

Biodiversity survey for myxomycetes in the mountains of central Cuba

Mayra Camino¹, Steven L. Stephenson², Tatiana Krivomaz³, Diana Wrigley de Basanta⁴,
Carlos Lado⁴, Arturo Estrada-Torres⁵

¹Jardín Botánico Nacional, Universidad de La Habana, La Habana, Cuba. ²Dept. of Biological Sciences, University of Arkansas, Fayetteville, AR 72701, U.S.A. ³International Solomonov University, Olegovskaia 39, Kiev 04071, Ukraine. ⁴Real Jardín Botánico de Madrid, CSIC, Plaza de Murillo, 2. 28014 Madrid, Spain. ⁵Universidad Autónoma de Tlaxcala, Apdo. Postal 183, Tlaxcala C.P. 90000, Tlaxcala, Mexico

Catálogo de los myxomycetes de las montañas del centro de Cuba

Resumen. Se presentan los resultados de un muestreo de la myxobiota en la Reserva Ecológica Alturas de Banao, situada en la cordillera de Guamuahaya en el centro de Cuba. El trabajo se centró en los bosques mesófilos de montaña, donde se recolectaron más de 200 muestras en el campo. Se identificaron 56 especies entre las muestras de campo y las obtenidas posteriormente en cámara húmeda, de las cuales 23 son nuevos registros para Cuba: *Arcyria afroalpina*, *A. globosa*, *Badhamia melanospora*, *Ceratiomyxa sphaerosperma*, *Clastoderma debaryanum*, *Collaria lurida*, *Comatricha laxa*, *C. nigra*, *C. tenerrima*, *Craterium concinnum*, *Cribraria microcarpa*, *C. tenella*, *Diderma corrugatum*, *Didymium iridis*, *Echinostelium bisporum*, *E. minutum*, *Hemitrichia pardina*, *Licea bulbosa*, *L. erecta* var. *erectoides*, *L. scyphoides*, *Perichaena vermicularis*, *Physarum crateriforme* y *P. galbeum*. Las hojas muertas de la palma *Roystonea regia* fueron un sustrato especialmente productivo para Myxomycetes, en el cual se encontraron muchas especies de Trichiales. El total de especies de Myxomycetes registradas en la Reserva es de 69.

Palabras clave: catálogo de especies, distribución, Eumycetozoa, hongos mucilaginosos plasmodiales, Reserva Ecológica Alturas de Banao.

Abstract. The results of a biodiversity survey for myxomycetes, carried out in montane rainforests of the Ecological Reserve "Alturas de Banao" in the Macizo Guamuahaya Mountains of central Cuba, are reported here. The survey yielded more than 200 field collections of myxomycetes, and 56 species were identified, from these field collections and moist chamber culture collections. Amongst these were 23 species recorded for the first time from Cuba: *Arcyria afroalpina*, *A. globosa*, *Badhamia melanospora*, *Ceratiomyxa sphaerosperma*, *Clastoderma debaryanum*, *Collaria lurida*, *Comatricha laxa*, *C. nigra*, *C. tenerrima*, *Craterium concinnum*, *Cribraria microcarpa*, *C. tenella*, *Diderma corrugatum*, *Didymium iridis*, *Echinostelium bisporum*, *E. minutum*, *Hemitrichia pardina*, *Licea bulbosa*, *L. erecta* var. *erectoides*, *L. scyphoides*, *Perichaena vermicularis*, *Physarum crateriforme*, and *P. galbeum*. Dead leaves of the palm *Roystonea regia* were an especially productive substrate for myxomycetes, with members of the Trichiales particularly abundant. The myxomycetes recorded from this most recent survey, increases the total number of species reported for the Reserve to 69.

Key words: distribution, Alturas de Banao Ecological Reserve, Eumycetozoa, plasmodial slime molds, species inventory.

Received 15 March 2006 ; accepted 8 February 2008.

Recibido 15 de marzo 2006; aceptado 8 de febrero 2008.

Autor para correspondencia: Diana Wrigley de Basanta
dwb@eresmas.net

Introduction

The myxomycetes (plasmodial slime molds or myxogastrids) are a small group of fungus-like organisms, with approximately 900 species described worldwide [12]. The majority of species have been considered to be cosmopolitan [23], but a few species appear to be confined to the tropics or subtropics and some others have been collected only in temperate regions of the world [1, 8, 17]. Most of what is known about the assemblages of myxomycetes associated with particular types of terrestrial ecosystems has been derived from studies carried out in temperate regions of the Northern Hemisphere [29]. Only recently have studies been carried out in the tropics and subtropics, and the majority of these have involved areas of the Neotropics in Central and South America. Prominent examples include those of Schnittler and Stephenson [24] in Costa Rica, Schnittler *et al.* [25] and Stephenson *et al.* [31] in Ecuador, Lado *et al.* [15, 14] and Stephenson *et al.* [29] in Mexico and Novozhilov *et al.* [20] in Puerto Rico. These studies were reviewed by Stephenson *et al.* [32].

