uses computer algorithms to identify putative areas within a landscape that have "**similar**" environments to areas where a species has been previously reported

……NOTHING MORE…. However,

Species Distribution modeling…

Uses computer algorithms to identify putative areas within a landscape that have "**similar**" environments to areas where a species has been previously reported

……NOTHING MORE…. However,

This information can be extremely useful = ECOLOGICAL KNOWLEDGE

Approaches of modeling

- **Correlative** VS. Mechanistic

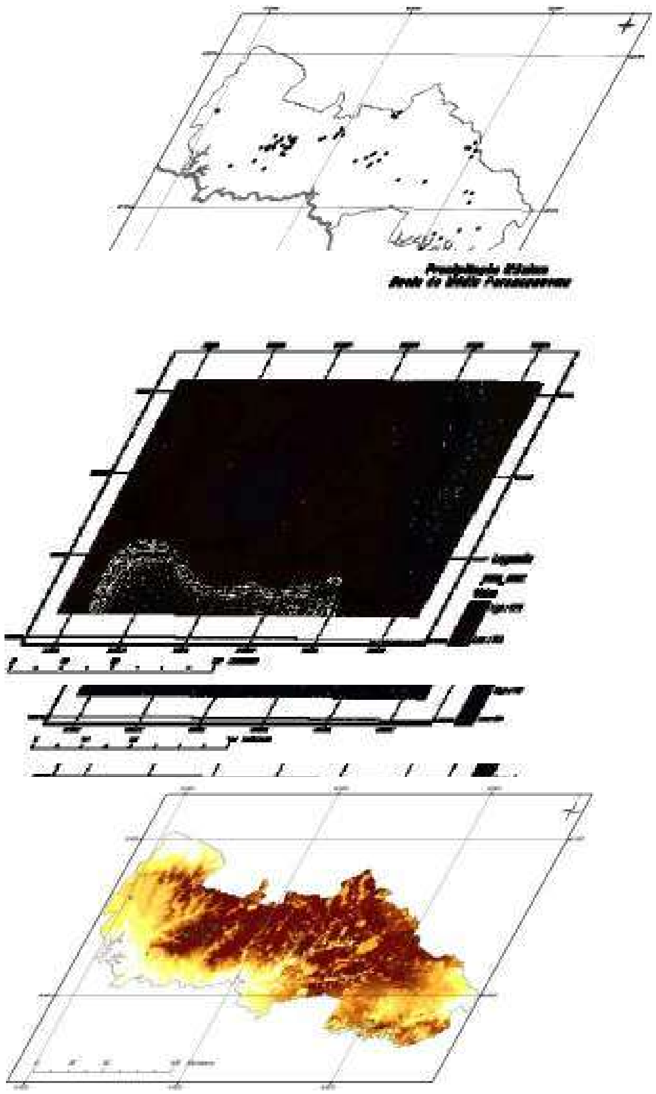
aim to estimate the environmental conditions that are suitable for a species by **associating** known **species' occurrence records** with **suites of environmental variables** that can reasonably be expected to affect the species' physiology and probability of persistence. (Pearson, 2011)

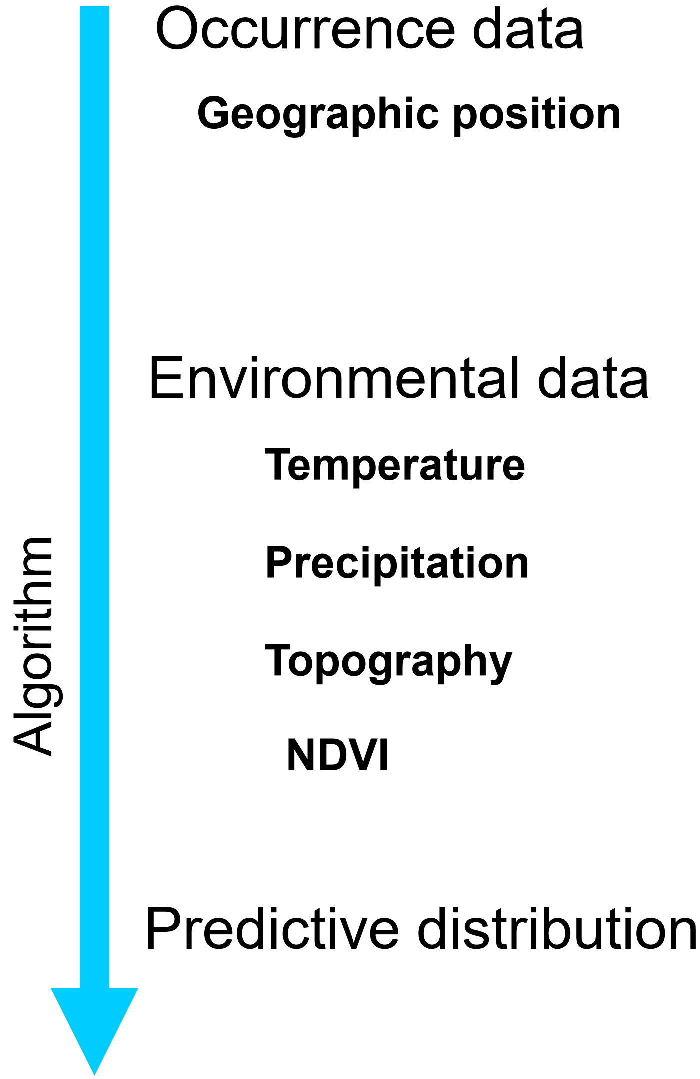
Approaches of modeling

- Correlative VS. **Mechanistic**

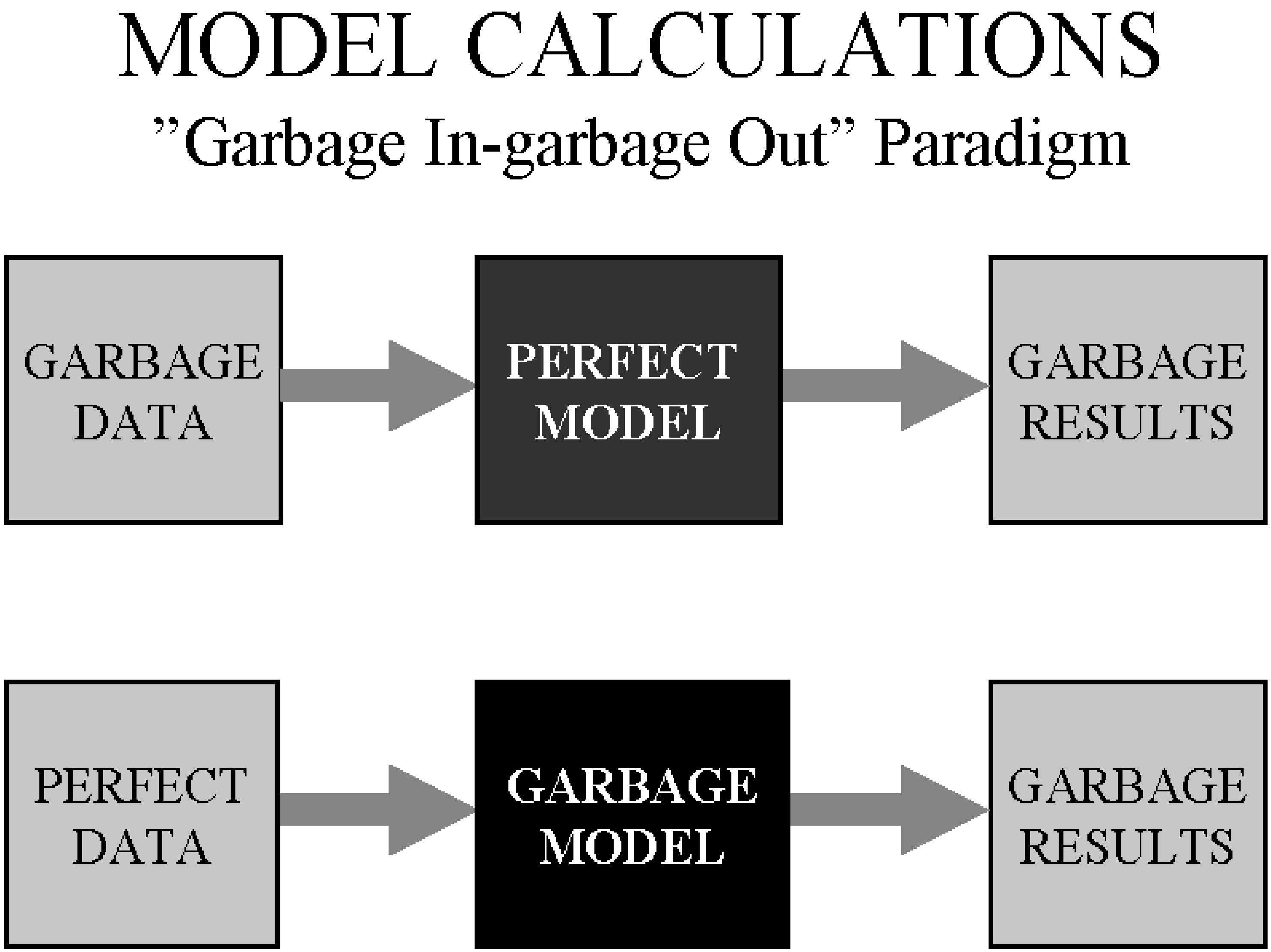
Require detailed understanding of the physiological response of species to environmental factors and are therefore difficult to develop for all but the most well understood species. (Pearson, 2011)

How species distribution models work?



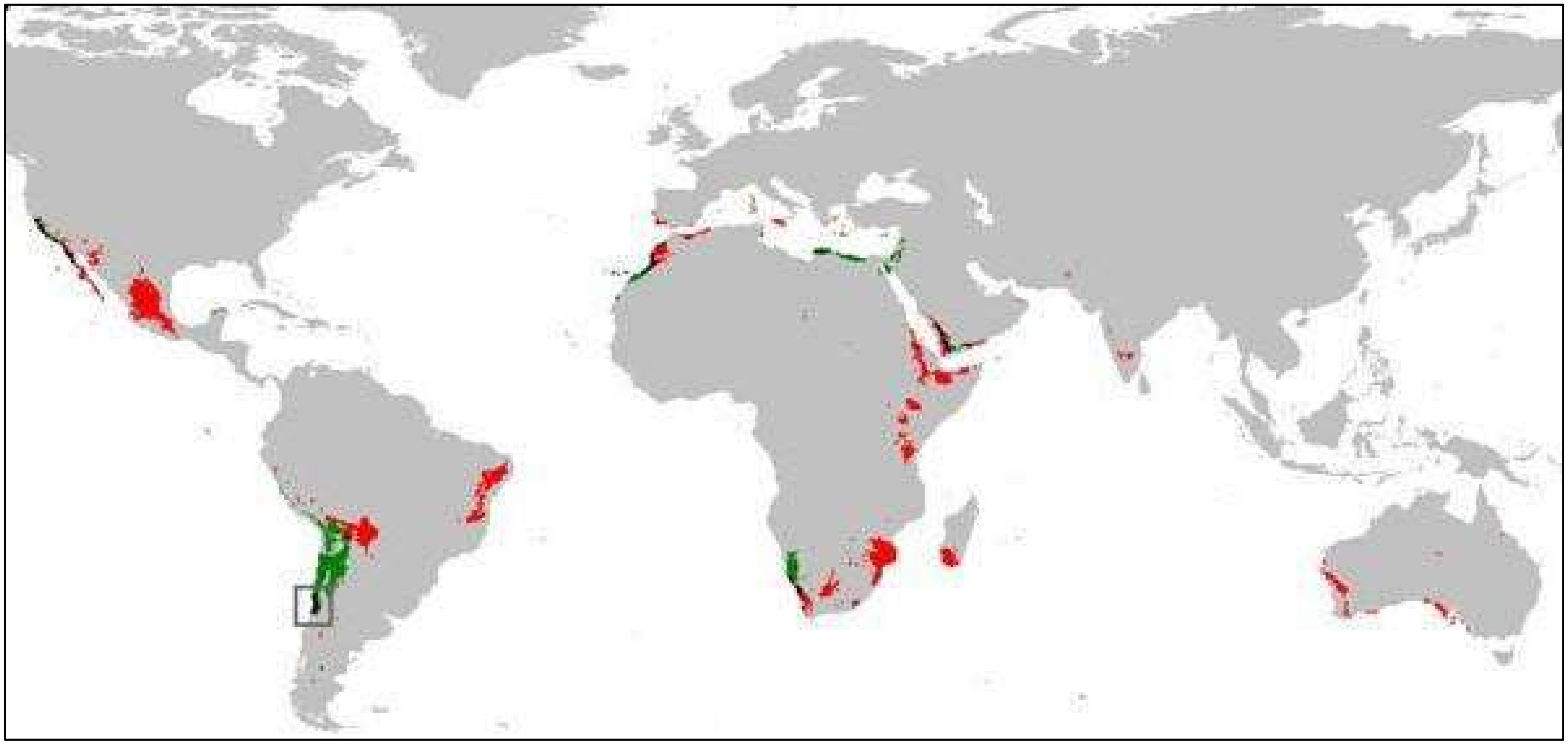


WARNING!!!!


MODEL CALCULATIONS
"Garbage In-garbage Out" Paradigm
GARBAGE DATA
PERFECT MODEL
GARBAGE RESULTS
PERFECT DATA
GARBAGE MODEL
GARBAGE RESULTS

Applying modelling to slime molds research

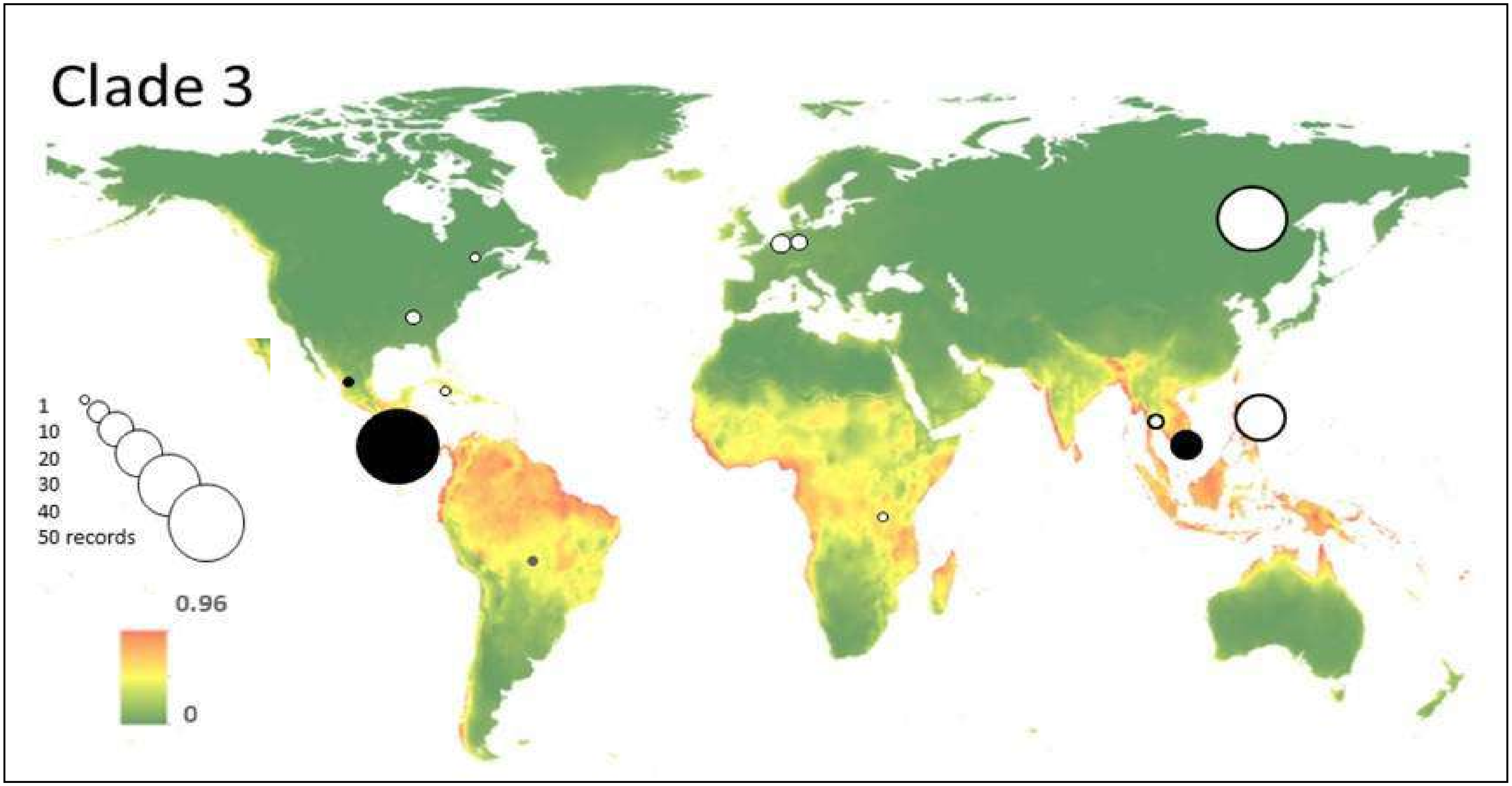
Testing biogeographical hypothesis



Highlights:
Two cryptic species of *Badhamia melanospora* showed structured distribution

Aguilar et al., 2014 , ISME Journal

Testing biogeographical hypothesis



Dagamac et al., 2017, PLOS One

Highlights:
Four reproductively isolated biospecies of *Hemitrichia serpula* was reported with Clade 3 (var. parviverrucospora) showing restricted pantropical distribution

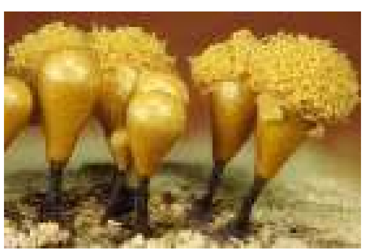
Establishing baseline data for local environmental policies

Arcyria cinerea

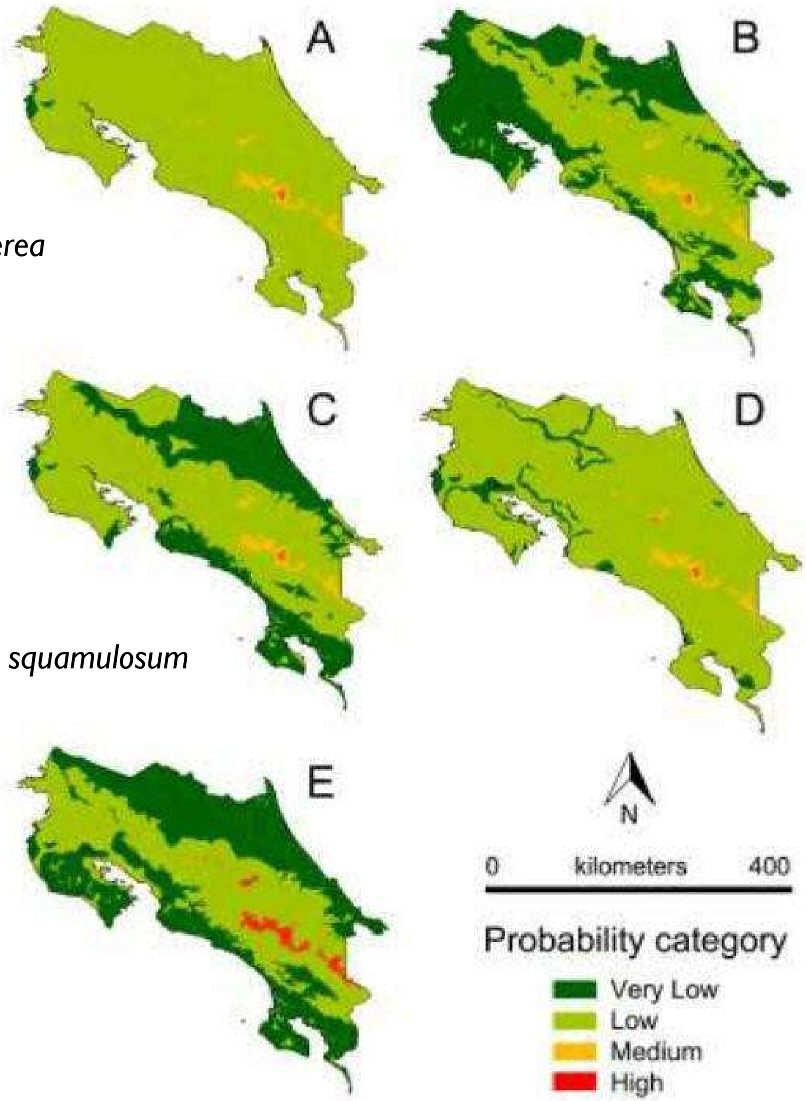
Physarum compressum

Didymium squamulosum

Didymium iridis

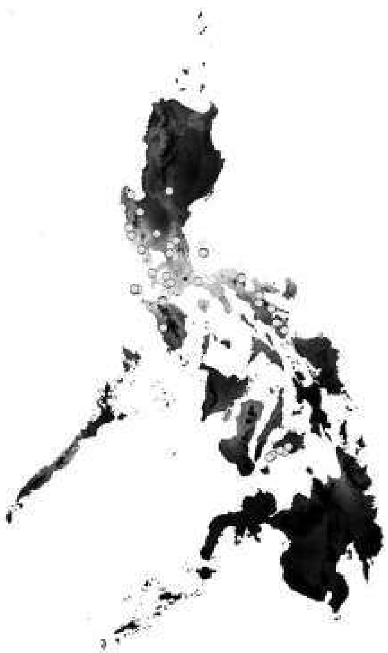


Hemitrichia calyculata

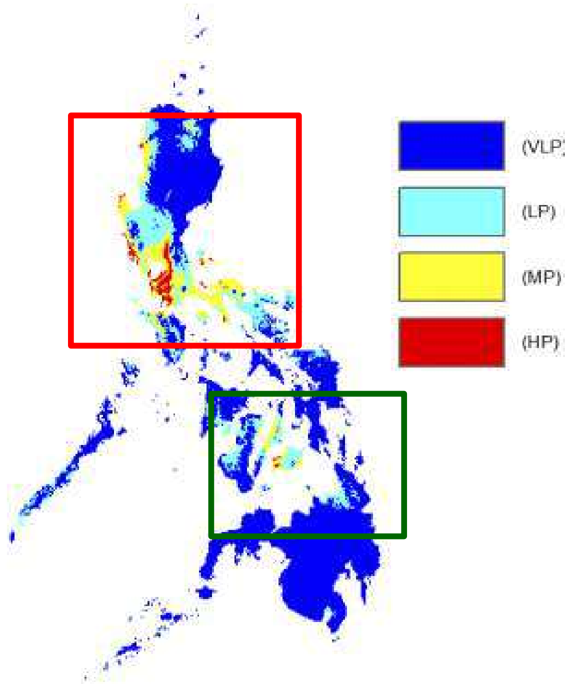


Rojas et al., 2015, Curr. Res. Environ. App. Mycol.

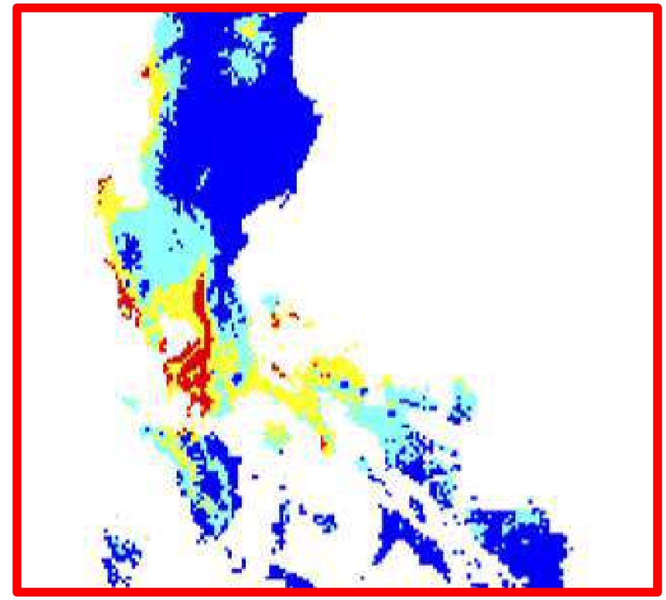
Establishing baseline data for local environmental policies

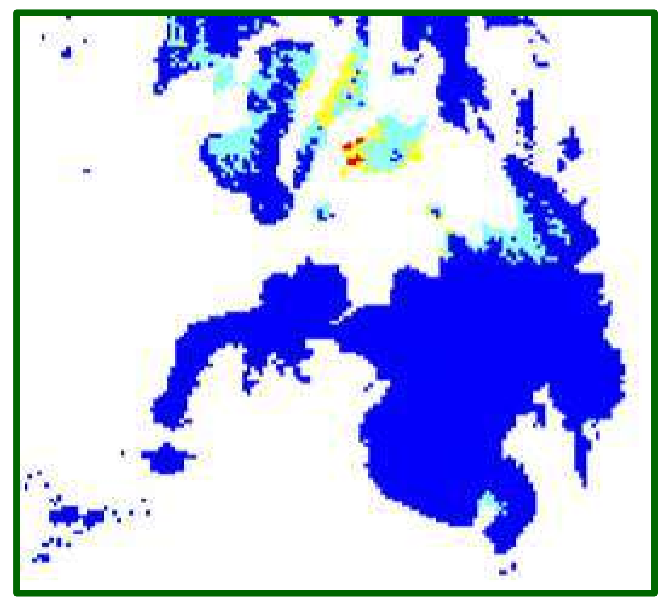


***Diderma hemisphaericum* local distribution**



Current Climate





Diderma hemisphaericum

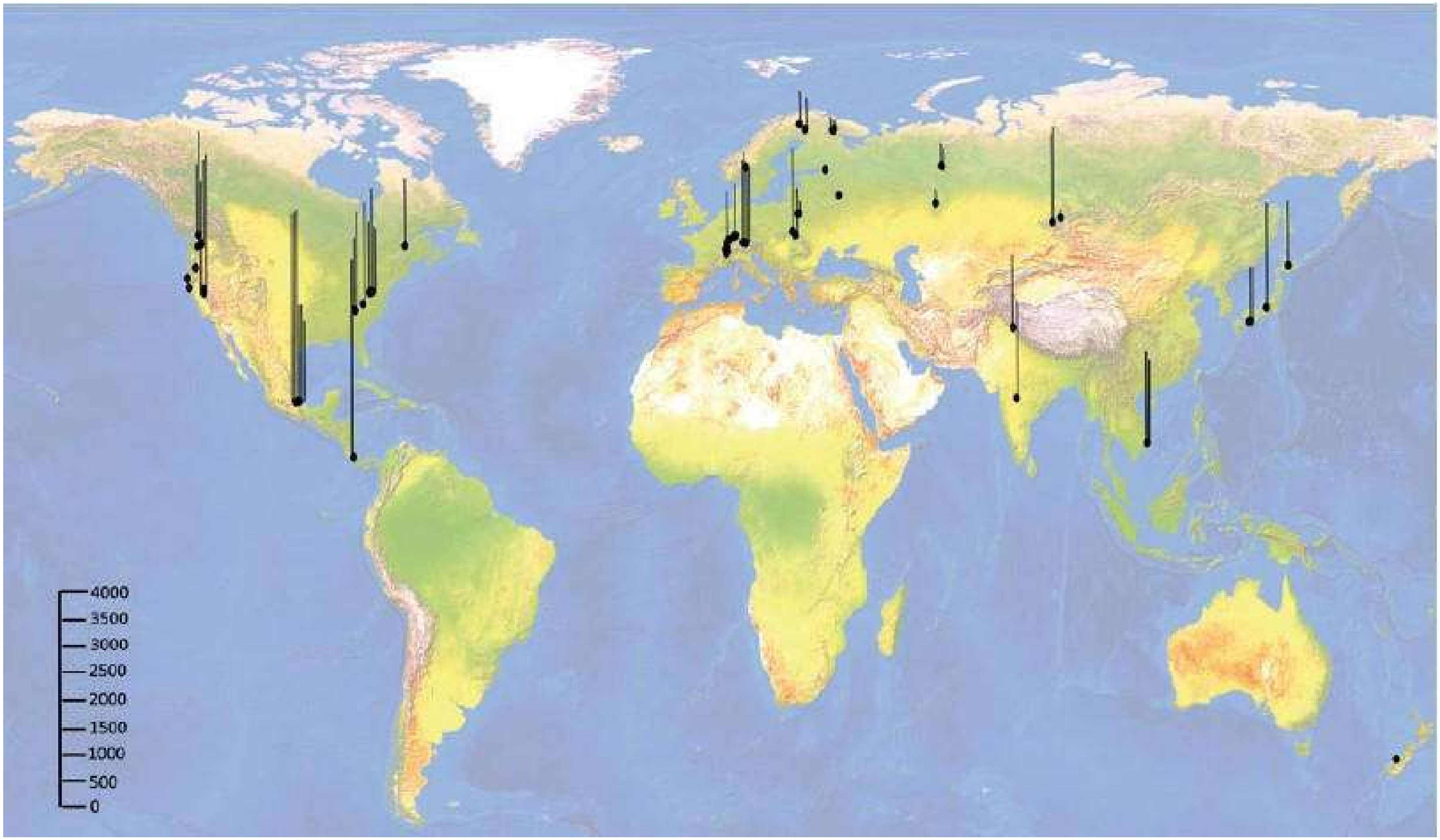
Almadrones-Reyes & Dagamac, 2018, Curr. Res. Environ. App. Mycol.

Predicting distributional ranges:
Case study of *Barbeyella minutissima*

- Rare myxomycete
- known preferentially from mountain coniferous biomes of the Northern Hemisphere
- Distributional limits?

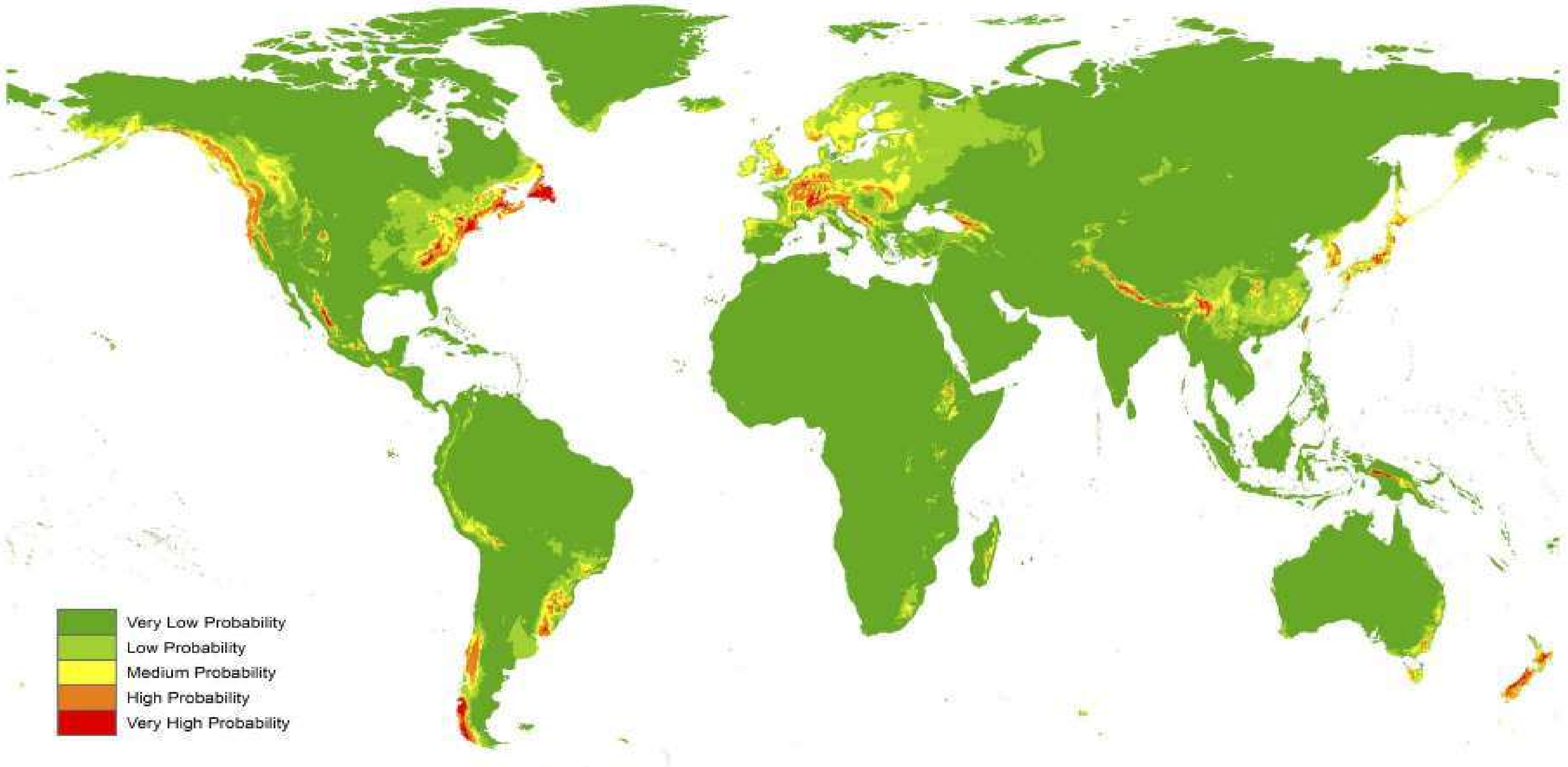
Stephenson et al., 2019, Nova Hedwigia

Predicting distributional ranges:
Case study of *Barbeyella minutissima*



Stephenson et al., 2019, Nova Hedwigia

Predicting distributional ranges:
Case study of *Barbeyella minutissima*



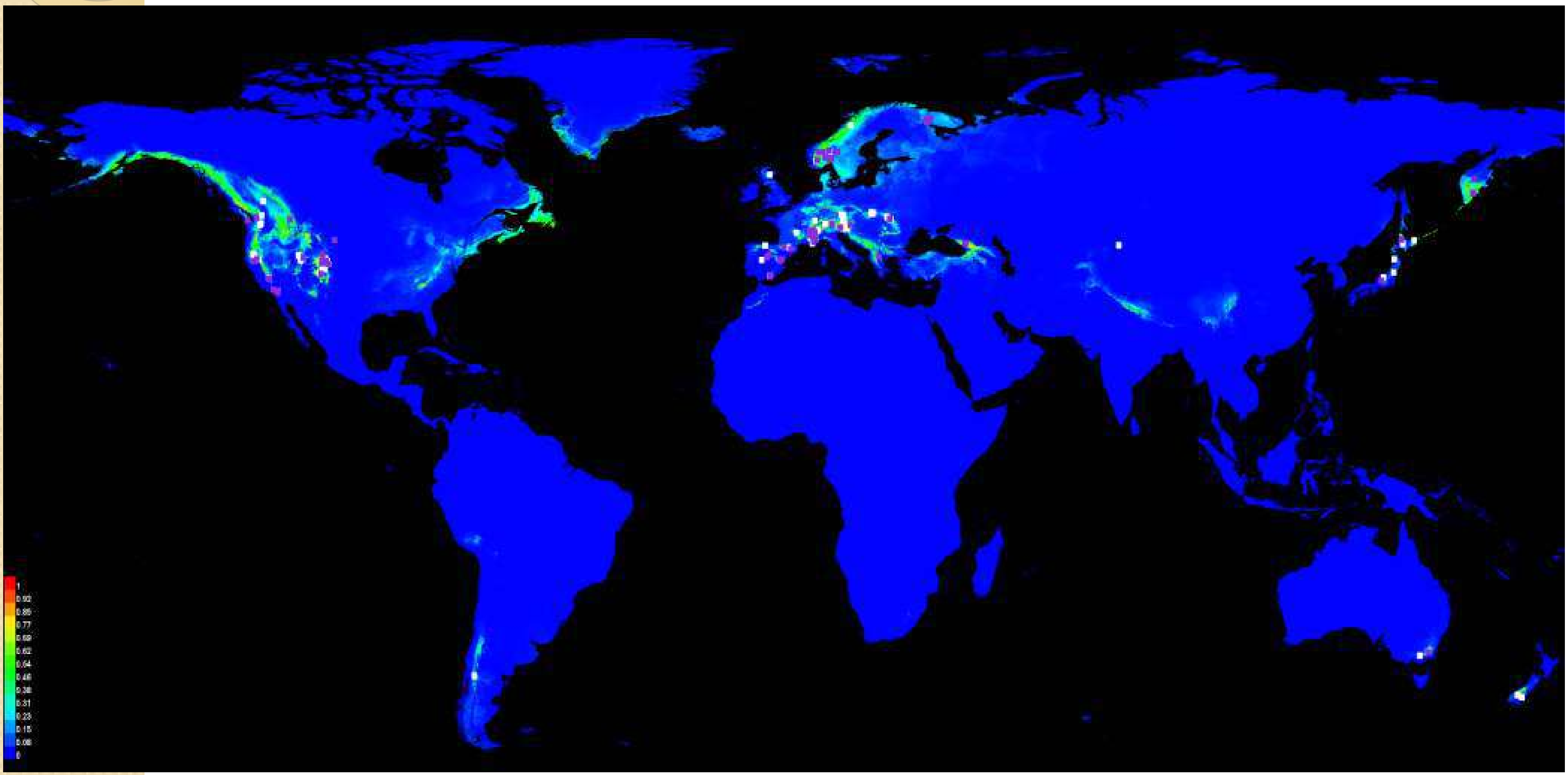
Stephenson et al., 2019, Nova Hedwigia

Predicting distributional ranges:
Case study of *Physarum albescens*

Which suitable places can we probably find morphologically clear cut nivicolous myxomycete species *Phy. albescens?*

Predicted model generated from MaxEnt

Most probable in the Northern Hemisphere
AUC = 0.980



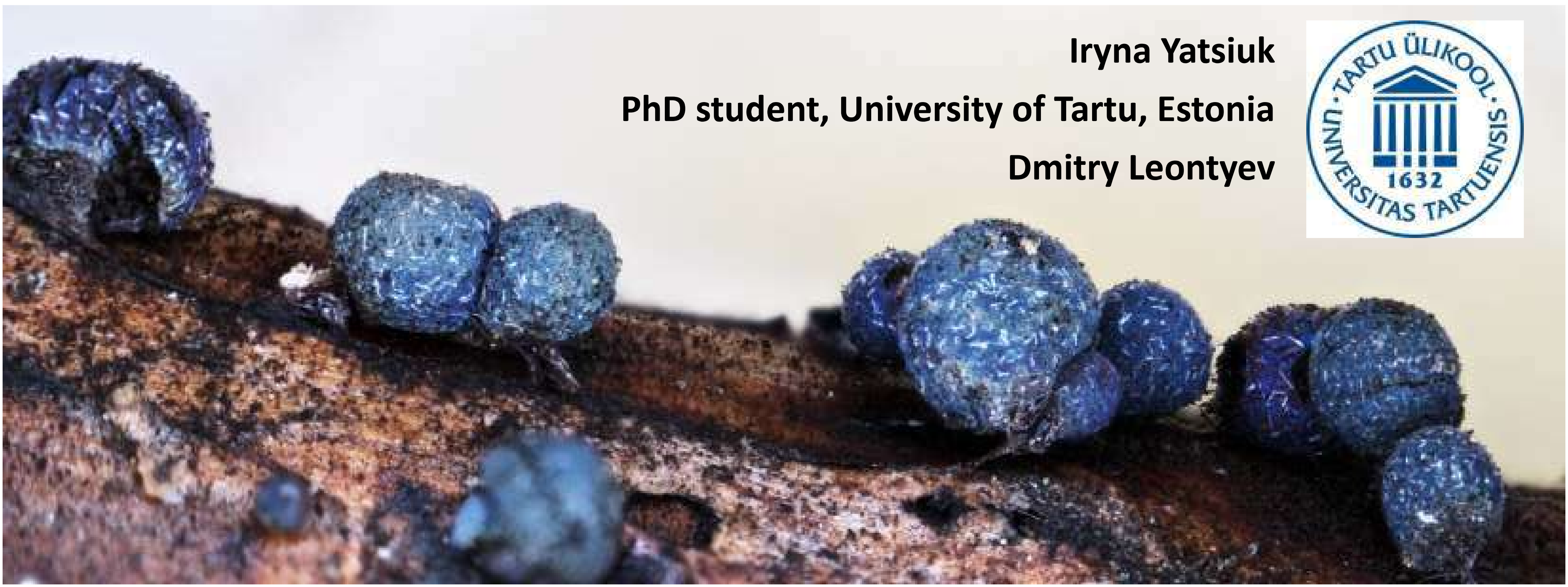
Take Home Message

Bare with me…

this will only take the last few minutes….