The objective of the biodiversity survey reported herein was to obtain data on the myxomycetes associated with another region of the Neotropics. The survey was carried out in the Ecological Reserve “Alturas de Banao” (21°53' N 79°36'W), which is located in the province of Sancti Spiritus in the Guamuahaya Mountains of central Cuba. The Reserve encompasses an area of 6,159 hectares, most of which falls within the municipality of Sancti Spiritus but with some portions also extending into Fomento and Trinidad. The highest point (Tetas de Juana) in the Reserve reaches an elevation of 843 m, and the Reserve represents a major watershed for all or a portion of three river systems (the Banao, Higuanojo and the Tayabacoa). Annual precipitation ranges from 1700 to 2000 mm, and the mean temperature from 22°C to 26°C. Relative humidity increases from about

81% in March-April to 90% in October-November, although at the very highest elevations it can be 100% for as many as 300 days in the year because of cloud contact. The vegetation of the Reserve is diverse and includes both montane rain forest and evergreen mesophyll forest. Bécquer [2] described 445 infrageneric plant taxa consisting of 344 spermatophytes and 101 pteridophytes for one particular locality (Tetas de Juana) within the Reserve. Among the more characteristic plant species are the royal palm (*Roystonea regia*), which makes up part of the coat of arms for Cuba, and the tree-sized fern (*Cyathea arborea*).

Mycological studies within the general study area are few. Most of these have been directed towards lignicolous Ascomycota, particularly members of the family Xylariaceae [22], and 69 taxa from the Ascomycota, Basidiomycota and Deuteromycota as well as a few myxomycetes were reported by Pérez and Camino [21]. Myxomycetes of the reserve have been the subject of a number of previous studies [7] and Camino and Pérez [6] described 33 taxa, but most of these considered only specimens that had fruited in the field under natural conditions. In the present study, field collections were supplemented with specimens obtained with the use of the moist chamber culture technique, *sensu* Gilbert and Martin [10] as it applies to myxomycetes. In tropical forests, myxomycetes are known to be associated with a number of different microhabitats. The most important of these are coarse woody debris on the forest floor, the bark surface of living trees, forest floor leaf litter and aerial litter (dead but still attached plant parts above the ground). Other microhabitats include the inflorescences of large herbaceous plants [25], living and dead lianas [33], and living leaves of understory plants with a cover of epiphyllic liverworts present [23]. Most specimens of myxomycetes obtained as field collections tend to be associated with coarse woody debris and (to a lesser extent) the two types of litter. However, numerous previous studies [28] have demonstrated that the moist chamber culture technique represents an effective

means of obtaining specimens of the myxomycetes associated with microhabitats other than coarse woody debris and litter as well as revealing a more complete picture of the species associated with litter microhabitats.

Materials and methods

The basic methods used in the field survey component of the study reported herein were essentially the same as those described for a number of similar studies [27, 28]. In addition to collecting specimens of myxomycetes that had fruited under natural conditions in the field, the moist chamber culture technique was used to examine the species associated with the microhabitats represented by (a) forest floor litter, (b) aerial litter, (c) the bark surface of living trees, (d) living and dead lianas and (e) leaves with a cover of epiphyllic liverworts present. Samples of material were collected from each of these microhabitats, placed in small paper bags and transported back to the laboratory. Moist chamber cultures were prepared in the manner described by Stephenson and Stempen [30]. The moist chambers used consisted of disposable plastic Petri dishes (10 cm diameter) lined with filter paper. Substrates were moistened with distilled water. After a period of approximately 24 hours, excess water in each dish was poured off. Cultures were kept at room temperature (22-25°C) in diffuse daylight and examined with a dissecting microscope every week for a period of approximately six weeks in order to detect plasmodia and/or fruiting bodies of myxomycetes. Cultures were kept moist and examined at less frequent intervals for another two to three months.

Myxomycete plasmodia and/or fruiting bodies were noted and recorded each time a culture was checked. When fruiting bodies of a given species developed more than once, in the same culture, they were considered to represent a single record. As soon as the fruiting bodies were judged to be fully

mature, the portion of the substrate upon which the fruiting occurred was removed from the moist chamber culture, allowed to dry and then glued in a small paper box suitable for long-term storage. Identifications of collections were made using the descriptions and keys provided by Martin and Alexopoulos [16], whereas the nomenclature used herein follows Lado [12] and Hernández-Crespo and Lado [11], which now includes the conserved names of several genera [13] approved recently by the Committee for Fungi [9] of the IAPT.

All species in the annotated species list given below are arranged alphabetically. The abbreviation 'cf.' in the name of a taxon indicates the specimen representing the source of the record could not be identified with certainty. The various types of substrates upon which each species was recorded are provided, along with comments relating to records of particular interest or which are apparently new to Cuba. Records based upon specimens appearing in moist chamber cultures (MC) are indicated in each instance other records were collected in the field. Unless otherwise noted, collections reported herein are those of Carlos Lado (Lado), Steven L. Stephenson (SLS), Tatyana Krivomaz (CB) or Diana Wrigley de Basanta (dwb). Vouchers were deposited several places, with those of Stephenson in the mycological herbarium of the University of Arkansas (UARKM), those of Lado in the herbarium of the Real Jardín Botánico of Madrid (MA-Fungi), those of Camino in the herbarium of the Jardín Botánico Nacional of Cuba (HAJB) and those of Wrigley de Basanta and Tatyana Krivomaz in the personal collections of these two authors.