- Models works but consider critical points
  - What type of species data should I use?
  - Is absence really an absence?
  - How many occurrence point should I need?
  - Are my data points bias?
  - Are the spatial data accurate?
- Models needs to be back up by theoretical and experiential knowledge
- **Modeling myxomycetes is a promising feat**

Do “lowland nivicolous” myxomycetes fruitify more regularly than we think?



Iryna Yatsiuk

PhD student, University of Tartu, Estonia

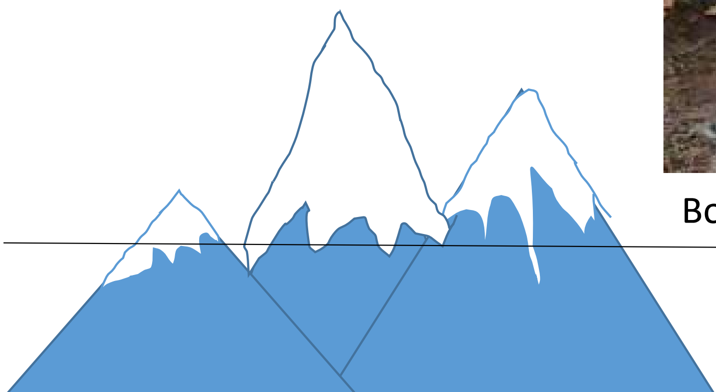
Dmitry Leontyev

TARTU ÜLIKOOL UNIVERSITAS TARTUENSIS 1632


Spring 2017, Ukraine
Weird toadspawn?

Nivicolous myxomycetes (NM) form fruitbodies under special “nivicolous” conditions

>100 species



Border of melting snow

- **1908** – NM are strictly confined to alpine and subalpine biotopes (Meylan, 1908)
- **100 years later** – NM fruit in mountain forests, rather than in alpine meadows (Ronikier and Ronikier, 2009)
- **Recent metagenomic studies:** sequences attributed to NM are repeatedly found in lowland soils, even if no fruitbodies are detected (Kamono et al, 2013; Novozhilov et al., 2012; Clissmann et al., 2015; Fiore-Donno et al., 2016; Shchepin et al., 2019 …)

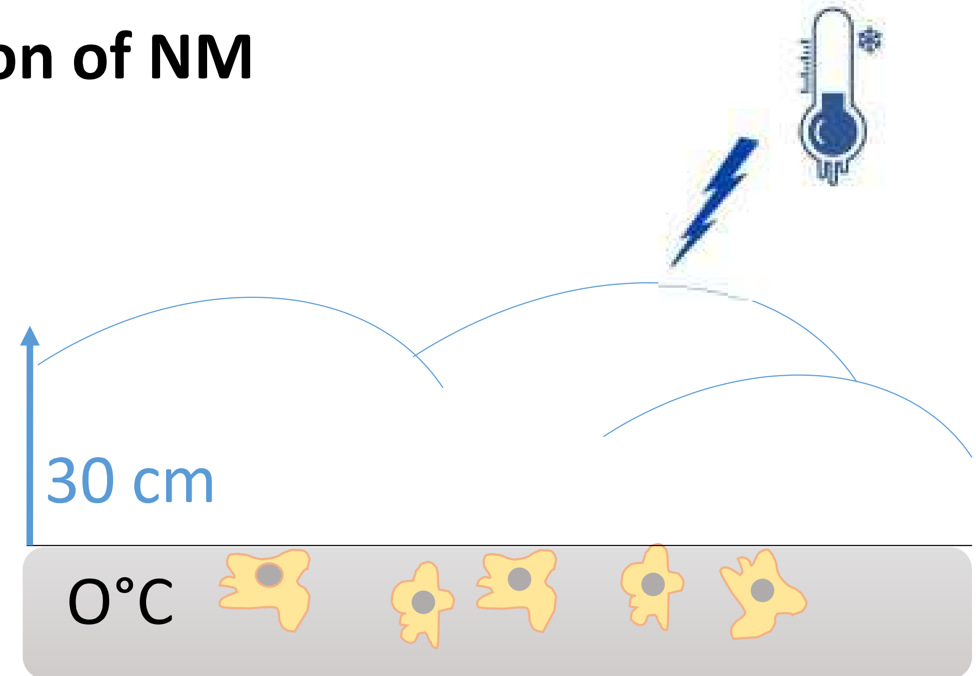
Conditions favourable for frutification of NM according to Schnittler et al, 2015

- a stable snow cover is established

  before the first sharp night frosts

- the depth of snow cover mostly **exceeds 30 cm**, providing a protection against frost and a long period of snowmelt in spring

- a snow cover is **stable until frosts decline** in the spring



Four years in the Caucasus – observations on the ecology of nivicolous myxomycetes

M. SCHNITTLER[a,*], D.A. ERASTOVA[b], O.N. SHCHEPIN[b], E. HEINRICH[a], Y.K. NOVOZHILOV[b]

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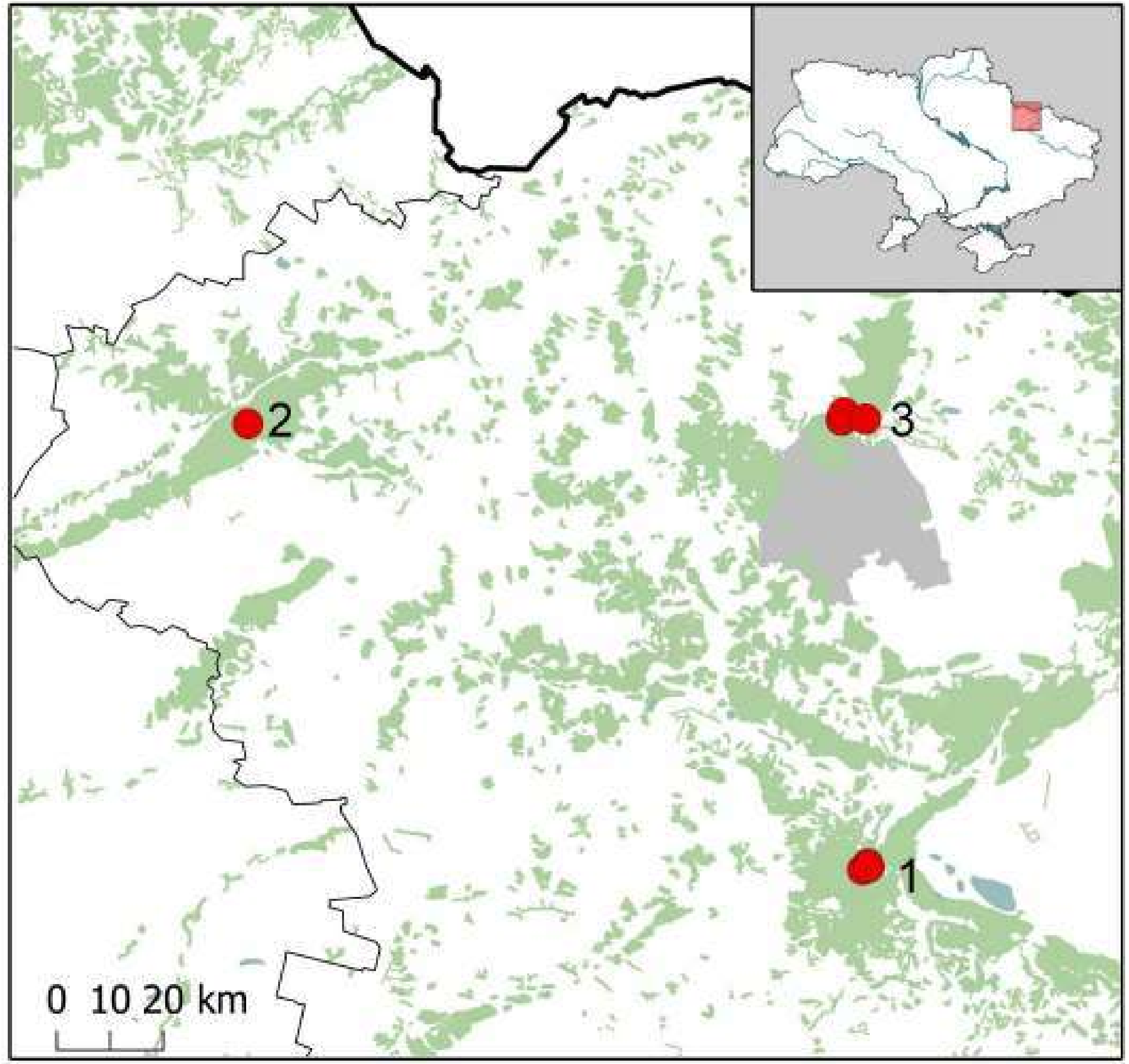
[b]V.L. Komarov Botanical Institute of the Russian Academy of Sciences, Prof. Popov St. 2, 197376 St. Petersburg, Russia

- 3 years: 2017-2019
- 3 localities
- 26 specimens
- abundant fruiting



- Collection sites: *Quercus robur*-dominated upland forests, *Populus tremula*-dominated -dominated groves
- Elevations: 116-192 m a.s.l.
- Successional and climax communities

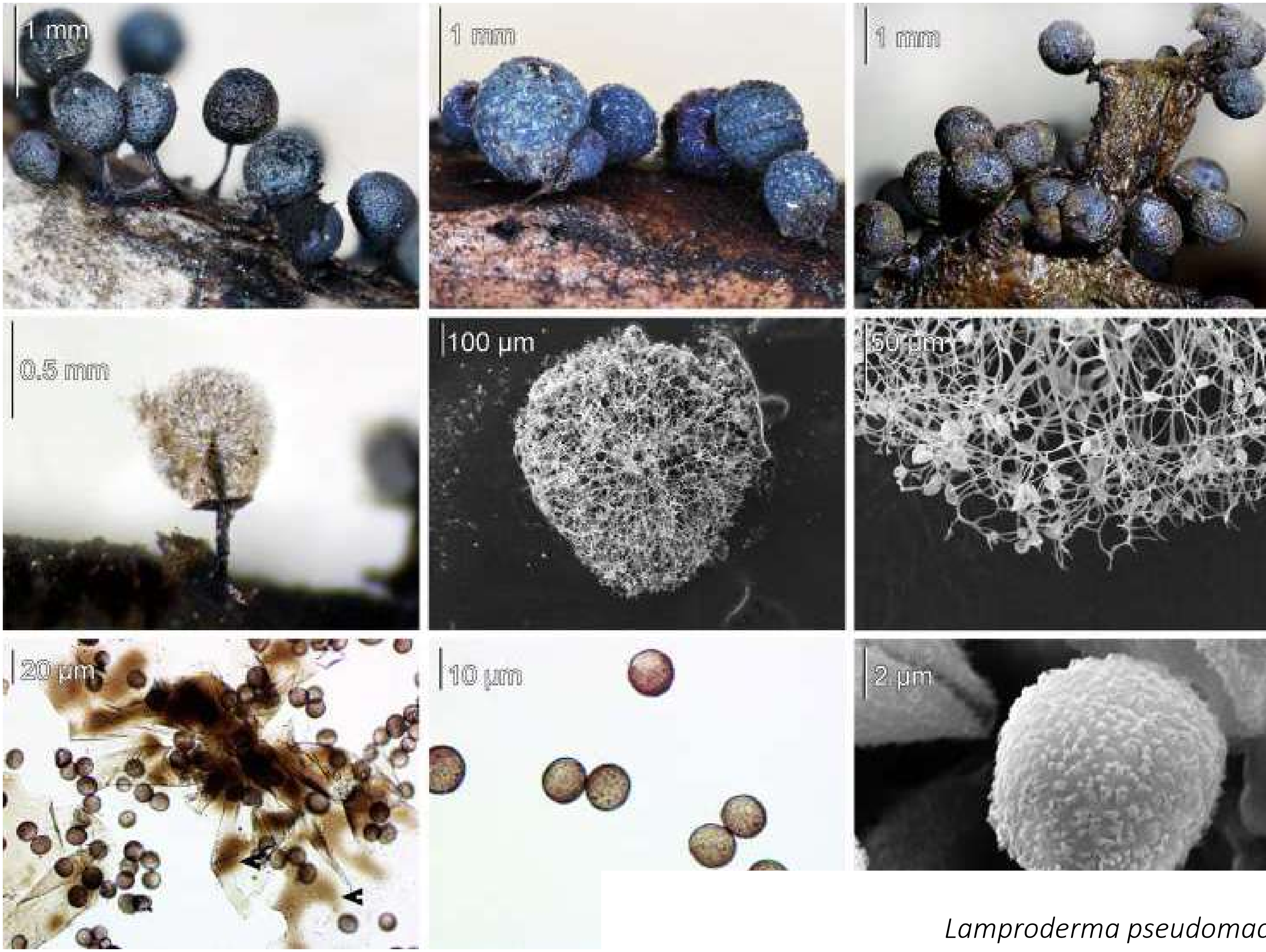
The dataset is here:
https://dx.doi.org/10.15156/BIO/786365

PlutoF

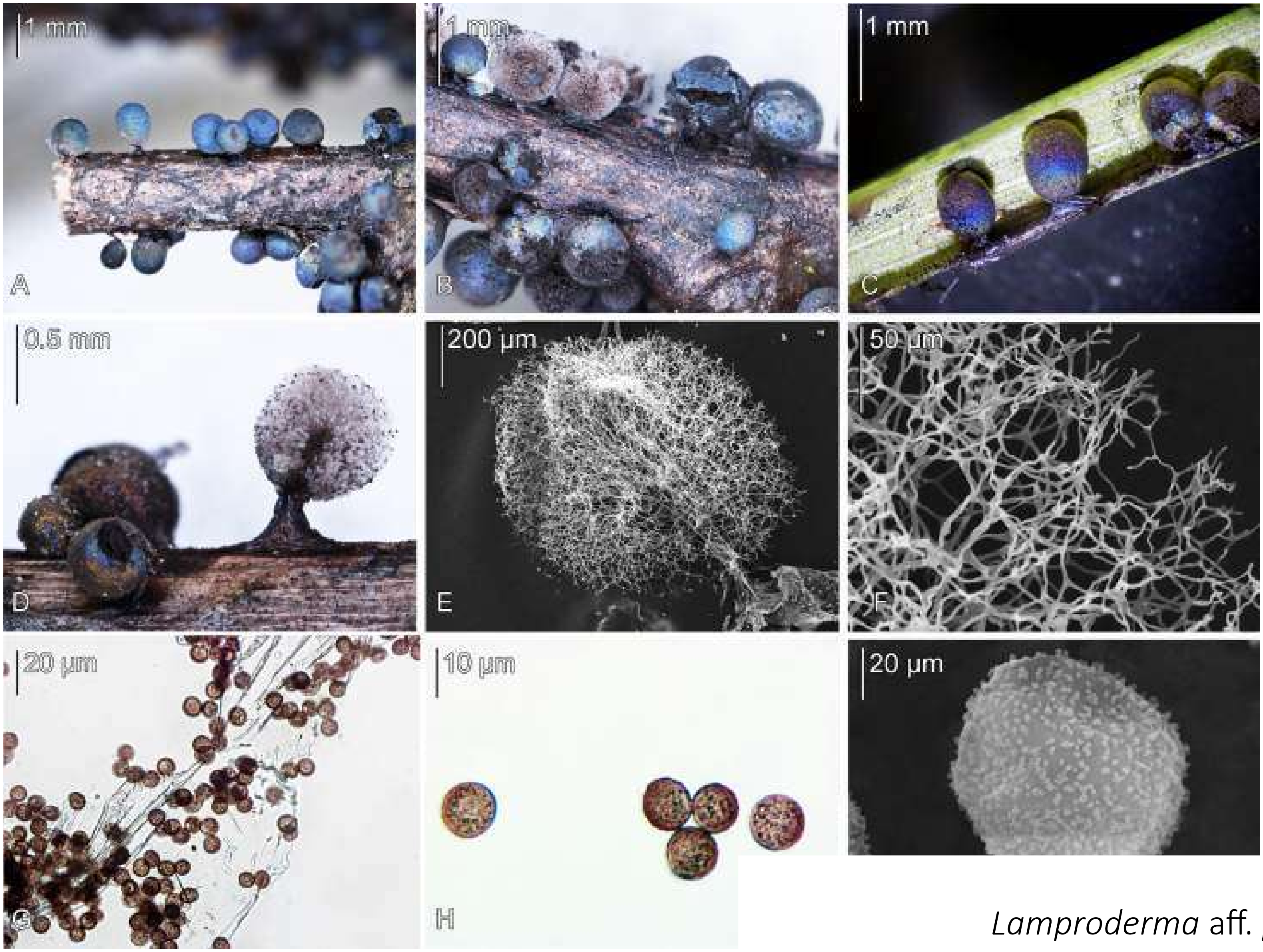
Two taxa identified by morphological examination

Lamproderma pseudomaculatum

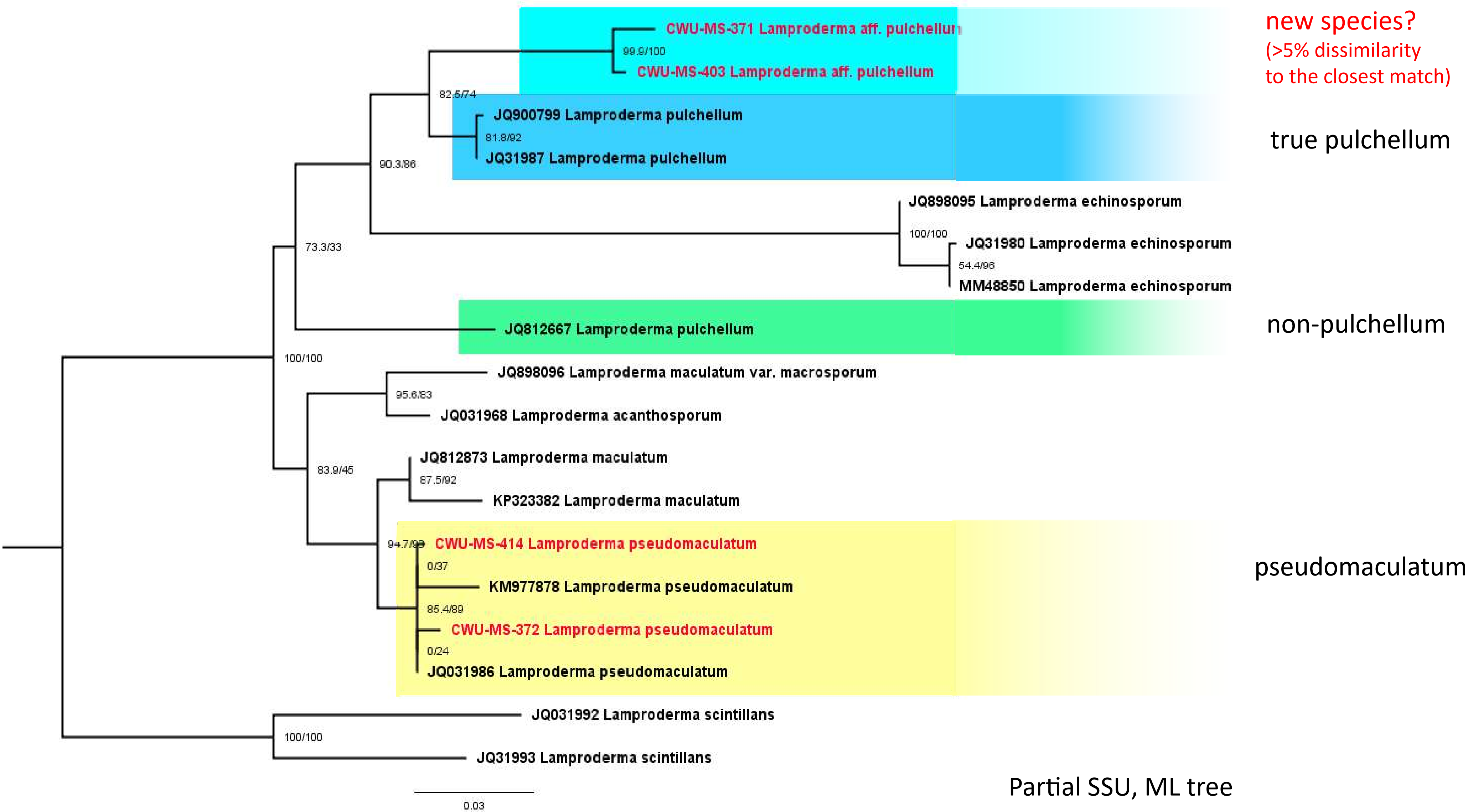
Lamproderma aff. *pulchellum*



Lamproderma pseudomaculatum



Lamproderma aff. *pulchellum*



CWU-MS-371 Lamproderma aff. pulchellum
99.9/100
CWU-MS-403 Lamproderma aff. pulchellum
82.5/74
JQ900799 Lamproderma pulchellum
81.8/92
JQ31987 Lamproderma pulchellum
90.3/86
JQ898095 Lamproderma echinosporum
100/100
JQ31980 Lamproderma echinosporum
54.4/96
MM48850 Lamproderma echinosporum
73.3/33
JQ812667 Lamproderma pulchellum
100/100
JQ898096 Lamproderma maculatum var. macrosporum
95.6/83
JQ031968 Lamproderma acanthosporum
JQ812873 Lamproderma maculatum
87.5/92
83.9/45
KP323382 Lamproderma maculatum
94.7/98
CWU-MS-414 Lamproderma pseudomaculatum
0/37
KM977878 Lamproderma pseudomaculatum
85.4/89
CWU-MS-372 Lamproderma pseudomaculatum
0/24
JQ031986 Lamproderma pseudomaculatum
JQ031992 Lamproderma scintillans
100/100
JQ31993 Lamproderma scintillans
0.03
new species?
(>5% dissimilarity
to the closest match)
true pulchellum
non-pulchellum
pseudomaculatum
Partial SSU, ML tree

Two taxa identified by morphological examination

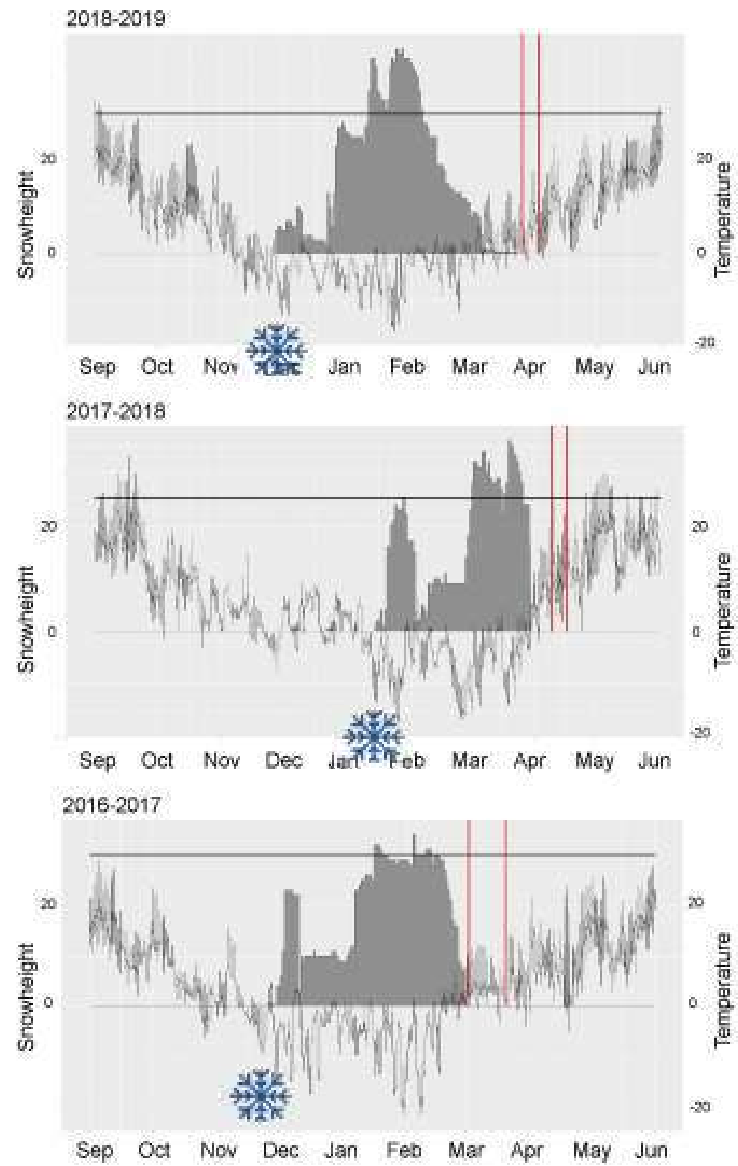
Lamproderma aff. *pulchellum*

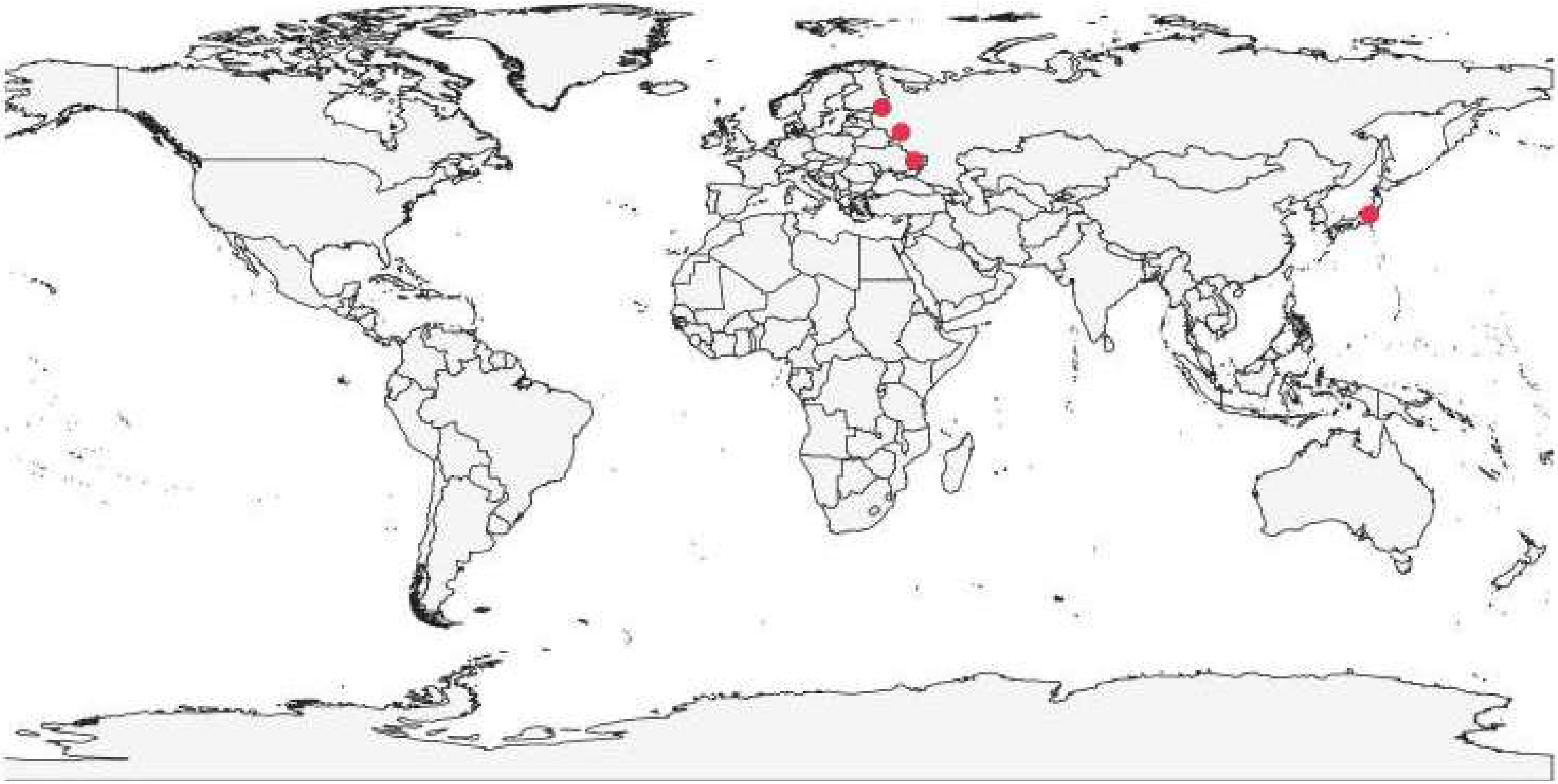
↓

Lamproderma 'cinctopulchellum' nom. prov. (lat. "cinctus" - belted)

Have the environmental criteria been met in our case?

- Frosts preceded the formation of a stable snow cover, falling below –10°C —
- No frosts occurred after snow melting during all studied spring seasons +
- A strong snow cover, exceeding 30 cm, was rare —

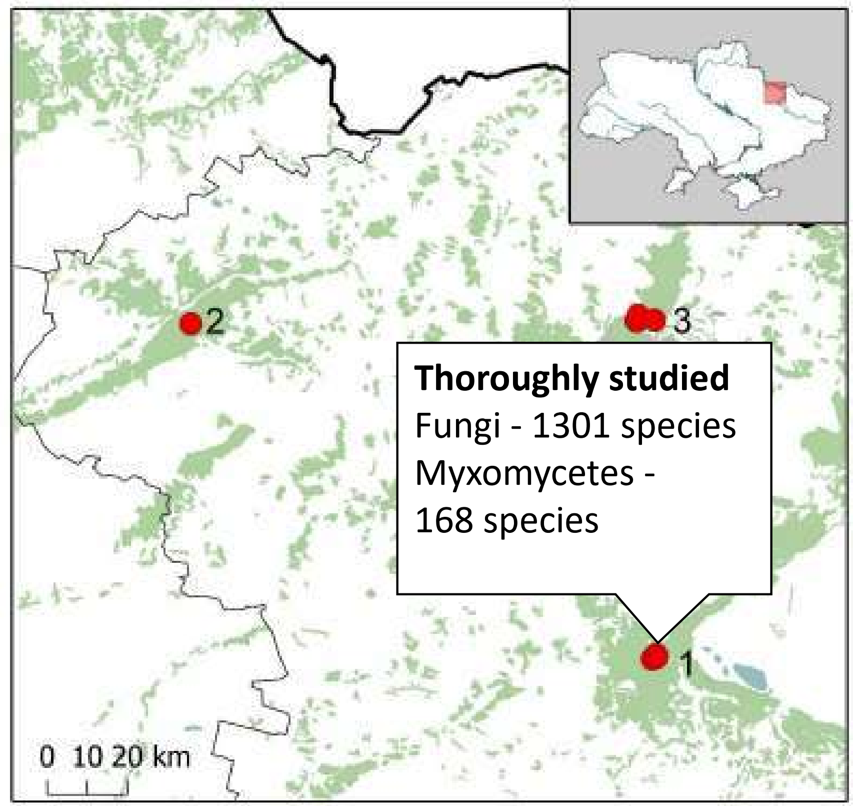




● Fruitbodies of nivicolous myxomycetes reported from lowland biotopes – 22 species (Gmoshinskii, 2018; Erastova and Novozhilov, 2015, Tamayama, 2000)

If at least some of the lowland nivicolous myxomycetes form fruitbodies regularly, why were they not regularly reported before?

1) Overlooked due to short and unexpected season of fructification?
2) Climate change?

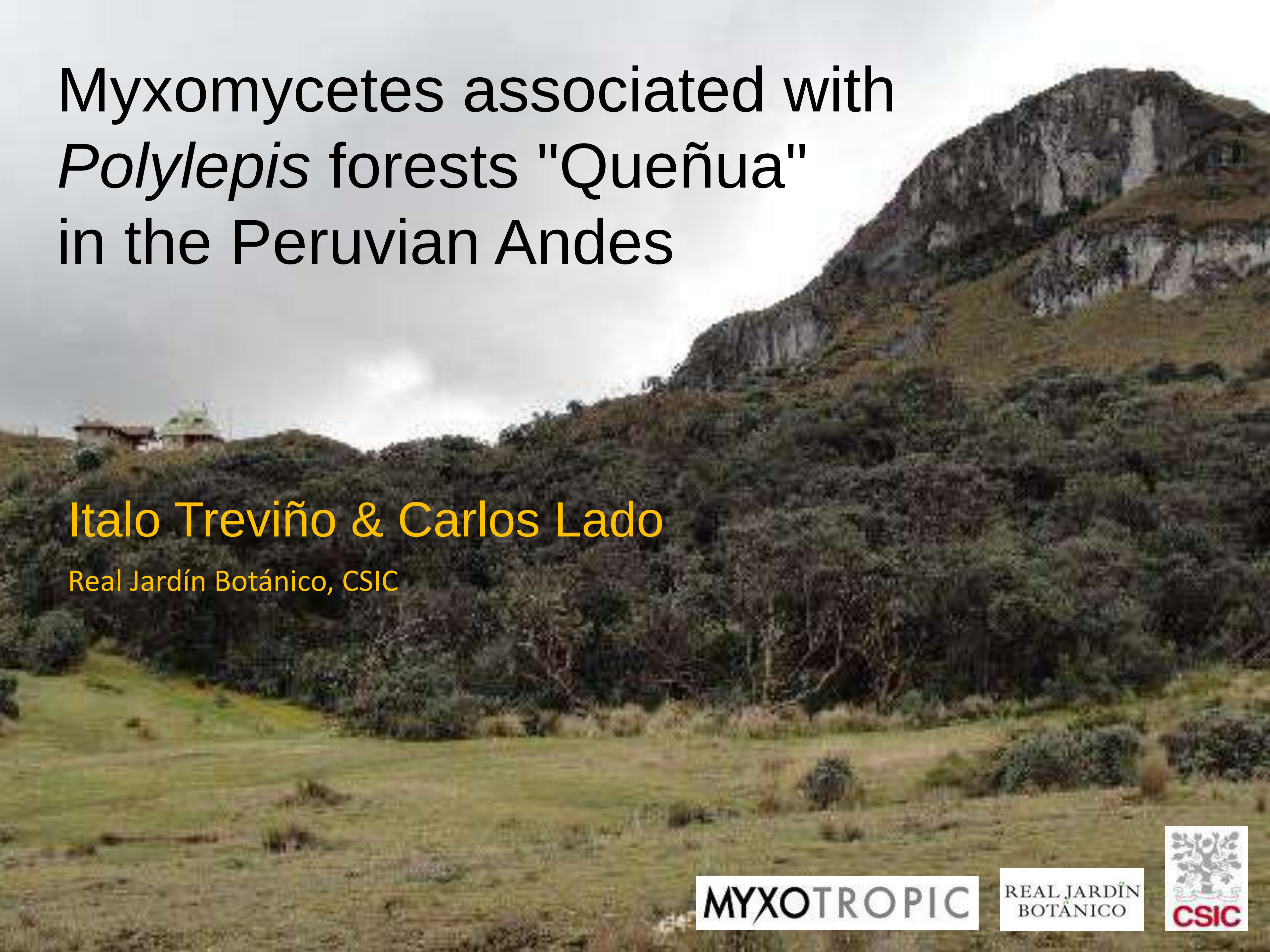


Thank you for your attention!

Myxomycetes associated with *Polylepis* forests "Queñua" in the Peruvian Andes

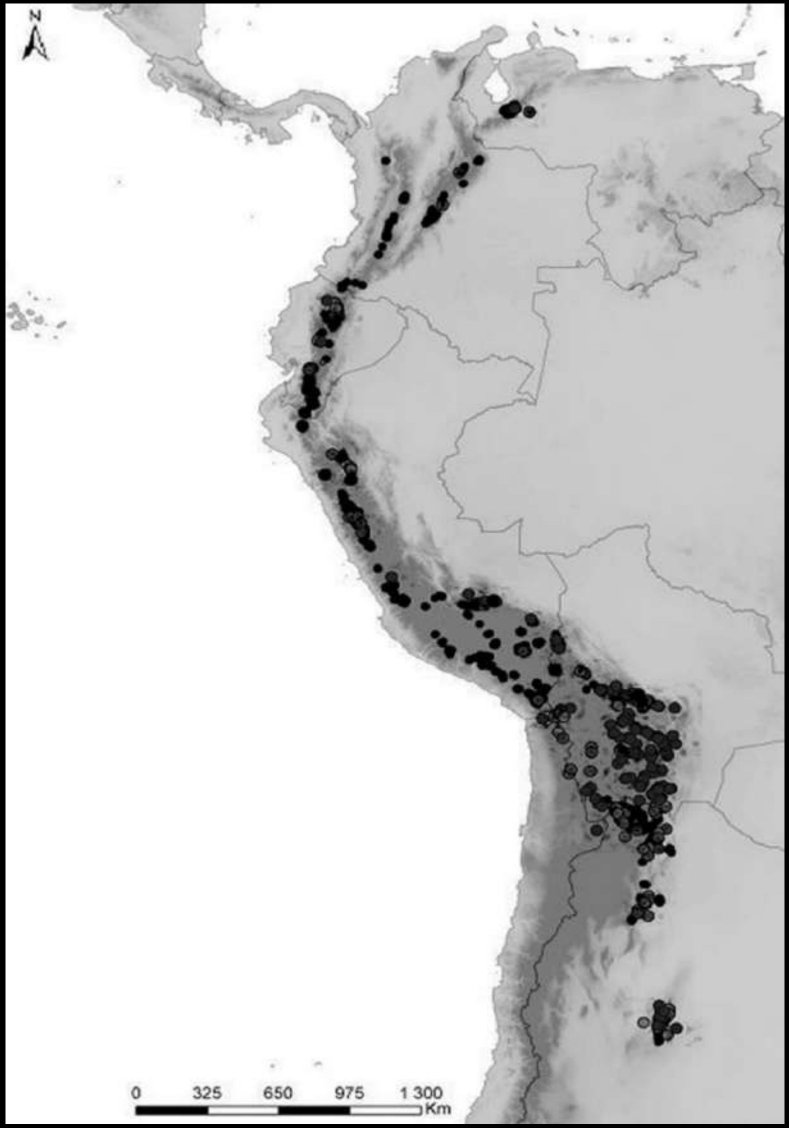
Italo Treviño & Carlos Lado

Real Jardín Botánico, CSIC



The *Polylepis* forest

- Genus *Polylepis* (Queñua)
- 28 species
- Distributed 3,500 – 5,200 m. a. s. l.

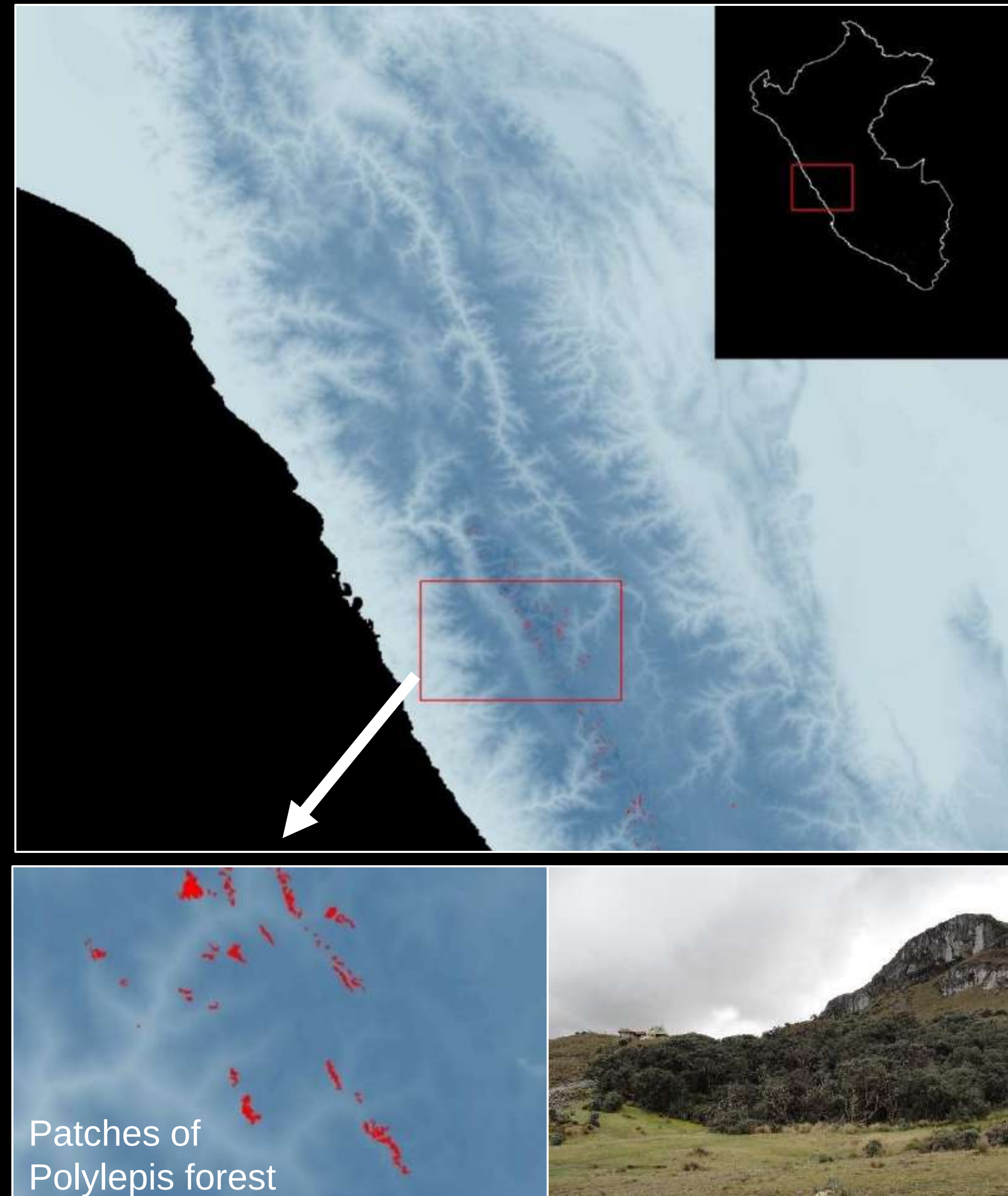


Diversity of Polylepis forest

Birds 120 spp.