Collecting localities

Locality 1: Cuba: Sancti Spiritus, Banao, Reserva Ecológica Alturas de Banao, catchment area of the river Higuanojo, 21°53'39" N, 79°36'11" W, 575 m, 24-XI-2002, secondary wet

montane rainforest with *Guarea guara*, *Roystonea regia*, *Alsophila cubensis*, *Cinnamomum montanum*, *Laurocerasus occidentalis* and *Cedrela odorata* the most characteristic species present.

Locality 2: Cuba: Sancti Spiritus, Banao, Reserva Ecológica Alturas de Banao, catchment area of the river Higuanojo, 21°53'30" N, 79°35'57" W, 610 m, 24-XI-2002, secondary wet montane rainforest with *Guarea guara*, *Roystonea regia*, *Alsophila cubensis*, *Cinnamomum montanum*, *Laurocerasus occidentalis* and *Cedrela odorata* the most characteristic species present.

Locality 3: Cuba: Sancti Spiritus, Banao, Reserva Ecológica Alturas de Banao, North side of the Caja de Agua ridge from Cañada de los Leones, 21°52'39" N, 79°36'03" W, 780 m, 25-XI-2002, wet montane rainforest with *Alsophila cubensis*, *Cyathea aspera*, *Ocotea wrightii*, *O. leucoxyllum*, *Calyptronoma plumeriana*, *Beilschmiedia pendula* and *Magnolia cubensis* subsp. *acunae* the most characteristic species present.

Results

Our survey yielded more than 200 field collections of myxomycetes, and 139 moist chamber cultures (MC) prepared with samples of various types of plant material, yielded additional collections. These cultures were 65% positive for myxomycetes. Collectively, these collections represent 56 species of myxomycetes, including a number of new records for Cuba.

Annotated list of species

Arcyria afroalpina Rammeloo

Loc. 2, MC, on leaf with a cover of epiphyllic liverworts present, SLS 15686.

This species was described originally from Africa and only

recently has been reported from the Neotropics [23, 26]. The single collection SLS 15686 consists of a single fruiting body but all characters match those of *A. afroalpina*.

Arcyria cinerea (Bull.) Pers.

Loc. 1, on decayed wood, Lado 14278; on rachis of *Roystonea regia*, Lado 14296; on herbaceous plant, Lado 14299; on dead petiole of *Roystonea regia*, HAJB 9399; on decayed wood of *Cecropia peltata*, HAJB 9400; on decayed bark, CB 21101; MC, on bark of living liana, dwb 2264; MC, on dead liana, SLS 15701.

Loc. 2, on dead petiole of *Calyptronoma plumeriana*, HAJB 9420.

Loc 3, MC, on bark of *Buchenavia tetraphylla*, dwb 2284; MC, on bark of *Beilschmiedia pendula*, dwb 2296.

Arcyria cinerea was reported previously from Alturas de Banao by Camino and Pérez [5, 6].

This species is one of the most common myxomycetes in tropical forests, where it develops in the field under natural conditions as well as appearing in moist chamber culture on various types of plant debris. *Arcyria cinerea* is known from Cuba [18] and all areas of the Neotropics [e.g., 14, 20, 24, 29] that have been investigated for myxomycetes. As noted by Farr [8] and others, there is considerable variation in the shape, size and color of the fruiting bodies, and this was observed in our collections.

Arcyria denudata (L.) Wettst.

Loc. 1, on rachis of *Roystonea regia*, Lado 14285, 14298, 14302; on decayed wood, CB21102; on rachis of *Roystonea regia*, SLS 15572; on dead wood of *Cinnamomum montanum*, HAJB 9393; on dead wood, HAJB 9394; on dead petiole of *Roystonea regia*, HAJB 9402; on dead wood of *Sapium jamaicensis*, HAJB 9409; MC, on aerial litter of *Roystonea regia*, SLS 15643, 15681.

Loc. 2, on decayed wood, Lado 14314; on dead wood of *Cinnamomum*, HAJB 9419.

Loc. 3, on decayed wood, Lado 14329.

Arcyria denudata was reported previously from Alturas de Banao by Camino and Pérez [5, 6] and also is known from numerous collections from elsewhere in the Neotropics [e.g., 8, 14, 20, 24, 29]. Collections SLS 15643 and 15681 represent a dwarf form that appears in moist chamber culture on samples of litter.

Arcyria globosa Schwein.

Loc. 2, MC, ground litter, SLS 15653, 15563.

This species is listed for the Neotropics by Farr [8] but appears to have a limited distribution. It was recorded from cloud forests in Ecuador by Schnitter *et al.* [26] but has not been reported for most other areas of the Neotropics investigated recently. In temperate forests of eastern North America, *Arcyria globosa* was once a relatively common species and most fruitings were associated with old chestnut (*Castanea* spp.) burs prior to the virtual elimination of chestnut by the chestnut blight in the first half of the 20th century. Collections from the Neotropics referred to *A. globosa* generally have a longer stipe and shallower calyculus than those from temperate eastern North America. These collections are a new record for Cuba.