Flowering plants
>150 spp.

Mammals 38 spp.



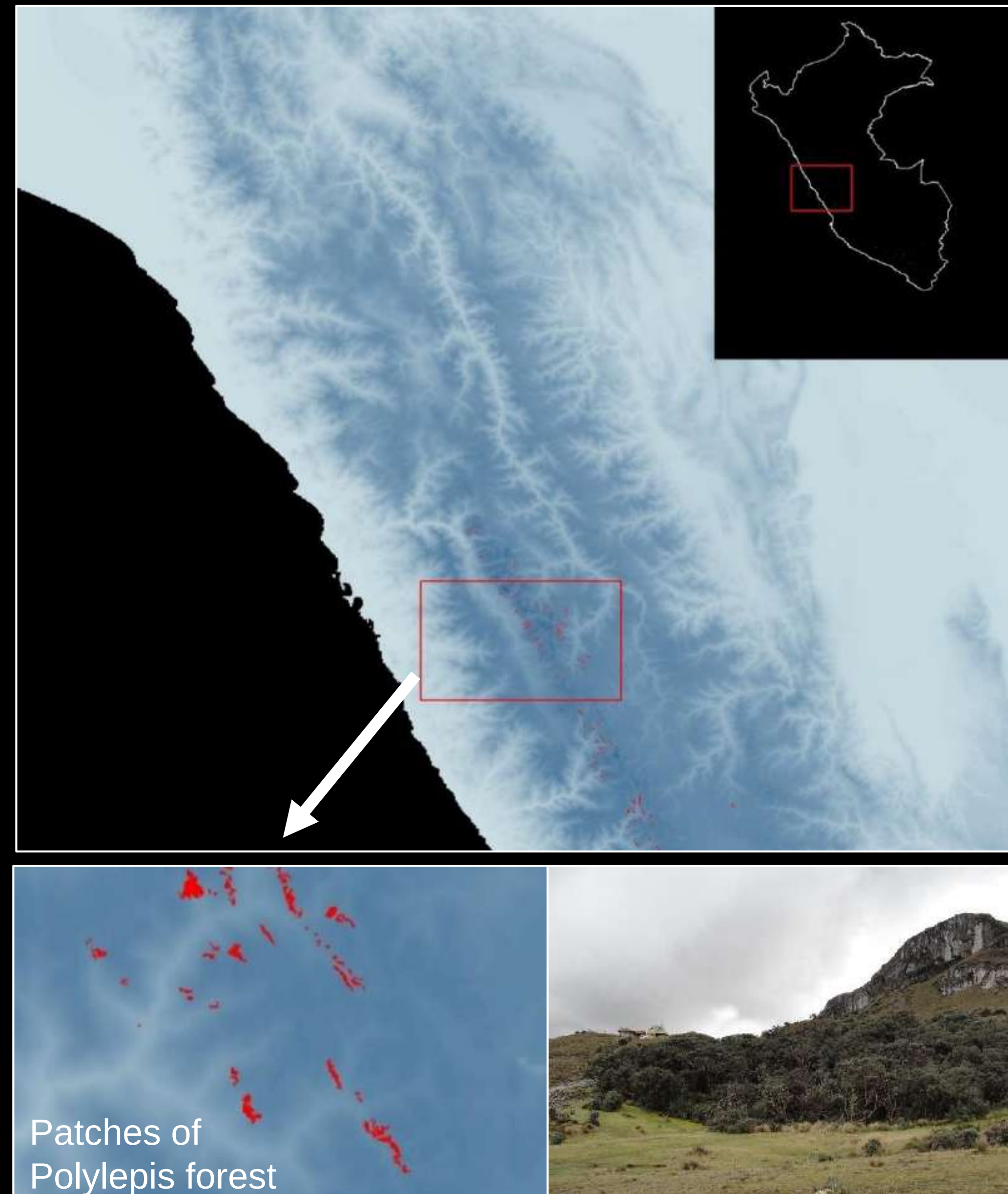
Diversity of Polylepis forest

MYXOTROPIC

Birds 120 spp.

Flowering plants
>150 spp.

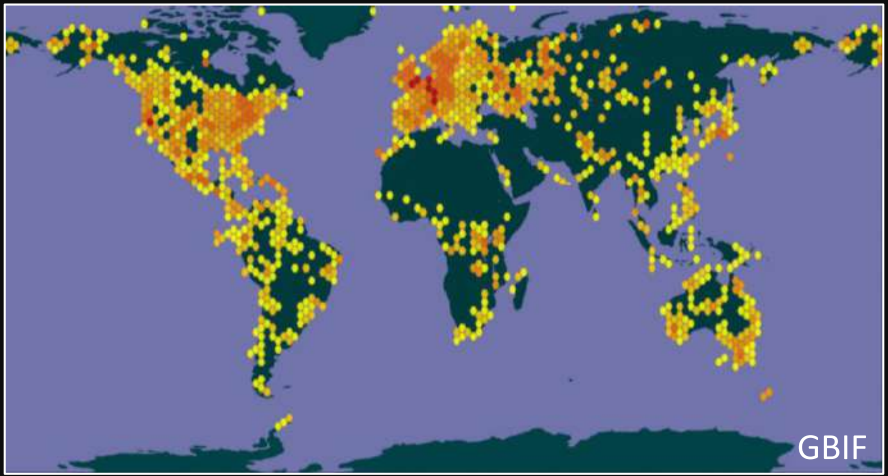
Mammals 38 spp.



Myxomycetes

MYXOTROPIC

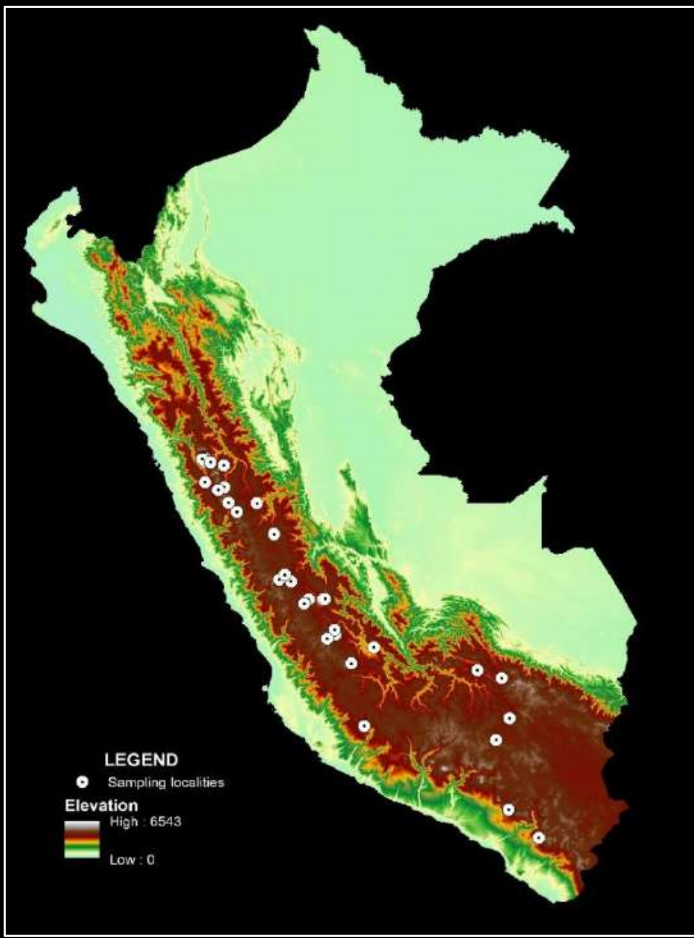
- Eukaryotic, fagotrophic, bacterivore, non-pathogenic organisms that help to break down plant debris.
- Approx. 1100 spp.



Sampling

What species of Myxomycetes are associated to *Polylepis* Forest?

What parts of the tree are more preferred by the Myxomycetes?



Moist chamber culture

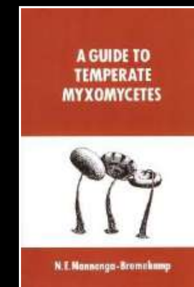
Processing samples

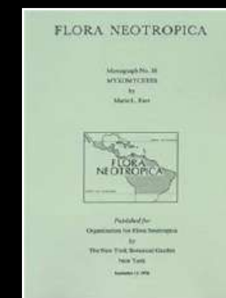
MYXOTROPIC

Collections

Preservation

Identification





Illustration

Results

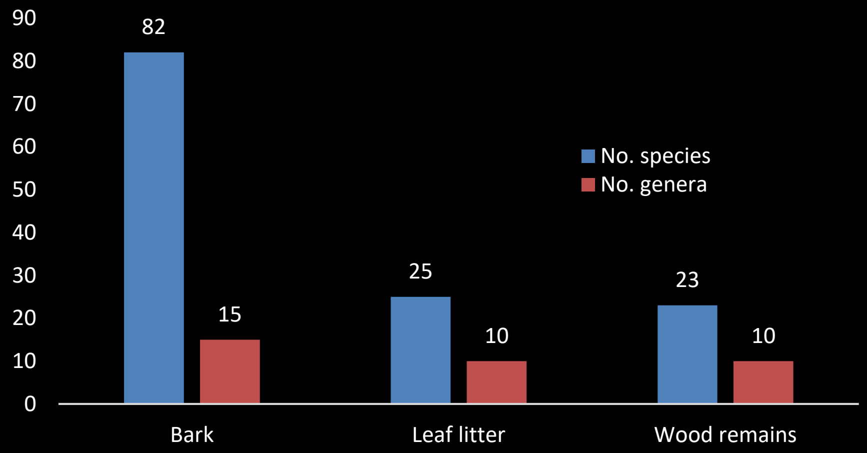
MYXOTROPIC

- 650 collections
- 17 genera
- 97 species

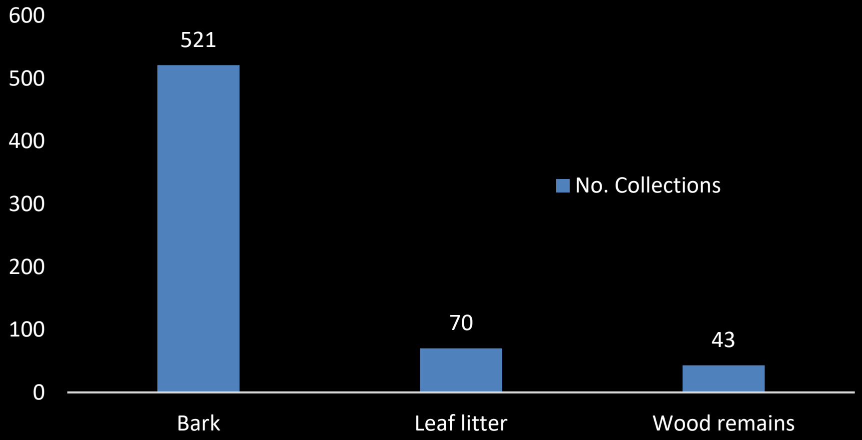
Moist chamber culture (9 gen., 20 spp)

Collection from field (14 gen, 80 spp.)

Number of species and genera by substrata



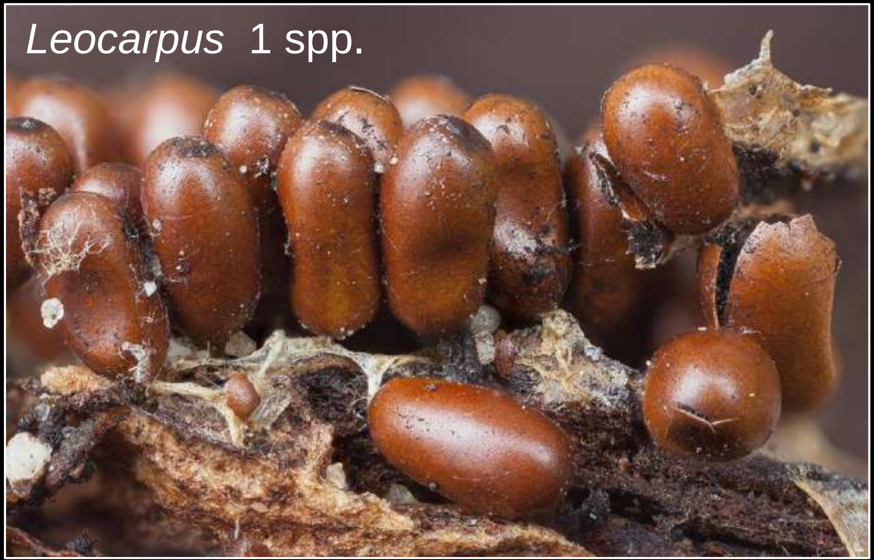
Number of collections by substrata

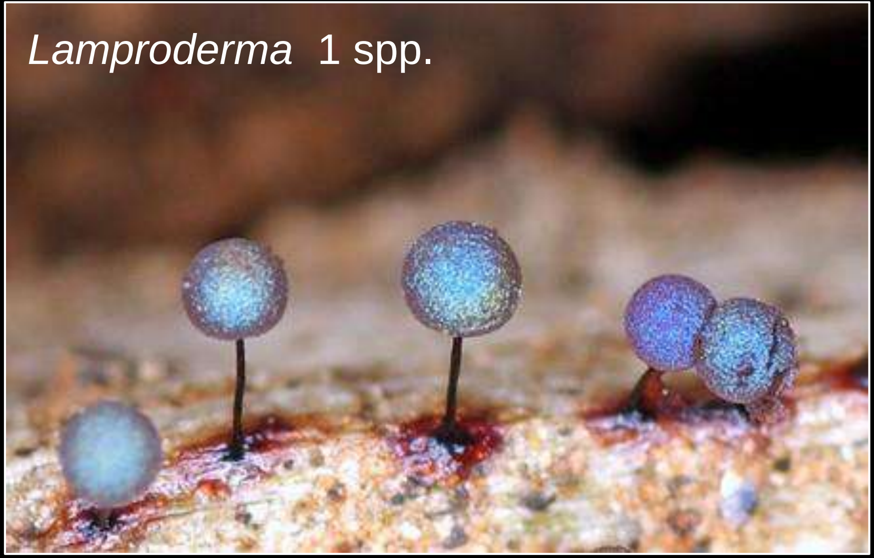


Genera recorded

MYXOTROPIC

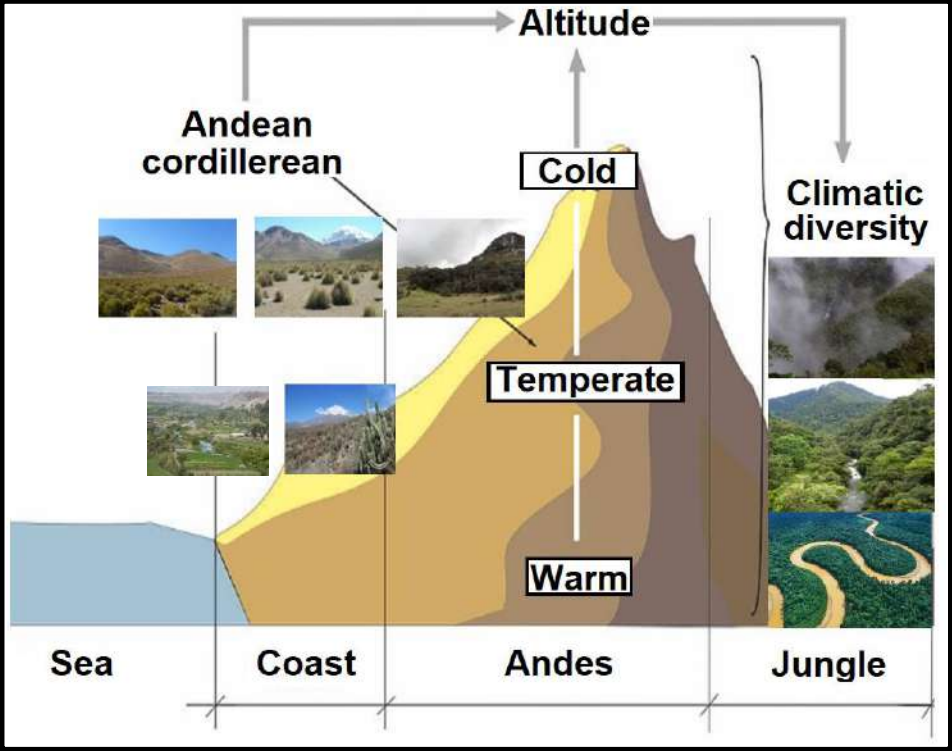
Genera recorded

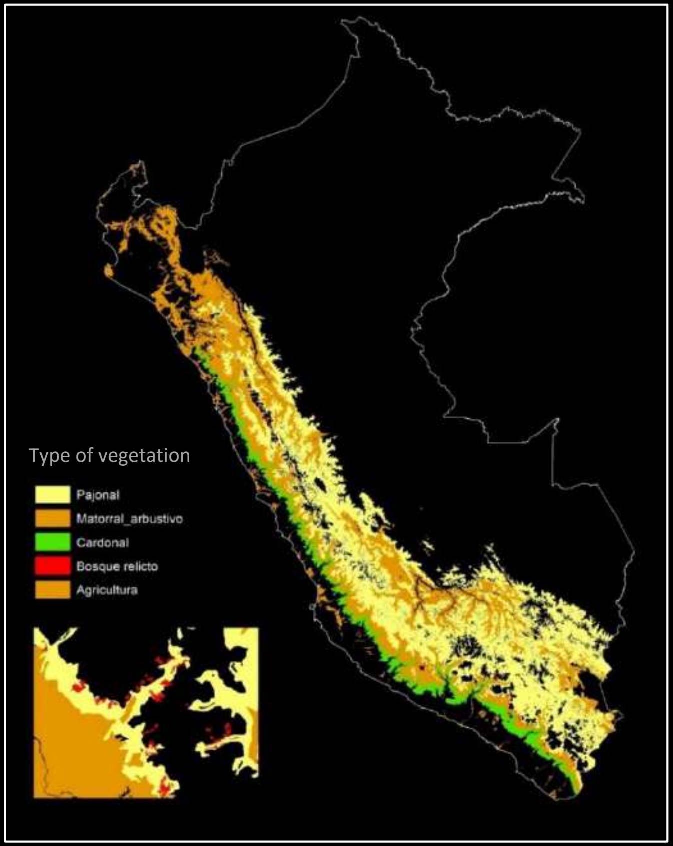




Myxomycetes diversity

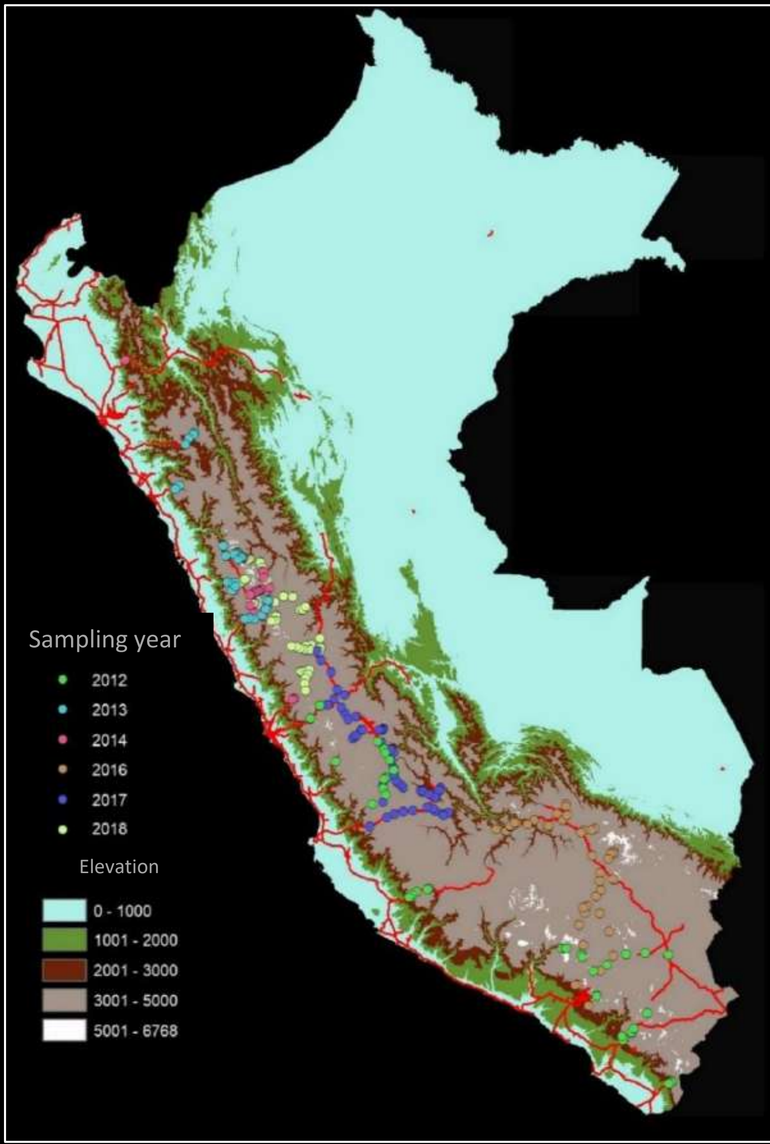
- What is the potential diversity of Myxomycetes in *Polylepis* forest?
- Are more diverse than others environments?



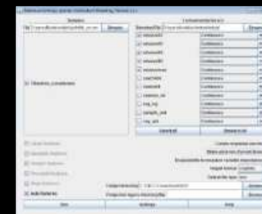


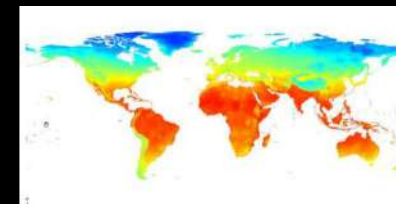
Potential distribution and richness maps

MYXOTROPIC



Maxent

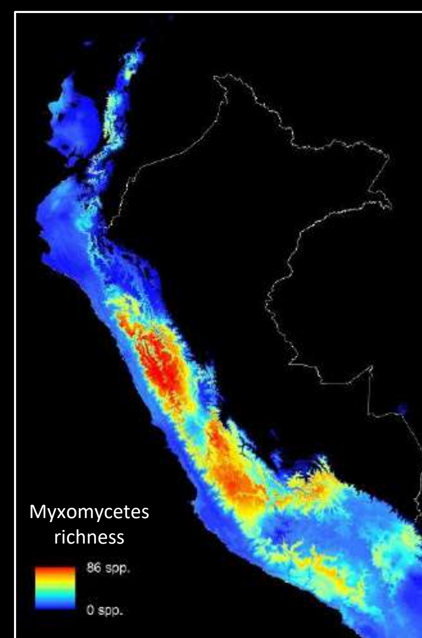


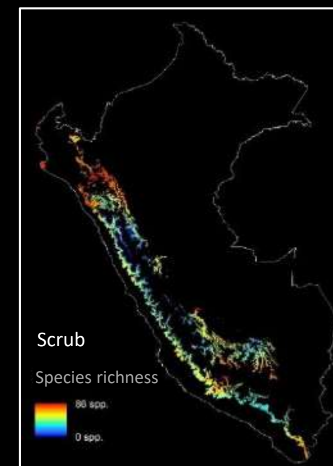


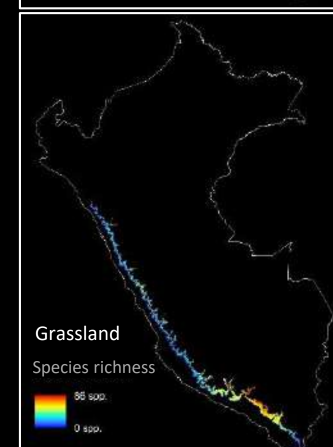
Bioclimatic Variables

≥12 Bootstrap, 6-11 Cross-validate
10000 background

BINARI GRID



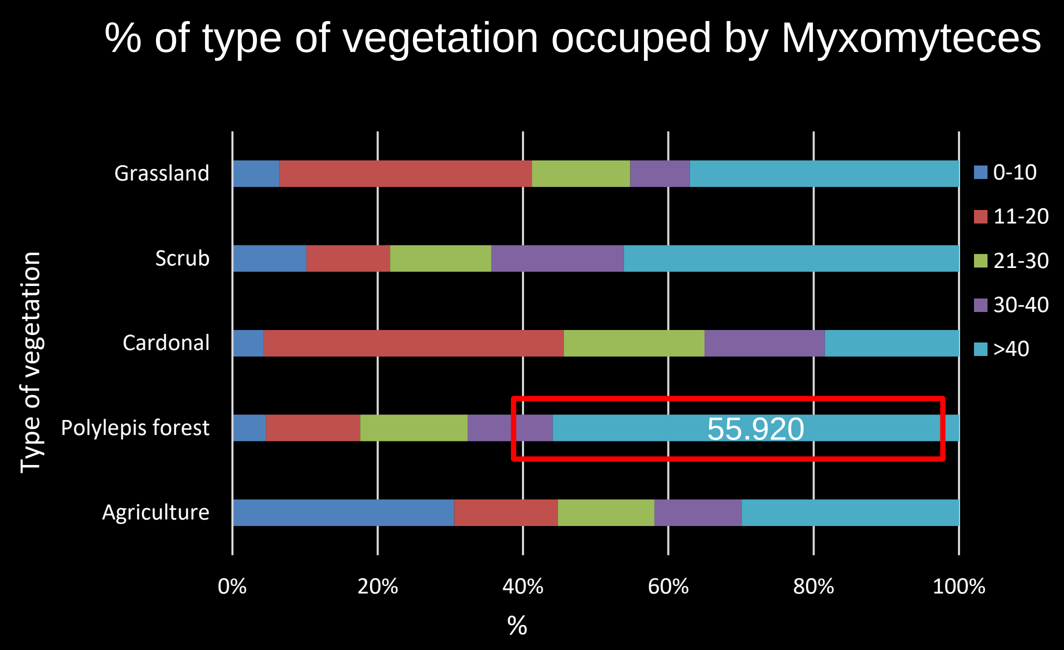




Myxomycetes richness

MYXOTROPIC

Type of Vegetation	Area (Km²)
Grassland	219774
Scrub	90149
Agriculture	69194
Cardonal	31068
Polyelpis forest	1250



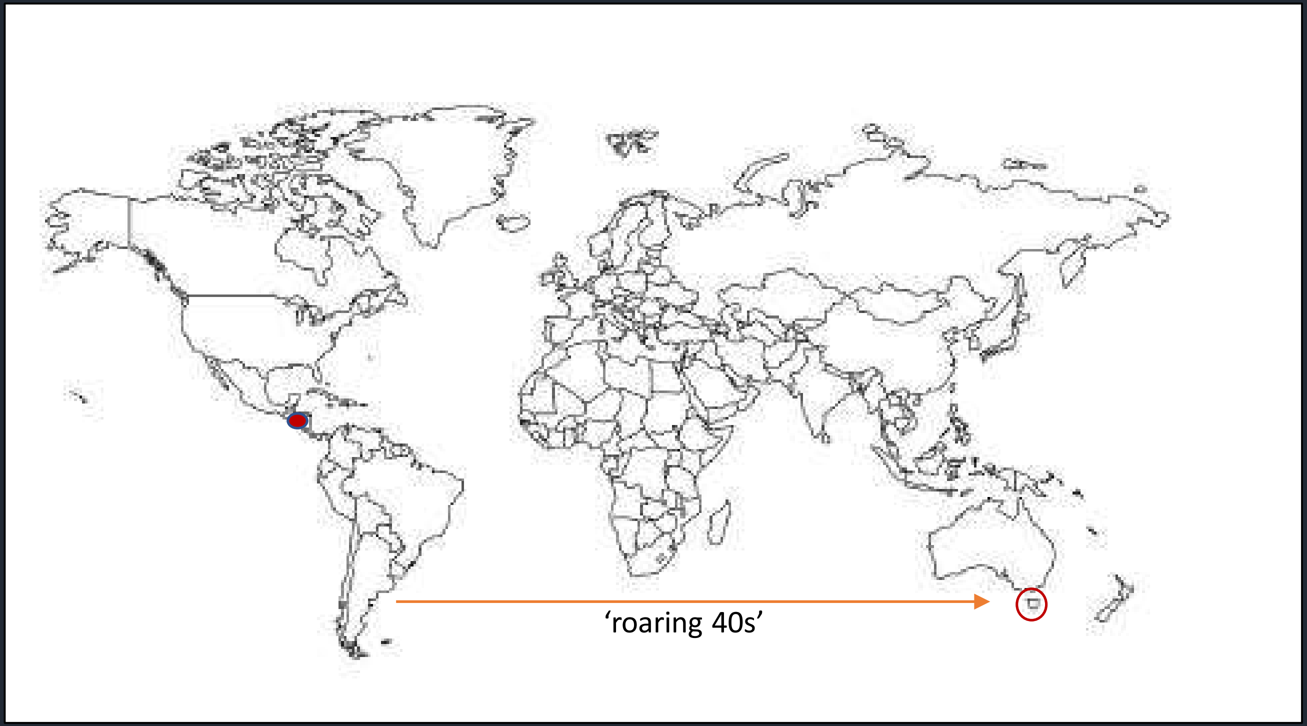
Thanks

This study is part of the Myxotropic project, supported by the Spanish Government [CGL2014-52584P, PGC2018-094660-B-I00 (MCIU/AEI/FEDER,UE)]


Black Sugarloaf, northern Tasmania
– a myxomycete hotspot?
Sarah Lloyd OAM

Tasmania – location & climate

- mild maritime climate
- rain in every month
- average maximum daily summer temperatures between 17 & 23°C
- average maximum daily winter temperatures between 3 & 11°C



Approximately 130 species found at Black Sugarloaf

- temperate climate
- healthy native forest with abundant organic material
- plant assemblage
- ‘hotspots’ e.g. crown of *Dicksonia antarctica*
- daily access to the study site

Black Sugarloaf

Melaleuca ericifolia ‘paperbark’ swamp forest

Wet eucalypt forest

Didymium serpula


Elaeomyxa cerifera

Elaeomyxa cerifera

Very common in 2019 from June - October

Clematis aristata

Perichaena vermicularis *

Badhamia panicea *

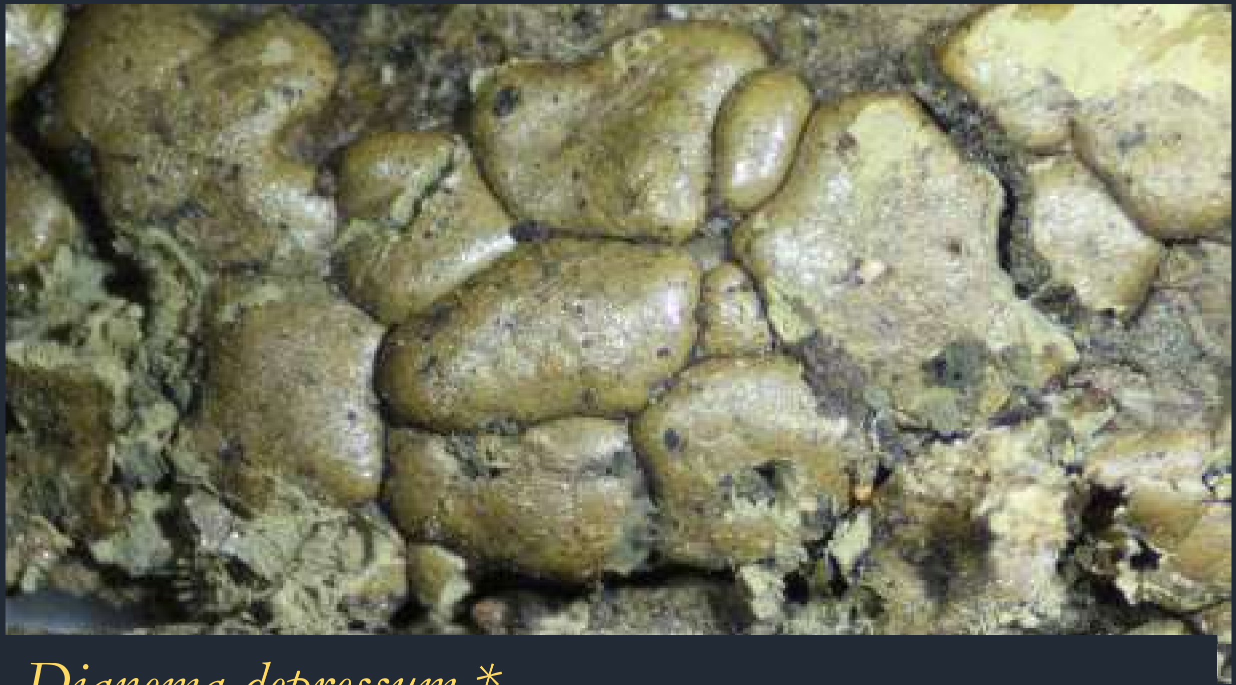
?Macbrideola *

Perichaena chrysosperma *

Clematis aristata

Dictydiaethalium plumbeum

Didymium applanatum *



Dianema depressum *

Physarum compressum

Physarum pusillum

Bedfordia salicina

Physarum pseudocollumelatum *

Arcyria leiocarpa

Physarum decipiens

Trichia decipiens

Dicksonia antarctica

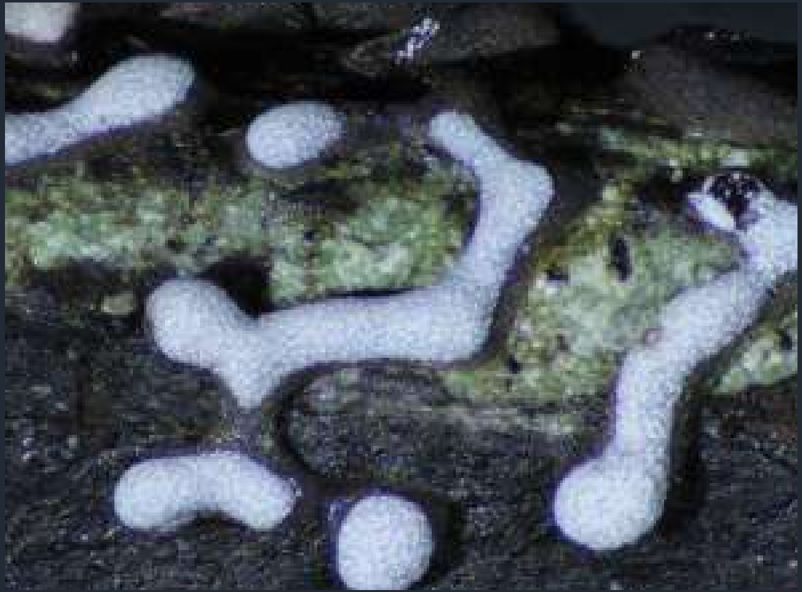


Dicksonia antarctica

Physarum contextum *

Physarum bivalve *

?Diderma *



Physarum bitectum

Didymium clavus


Leaf litter
Craterium minutum

Leaf litter

Elaeomyxa reticulospora

Leaf litter

Didymium squamulosum on *Pomaderris apetala* leaf

Large logs and stumps

Cribraria cancellata 13 March 2016

C. macrocarpa 15 March 2016

C. ferruginea 12 March 2016

C. mirabilis 13 March 2016

Tubifera ferruginosa

Tubifera tomentosa

Tubifera glareata

Tubifera vanderheuliae


Alwisia lloydiae

Lamproderma 'umbilicatum'