Arcyria insignis Kalchbr. & Cooke

Loc. 1, MC, on bark of *Buchenavia tetraphylla*, dwb 2280.

Loc. 3, MC, on bark of *Buchenavia tetraphylla*, dwb 2276.

This species was reported from Cuba by Camino [4] and Camino and Pérez [5], but these two collections are the first known from Alturas de Banao. It also appears not to be rare in other Caribbean areas [18].

Arcyria obvelata (Oeder) Onsberg

Loc. 1, on decayed wood, CB 21103; on dead wood of *Guarea guara*, HAJB 9407.

Arcyria obvelata (= *A. nutans* in some published records from the Neotropics) was reported previously from Alturas de

Banao by Camino and Pérez [6]. Also known from other Caribbean areas [18].

Badhamia melanospora Speg.

Loc. 1, on dead liana, SLS 15674A

This species was reported as *Badhamia gracilis* (T. Macbr.) T. Macbr. from Antigua and Puerto Rico by Minter *et al.* [18].

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

Loc. 1, on decayed wood and bark, CB 21104; on dead wood, HAJB 9388.

Loc. 2, on decayed wood, Lado 14312, 14315.

Loc. 3, on inflorescence of *Calyptronoma plumeriana*, Lado 14328; on rachis of *Roystonea regia*, Lado 14337, 14340; on decayed wood, Lado 14338.

This exceedingly common species was reported previously from Alturas de Banao by Camino and Pérez [6]. It has been reported from throughout the Neotropics [e.g., 8, 14, 18, 20, 24, 29].

Ceratiomyxa sphaerosperma Boedijn

Loc. 2, on decayed wood, Lado 14313.

This collection is a new record for Cuba. It has been reported from other Caribbean areas [18].

Clastoderma debaryanum A. Blytt

Loc. 1, MC, on bark of *Laurocerasus occidentalis*, dwb 2271.

Loc. 3, on decayed wood, Lado 14326, 14330.

This is a new record for Cuba, although it was collected at Alturas de Banao by U. Eliasson and M. Camino in 1997 (Eliasson, pers. comm.).

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

Loc. 1, MC, on dead liana, SLS 15655.

Loc. 2, MC, on aerial litter of *Roystonea regia*, SLS 17266.

Loc. 3, on decayed wood, Lado 14321.

Reported previously (as *Lamproderma arcyrionema*) from

Alturas de Banao by Camino and Pérez [6], and other Caribbean areas [18]. Our specimens represent the two different forms of this species, one of which occurs on coarse woody debris and the other appearing in moist chamber cultures on samples of litter (SLS 15655 and 17266).

Collaria lurida (Lister) Nann.-Bremek.

Loc. 2, MC, ground litter of *Roystonea regia*, SLS 15696.

Our collections of this species consist of a single sporocarp, but all characters are consistent with published descriptions.

Collaria lurida appears to be rare in the Neotropics [8], and this is the first record of the species from Cuba.

Comatricha laxa Rostaf.

Loc. 1, MC, on leaf with epiphyllid liverworts present, SLS 15663, 15678, 15679, 17304.

Farr [8] cited this species from Guadalupe island as reported by Alexopoulos with a question mark. This is the first record for Cuba.

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

Loc. 2, MC, aerial litter of *Roystonea regia*, SLS 15660, 15661, 15672, 17255.

This species has been reported from several Caribbean countries [18], but the collection noted above is a new record for Cuba.

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

Loc. 1, MC, on bark of *Cedrela odorata*, dwb2282; MC, on dead liana, SLS 17237.

Loc. 3, on decayed wood, Lado 14331.

This is a new record for Cuba, but the species has been reported previously from Antigua and Jamaica [18].

Craterium concinnum Rex

Loc. 2, MC, on ground litter, SLS 17262.

This is a new record for Cuba. The species was known

previously in the Caribbean only from Jamaica [18].

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

Loc. 1, on *Blechnum* cf. *occidentalis*, Lado 14306.

Loc. 2, on decayed leaves, Lado 14309, 14319.

This species appears to be fairly common in the Caribbean region [18] and was collected previously from Alturas de Banao by U. Eliasson and M. Camino in 1997 (Eliasson, pers. comm.).

Cribraria cancellata (Batsch) Nann.-Bremek.

Loc. 1, on decayed wood, Cb21105.

This collection is the first known from Alturas de Banao. Common in the Caribbean area [18].

Cribraria microcarpa (Schrad.) Pers.

Loc. 1, on decayed wood, Lado 14274; on decayed wood, CB21106; dead wood of *Guarea guara*, HAJB 9395; on dead wood, HAJB 9398.

Loc. 3, on decayed wood, Lado 14324 (very old material).

The collections of this species noted above are the first known from Cuba.

Cribraria tenella Schrad.

Loc. 1, on decayed wood, Lado 14277.

Loc. 2, on wood of *Pinus caribea*, Lado 14316, 14317, 14318 (very old material).

These collections are the first records from Cuba. Known from Antigua, Dominica, Haiti and Jamaica [18].

Cribraria violacea Rex

Loc. 1, MC, on dead liana, SLS 17263, 17264.

Loc. 2, MC, on dead liana, SLS 17261B.

This species was reported previously Alturas de Banao by Camino and Pérez [6].

Diachea leucopodia (Bull.) Rostaf.

Loc. 1, MC, on bromeliad litter, SLS 15692.

Loc. 2, MC, on leaf with a cover of epiphyllid liverworts present, SLS 15692.

This species was reported previously from Alturas de Banao by Camino and Pérez [6].

Diderma corrugatum T. E. Brooks & H. W. Keller

Loc. 1, MC, on bark of *Samanea saman*, dwb 2281.

This species was described from material collected in Kentucky, Florida and Georgia in the United States [3]. Our specimens have the typical wrinkled polygonal appearance of the sporotheca and a cylindrical columella. The stipe is bicolored, white and calcareous above and dark brown below. The fine filamentous yellowish capillitium arises along the columella, and the densely ornamented spores are (12-)14-16 µm diam. This supposes the first record of this species outside of the United States. This collection is the same as four specimens listed by Lado *et al.* [14] from Mexico as a possible form of *Diderma rugosum*. Further study of all the specimens show that they belong to the same species, so its distribution appears to be so far the United States, Mexico, Ecuador and Cuba, although, as mentioned by Lado *et al.* [14], a collection described by Farr from Jamaica as *D. rugosum* may also belong to this species.

Diderma effusum (Schwein.) Morgan

Loc. 1, on leaves of *Ocotea* sp., Lado 14301; on dead leaves, CB21107.

Loc. 2, on decayed leaves, Lado 14320.

This species was reported previously from Alturas de Banao by Camino and Pérez [6].

Diderma hemisphaericum (Bull.) Hornem.

Loc. 1, on leaves of *Musa paradisiaca*, Lado 14289; MC, on dead liana, SLS 15690; 17253A; MC, aerial litter of *Roystonea regia*, SLS 15694.

Loc. 2, MC, on leaf with a cover of epiphyllid liverworts present, SLS 15686A, 17306, 17279; MC, on aerial litter of *Roystonea regia*, SLS 15666; MC, on bromeliad aerial litter, SLS 17242.

This species was reported previously from Alturas de Banao by Camino and Pérez [6].

Didymium iridis (Ditmar) Fr.

Loc. 1, MC, on bark of *Cissus* sp., dwb 2260; MC, on dead liana, SLS 15717.

Our collections are the first record of this species from Cuba, but it is widely reported from other Caribbean regions [18].

Didymium squamulosum (Alb. & Schwein.) Fr.

Loc. 1, MC, dead liana, SLS 15651, 15654, 15658, 15659B; MC, on leaf with a cover of epiphyllid liverworts present, SLS 15676.

Loc. 2, MC, on leaf with a cover of epiphyllid liverworts present, SLS 15697.

Loc. 3, MC, dead liana, dwb 2276.

These collections of this species are the first known from Alturas de Banao. Our specimens represent a dwarf form of this species that often appears in moist chamber cultures on dead plant material collected in the Neotropics.

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

Loc. 1, MC, on aerial litter in cultures prepared for isolation of protostelids, observed but not collected. (J. Shadwick, pers. comm.)

This species is the smallest of all myxomycetes and is usually recorded in surveys carried out for another group of slime molds, the protostelids. This was the case for our specimens which represent the first record of this species for Cuba. *Echinostelium bisporum* was first reported from the Neotropics by Moore and Stephenson [19] and also is known from Puerto Rico (Stephenson, unpublished data).

Echinostelium minutum de Bary

Loc. 1, MC, on aerial litter of *Roystonea regia*, SLS 15645, 15644; MC, on bark of *Laurocerasus occidentalis*; dwb 2273, 2277; MC, on bark of *Syderoxylon foetidissimum*, dwb 2266.

Loc. 2, MC, on aerial litter of *Roystonea regia*, SLS 15665.

Loc. 3, MC on bark of *Pinus cubensis*, dwb 2274; MC, on bark of *Buchenavia tetraphylla*, dwb 2278.

Our collections represent the first record for Cuba, but this species has been frequently recorded in the Caribbean [18].

Echinostelium minutum was particularly common on palm aerial litter. SLS1 5665, 15645.

Hemitrichia calyculata (Speg.) M. L. Farr

Loc. 1, on decayed wood, Lado 14271, 14272, 14284, 14290, 14293, 14303; on decayed wood, CB21108; on dead wood of *Cinnamomum montanum*, HAJB 9390; on dead wood of *Sapium jamaicensis*, HAJB 9404.

Loc. 2, on decayed wood, Lado 14308; on dead wood of *Guarea guara*, HAJB 9414; on dead petiole of *Calyptronoma plumeriana*, HAJB 942.1

Loc. 3, on decayed wood, Lado 14325, 14332.

This species, reported previously from Alturas de Banao by Camino and Pérez [6] is common in Cuba and appears to be one of the most characteristic myxomycetes of Neotropical forests and has been reported as common in a number of studies [14, 29].

Hemitrichia pardina (Minakata) Ing

Loc. 1, MC, on dead lianas, SLS 15702.

Loc. 2, MC, on bromeliad litter, SLS 17246.

These two collections are the first record of this species from Cuba.