‘Hotspot’ 2019 *Pomaderris apetala*

'Hotspot' 2019 *Pomaderris apetala*

Physarum album 5 & 21 June

Badhamia utricularis 7 June

‘Hotspot’ 2019 *Pomaderris apetala*

Physarum viride 24 June

Trichia decipiens 24 & 30 August & 15 September

Arcyria affinis 26 August & 26 September

Arcyria leiocarpa 22 September

‘Hotspot’ 2019 *Pomaderris apetala*

Metatrichia floriformis 16 September

Clastoderma debaryanum 16 September

Stemonitopsis typhina 7 October

Stemonitis smithii 9 October

Firewood piles 2016

Comatricha aff. *ellae* 29 June 2016

Comatricha rigidireta 9 September 2016

Comatricha cf. *alta* 14 July 2016

Comatricha vineatilis 26 June 2016

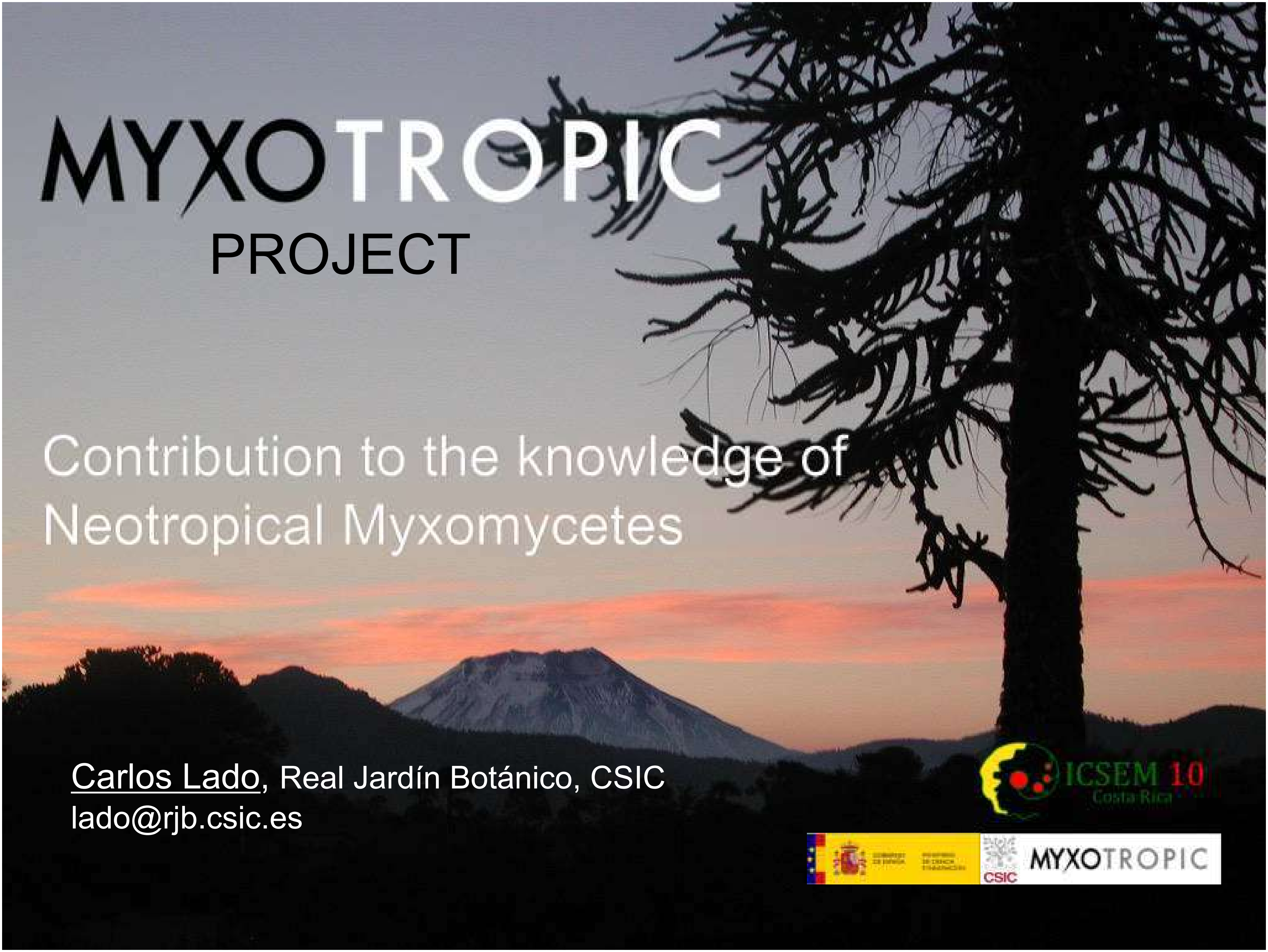
Summer 2020

Stemonitis 27 January 2020

Arcyria obvelata 30 January 2020

Reticularia 21 January 2020

Lycogala epidendrum 3 January 2020

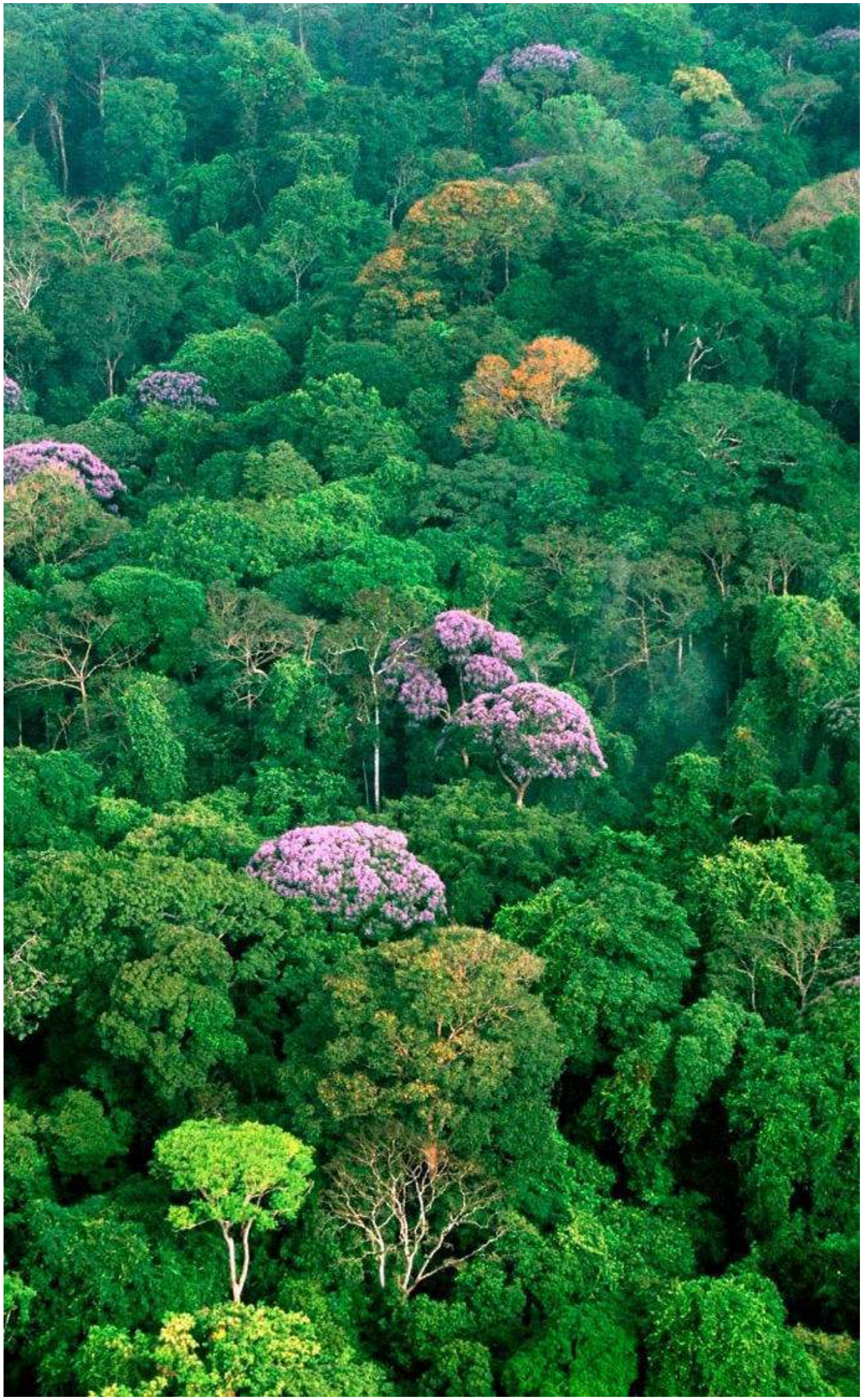

MYXOTROPIC
PROJECT
Contribution to the knowledge of
Neotropical Myxomycetes
Carlos Lado, Real Jardín Botánico, CSIC
lado@rjb.csic.es
ICSEM 10
Costa Rica
CSIC
MYXOTROPIC

Neotropical Bioregion

Seven hotspots:

- Madrean Pine-Oak Woodlands
- Mesoamerica
- Caribean
- Tumbes-Choco-Magdalena
- Tropical Andes
- Cerrado
- Atlantic Forest
- Chilean Winter Rainfall-Valdivian Forests





Other Neotropical environments



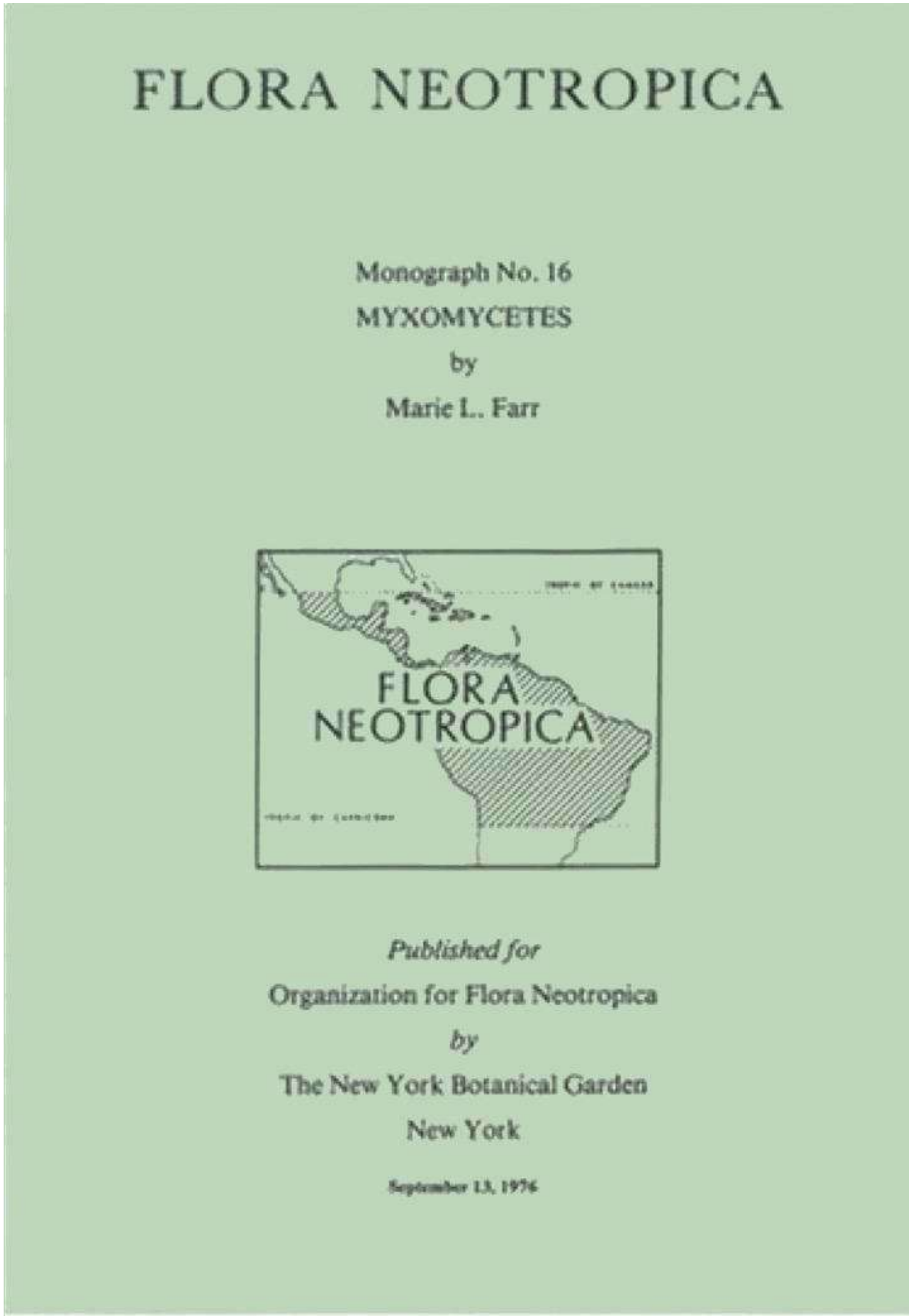






Myxomycete diversity

MYXOTROPIC



FLORA NEOTROPICA

Monograph No. 16

MYXOMYCETES

by

Marie L. Farr

FLORA NEOTROPICA

Published for

Organization for Flora Neotropica

by

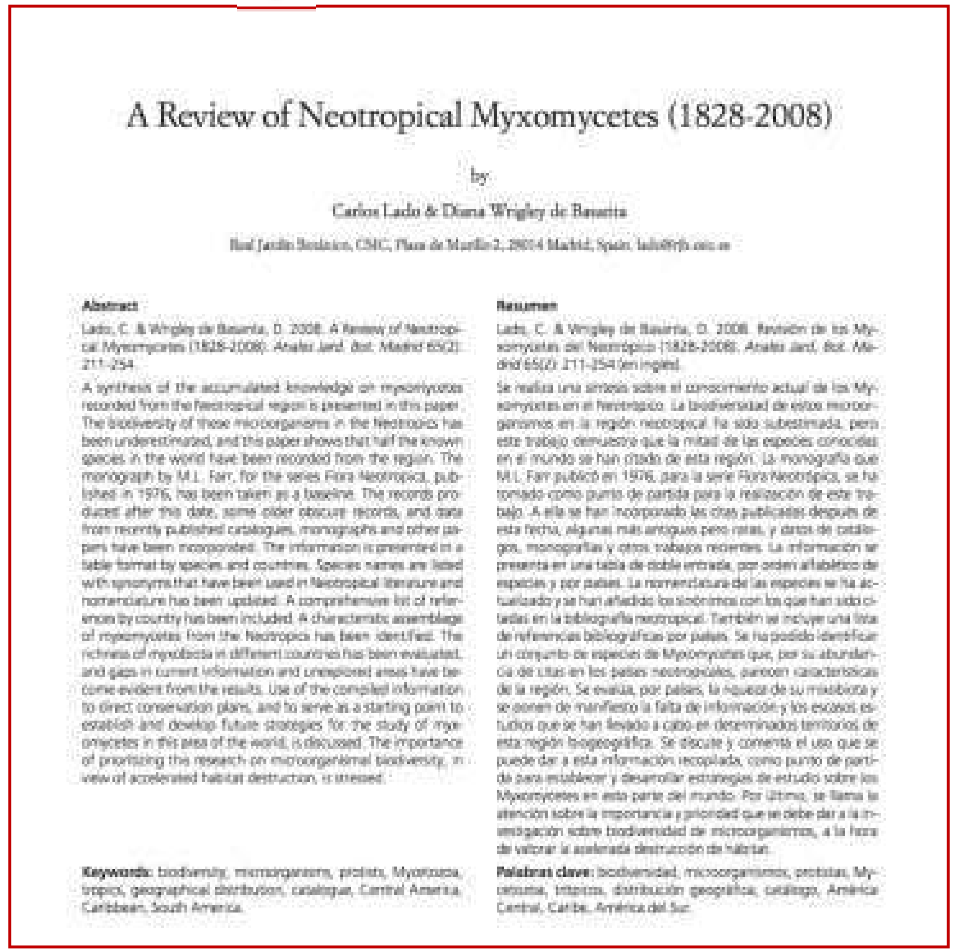
The New York Botanical Garden

New York

September 13, 1976

240 species described (1976)

431 species recorded (2008)



A Review of Neotropical Myxomycetes (1828-2008)

by

Carlos Lado & Diana Wrigley de Basanta

Real Jardín Botánico, CSIC, Plaza de Murillo 2, 28014 Madrid, Spain. lado@rjb.csic.es

Abstract

Lado, C. & Wrigley de Basanta, D. 2008. A Review of Neotropical Myxomycetes (1828-2008). *Anales Jard. Bot. Madrid* 65(2): 211-254.

A synthesis of the accumulated knowledge on myxomycetes recorded from the Neotropical region is presented in this paper. The biodiversity of these microorganisms in the Neotropics has been underestimated, and this paper shows that half the known species in the world have been recorded from the region. The monograph by M.L. Farr, for the series Flora Neotropica, published in 1976, has been taken as a baseline. The records produced after this date, some older obscure records, and data from recently published catalogues, monographs and other papers have been incorporated. The information is presented in a table format by species and countries. Species names are listed with synonyms that have been used in Neotropical literature and nomenclature has been updated. A comprehensive list of references by country has been included. A characteristic assemblage of myxomycetes from the Neotropics has been identified. The richness of myxobiota in different countries has been evaluated, and gaps in current information and unexplored areas have become evident from the results. Use of the compiled information to direct conservation plans, and to serve as a starting point to establish and develop future strategies for the study of myxomycetes in this area of the world, is discussed. The importance of prioritizing this research on microorganismal biodiversity, in view of accelerated habitat destruction, is stressed.

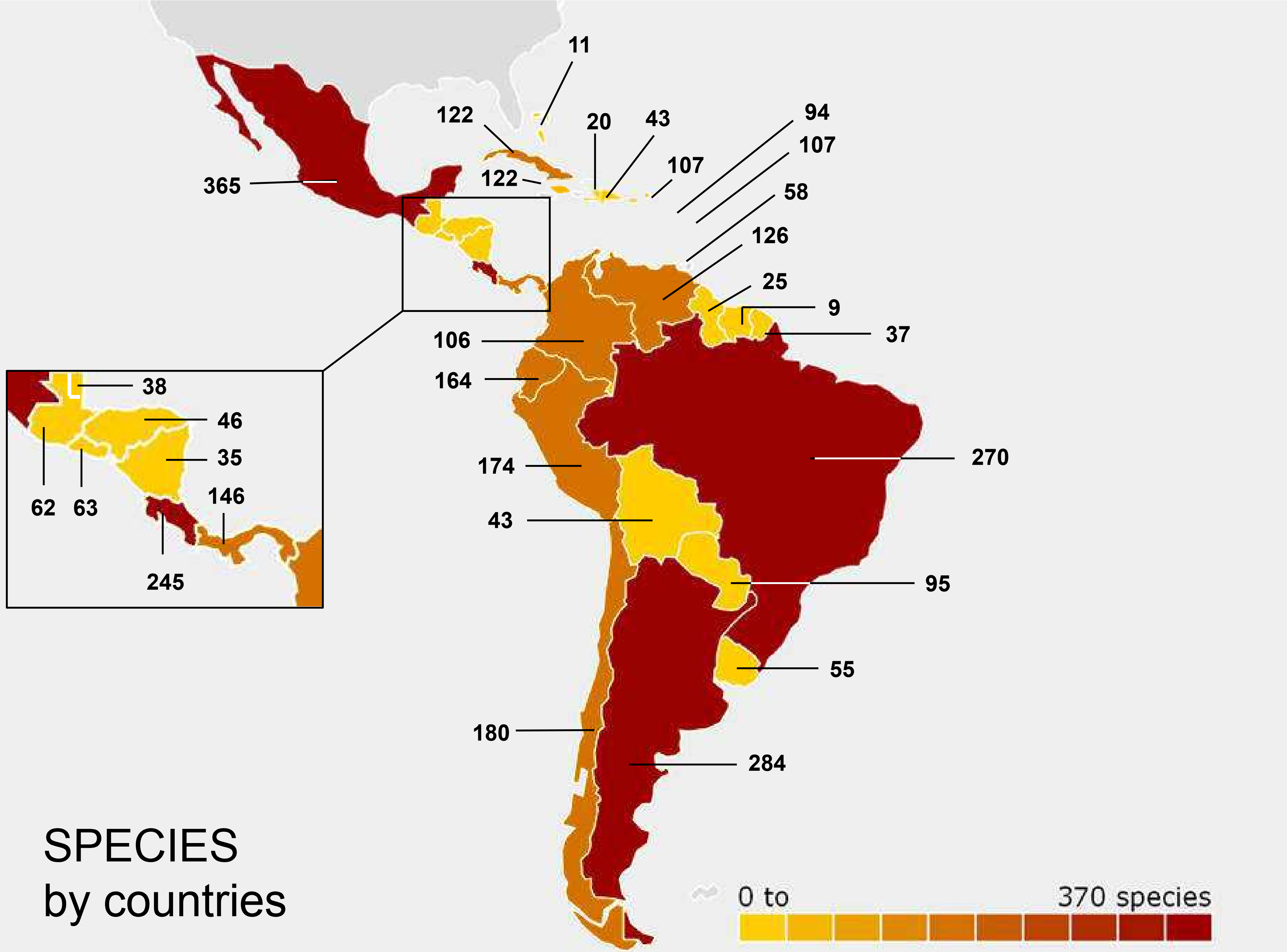
Keywords: biodiversity, microorganisms, protists, Myxozoa, tropics, geographical distribution, catalogue, Central America, Caribbean, South America.

Resumen

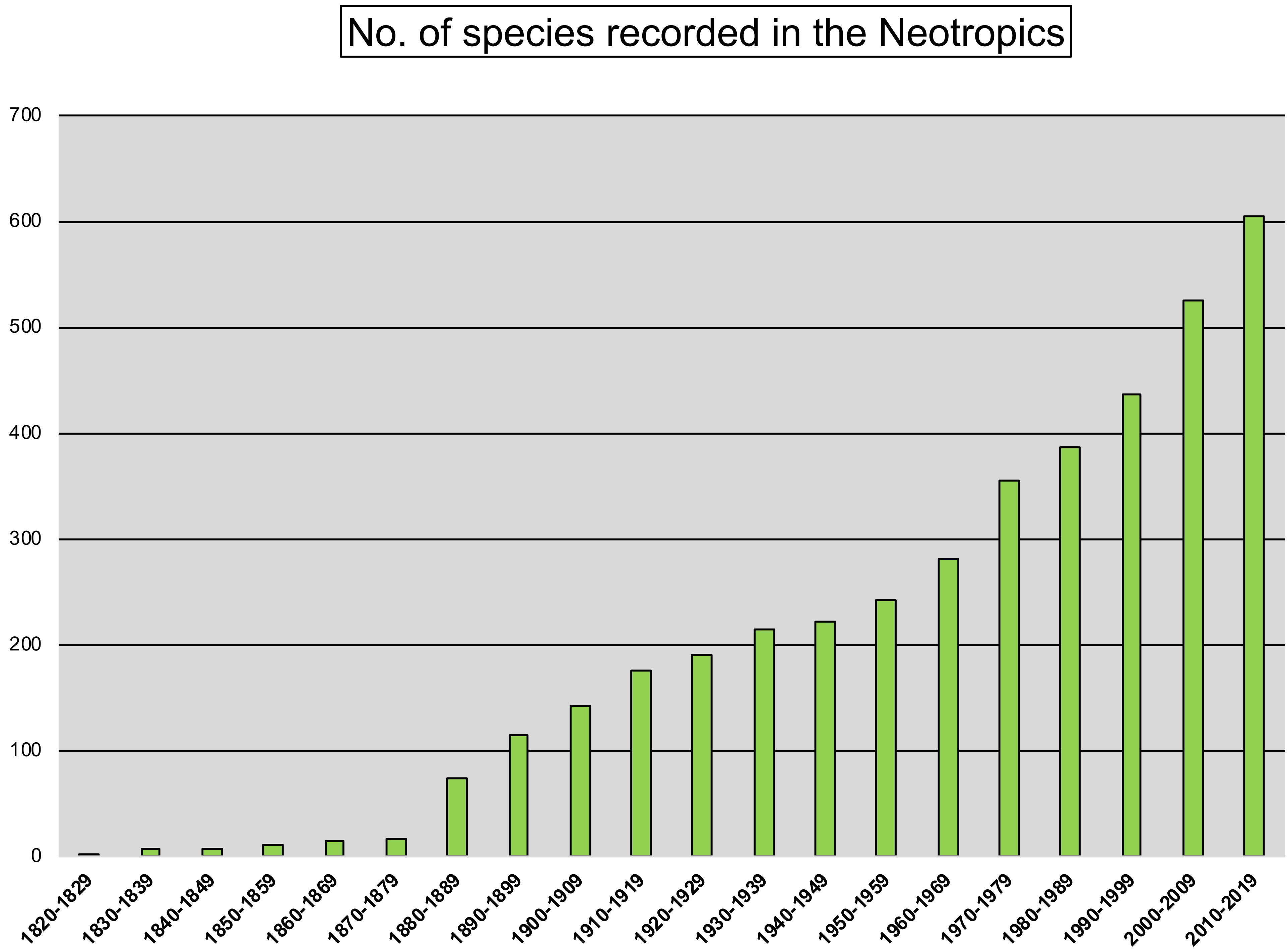
Lado, C. & Wrigley de Basanta, D. 2008. Revisión de los Myxomycetes del Neotrópico (1828-2008). *Anales Jard. Bot. Madrid* 65(2): 211-254 (en inglés).

Se realiza una síntesis sobre el conocimiento actual de los Myxomycetes en el Neotrópico. La biodiversidad de estos microorganismos en la región neotropical ha sido subestimada, pero este trabajo demuestra que la mitad de las especies conocidas en el mundo se han citado de esta región. La monografía que M.L. Farr publicó en 1976, para la serie Flora Neotrópica, se ha tomado como punto de partida para la realización de este trabajo. A ella se han incorporado las citas publicadas después de esta fecha, algunas más antiguas pero raras, y datos de catálogos, monografías y otros trabajos recientes. La información se presenta en una tabla de doble entrada, por orden alfabético de especies y por países. La nomenclatura de las especies se ha actualizado y se han añadido los sinónimos con los que han sido citadas en la bibliografía neotropical. También se incluye una lista de referencias bibliográficas por países. Se ha podido identificar un conjunto de especies de Myxomycetes que, por su abundancia de citas en los países neotropicales, parecen características de la región. Se evalúa, por países, la riqueza de su mixobiota y se ponen de manifiesto la falta de información y los escasos estudios que se han llevado a cabo en determinados territorios de esta región biogeográfica. Se discute y comenta el uso que se puede dar a esta información recopilada, como punto de partida para establecer y desarrollar estrategias de estudio sobre los Myxomycetes en esta parte del mundo. Por último, se llama la atención sobre la importancia y prioridad que se debe dar a la investigación sobre biodiversidad de microorganismos, a la hora de valorar la acelerada destrucción de hábitat.

Palabras clave: biodiversidad, microorganismos, protistas, Myxozoa, trópicos, distribución geográfica, catálogo, América Central, Caribe, América del Sur.



SPECIES
by countries



No. of species recorded in the Neotropics
700
600
500
400
300
200
100
0
1820-1829
1830-1839
1840-1849
1850-1859
1860-1869
1870-1879
1880-1889
1890-1899
1900-1909
1910-1919
1920-1929
1930-1939
1940-1949
1950-1959
1960-1969
1970-1979
1980-1989
1990-1999
2000-2009
2010-2019

MYXOTROPIC project

- International project in which researchers from Spain, Peru, Mexico, Costa Rica, Chile, Poland and the United States, participate.
- Funded by the Government of Spain (Grant PGC2018-094660-B-I00).
- Coordinated and directed by the Royal Botanical Garden (CSIC).
- 9 Scientific Institutions and Universities are involved.

REAL JARDÍN BOTÁNICO

UAM UNIVERSIDAD AUTÓNOMA DE MADRID

UNIVERSIDAD DE COSTA RICA

UNIVERSIDAD BERNARDO O'HIGGINS

PAN

UNIVERSITY OF ARKANSAS

Herbario Nacional de Bolivia (LPB)

MYXOTROPIC project

Phase I: Tehuacán-Cuicatlán and Sierra Gorda Biosphere Reserves (Mexico) (2003-2005)

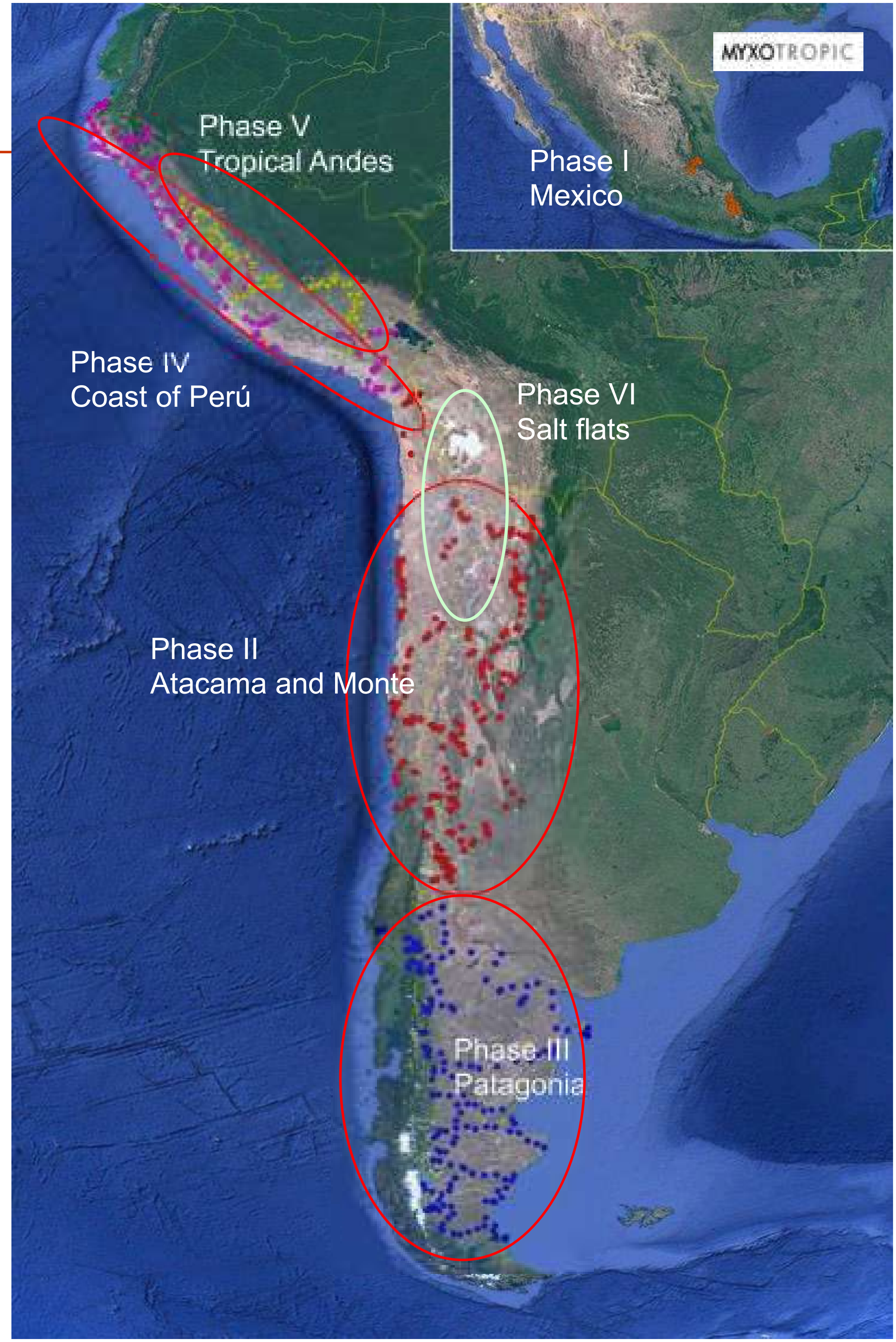
Phase II: Monte Desert (Argentina), Atacama Desert (Chile) and Central Chile (2006-2008)

Phase III: Patagonian steppe (Argentina) (2009-2011)

Phase IV: Coastal desert of Peru (2012-2015)

Phase V: Arid areas of Tropical Andes of Peru (2016-2018)

Phase VI: Salt flats of the Andes (Bolivia, Chile and Argentina) (2019-2021)



Environments explored







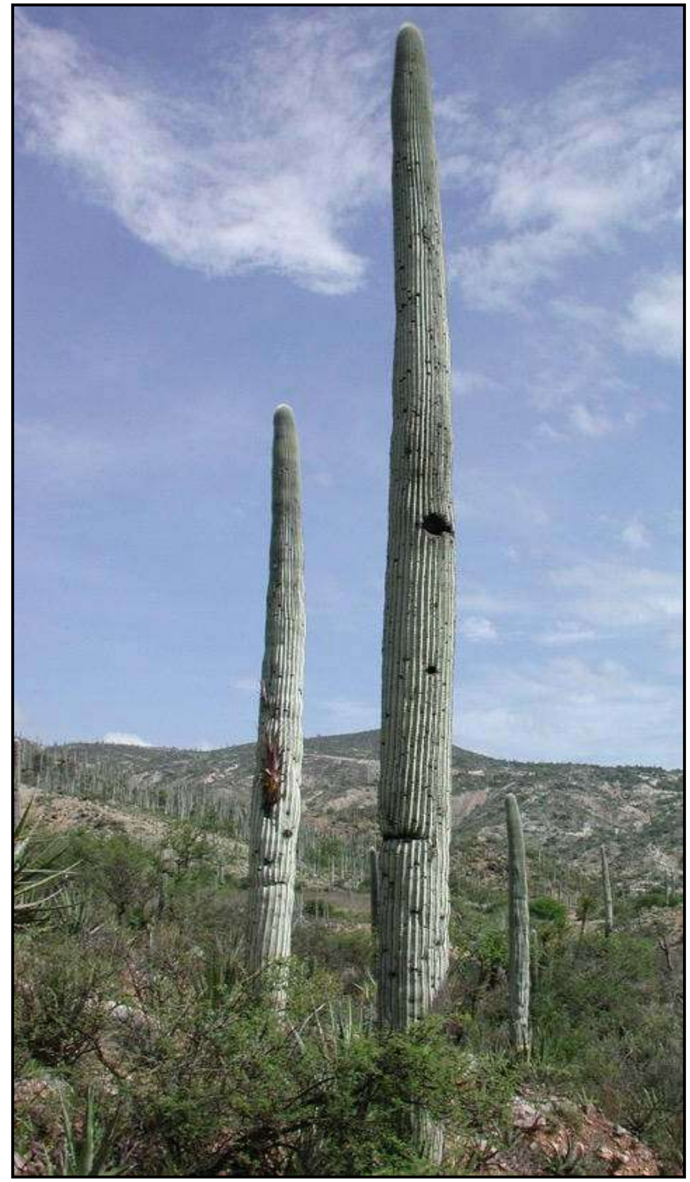


Territory explored in Phase I

Tehuacán-Cuicatlán and Sierra Gorda Biosphere Reserves (Mexico) (2003-2005)

New species described:

- *Didymium tehuacanense*
- *Perichaena stipitata*
- *Physarum polygonosporum*
- *Didymium umbilicatum*



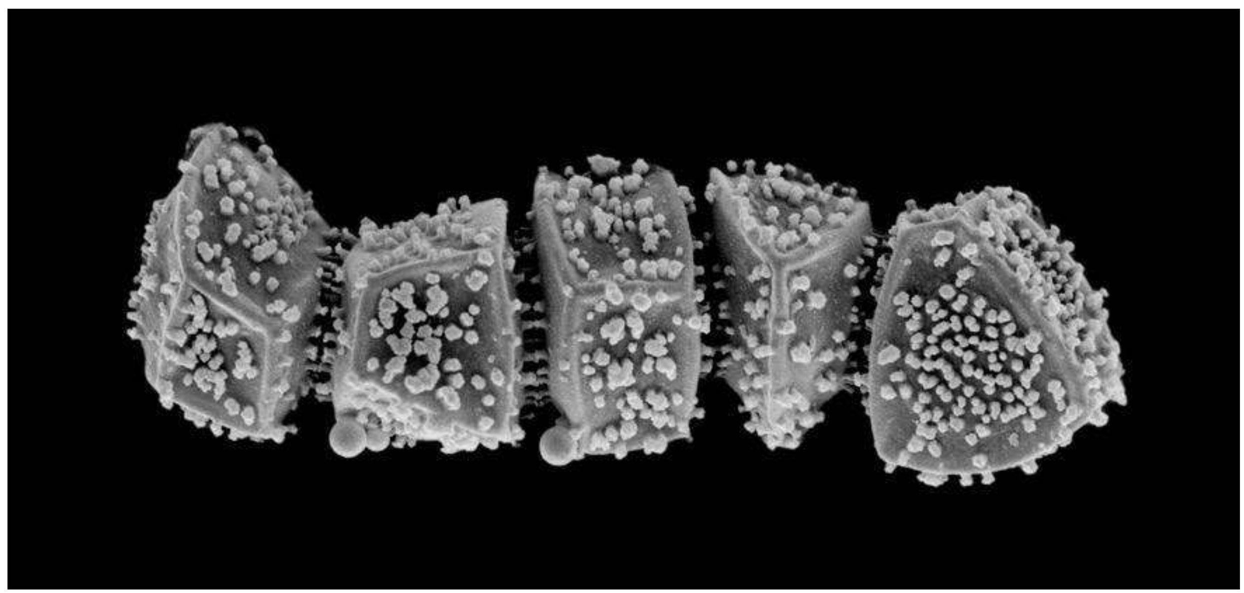
Some new species

MYXOTROPIC

Didymium tehuacanense

Perichaena stipitata

Didymium polygonosporum



Several publications

MYXOTROPIC

Fungal Diversity

Myxomycetes associated with dryland ecosystems of the Tehuacán-Cuicatlán Valley Biosphere Reserve, Mexico

Estrada-Torres, A.[1], Wrigley de Basanta, D.[2], Conde, E.[1] and Lado, C.[2*]

[1]Centro de investigación en Ciencias Biológicas, Universidad Autónoma de Tlaxcala, Apartado Postal 183, 90,000, Tlaxcala, México.
[2]Departamento de Micología. Real Jardín Botánico, CSIC, Plaza de Murillo, 2. 28014 Madrid. Spain.

Estrada-Torres, A., Wrigley de Basanta, D., Conde, E. and Lado, C. (2009). Myxomycetes associated wit ecosystems of the Tehuacán-Cuicatlán Valley Biosphere Reserve, Mexico. Fungal Diversity 36: 17-56.

The results of a biodiversity survey of a xeric Mexican Biosphere Reserve are presented. This survey represen intensive study of cacti and succulent plants ever carried out for myxomycetes. The results include 104 specie variety, identified from 1200 records from field and moist chamber culture collections. Two new species (*tehuacanense* and *Perichaena stipitata*), found on decayed remains of succulent plants, are described. Eleve (*Comatricha reticulospora*, *Cribraria lepida*, *Didymium clavodecus*, *D. eremophilum*, *D. orthonemata*, *D. st* *subreticulosporum*, *Licea belmontiana*, *Macbrideola oblonga*, *M. synsporos* and *Perichaena quadrata*) are ne for the Neotropics, and seven others taxa have not been recorded previously from Mexico. Taxonomic comm on distrib... that exist... assemblag... patterns of...

Key word... xerophyllo...

Mycologia, 95(3), 2003, pp. 474–479.

Primers are designed for amplification and direct sequencing of ITS region of rDNA from Myxomycetes

María P. Martín[1]
Carlos Lado
Real Jardín Botánico, C.S.I.C., Plaza de Murillo 2, 28014 Madrid, Spain

Stein...

rDNA) sequence phylogeny, myxomycetes are included in the Protozoa (Cavalier-Smith 1993). However, only one myxomycete species (*Physarum polycephalum* Schwein.) was included in the analysis. Based on gene analysis of the elongation factor EF-1α, Baldauf

TAXON 54 (2) • May 2005: 543–545 Lado & al. • (1688–1691) Conserve *Amaurochaete*, *Ceratiomyxa*, and *Hemitrichia*

(1688–1691) Proposals to conserve the names *Amaurochaete* against *Lachnobolus*, *Ceratiomyxa* against *Famintzinia*, *Cribraria* Pers. against *Cribraria* Schrad. ex J. F. Gmel. and *Hemitrichia* against *Hyporhamma* (Myxomycetes)

Carlos Lado[1], Uno Eliasson[2], S. L. Stephenson[3], A. Estrada-Torres[4] & M. Schnittler[5]

[1] *Real Jardín Botánico de Madrid, Consejo Superior de Investigaciones Científicas, Plaza de Murillo 2, E-28014 Madrid, Spain. lado@ma-rjb.csic.es (author for correspondence)*
[2] *Göteborg University, Botanical Institute, P.O. Box 461, SE 40530 Göteborg, Sweden. uno.eliasson@botany.gu.se*
[3] *Department of Biological Sciences, Sen 632, University of Arkansas, 72701, Fayetteville, Arkansas, U.S.A. slsteph@uark.edu*
[4] *Centro de Investigación en Ciencias Biológicas, Universidad Autónoma de Tlaxcala, Apdo. Postal 183, Tlaxcala 90 000, Tlaxcala, México. arturomixo@hotmail.com*
[5] *University Greifswald, Botanical Institute and Botanical Garden, Grimmer Str. 88, 17487 Greifswald, Germany. martin.schnittler@uni-greifswald.de*

Fungal Diversity

A taxonomic evaluation of the stipitate *Licea* species

D. Wrigley de Basanta and C. Lado[*]

Real Jardín Botánico de Madrid, CSIC. Plaza de Murillo, 2, 28014 Madrid, Spain

Wrigley de Basanta, D. and Lado, C. (2005). A taxonomic evaluation of the stipitate *Licea* species. Fungal Diversity 20: 261-314.

A taxonomic study was made of the type specimens of 21 stipitate *Licea* species. Relevant characters were examined by light microscope and by SEM. Evidence of synonymy was found in five of the taxa, *Licea tropica* with *L. bulbosa*, *L. cristallifera* with *L. eleanorae*, *L. longa* and *L. capitata* with *L. floriformis* var. *aureospora*, and *L. tanzanica* with *L. scyphoides*. One taxon *Licea capitatoides* var. *fujiokana* is recombined as a variety of a different species, *Licea rugosa* var. *fujiokana*. A new name *Licea verrucospora*, and a new status was given to *Licea scyphoides* var. *reticulata*. One species, *Licea takahashii* was excluded as it is an immature form of another genus. Detailed standardized descriptions are made of each species examined, with comments on the most relevant taxonomic characters. Light and scanning electron micrographs of relevant morphological details are included. Nomenclatural information is given for each taxon. A key to the stipitate *Licea* species is proposed.

Key words: distribution, *Liceales*, *Myxomycetes*, nomenclature, taxonomy, type collections.