Hemitrichia serpula (Scop.) Rostaf. ex- Lister

Loc. 1, on decayed wood, Lado 14276, on rachis of *Roystonea regia*, Lado 14279, 14292, 14295, 14297, 14300, 14305; on decayed wood and bark, CB21109; on rachis of *Roystonea*

regia, SLS 15571; on dead petiole of *Roystonea regia*, HAJB 9392; on dead wood, HAJB 9396.

Loc. 2, on dead wood of *Miconia*, HAJB 9422; on dead trunk of *Cyathea arborea*, HAJB 9426.

Loc. 3, on rachis of *Roystonea regia*, Lado 14335, 14339.

Hemitrichia serpula was reported previously from Alturas de Banao by Camino and Pérez [6]. It was exceeding common in our survey, with large fruitings often occurring on old rachis and petiole of *Roystonea regia* (Figure 1).

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

Loc. 1, MC, petiole of *Alsophila cubensis*, dwb 2256.

A description and images of *Licea bulbosa* are provided in Wrigley de Basanta and Lado [34]. This material formed part of the study of stipitate *Licea* spp. and represents the first record of this species not only from Cuba but for the Neotropics.

Licea erecta* var. *erectoides (Nann.-Bremek. & Y. Yamam.) Y. Yamam.

Loc. 1, MC on bark of *Laurocerasus occidentalis* dwb 2272.

Loc. 2, MC, on dead liana, SLS 15657; MC, on aerial litter of unidentified bromeliad, SLS 15685.

Loc. 3, MC on dead liana, dwb 2258.

The specimens (dwb) formed part of the study of stipitate *Licea* spp. by Wrigley de Basanta and Lado [34], and represent the first records of this species from Cuba. Illustrations and a description of this species can be found in this publication.

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

Loc. 3, MC on dead liana dwb 2255.

This collection formed part of the study of stipitate *Licea* spp. [34] and represents the first record of the species from Cuba. *Licea scyphoides* was also reported from Mexico, Peru and Puerto Rico in the same paper, but appears to be uncommon in the Neotropics.



Figure 1. *Hemitrichia serpula* on rachis and petiole of *Roystonea regia*.

Lycogala exiguum Morgan

Loc. 1, on decayed wood, Lado 14273; on decayed wood, CB21110; on dead wood, HAJB 9406, 9412.

This species was reported from Cuba by Minter & al. [18].

Metatrichia* cf. *horrida Ing

Loc. 1, on decayed bark, Cb21111

Loc. 3, on decayed wood, Lado 14333, 14334.

Our specimens are characterized by brown, sessile or almost sessile, grouped sporocarps, with a flat lid. The capillitium is deep orange in mass, the elaters ornamented with widely spaced spiral bands and spines 2-4 μm long. The spores are very pale yellow, 8-9 μm diam. and warted. *Metatrichia horrida* was described originally from Nigeria, and has been reported elsewhere in the Neotropics from Mexico [14].

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

Loc. 1, on rachis of *Roystonea regia*, Lado 14280, 14282,

14304.

On decayed wood, CB21112. Our specimens are characterized by almost black, iridescent, stipitate sporocarps in groups with fused long stipes. The spiral bands of the capillitium are tightly coiled, the spines are from 2-3 μm long. The spores are of 9-10 μm diam. and densely warted and darker than *M. horrida*. This species is widely distributed in the Caribbean region [18].

Perichaena chrysosperma (Curr.) Lister

Loc. 1, MC, on dead lianas, SLS 15656.

Loc. 2, MC, on dead liana, SLS 15675.

This species was reported previously from Alturas de Banao by Camino and Pérez [6].

Perichaena depressa Lib.

Loc. 1, on rachis of *Roystonea regia*, Lado 14294; on decayed wood and bark, CB21113; on dead wood, HAJB 9391; MC, on dead liana, SLS 17303.

Loc. 2, MC, on dead liana, SLS 15669.

This species was reported previously from Alturas de Banao by Camino and Pérez [6].

Perichaena vermicularis (Schwein.) Rostaf.

Loc. 1, on aerial litter of *Roystonea regia*, SLS 15673.

Loc. 3, MC, on dead liana dwb 2268.

This is a new record for Cuba. It has been reported previously from Antigua and Dominica in the Caribbean [18].

Physarella oblonga (Berk. & M. A. Curtis) Morgan

Loc. 1, on rachis of *Roystonea regia*, Lado 14283 (very old material); on dead petiole of *Roystonea regia*, HAJB 9397; on dead wood of *Cinnamomum montanum*, HAJB 9405.

Physarella oblonga was reported previously from Alturas de Banao by Camino and Pérez [6].

Physarum album (Bull.) Chevall.

Loc. 1, on rachis of *Roystonea regia*, Lado 14281.

This species was reported previously (as *Physarum nutans* Pers.) from Alturas de Banao by Camino and Pérez [6].

Physarum bogoriense Racib.

Loc. 1, on leaves of *Musa paradisiaca*, Lado 14286; on dead leaves, CB21114.

Physarum bogoriense was reported previously from Alturas de Banao by Camino and Pérez [6]. It was described originally from Bogort Island in Sumatra but seems to be widely distributed throughout the Neotropics [e.g., 14, 20, 24, 29].

Physarum compressum Alb. & Schwein.

Loc. 1, MC, on bark of *Piper auritum*, dwb 2262; MC, on dead liana, SLS 15642, 15649.

These collections of this species are the first known from Alturas de Banao, but it is widely distributed throughout the Caribbean [18].

Physarum crateriforme Petch

Loc. 1, MC, on dead liana, SLS 15668.

This is the first record of this species from Cuba, but *P. crateriforme* is otherwise known from Antigua and Santa Lucia [8] and the Yucatan Peninsula of Mexico [14].

Physarum didermoides (Pers.) Rostaf.

Loc. 1, MC, on dead liana, SLS 15691, 15717.

These collections of this species are the first known from Alturas de Banao, but it is widely distributed throughout the Caribbean [18].

Physarum galbeum Wingate

Loc. 1, on aerial litter of *Roystonea regia*, SLS 15647.

In the Neotropics this species is only known from Dominica and Jamaica [8]. Our collection is the first record for Cuba.

Physarum* cf. *leucopus Link

Loc. 1, on living herbaceous plants, Lado 14287.

This is the first time this species has been reported from Cuba. However, our material is not good enough to be completely certain of its identification.

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

Loc. 1, MC, on dead liana, SLS 15667.

This species was reported previously from Alturas de Banao by Camino and Pérez [6].

Physarum viride (Bull.) Pers.

Loc. 1, MC, on aerial litter of *Roystonea regia*, SLS 15679, 15687C.

Loc. 2, on dead trunk of *Guarea guara*, HAJB 9413.

Loc. 3, on decayed wood, Lado 14322 (very old material).

This species was reported previously from Alturas de Banao by Camino and Pérez [6].

Stemonitis axifera (Bull.) T. Macbr.

Loc. 1, on dead wood of *Guarea guara*, HAJB 9410.

This species is widely distributed in the Caribbean region [18].

Stemonitis fusca Roth

Loc. 1, on decayed wood, Lado 14275, 14288; on decayed wood and leaves, Lado 14307.

Loc. 2, on dead wood of *Cinnamomum montanum*, HAJB 9417; MC, on bromeliad aerial litter, SLS 17305, 17312.

This species was reported previously from Alturas de Banao by Camino and Pérez [6]. Collections SLS 17312 and 17312 represent *Stemonitis fusca* var. *nigrescens* (Rex) Torrend, which is sometimes recognized as a distinct species (*Stemonitis nigrescens* Rex).

Stemonitopsis hyperopta (Meyl.) Nann.-Bremek.

Loc. 3, on trunk of *Podocarpus* sp., Lado 14336.

Our collection of this species is the first known from Alturas de Banao, however the material was old.

Trichia affinis de Bary

Loc. 3, on decayed wood, Lado 14323.

This species is not always recognized as distinct from *Trichia favoginea* [8], so information on its distribution is incomplete.

Trichia favoginea (Batsch) Pers.

Loc. 1, on decayed wood, CB21115.

This species was reported previously from Alturas de Banao by Camino and Pérez [6].

Discussion

The total number of Myxomycetes now known from the Ecological Reserve Alturas de Banao is 69, 56 from the study

described herein and 13 others [*Arcyria incarnata* (Pers. ex J. F. Gmel.) Pers., *Diachea bulbilosa* (Berk. & Broome) Lister, *Didymium clavus* (Alb. & Schwein.) Rabenh., *Lycogala epidendrum* (L.) Fr., *Physarum cinereum* (Batsch) Pers., *Physarum melleum* (Berk. & Broome) Masee, *Physarum nucleatum* Rex, *Stemonaria longa* (Peck) Nann.-Bremek., *Stemonitis flavogenita* E. Jahn, *Stemonitis smithii* T. Macbr., *Stemonitis splendens* Rostaf., *Stemonitopsis typhina* (F. H. Wigg.) Nann.-Bremek., *Tubifera microsperma* (Berk. & M. A. Curtis) G. W. Martin] reported previously by Camino & Pérez [6]. A total of 23 species from this survey are new records from Cuba, half of them obtained from moist chamber culture. Of the 56 species reported here, 30 were found in the field, 31 species were isolated from moist chamber cultures, and only 8 species were collected by both methods.

Information relating to the total number of species of myxomycetes reported for a particular study area within the Neotropics is provided in several recent papers. For example, Lado *et al.* [14] reported 76 species for a study area (El Eden) in the Yucatan Peninsula of Mexico and 63 species for a tropical forest reserve (Los Tuxtlas) in Veracruz, Mexico, whereas Schnittler *et al.* [26] reported a total of 77 species from three cloud forest study sites in Ecuador. Both of these studies were based on results obtained from field collecting as well as specimens from moist chamber cultures. When only field collections have been considered, the totals tend to be somewhat lower, and Novozhilov *et al.* [20] reported just 44 species from a survey carried out in Puerto Rico. As such, the total of 69 now known from the Ecological Reserve Alturas de Banao is comparable to those reported in similar surveys carried out elsewhere in the Neotropics.