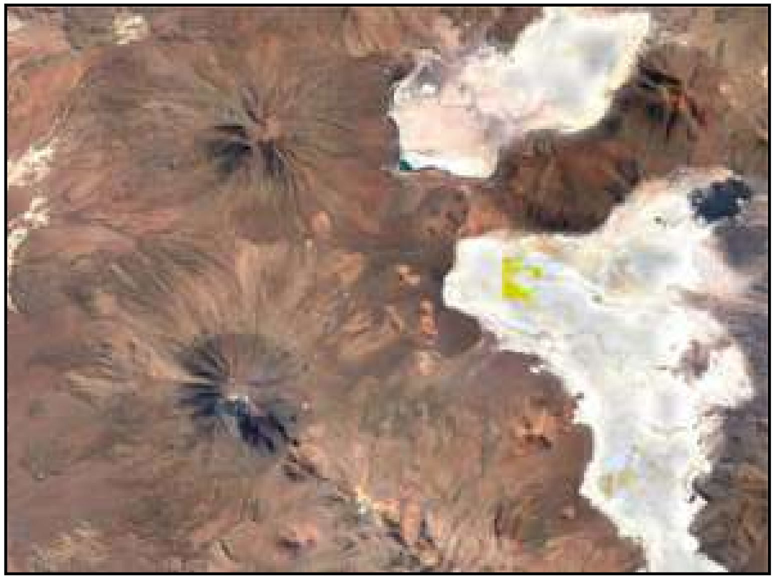
Territory explored in Phase II

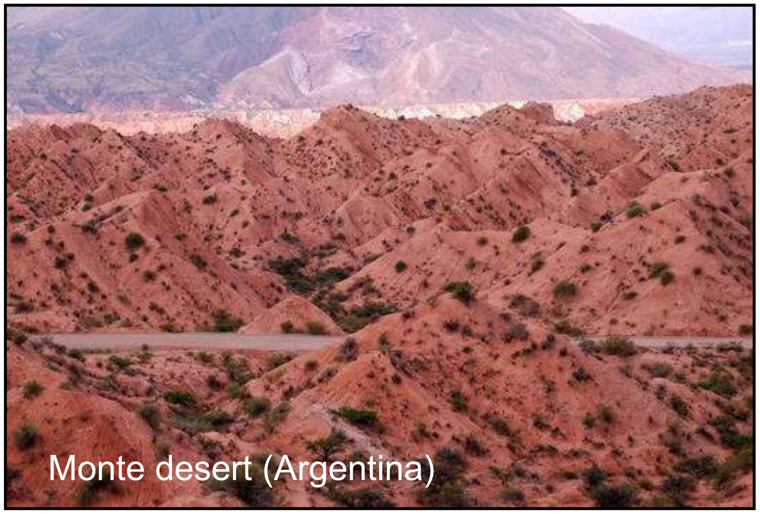
MYXOTROPIC

Monte Desert (Argentina), Atacama Desert and Central Chile (2006-2008)

New species described:

- *Dianema suculenticola*
- *Didymium chilense*
- *Didymium infundibuliforme*
- *Didymium operculatum*
- *Licea eremophila*
- *Perichaena calongei*
- *Physarum atacamense*



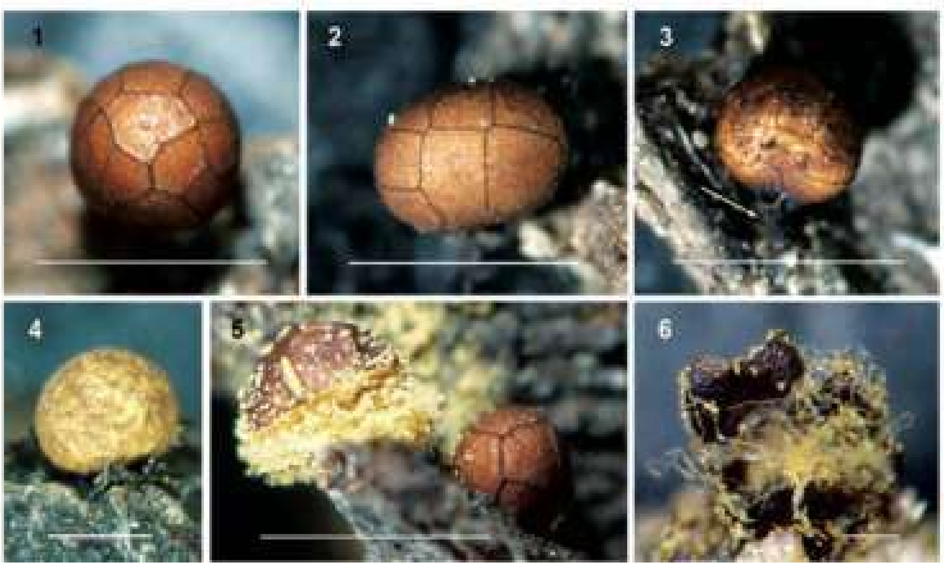


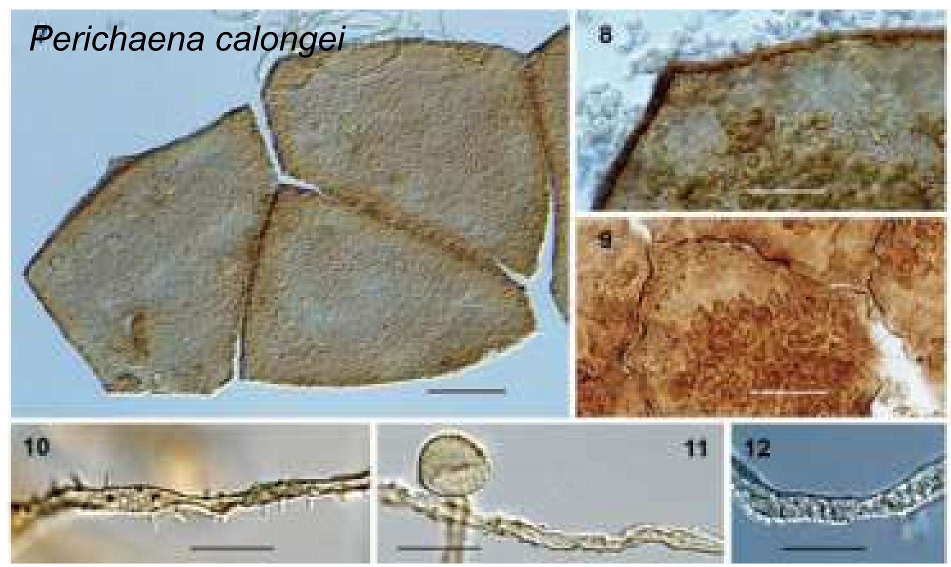
Monte desert (Argentina)

Atacama desert and Central Chile

Some new species

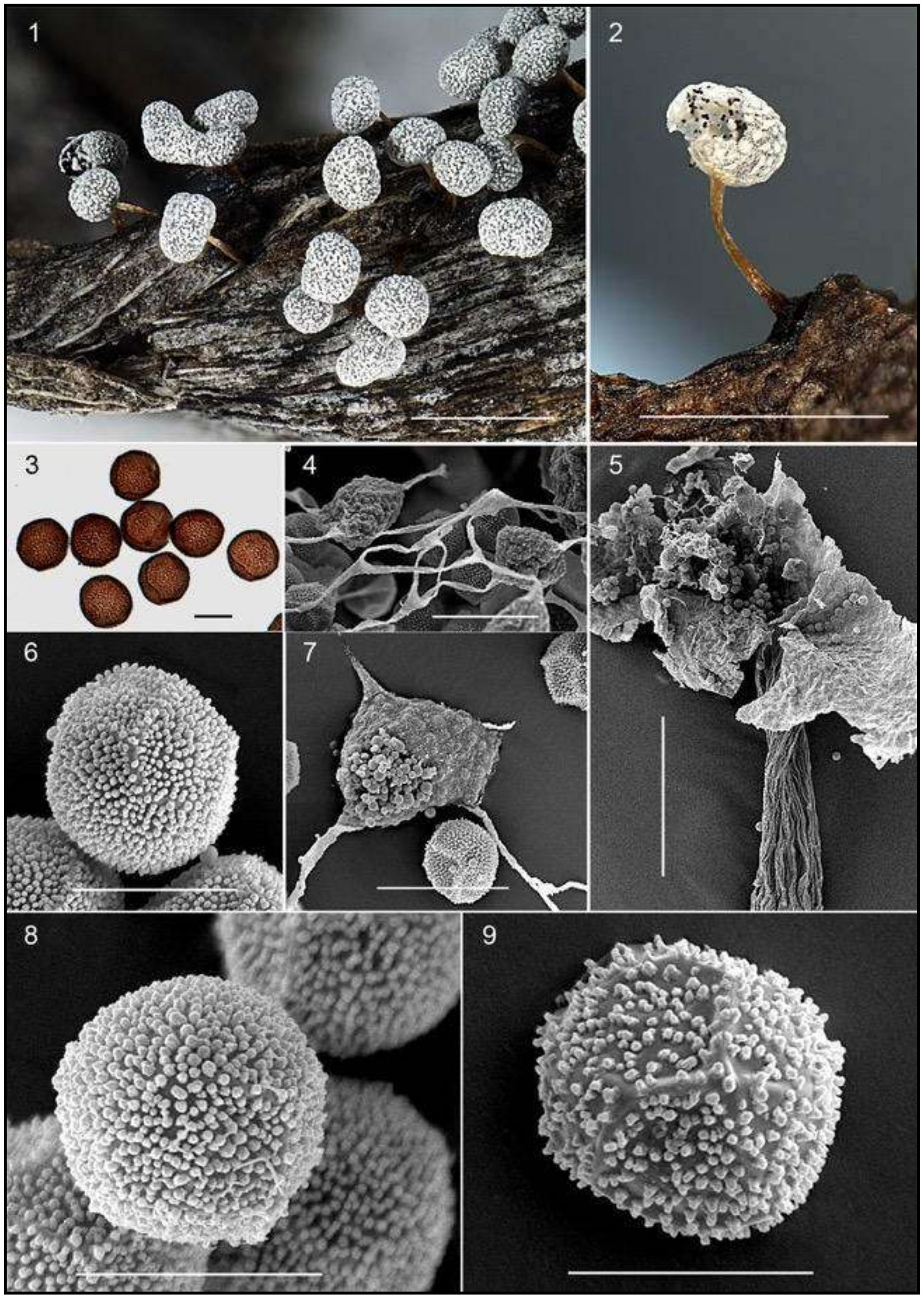
MYXOTROPIC

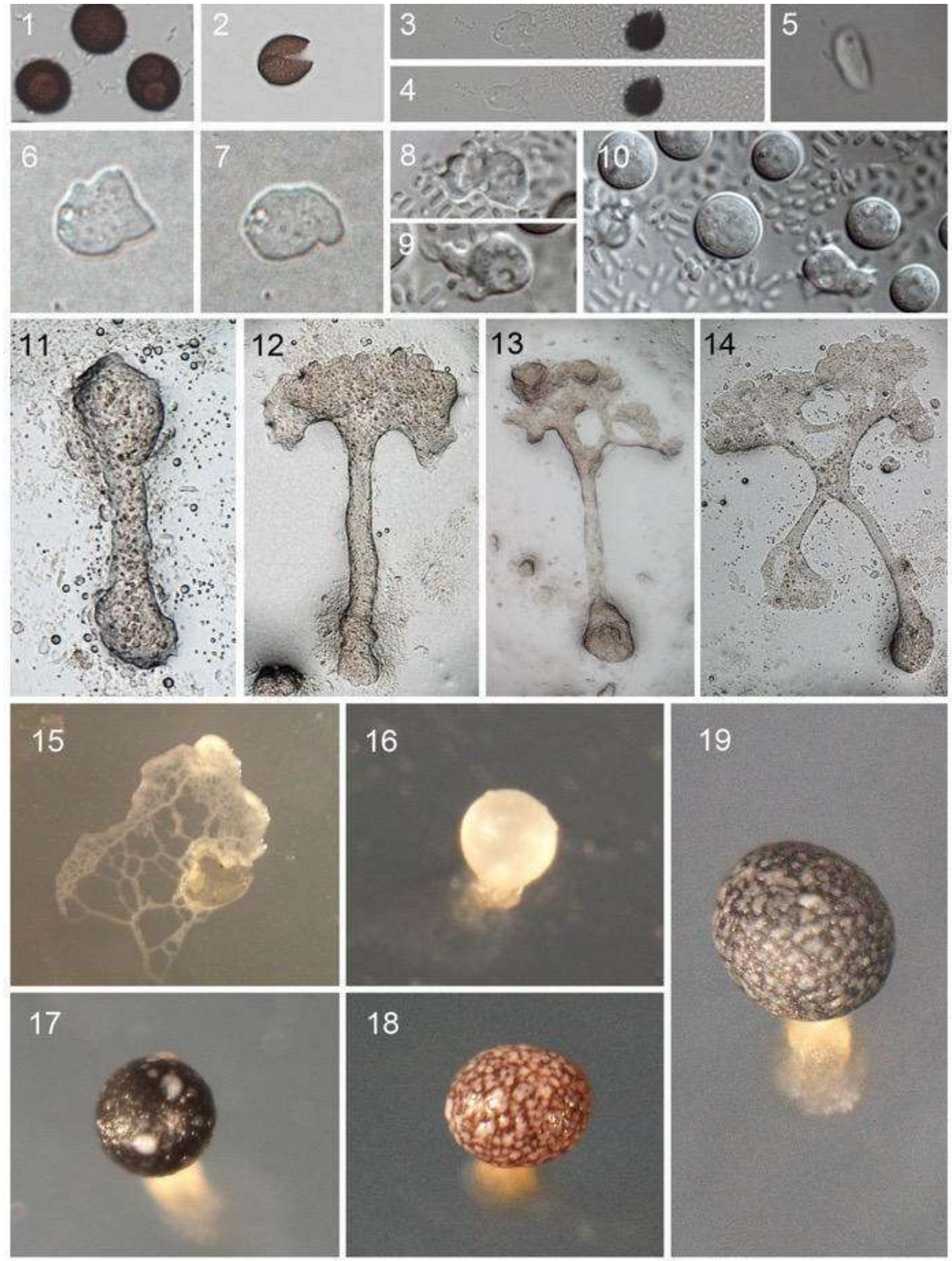




Some new species

Physarum atacamense





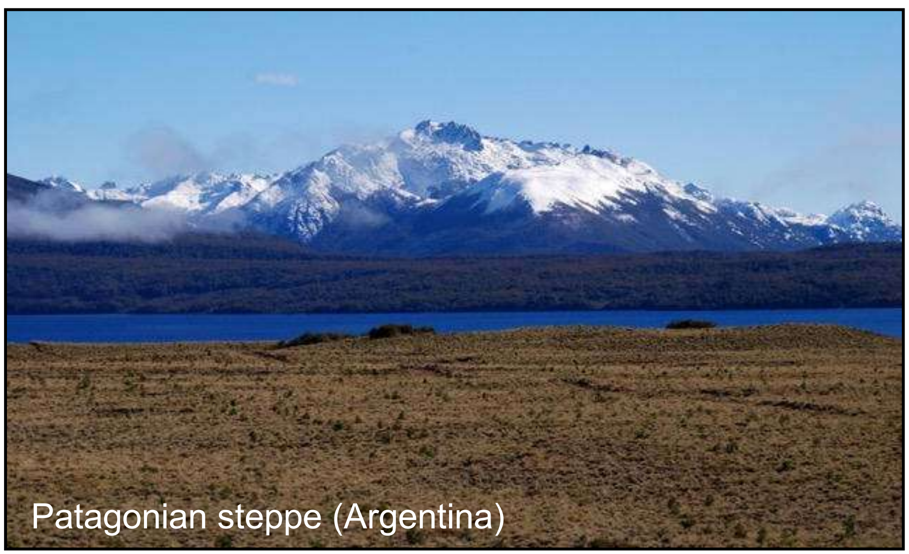
Several publications

MYXOTROPIC

Territory explored in Phase III

MYXOTROPIC

Patagonian steppe and Andean-Patagonian forests (Argentina) (2009-2011)



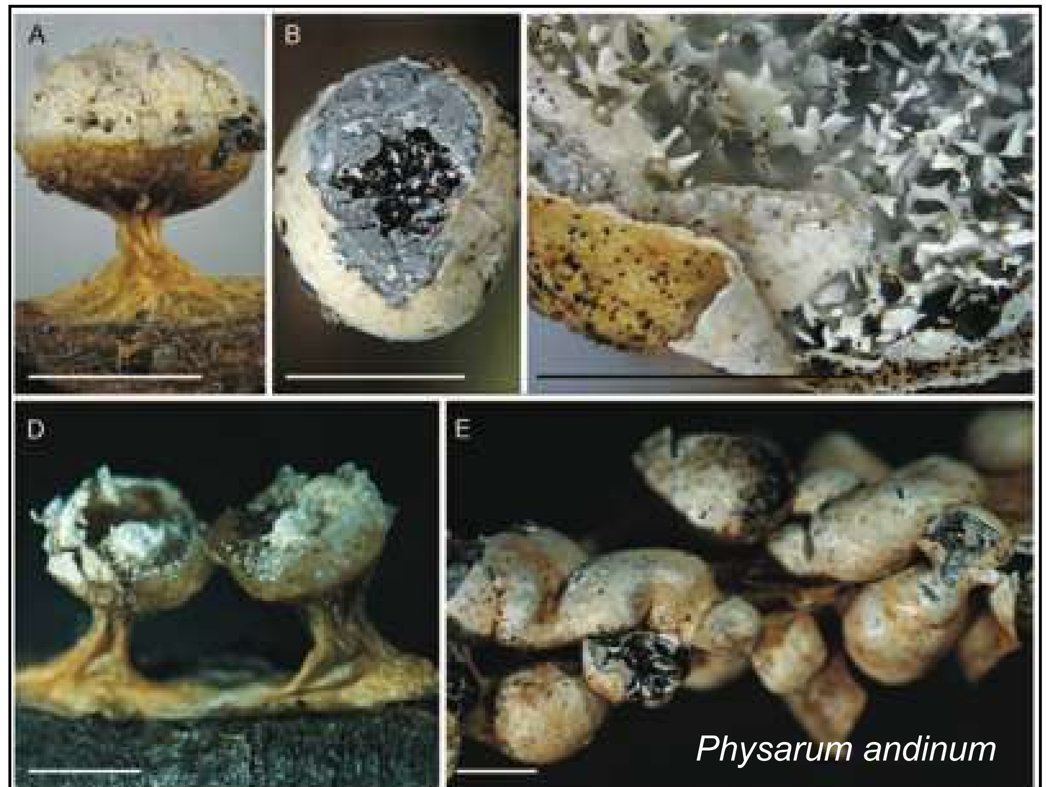
Some new species

MYXOTROPIC

New species described:

- *Lamproderma andinum*
- *Lamproderma argenteobrunneum*
- *Lamproderma kowalskii*
- *Macbrideola andina*
- *Perichaena nigra*
- *Perichaena megaspora*
- *Physarum andinum*


Lamproderma andinum

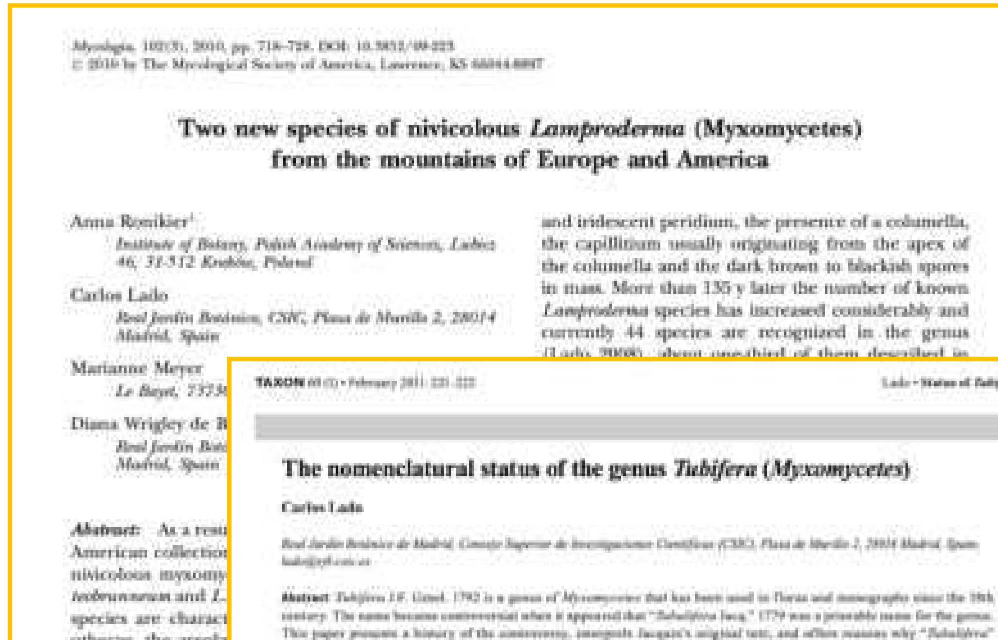


Physarum andinum


Perichaena megaspora

Several publications

MYXOTROPIC


Mycologia, 102(3), 2010, pp. 718–728. DOI: 10.3852/09-223
© 2010 by The Mycological Society of America, Lawrence, KS 66044-8897

Two new species of nivicolous *Lamproderma* (Myxomycetes) from the mountains of Europe and America

Anna Ronikier[1]
Institute of Botany, Polish Academy of Sciences, Lubicz 46, 31-512 Kraków, Poland
Carlos Lado
Real Jardín Botánico, CSIC, Plaza de Murillo 2, 28014 Madrid, Spain
Marianne Meyer
Le Bayet, 7373…
Diana Wrigley de B…
Real Jardín Bot…
Madrid, Spain

Abstract: As a resu… American collection… nivicolous myxomy… *umbrunneum* and *L.*… species are charact… otherwise, the spor…

and iridescent peridium, the presence of a columella, the capillitium usually originating from the apex of the columella and the dark brown to blackish spores in mass. More than 135 y later the number of known *Lamproderma* species has increased considerably and currently 44 species are recognized in the genus (Lado 2008), about one-third of them described in…


TAXON 60 (1) • February 2011: 221–222

The nomenclatural status of the genus *Tubifera* (*Myxomycetes*)

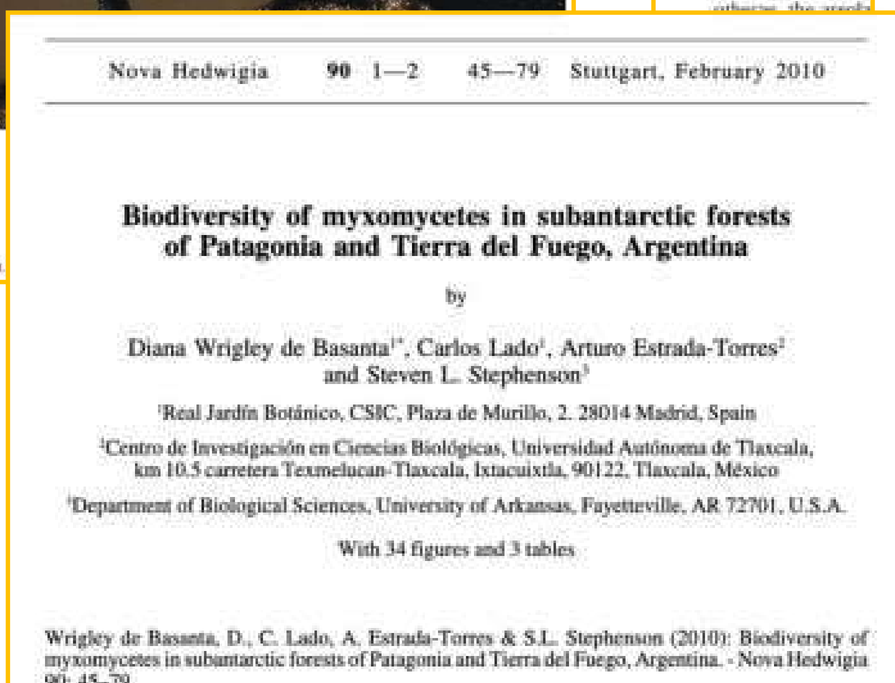
Carlos Lado

Keywords *Myxomycetes*; Nomenclature; *Tubifera*; *Tubulifera*; *Tubulina*

INTRODUCTION

TUBIFERA

TUBULIFERA


Nova Hedwigia 90 1—2 45—79 Stuttgart, February 2010

Biodiversity of myxomycetes in subantarctic forests of Patagonia and Tierra del Fuego, Argentina

by

Diana Wrigley de Basanta[1*], Carlos Lado[1], Arturo Estrada-Torres[2] and Steven L. Stephenson[3]

[1]Real Jardín Botánico, CSIC, Plaza de Murillo, 2. 28014 Madrid, Spain

[2]Centro de Investigación en Ciencias Biológicas, Universidad Autónoma de Tlaxcala, km 10.5 carretera Texmelucan-Tlaxcala, Ixtacuixtla, 90122, Tlaxcala, México

[3]Department of Biological Sciences, University of Arkansas, Fayetteville, AR 72701, U.S.A.

With 34 figures and 3 tables

Wrigley de Basanta, D., C. Lado, A. Estrada-Torres & S.L. Stephenson (2010): Biodiversity of myxomycetes in subantarctic forests of Patagonia and Tierra del Fuego, Argentina. - Nova Hedwigia 90: 45–79.

Territory explored in Phase IV

MYXOTROPIC

Coastal desert of Peru (2012-2014)

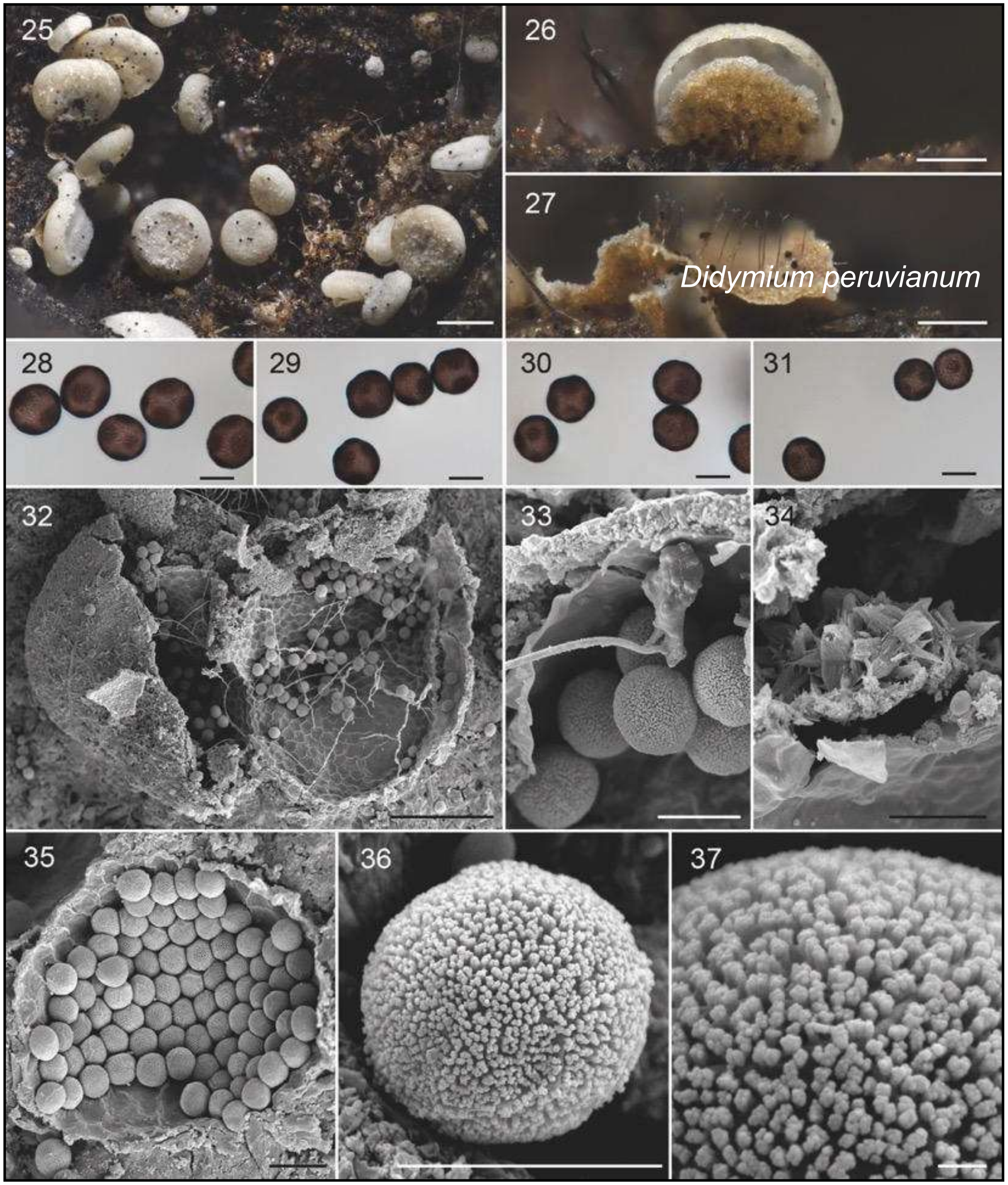
Coastal desert of Peru

Didymium xerophilum

Some new species

New species described:

- *Didymium xerophilum*
- *Didymium azorellae*
- *Didymium peruvianum*



Special myxobiota: succulenticolous Myxomycetes

MYXOTROPIC

More than 23 species described from these substrata

Species	Substrate
Badhamia grandispora	*Opuntia ficus-indica*
Badhamia melanospora	*Cereus peruvianus*
Cribraria fragilis	*Stenocereus* sp.
Cribraria zonatispora	*Opuntia* spp.
Didymium eremophilum	*Carnegiea gigantean*
Didymium infundibuliforme	*Puya* sp., *Eulychnia iquiquensis, Copiapoa* sp.
Didymium mexicanum	*Agave schawii*
Didymium operculatum	*Copiapoa solaris*
Didymium subreticulosporum	*Opuntia maxima*
Didymium tehuacanense	*Agave* sp.
Didymium umbilicatum	*Yucca periculosa, Nolina parviflora, Agave* sp.,
Didymium wildpretii	*Echinocactus platyacantus, Ferocactus latispinus, Mammillaria carnea, Pachycereus hollianus, P. weberii, Neobuxbaumia* sp., *Opuntia* spp., *Stenocereus* sp.
Licea eremophila	*Puya* sp., *Trichocereus* sp., *Miqueliopuntia miqueli*
Licea suculenticola	*Agave* sp., *Aeonium* sp., *Austrocylindropuntia exaltata, Euphorbia canariensis, Myrtillocactus geometrizans, Nolina parviflora, Opuntia* spp., *Stenocereus* sp., *Yucca filifera*
Perichaena calongei	*Puya* sp.
Perichaena stipitata	*Myrtillocactus geometrizans, Pachycereus* sp., *Stenocereus* sp.
Physarum spectabile	*Opuntia maxima*
Trichia agaves	*Agave* sp., *Yucca* sp., *Hechtia* sp., *Opuntia* sp.

Several publications

MYXOTROPIC

Anales del Jardín Botánico de Madrid

Nivicolous Stemonitales from the Austral Andes: analysis of morphological variability, distribution and phenology as a first step toward testing the large-scale coherence of species and biogeographical properties

Anna Ronikier
Carlos Lado

ORIGINAL ARTICLE

Using environmental niche models to test the 'everything is everywhere' hypothesis for *Badhamia*

María Aguilar, Anna-Maria Fiore-Donno, Carlos Lado and Thomas Cavalier-Smith

Biogeographic patterns of the myxomycete biota of the Americas using a parsimony analysis of endemicity

Arturo Estrada-Torres · Diana Wrigley de Basanta · Carlos Lado

The ISME Journal (2012) 6, 1506–1514
© 2012 International Society for Microbial Ecology All rights reserved 1751-7362/12
www.nature.com/ismej

ORIGINAL ARTICLE

Ecological niche models reveal the importance of climate variability for the biogeography of protosteloid amoebae

María Aguilar and Carlos Lado
Mycology Department, Real Jardín Botánico, CSIC, Plaza de Murillo 2, Madrid, Spain

Habitat availability and environmental preferences of species are among the most important factors in determining the success of dispersal processes and therefore in shaping the distribution of protists. We explored the differences in fundamental niches and potential distributions of an ecological guild of slime moulds—protosteloid amoebae—in the Iberian Peninsula. A large set of samples collected in a north-east to south-west transect of approximately 1000 km along the peninsula was used to test the hypothesis that, together with the existence of suitable microhabitats, climate conditions may determine the probability of survival of species. Although protosteloid amoebae share similar morphologies and life history strategies, canonical correspondence analyses showed that they have varied ecological optima, and that climate conditions have an important effect in niche differentiation. Maxent environmental niche models provided consistent predictions of the probability of presence of the species based on climate data, and they were used to generate maps of potential distribution in an 'everything is everywhere' scenario. The most important climatic factors were, in both analyses, variables that measure changes in conditions throughout the year, confirming that the alternation of fruiting bodies, cysts and amoeboid stages in the life cycles of protosteloid amoebae constitutes an advantage for surviving in a changing environment. Microhabitat affinity seems to be influenced by climatic conditions, which suggests that the micro-environment may vary at a local scale and change together with the external climate at a larger scale.
The ISME Journal (2012) 6, 1506–1514; doi:10.1038/ismej.2012.12; published online 8 March 2012
Subject Category: microbial population and community ecology
Keywords: distribution; ecogeography; protists; protostelids; slime moulds

Territory explored in Phase V

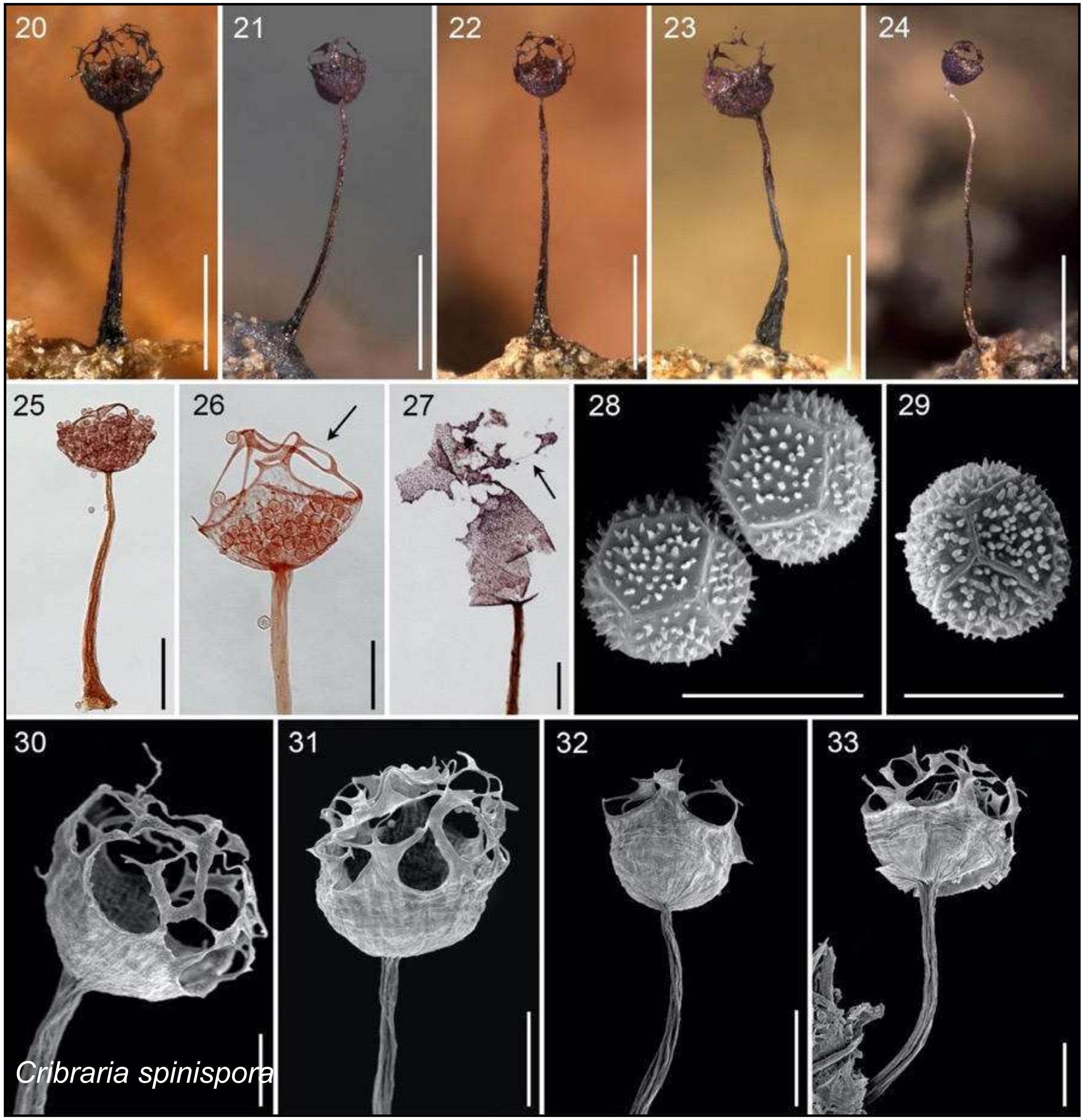
Arid areas of Tropical Andes (Peru) (2016-2018)

Some new species

MYXOTROPIC

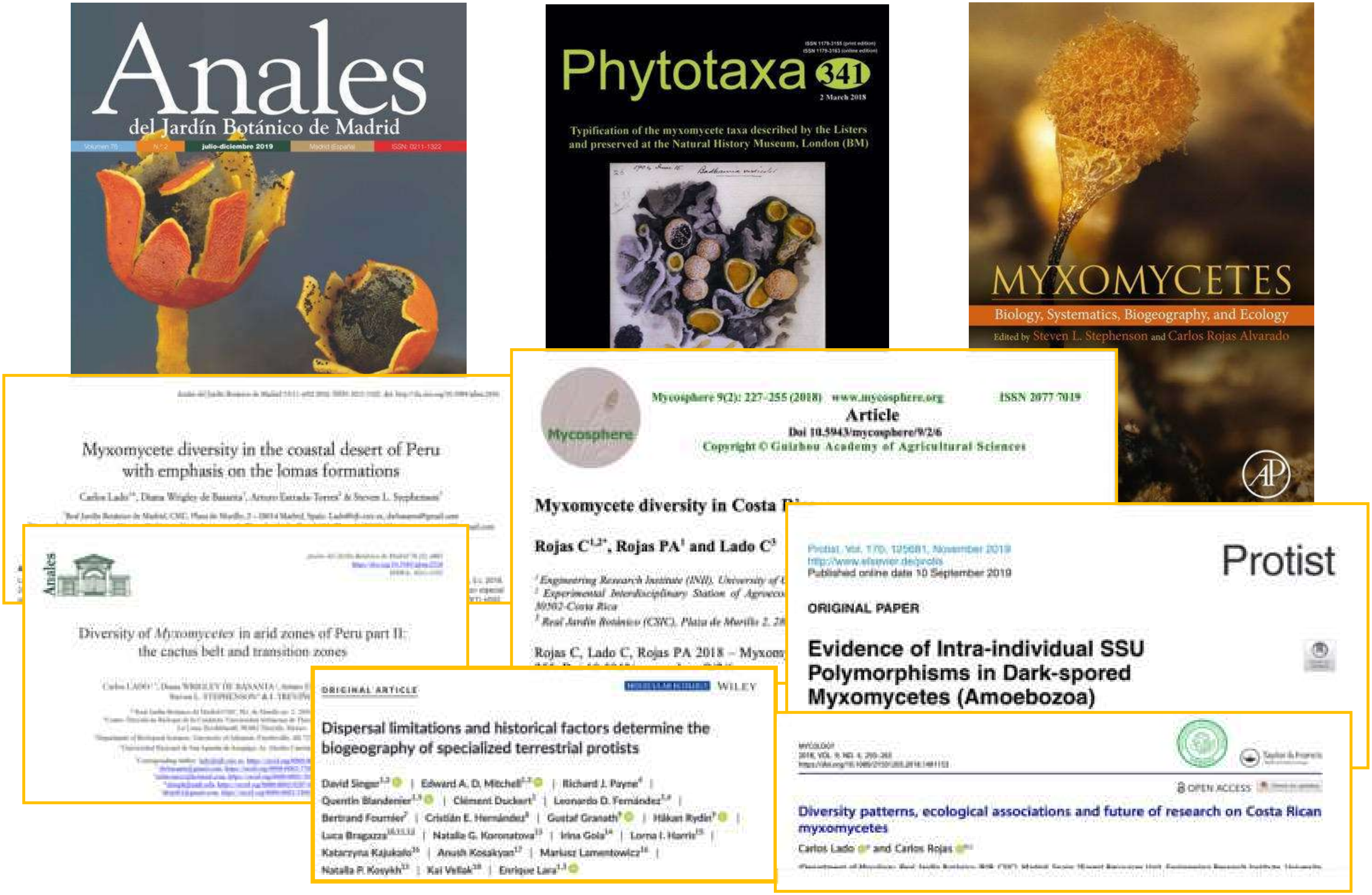
New species described:

- *Cribraria spinispora*
- *Licea aurea*
- *Diachea mitchellii* sp. nov.



Several publications

MYXOTROPIC

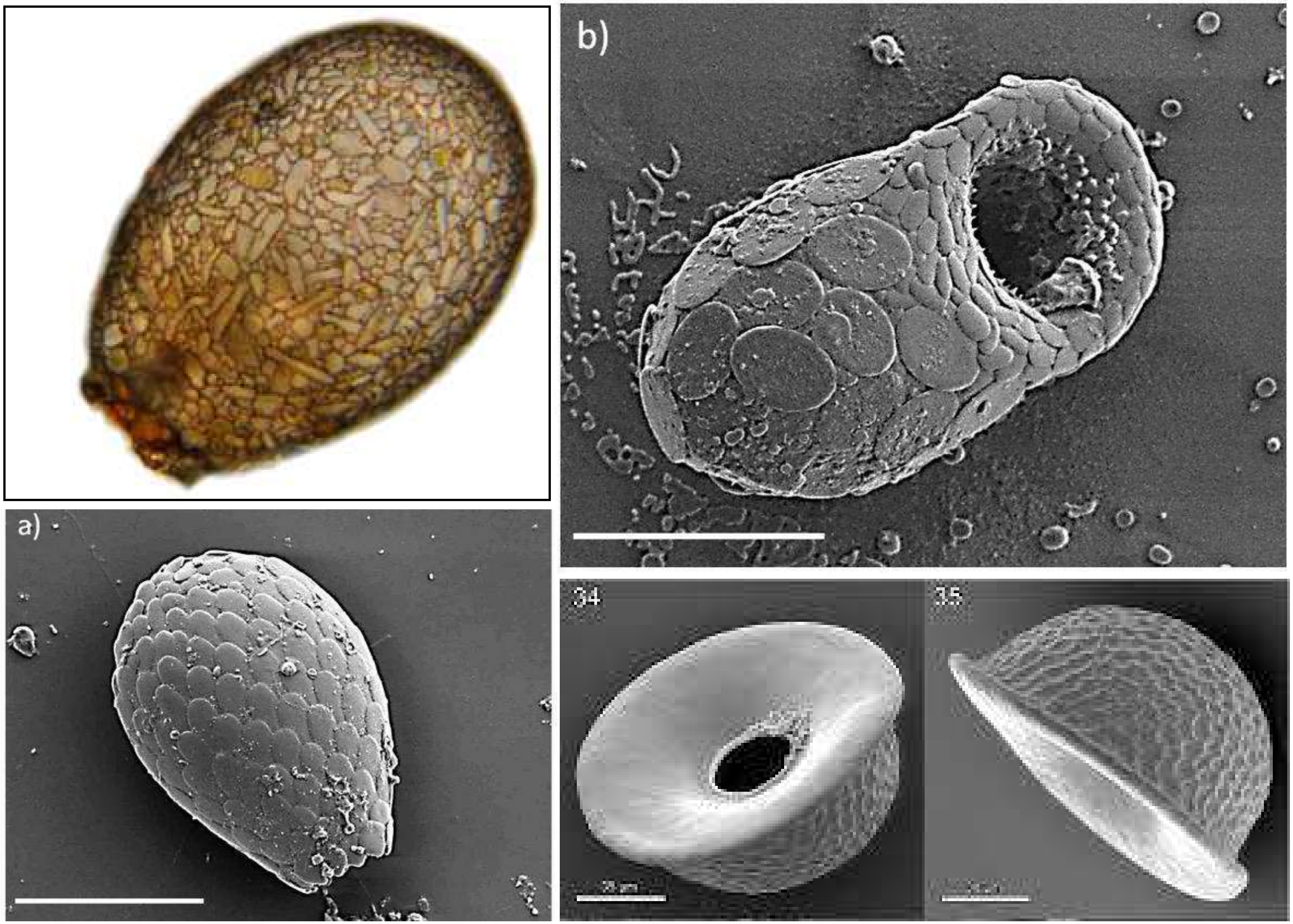


Territory to be explored in Phase VI

MYXOTROPIC

Salt flats of the Andes (Bolivia, Chile and Argentina) (2019-2021)

Arcellinida



MYXOTROPIC project

Team

Sampling effort

Year 2020
Salt flats of Chile: Surire, Huasco, Coposa, Atacama, Pajonales and Pedernales

Years 2020-2021
Salt flats of Argentina: Salinas Grandes, Arizaro, Pocitos, Cauchari, Olaroz, Antofalla, Ambargasta and Hombre Muerto

Year 2021
Salt flats of Bolivia: Uyuni, Coipasa, Empexa, Chiguana

MYXOTROPIC project

Main goal (phase VI):

To know the myxobiota of the "salares" (salt flats) of the Tropical Andes, an extreme environment.

Some specific objectives:

- To carry out the first survey and inventory of Myxomycetes and Arcellinida that live in the salt flats zones

- To perform a biosystematic study of the species involved.

- To analyze their geographical distribution and establish distribution patters of the species.

- To know how living organisms can efficiently colonize these inhospitable environments.

- To undertake an ecological and community analysis.

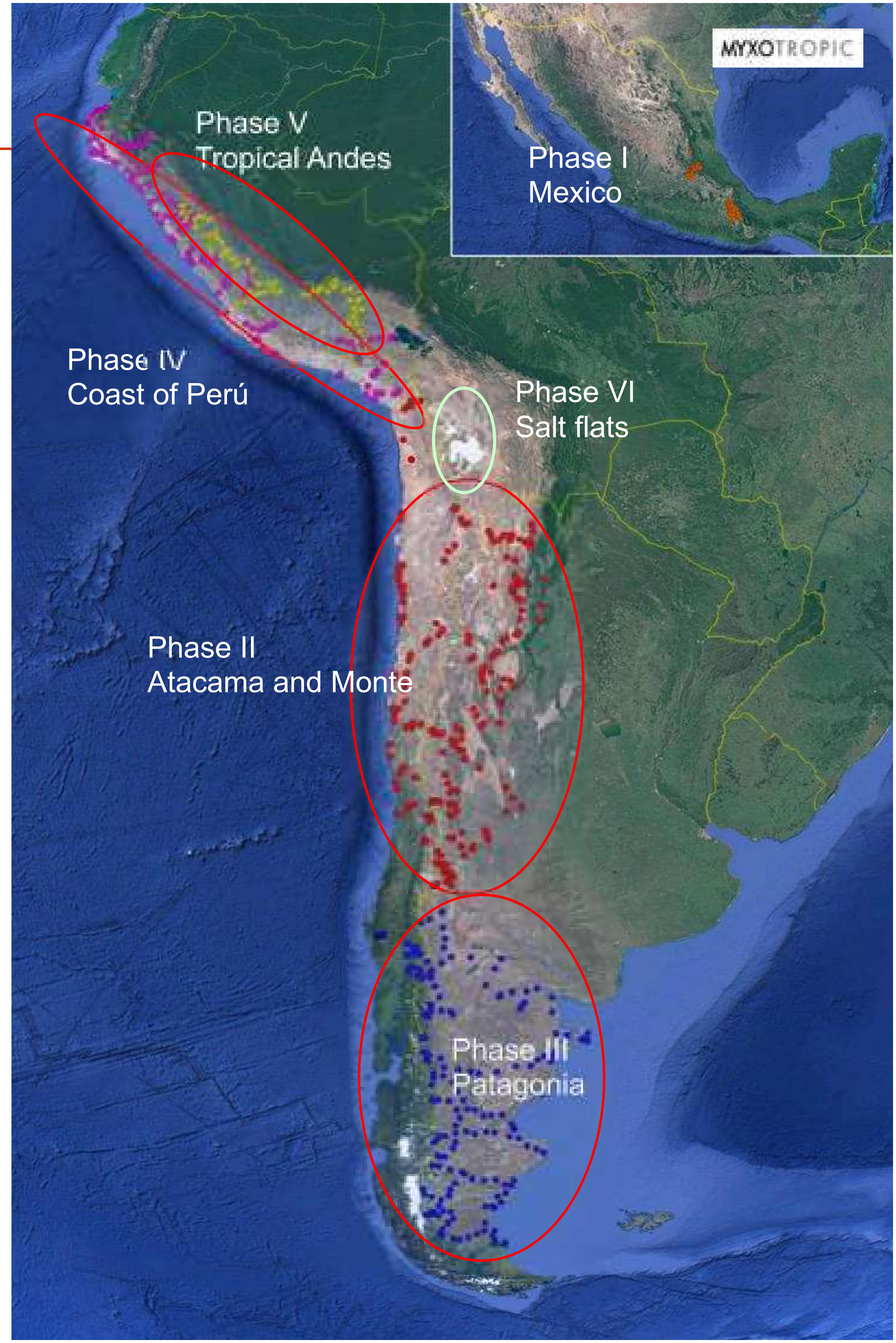
Some questions about the myxobiota

- Can distribution patterns be established?
- Are abiotic factors affecting the results, such as tº, salt concentration or pH?
- Do other arid regions of the world have the same myxobiota?
- Are there differences between myxobiota of cold and warm deserts?
- Which is more important, the macro or microenvironment?
- Do geographic barriers influence the myxobiota?

MYXOTROPIC project

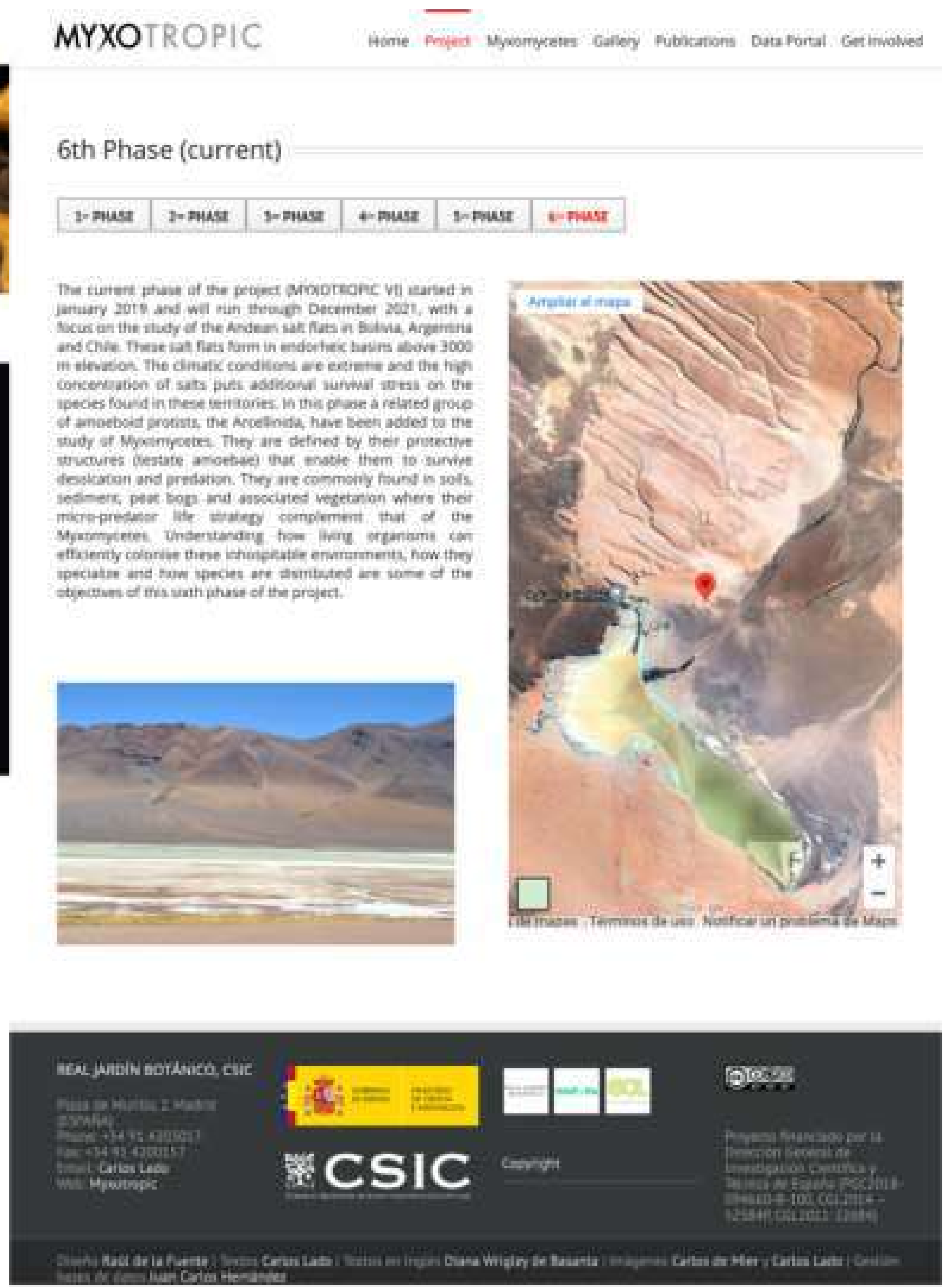
Results so far:

- 874 Sampling localities
- >9050 Field samples
- >400 Species recorded
- 23 New species described
- >200 New records for South America and the Neotropics
- 605 species currently recorded in the Neotropics
- 68 papers published



More information: www.myxotropic.org

MYXOTROPIC



Acknowledgements

MYXOTROPIC

The team members

Diana Wrigley
Anna Ronikier
Belén Estébanez
Juan Carlos Hernández
Iván García-Cunchillos
Carlos Rojas

Enrique Lara
Leo Fernández
Arturo Estrada
Kina García
Carlos de Mier
Carlos Lado

Are grateful to all those who have contributed to the knowledge of Myxomycetes in the Neotropics

and to the Spanish Government PGC2018-094660-B-I00 (MCIU/AEI/FEDER, UE) for funding the project.


Thank you very much for your attention
www.myxotropic.org
MYXOTROPIC

Some hypothesis about columella in the genus Didymium

Presented by Renato Cainelli
Associazione Micologica Bresadola - Gruppo di Muggia e del Carso
Trieste

PREFACE

The myxocarps are not the result of a predetermined assembly plan that ensures morphological consistency, as in multicellular organisms, but rather the result of a series of coordinated processes.

Some of these processes may be affected by environmental conditions causing variations in the developing.

Without the help of a theory explaining the mechanisms of formation of the most significant structures we often find it difficult to interprete the many doubtful cases in the field.

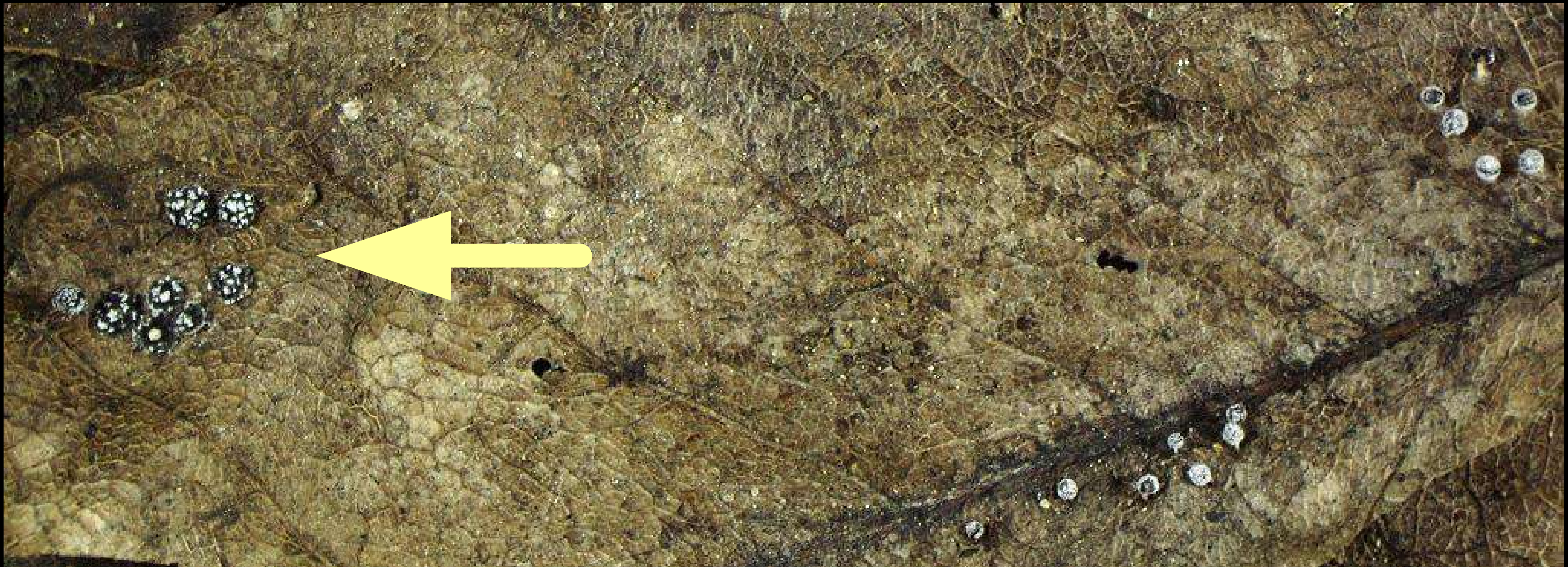
In July 2012 I found three different fructifications of the genus *Didymium* on the same leaf of *Carpinus betulus* .

In all cases it was *Didymium* with limy stalk belonging to the *squamulosum super complex* and ...it was evident that the differences between fructifications could not depend on the growing conditions.

The first fruiting corresponded well to the typical form of *Didymium squamulosum*.

The second had curious features, as a fragmented peridium likewise to Di*ymium floccosum* .

Even the third fruiting was difficult to classify, with some characters similar to *Didymium applanatum*.



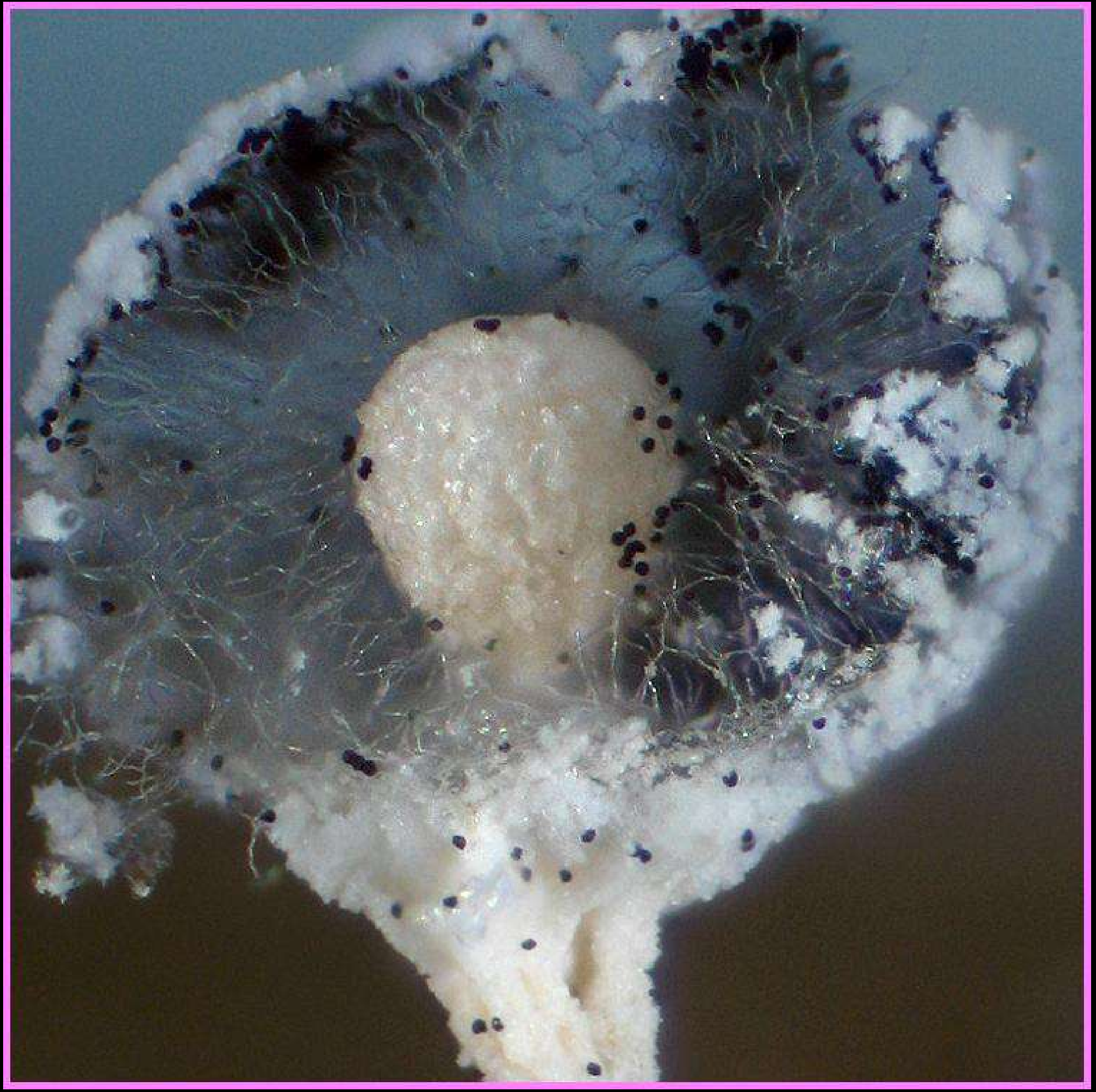
Later I collected several samples that stably exhibited the same characteristics as these fructification.

In addition to the shape and appearance of the peridium, the distinctive differences concerned mainly the development of the columella .

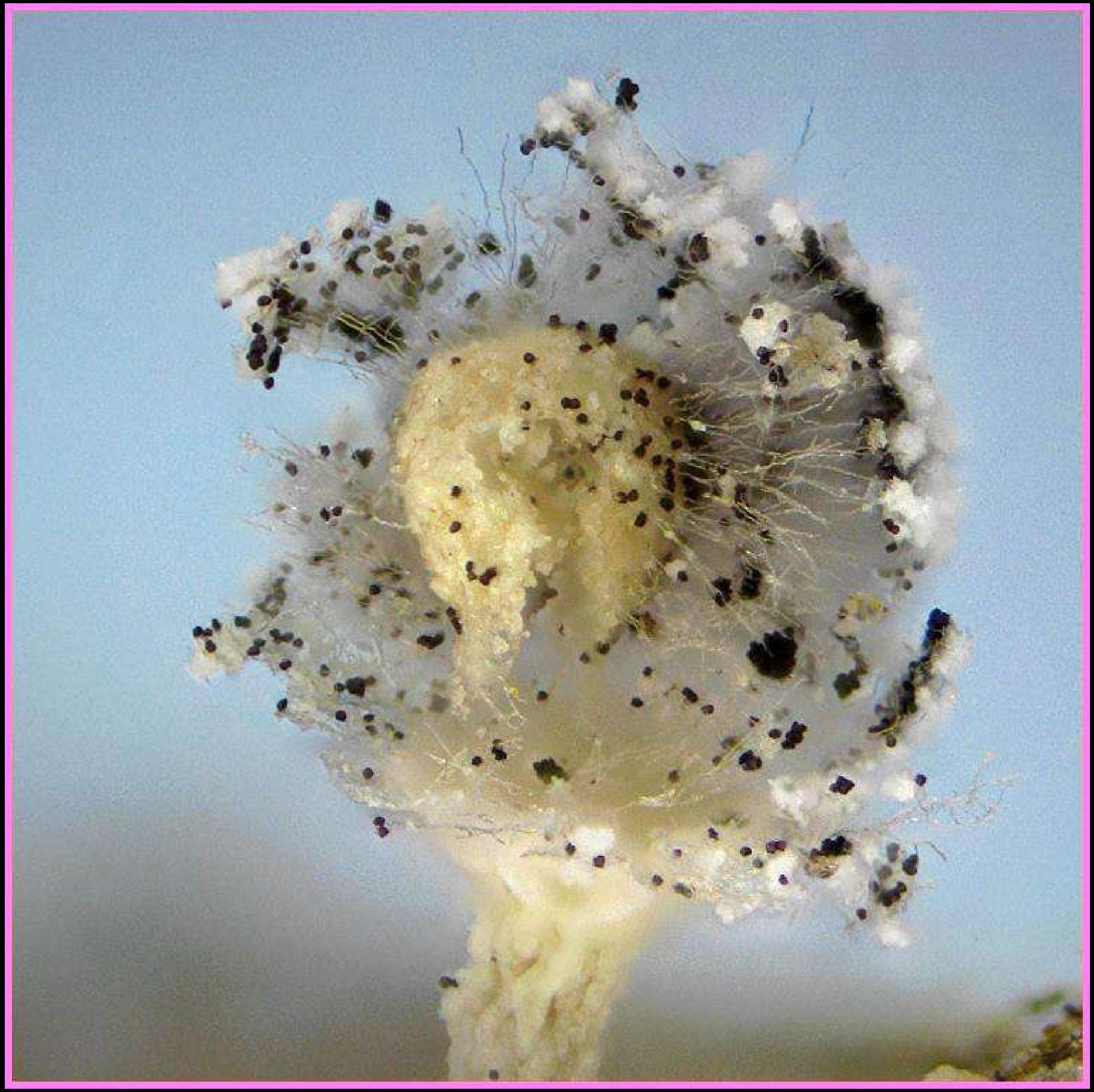
In the first case the columella appeared as a simple extension of the stalk.

500x750 µm

In the second case we had a clearly hollow clavate columella .

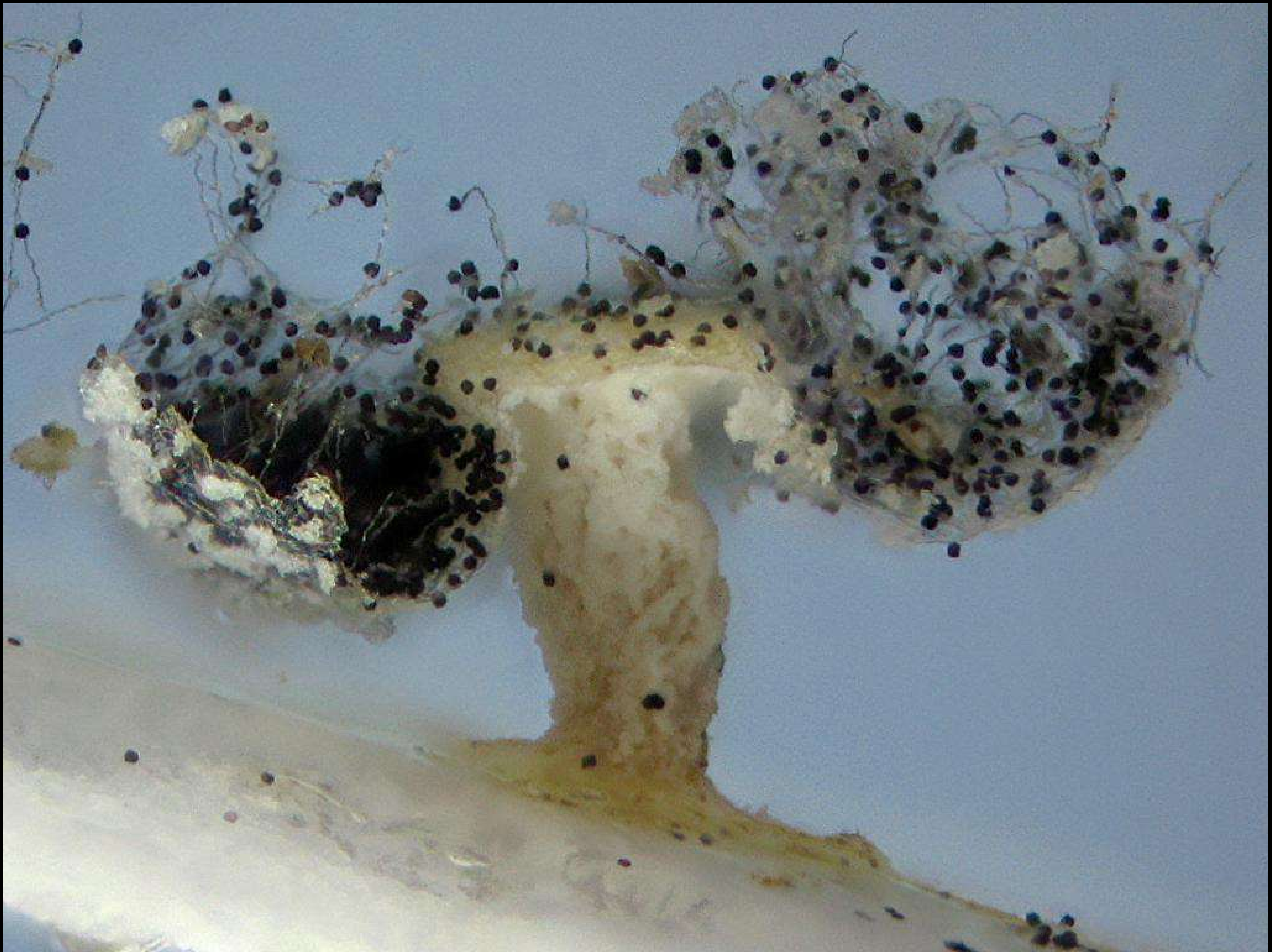


750x750 µm



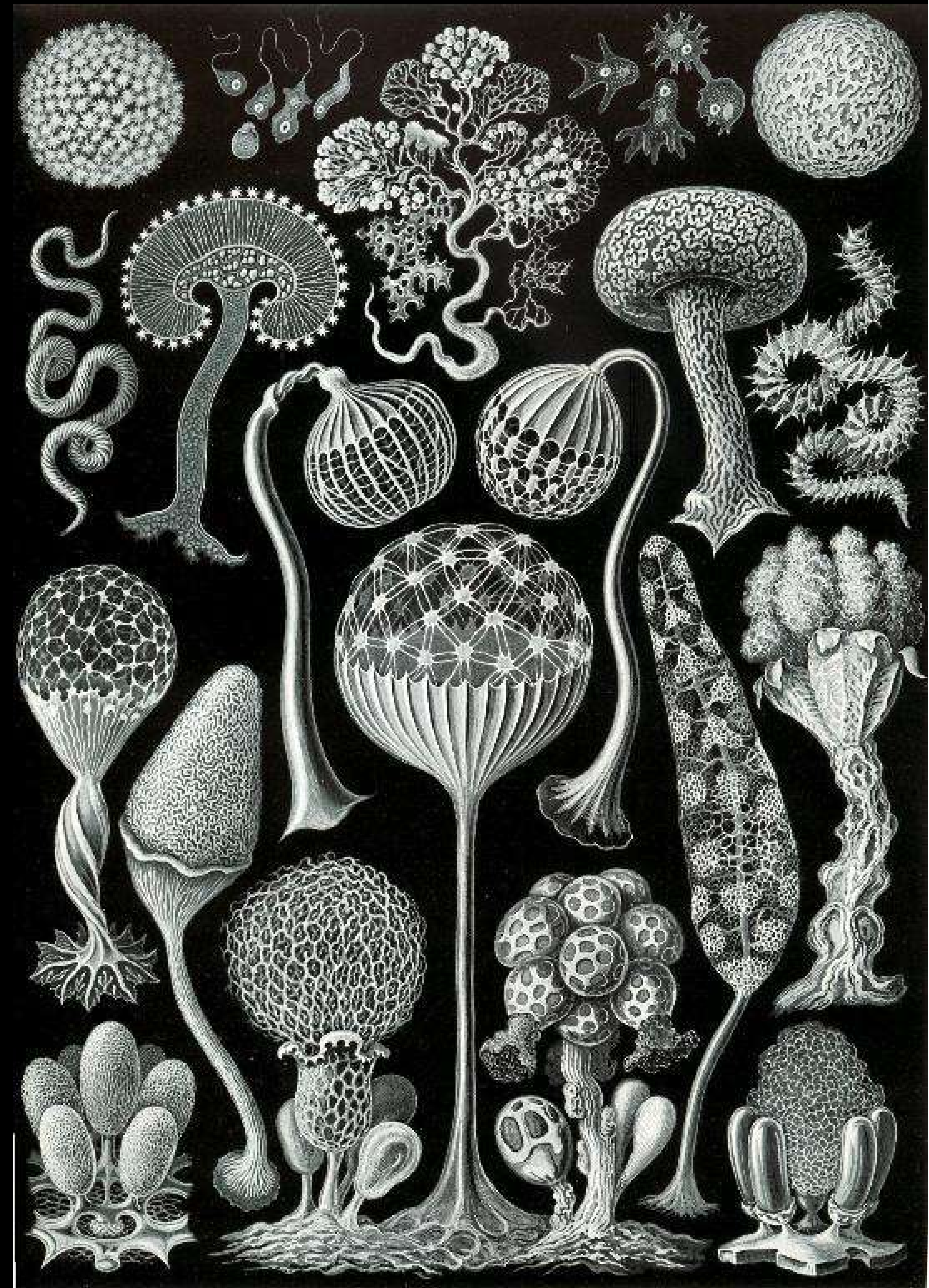
750x750 µm

In the third case the columella was absent or in any case reduced to the thickened base of the sporocysts in a shallow open umbilicus .



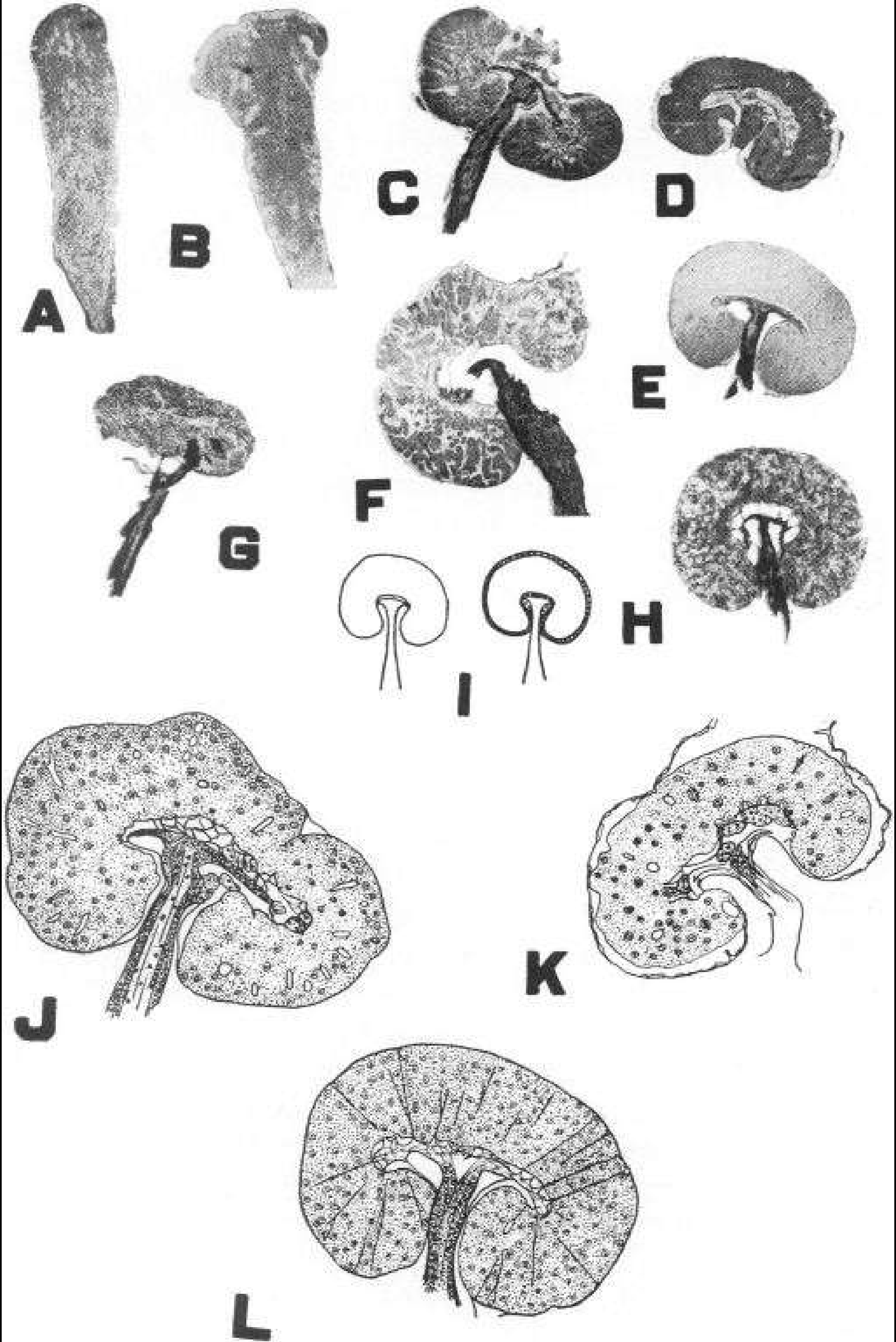
The historical definition of columella "as an extension of the stalk inside the sporangium" is not adequate for the Didymium genus , and we can find in literature basal columella, secondary columella and hypocolumella as already defined concepts.
These concepts are related to a peridial origin of the columella as it is explained in the book Les Myxomycetes by Michel Poulain, Marianne Meyer and Jean Bozonnet (2011), to which I will refer for the terminology used .

In one of the beautiful plates created by *Haenkel* in 1904 a very precise representation of the internal structure of a stalked *Didymium* was given.



Ernst Haenckel- Kunstformen der Natur, 1904 Micetozoa

The area of the columella was represented as a cavity filled with calcareous granules .



In his 1955 study of *Didymium iridis*, Arthur L. Welden clearly mentions a *"columella zone"* intended for the reception of materials from within the plasma membrane.

A.L.Welden-Capillitial development in the myxomicetes Badhamia gracilis and Didymium iridis. Mycologia,Vol.47,1955, Fig.3

The columella in the *Didymiaceae* plays the role played in the Physaraceae by the nodes of the capillium, that is to free the space destined for meiosis from excess materials, especially water and lime.

The capillitium is responsible for transporting materials both to the outside of the peridium and to the inside of the columella space.

The matrix in which the lime transfer take place determines its crystalline form (*).

While in the genus *Diderma* a denser matrix imprisons the lime in cryptocrystalline spherules in the genera *Didymium* and *Lepidoderma* a less constrictive matrix, it allows the formation of free crystals.

(*) Schoknecht J, Keller HW, 1989- Peridial calcification in the Myxomycetes. In Crick R(editor), Origin, Evolution and modern aspect of biomineralization in plants and animals. Plenum Press , New York. 455-488

Didymium vaccinum 18103102

This can also happen inside the columella space.

The formation of free crystals should require an abundant presence of water which could leave large empty spaces after drying.

In 1974 *Gustafson and Thurston* gave this schematic representation of the sporocarp of *Didymium squamulosum*. They showed how the plasma membrane separated the interior of the sporocysts from the outside and from the columella formation zone, and how the ionic Ca was expelled outside forming calcite crystals due to atmospheric CO2.

Gustafson and Thurston: Didymium squamulosum Mycologia, Vol.66, pg.400, 1974

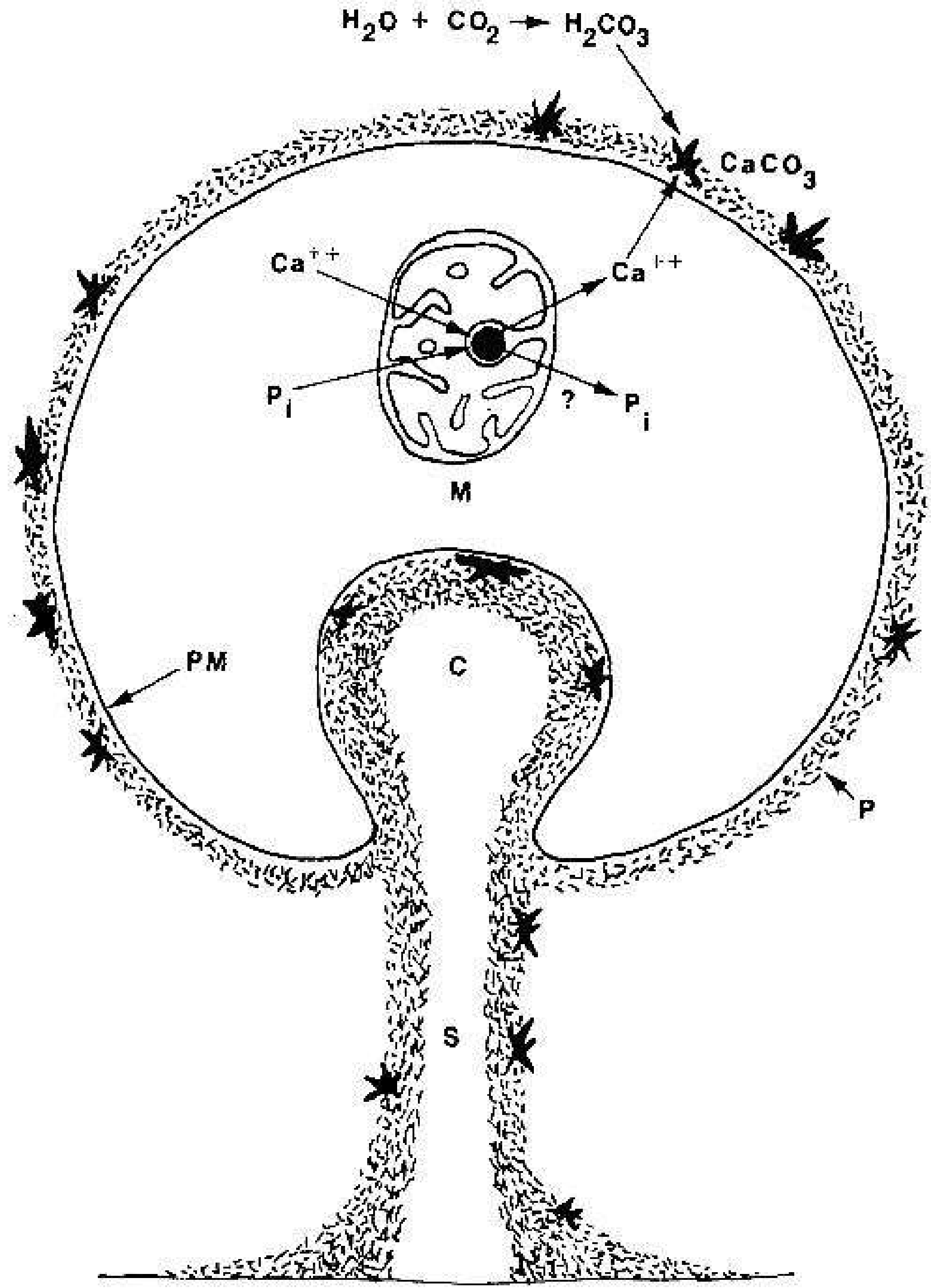
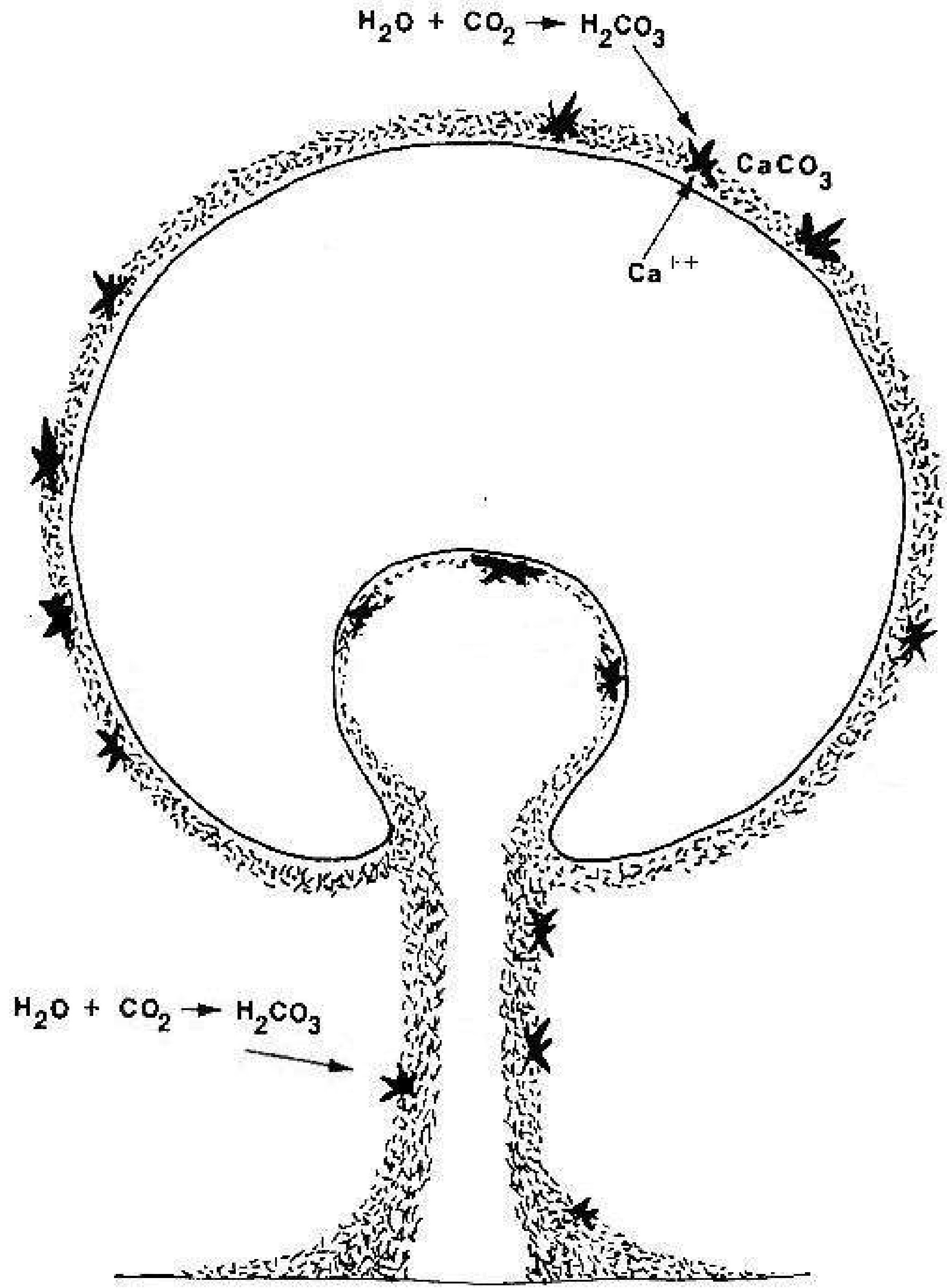


FIG. 3. *Didymium squamulosum.* Diagrammatical representation of a pre-cleavage sporangium. M, mitochondrion with granule; C, columella; S, stalk; PM, plasma membrane; P, peridium.

Phenomena similar to those that occur outside the peridium must also occur at the level of the stalk and the columella.

The fact that the formation of limestone occurs by reaction with atmospheric C02 implies that the calcification of the stalk proceeds from the outside towards the inside and that the area of the columella is affected last.

Often the available Ca may not be sufficient to guarantee a complete calcification of these structures.



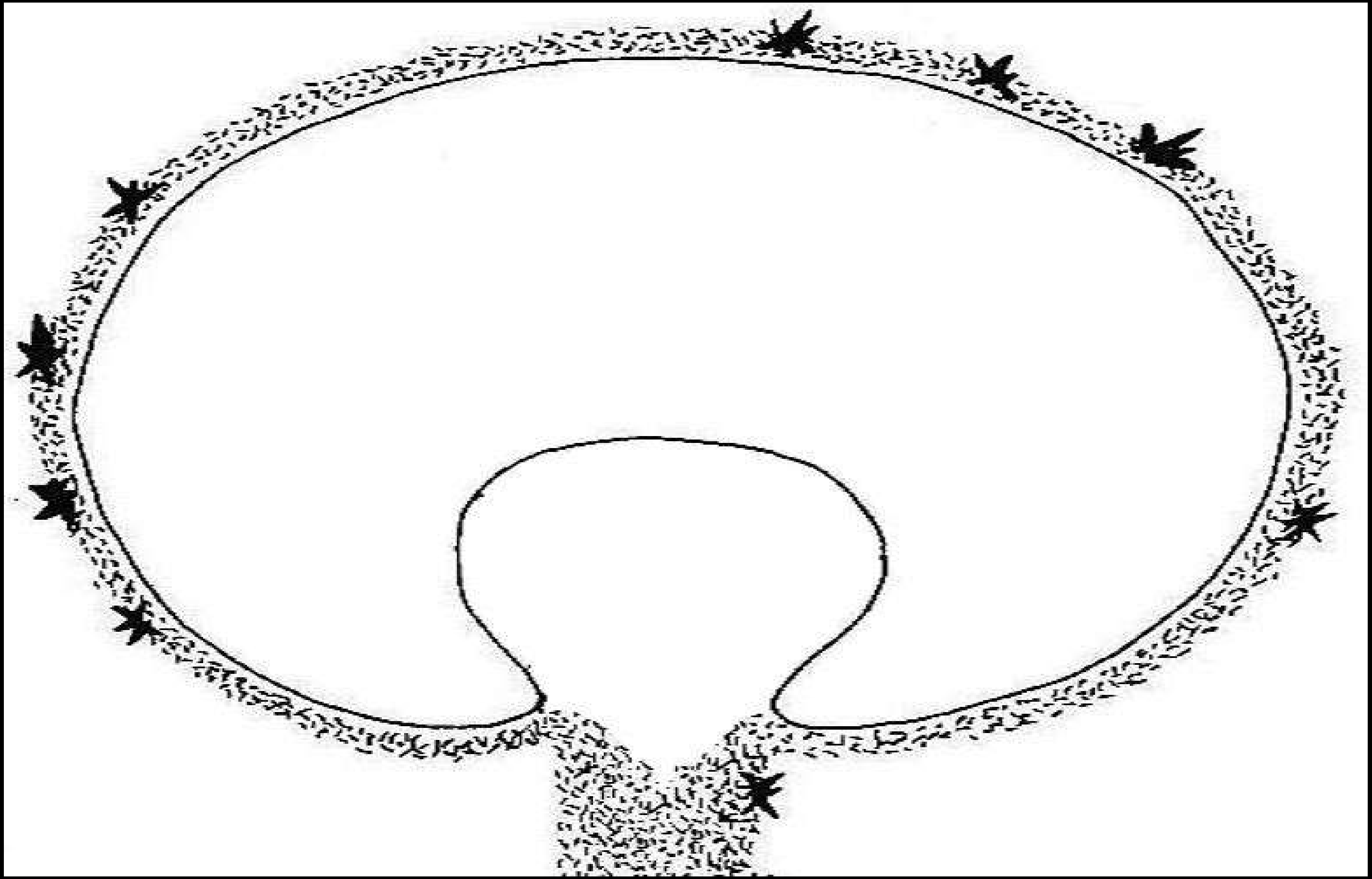
(freely modified design)

Actually Clark and Haskins placed the *squamulosum super complex* in the empty tube externally calcareus stipe group.

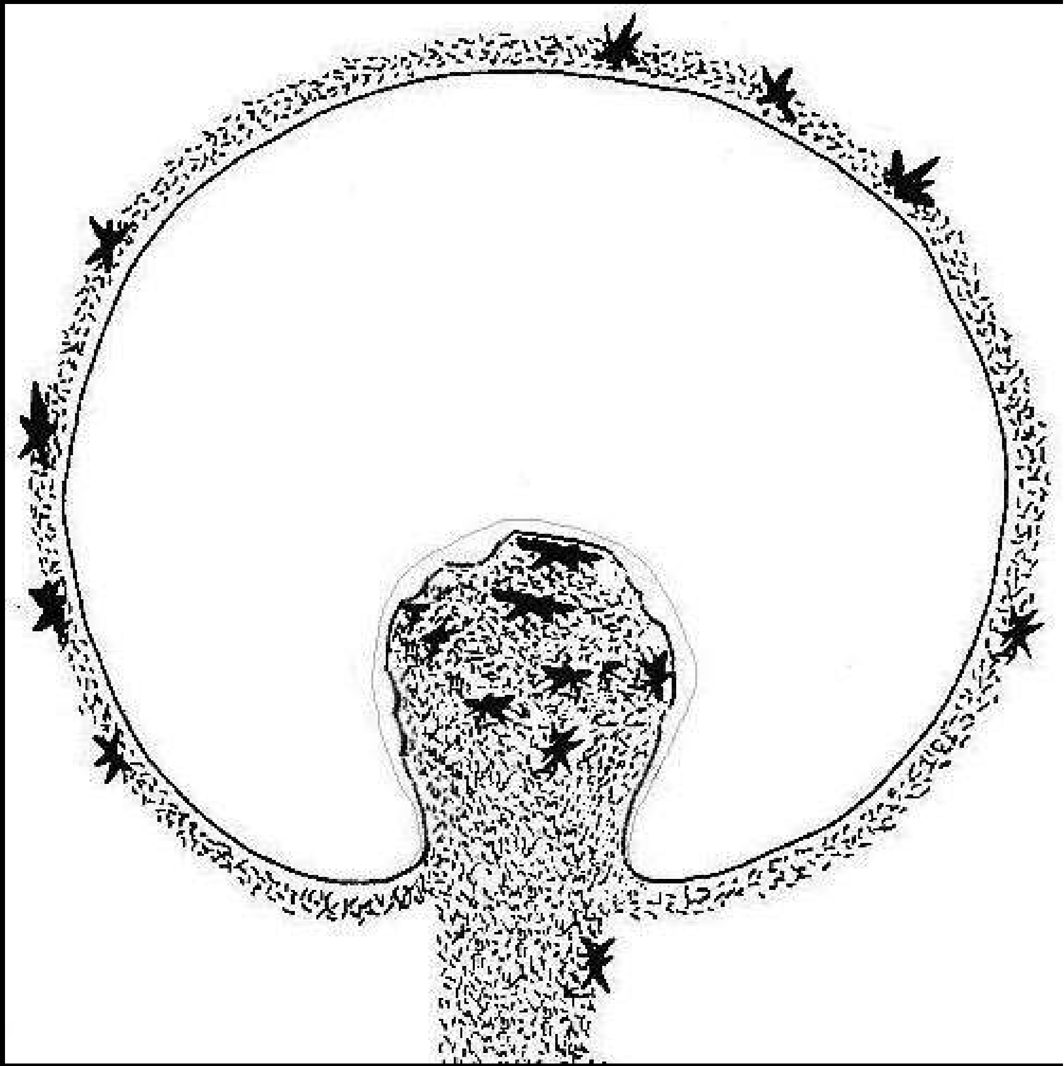
In many cases the columella remains hollow and also the apex of the stalk may be funnel-shaped .

In conclusion we can think that in an intermediate phase the space destined to the formation of the columella hosts a liquid bubble enclosed between the plasma membrane and the top of the stalk.

Let's see how these considerations can be applied to my three cases.

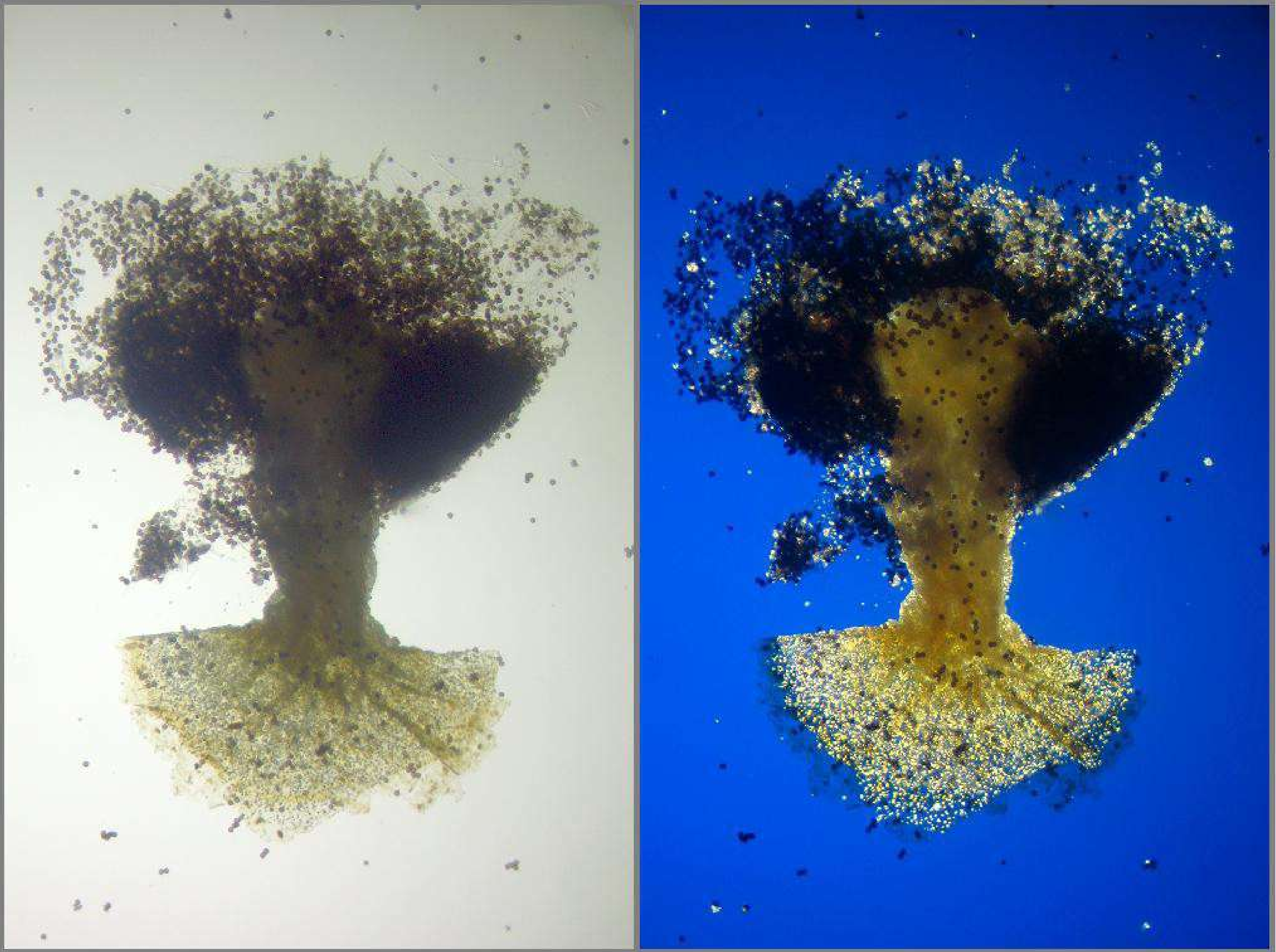


First case : columella which appears as an extension of the stalk .



The bubble is almost completely filled with the calcareous material on which the plasma membrane that has become internal peridium is adapted. The appearance may be that of a true columella, but still it is a *basal* columella (*).

(*) M.Poulain, M.Meyer, J.Bozonnet
Les Myxomicetes, Tome 1, pgg.291,295



But the situation could also be a little different.

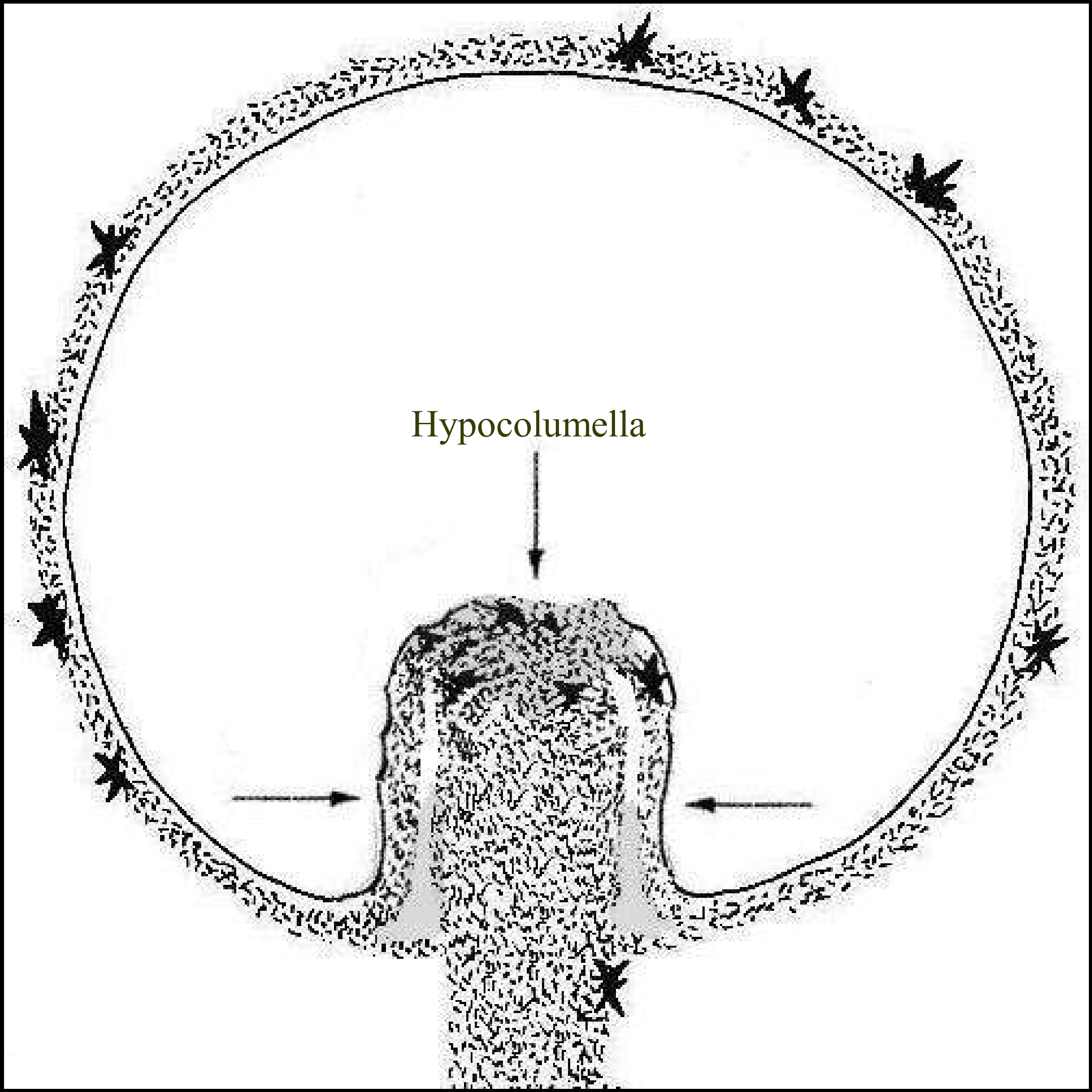
Even when the size of the columella appears conspicuous it could actually only be a *hypocolumella* (*) as it happens in the case of a *Didymium* with a lime-free stalk as *Didymium verrucosporum*.

17082203

(*) M.Poulain, M.Meyer, J.Bozonnet
Les Myxomicetes, Tome 1, pgg.291,295

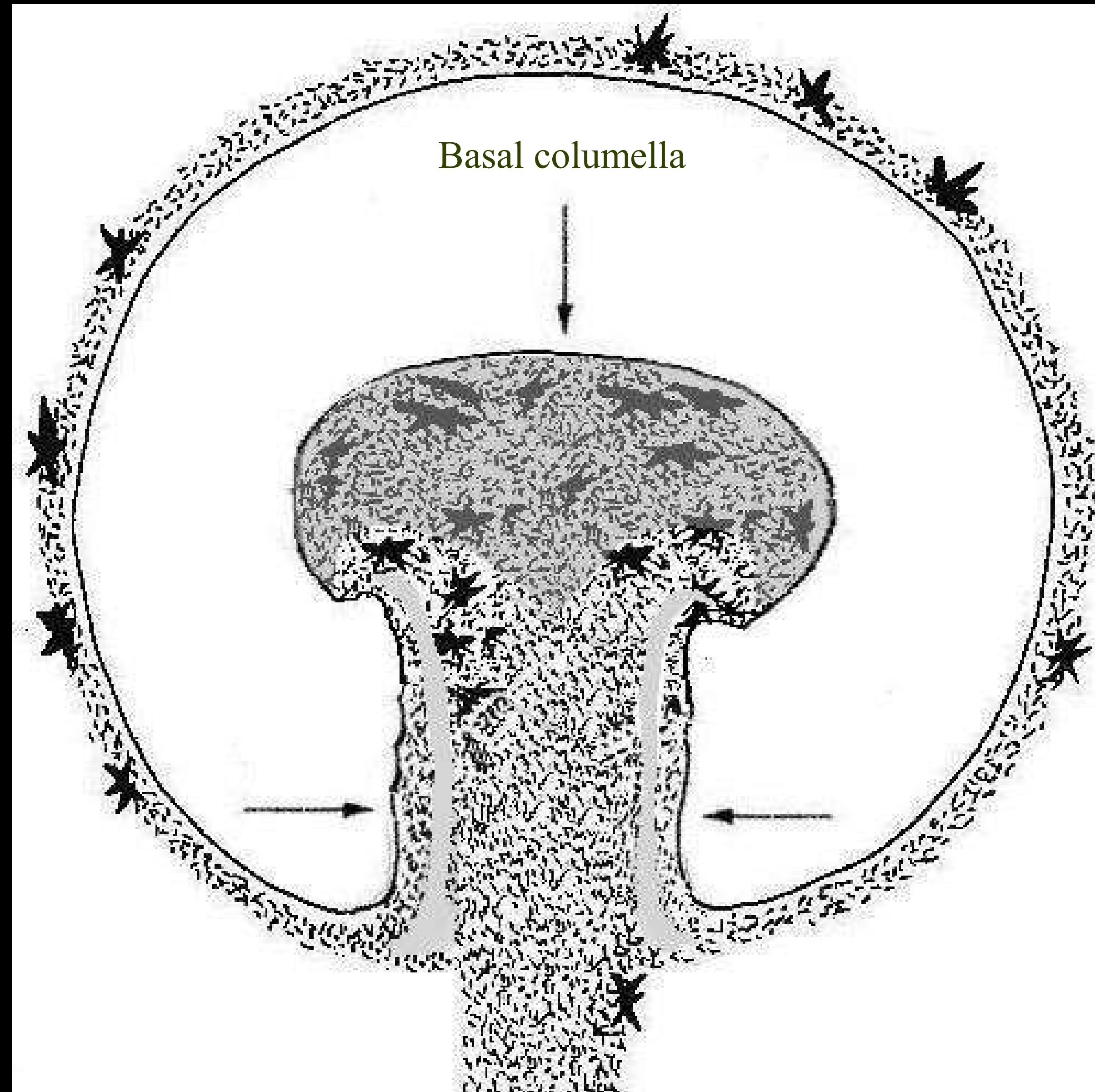
In many species of the genus *Didymium* the sporocyst are so deeply umbilicated that they tighten around the top of the stalk. When the two structures are clearly diversified, the real nature of the columella can easily be highlighted.

In the case of *Didymium* with calcareous stalk (like *Didymium squamulosum*) there is no such a difference, the two structures that come into contact may melt, and the top of the stalk sheathed by peridium may look like a *true columella* (*).



(*) M.Poulain, M.Meyer, J.Bozonnet
Les Myxomicetes, Tome 1, pgg.291,295

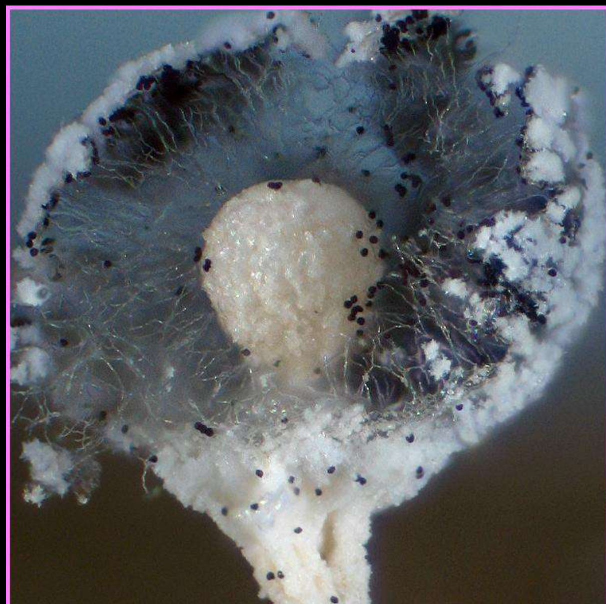
Probably the most typical condition for *Didymium squamulosum* is however that of having a quite conspicuous *basal columella* (*) on the top of a sheathed stalk that penetrates deeply into the sporocysts.

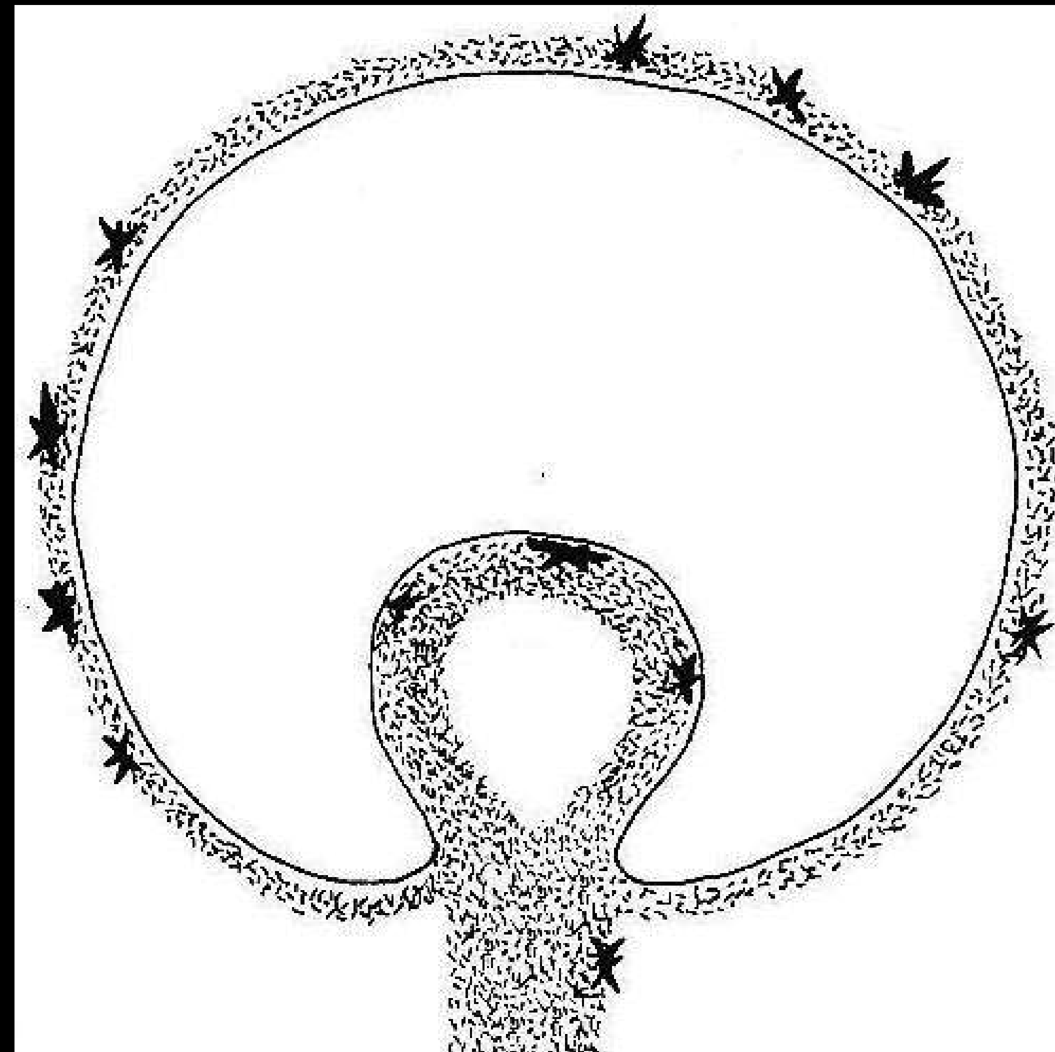


(*) M.Poulain, M.Meyer, J.Bozonnet
Les Myxomicetes, Tome 1, pgg.291,295


13030202

Second case: clavate and hollow columella.





The walls of the columella are sufficiently thickened and calcified to maintain the shape of the bubble even after complete drying.

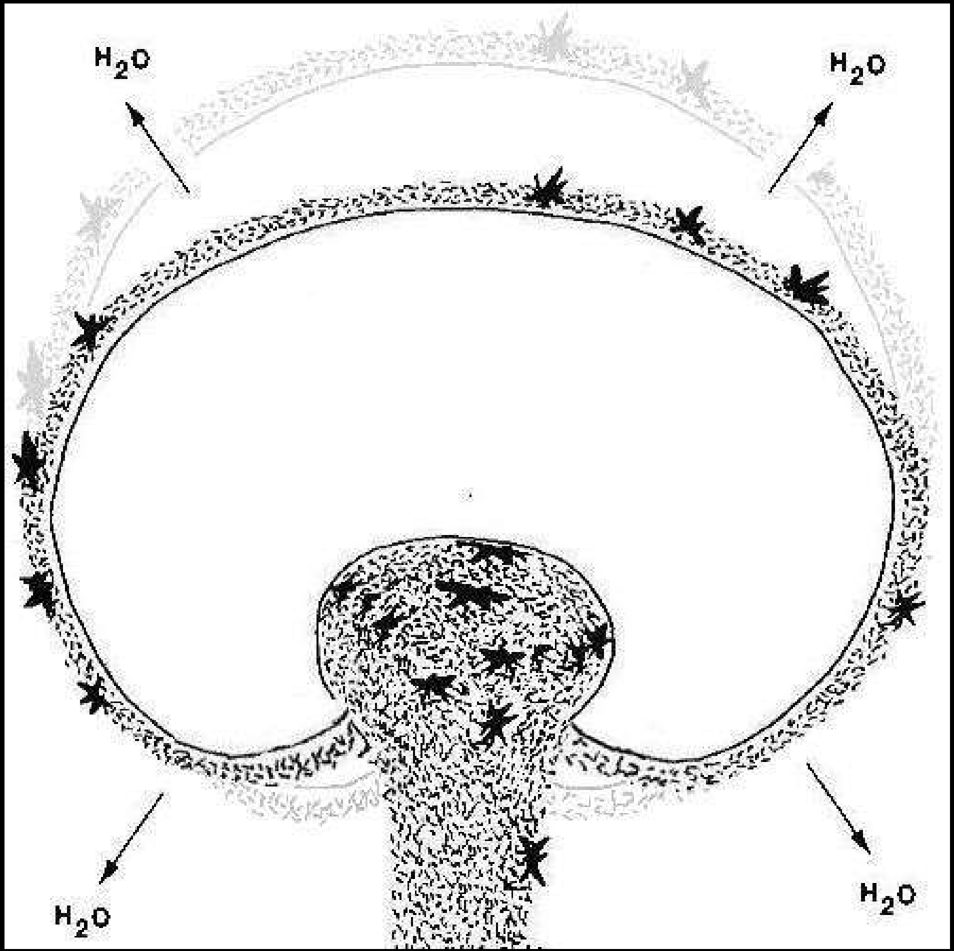
The situation is as described for *Didymium columellacavum* .

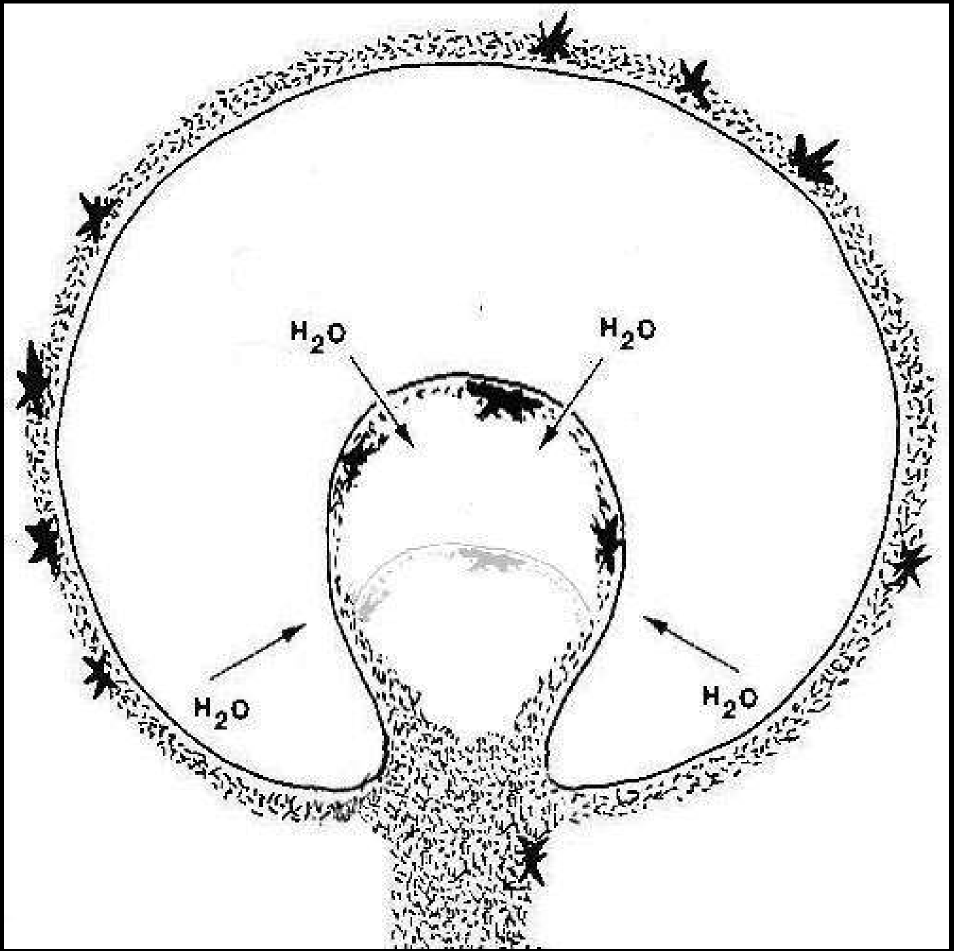
18110610

In my case the clavate and hollow character of the columella is even more evident. Note that the large columella is associated with a not umbilicated sporocyst .

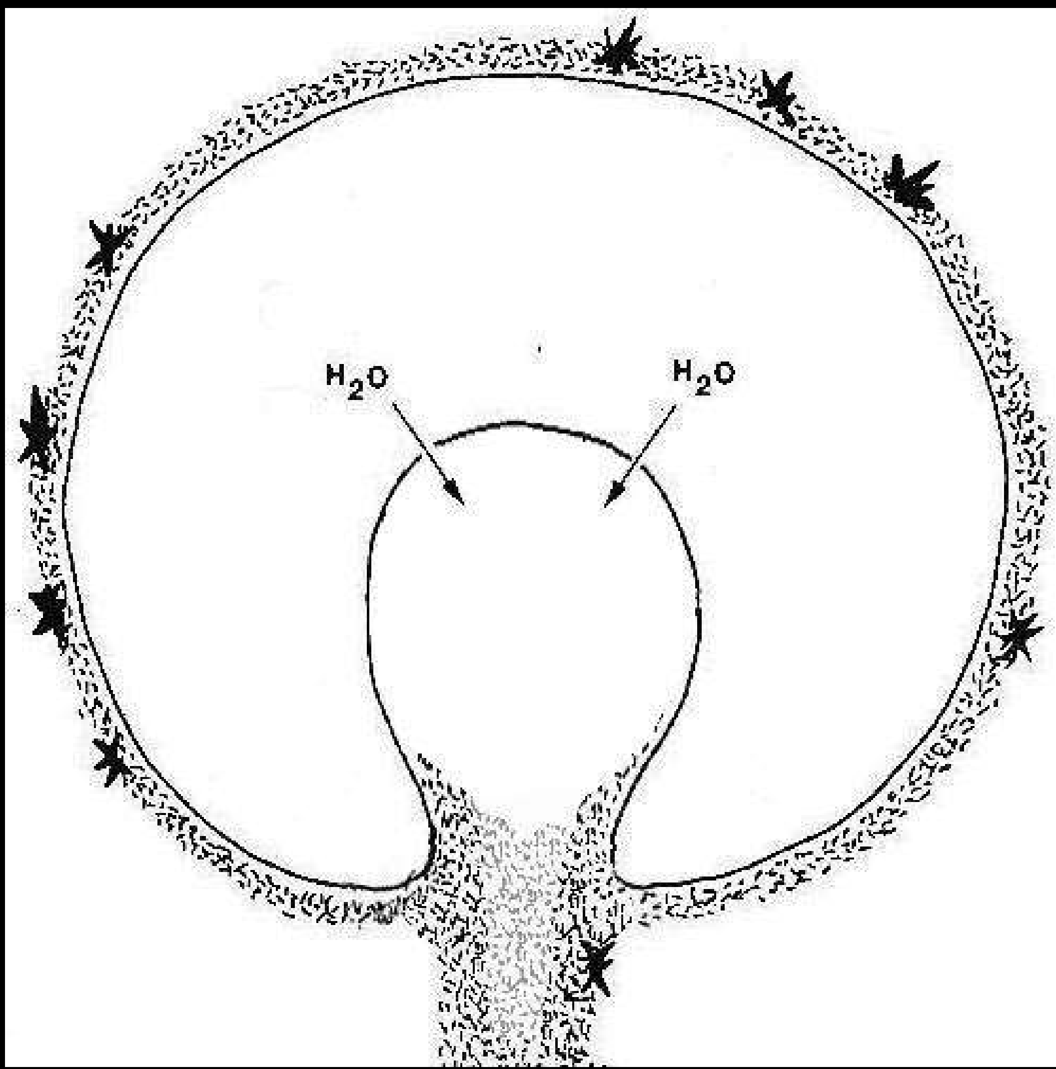
12080915

It is possible that the expulsion of liquid towards the outside through the plasma membrane has stopped and that instead it continues towards the area of the columella, swelling it and maintaining the subspherical shape of the complex.





It is also possible that the clavate form of the columella is due to the fact that the base first acquires rigidity by drying while the swelling process continues in the upper part.



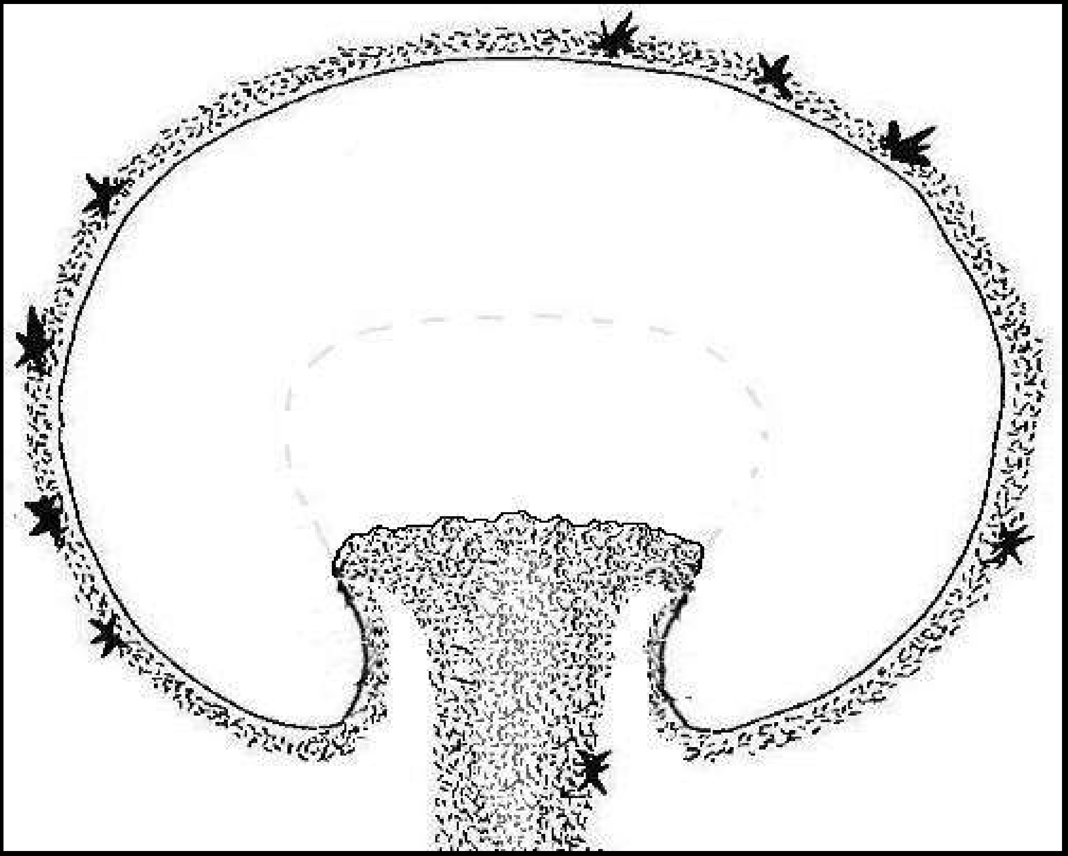
This could happen because the lower part of the columella is in continuity with the stalk which dries long before the sporotheca.

A columella with so a restricted base could become or could be mistaken for a pseudocolumella.

May be this could be the case of *Didymium pseudocolumellum*, a species known only for a single collection, and on which validity there are many doubts (*).

(*) A.Clark J and Haskins EF, A taxonomic guide to species of Didymium I. The stipitate specie Asian Journal of Mycology 1(1) 2018; p.52;

<u>Third case</u>: columella absent or reduced to the thickening of the base.



The plasma membrane transformed into internal peridium does not have a consistency such as to maintain its shape and with drying the bubble completely collapses leaving only a thickening of the base under the wrinkled trace of the membrane.

The hypothesis of a columella initially full of liquid and finally completely collapsed requires some deepening because we speak of a structure that cannot be observed by ordinary means and whose transitory presence we have only clues.

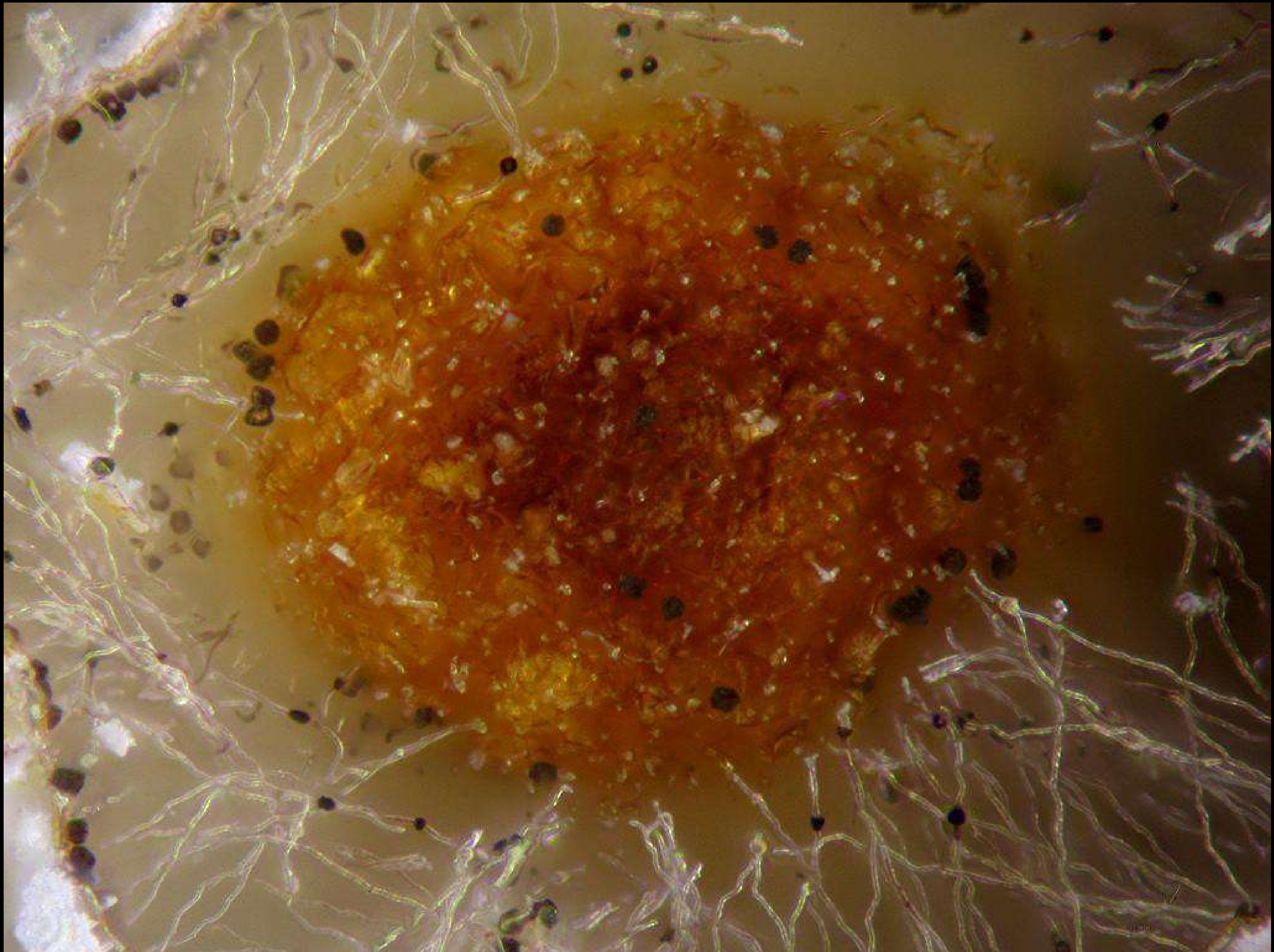
But there are pretty convincing clues.

The first clue is the intense coloring that the basis of the sporocyst sometimes takes on, which can be due to the concentration of the pigments contained in the bubble after drying.

12081109

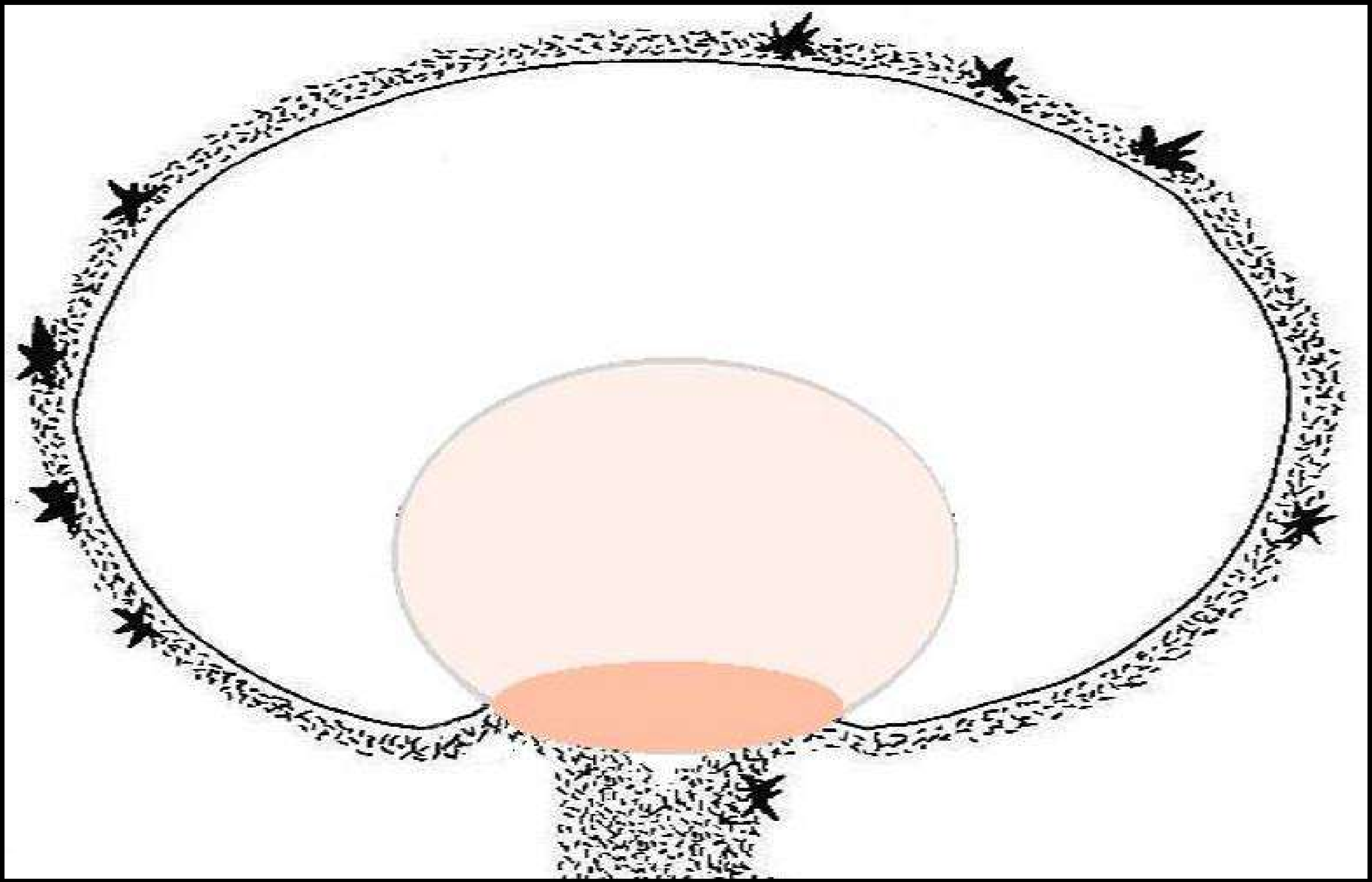
When the pigment content is high (see at the stalk's base) the phenomenom is impressive .

Wrinkled traces of the membrane are visible on the surface, moreover the stain may be more intense in the center for a depression related to the hollow apex of the stalk .



The second clue is the regular form, circular or elliptical, of the thickening of the base, easily explained by the hypothesis of a deposition of lime and pigments at the bottom of a bubble.

We have something like the plane section of a sphere or ellipsoid .



12082006

The third clue is the often total detachment of the capillitium from the base of the sporocyst due to the traction caused by the collapse of the bubble.

12080916

Of course it is a debatable topic because the detachment can be caused by the intervention of the operator.

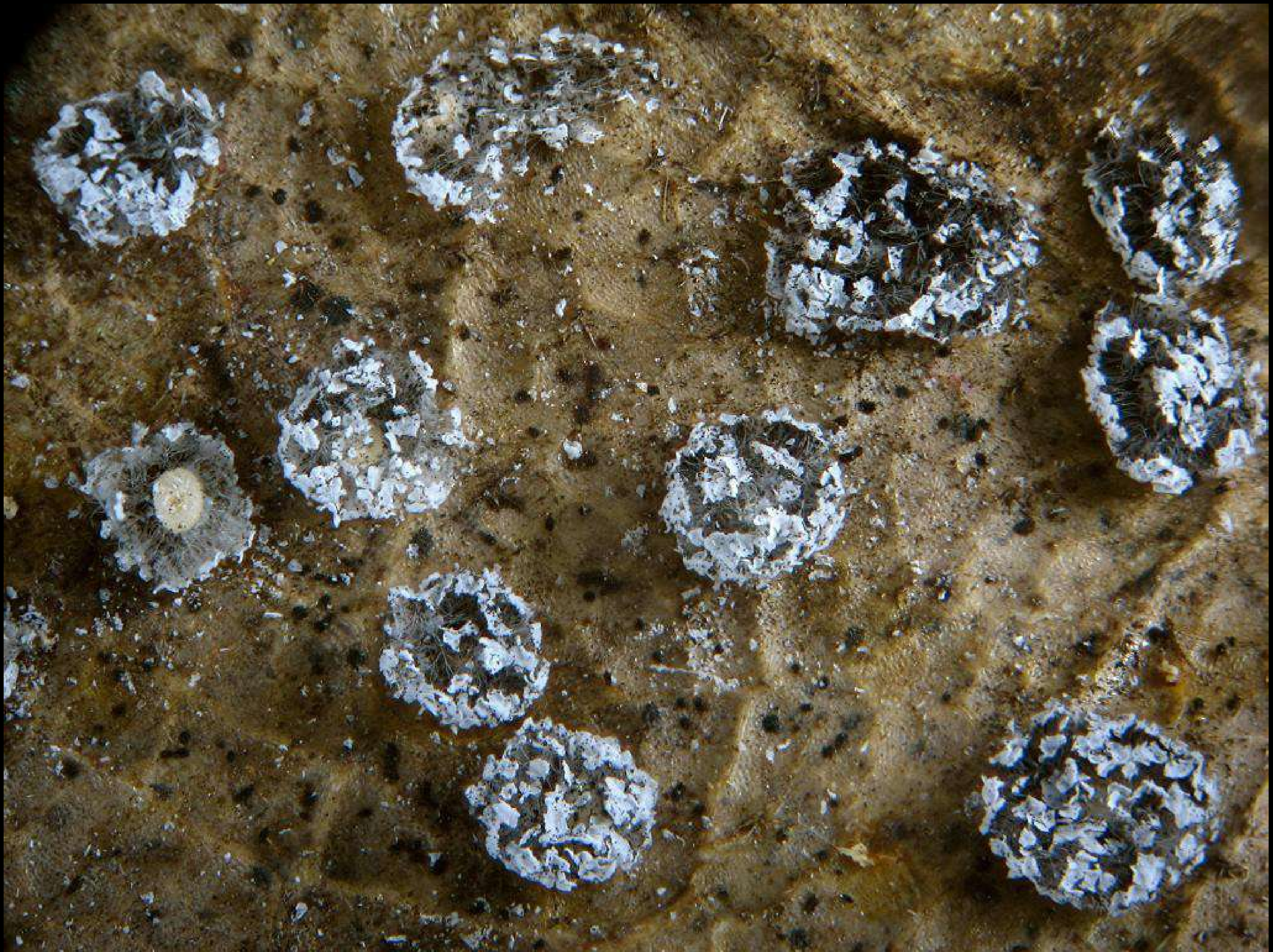
400x600 µm

12080916

However, examining different sporocarps the result was always the same.

12082006

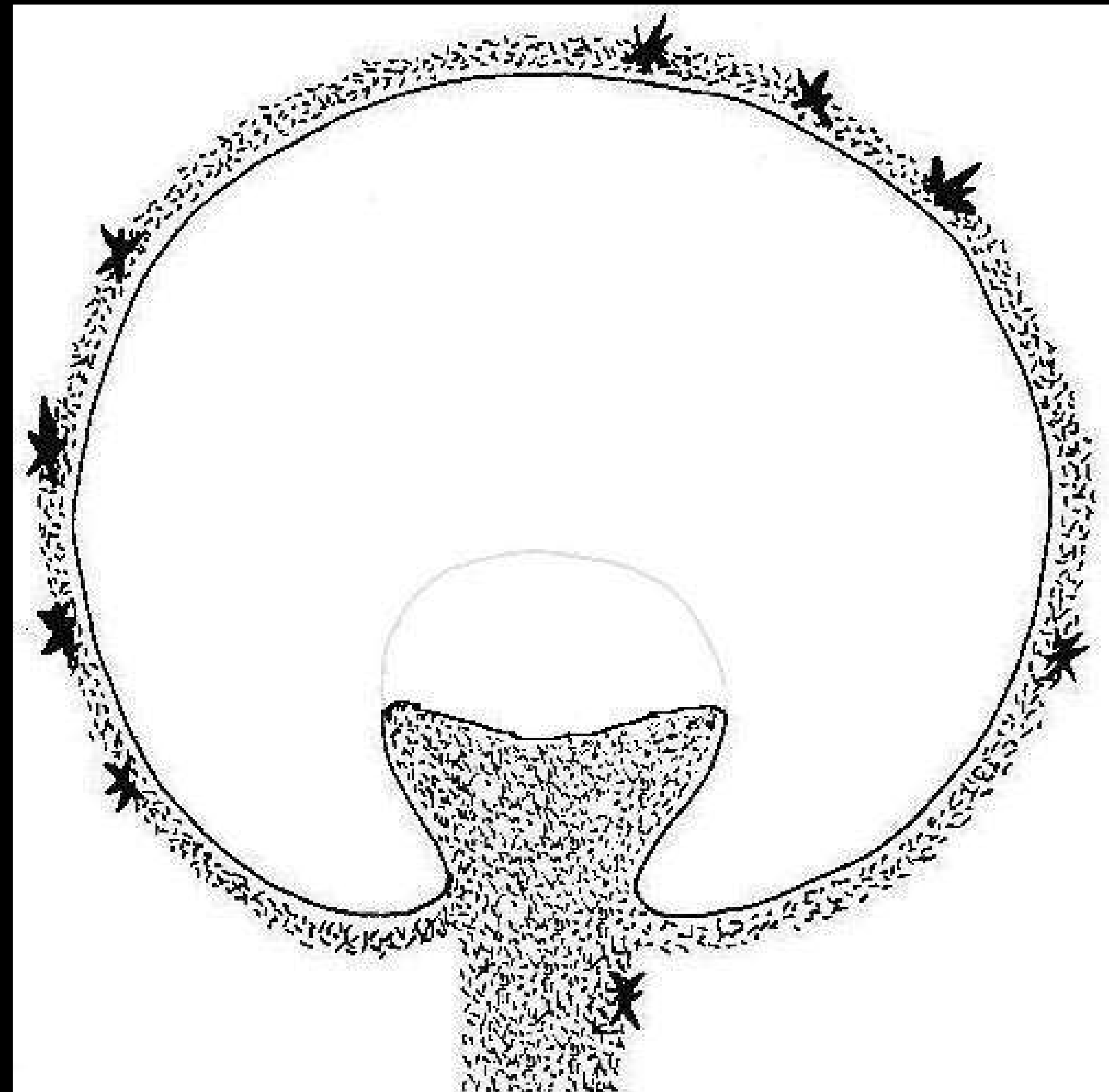
The hypothesis that the collapse of the bubble is also due to the a thin inner membrane appears to be well consistent with the fragmentation of the peridium.



However, the three cases presented do not exhaust all the possible situations compatible with the bubble hypothesis .

There are others we can examine.

There is also the possibility that the collapse of the bubble occurs after the formation of a fairly conspicuous columella.



This sample couuld be representative of the case.

16092601

Note that the non-umbilicated (rather obconic) sporocysts should exclude that the columella could be only a basal disc on the apex of the stalk .

16092601

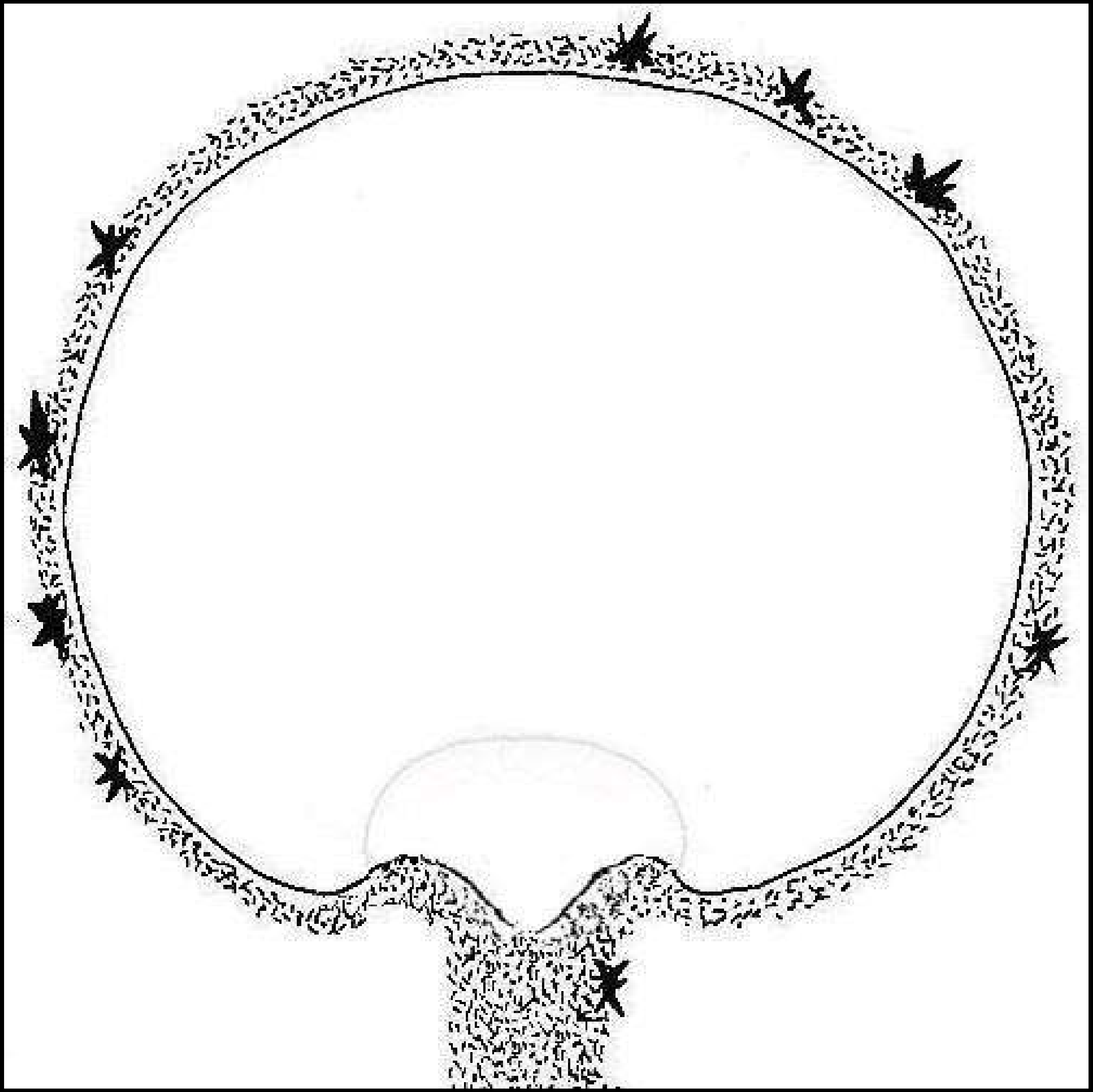
The non-umbilicated sporocysts are instead compatible with the hypothesis of a large bubble that collapsed only after the sporocarps had reached rigidity.

16092601

Had not the bubble collapsed probably the appearance of the sporocarps would have been that of this sample collected in California.

14042101

In an opposite case, the calcareous deposit can be so scarce that it cannot form, not only a columella, but also a consistent thickening at the base of the peridium.



The bubble collapses on the funnel-shaped head of the stalk and its contribution is reduced to the deposition of the concentrated pigment.

Phenomena such as those illustrated may also occur in fructifications that are essentially typical of *Didymium squamulosum*.

We note this sporocarp where there are clear indications of a collapsed bubble: the coloration of the distal columella and the total detachment of the capillitium .

Finally we note how dangerous it is to think of putting a limit on the imagination of Nature ...

Some samples collected by Marianne Meyer may look like *Didymium applanatum*

HMM40080

Looking better, it turns out that the peridium has a deep central invagination that reaches the apex of the stalk
This makes the sporocysts toroidal.

Due to a principle of symmetry, a toroidal sporocyst could correspond to a toroidal columella !

HMM40162

The situation was apparently similar to that of this fruiting of *Didymium bahiense* obtained in a MC, in which some sporangia were umbilized above.

The illusion of having a toroidal columella was given by the presence of a large basal disk on the expanded apex of a stipe inserted in a deep closed umbilicus.

Actually the situation was very different. Almost all sporangia were clearly umbilicated on the top and none of them had a deep umbilicus beneath, instead some of them were obconic.

HMM47071

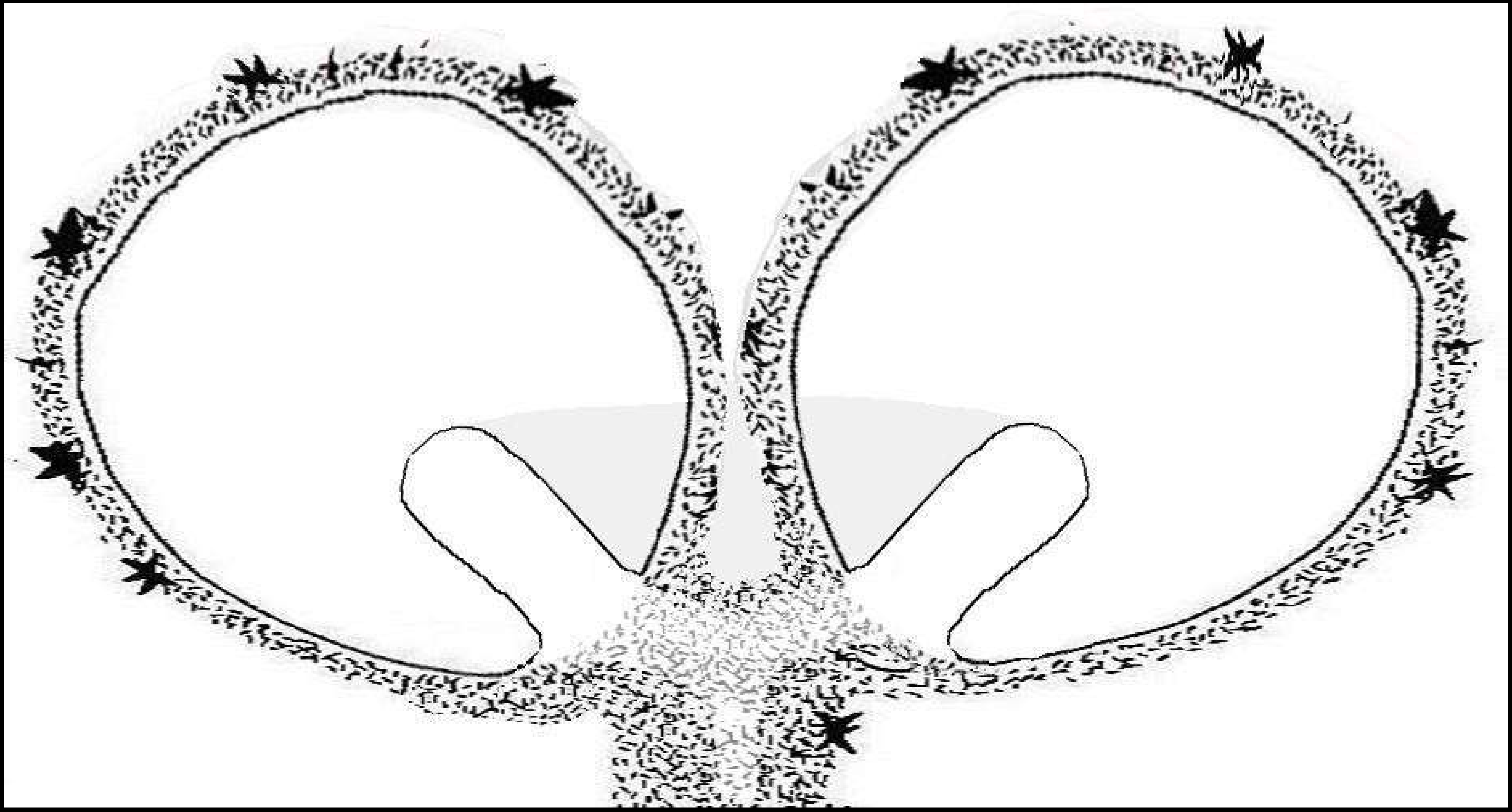
It was really a hollow toroidal columella.

HMM36848

This is what we can actually find in most of the sporocarps.

HMM40080

It is possible that the deep invagination of the peridium has crushed the bubble centrally, transforming it first into a flattened disk and then into a toroidal structure.
It could have been possible for the poor calcification of the bubble which transformed itself in an empty columella.



In any case, whatever the opinion on the hypothesis of the *columella as a bubble*, we can conclude this discussion by asking ourselves if the last case examined could be worthy of a taxonomic dignity.

At the moment I examined four collections of the herbarium of Marianne Meyer, all of them with overlapping characteristics.

HMM36848 Saint Paul sur Isére , 4/3/2007

HMM47071 Saint Oyen , 10/10/2012

HMM40080 Rognaix , 27/11/2018

HMM40162 Saint Paul sur Isére , 22/2/2018

Marianne Meyer

In reality *Marianne Meyer* attests that from 1997 in her herbarium there are many other collections (about 30) with the same characteristics.

All the collections took place in Savoy, and it may be that this species has a specific habitat: tufts of hanging flowers.

Alyssum & Aubretia

Aubretia

The spatial and temporal distance between the collections ensures the stability of the morphological characteristics has a genetic basis.

HMM40080

Apart the shape of the columella, the characteristics of the peridium, stalk and hypothallus have been well represented in the proposed images but are not clearly discriminating elements within the *squamulosum super complex.*

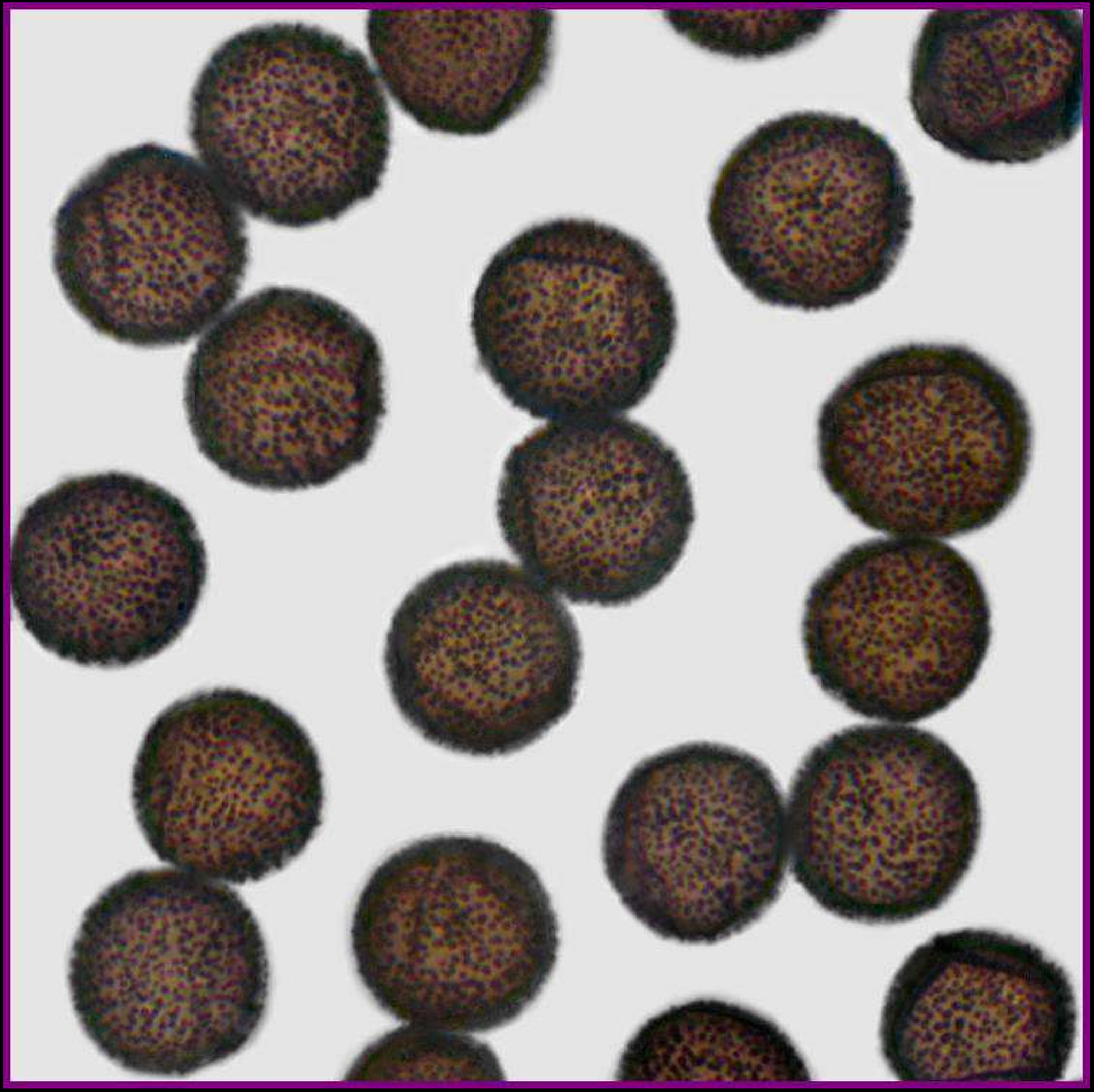
To understand if we have a recurring variation of an already known taxon or a new autonomous species we should look for other distinctive elements in microscopy.

This has been already done by *Marianne Meyer* who has found a distinctive element in the size and appearance of the spores

Didymium applanatum var. macrosporum ou sp nov ?

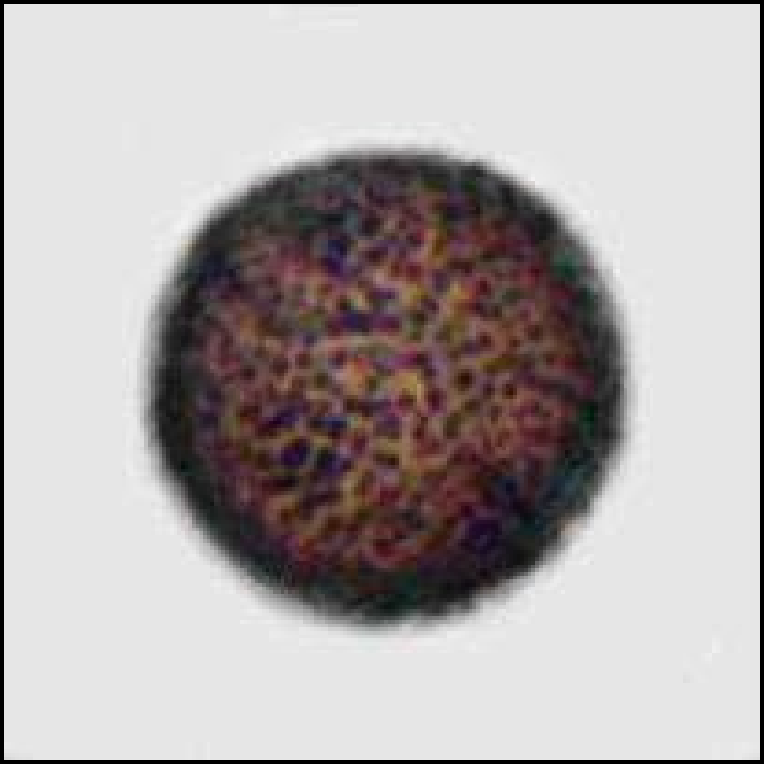
diffère de D. applanatum par ses <u>spores plus grandes, plus foncées</u>, la base du sporocyste non ombiliquée

The spores have a diameter of (11) 11.5-13 (14) µm, clearly sufficient to speak of " macrosporum", and quite distinctive in all the *squamulosum super complex.*



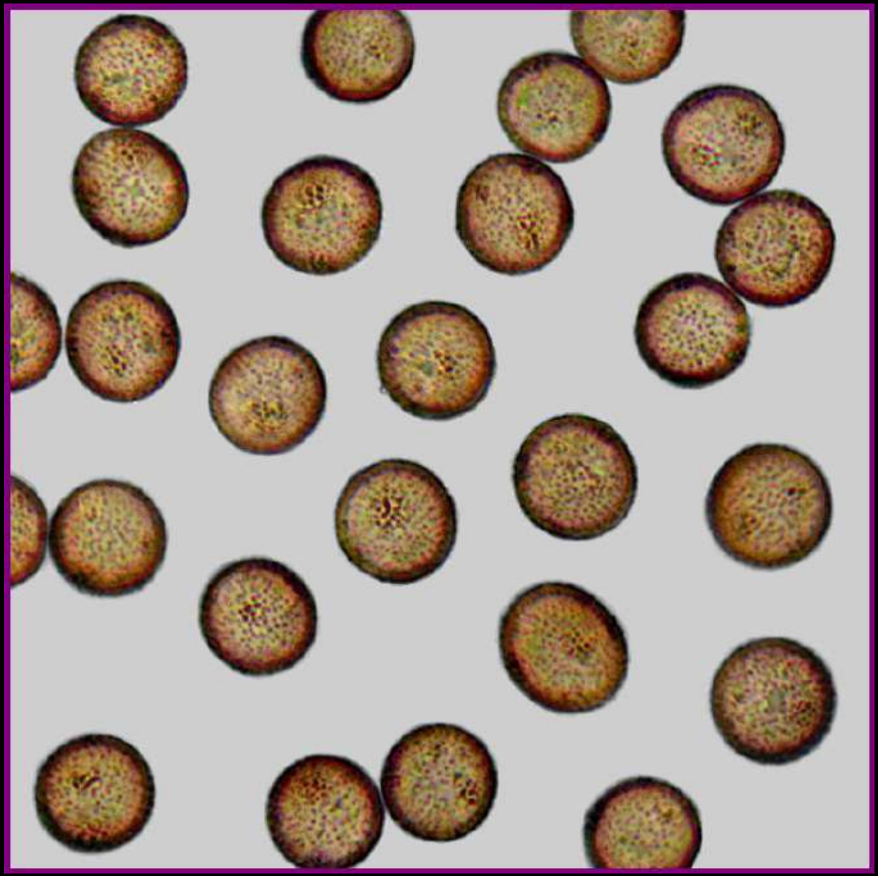
HMM47071 75 x 75 µm

HMM47071 50 x 50 µm



The spores appear to be densely spinulose with patches of larger spines and a coarse network of ridges, always present but not always easy to see.

Didymium applanatum HMM34663



75 x 75 µm

The spores of *applanatum* should be instead smaller (8-11µm), clearer, finely warted with patches of darker warts, and without ridges.

Now we think that the sporangia with umbilicate top, the very peculiar shape of the columella and the characters of the spores justify further studies for a complete definition of a new taxon.

While waiting for the validation process could end positively *Marianne Meyer* proposes the name of *Didymium lenneae* for the new species, in memory of *Mireille Lenne*, who died prematurely in October 2018.

For 15 years *Mireille Lenne* was a protagonist of the *Journées internationales de recherche et d'étude des espèces nivicoles des MYXOMYCÈTES*, and had participated in the inventory of the nivicolous species of Mercantour in May 2010.
Recently she created an educational site that is still accessible: myxo.be
On this site you can find a preliminary study that she herself had done on this species*

(*) http://myxo.be/pdf/didymium%20applanatum%20var%20macrosporum%20ou%20intermediaire.pdf

CONCLUSIONS

Many of the differences that we observe seem to be quantitative rather than qualitative and therefore potentially influenced by environmental factors. On the other hand, some structures manifest themselves with a certain stability and therefore could have a genetic basis.
This genetic basis could also be traced back to more or less recurrent mutations of single genes within the same species.

On the other hand, some forms in the *Didymium squamulosum super complex* could still be given taxonomic dignity.