As a general observation, based upon both field and moist chamber culture collections, dead portions of the palm *Roystonea regia* would seem to be an especially productive substrate for myxomycetes, with members of the Trichiales particularly abundant. This was true for both dead but still attached fronds (aerial litter), fronds on the forest floor

(ground litter), and portions of the rachis in contact with the ground. *Hemitrichia serpula* was noteworthy in terms of the size and abundance of fruitings on the latter substrate.

In summary, our survey represented a rapid biodiversity assessment of the assemblage of myxomycetes associated with montane forests of the Ecological Reserve Alturas de Banao in Cuba. It serves as a demonstration of just what can be accomplished in a relatively short period of time with a reasonable sampling effort by a group of people who have considerable field experience working with myxomycetes. The number of records obtained only from moist chamber cultures provides additional evidence that any survey of this type must include data from both field collections and laboratory studies carried out after the field component has been completed.

Acknowledgements

Appreciation is extended to Darwin Initiative (U.K.) for the financial support for the expedition to Alturas de Banao through the Project "Biodiversity Conservation in Cuba" (2001-2004). We would like to thank the staff of the Empresa Nacional para la Conservación de la Flora y la Fauna de Cuba, the administrative staff of the Ecological Reserve "Alturas de Banao" and the parataxonomists Oliver Valle Hernández, Julio Calviño, Jorge Félix Díaz Pérez and Gaspar Luna Valdivia. We also express our gratitude to M. Sc. Eldis Bécquer Granados for the substrate identifications and other help with this survey.

References

1. Alexopoulos, C. J., 1963. The myxomycetes II. Botanical Review 29:1-78.
2. Bécquer, E., 1999. Flora y vegetación de la alturas cársicas Tetras de Juana, Alturas de Banao, Cuba Central. Tesis de Master en Botánica, Jardín Botánico Nacional, Universidad de la Habana.
3. Brooks, T. E., H. W. Keller, M. Chassain, 1977. Corticolous Myxomycetes

- VI: A new species of *Diderma*. Mycologia 69:179-184.
4. Camino, M., 1991. Myxomycetes de Cuba I. Revista del Jardín Botánico Nacional, Universidad de la Habana 12:127-131.
5. Camino, M., J. M. Pérez, 2000. El género *Arcyria* Wiggers (Trichiales, Myxomycetes en Cuba. Revista del Jardín Botánico Nacional, Universidad de la Habana 21:115-126.
6. Camino, M., J. M. Pérez, 2001. Los Myxomycetes de la Reserva Ecológica "Alturas de Banao" (El Naranjal) Sancti Spiritus. Revista del Jardín Botánico Nacional, Universidad de la Habana 22:109-117.
7. Camino, M., U. Eliasson, 2002. Biodiversity of myxomycetes in the ecological reserve "Alturas de Banao", Sancti Spiritus, Cuba. Fourth International Congress on Systematics and Ecology of Myxomycetes Abstract Volume 1:10.
8. Farr, M. L., 1976. Myxomycetes. Flora Neotropica Monograph No. 16. New York Botanical Garden, New York.
9. Gams, W., 2005. Report of the Committee for Fungi: 13. Taxon 54: 828-830.
10. Gilbert, H. C., G.W. Martin, 1933. Myxomycetes found on the bark of living trees. Studies of Natural History, Iowa University 15: 3-8.
11. Hernández-Crespo, J. C., C. Lado, 2005. An on-line nomenclatural information system of Eumycetozoa. [http://www.nomen.eumycetozoa.com\(24-X-2005\)](http://www.nomen.eumycetozoa.com(24-X-2005)).
12. Lado, C., 2001. Nomenmyx. A Nomenclatural Taxabase of Myxomycetes. Cuadernos de Trabajo. Flora Micológica Ibérica 16:1-221.
13. Lado, C., U. Eliasson, S. L. Stephenson, A. Estrada-Torres, M. Schnittler, 2005. (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 *Hyporhama* (Myxomycetes). Taxon 54: 543-545.
14. Lado, C., A. Estrada-Torres, S. L. Stephenson, D. Wrigley de Basanta, M. Schnittler, 2003. Biodiversity assessment of myxomycetes from two tropical forest reserves in Mexico. Fungal Diversity 12:67-110.
15. Lado, C., M. Rodríguez-Palma, A. Estrada-Torres, 1999. Myxomycetes from a seasonal tropical forest on the Pacific coast of Mexico. Mycotaxon 71:307-321.
16. Martin, G. W., C. J. Alexopoulos, 1969. The Myxomycetes. University of Iowa Press, Iowa City.
17. Martin, G. W., C. J. Alexopoulos, M. L. Farr, 1983. The Genera of Myxomycetes. University of Iowa Press, Iowa City.
18. Minter, D. W., M. Rodríguez Hernández, J. Mena Portales, 2001. Fungi of the Caribbean. An annotated checklist. PDMS Publishing, Middlesex, UK.
19. Moore, D. L., S. L. Stephenson, 2003. Microhabitat distribution of protostelids in a tropical wet forest in Costa Rica. Mycologia 95:11-18.
20. Novozhilov, Y. K., M. Schnittler, A. W. Rollins, S. L. Stephenson, 2001. Myxomycetes in different forest types of Puerto Rico. Mycotaxon 77:285-299.
21. Pérez J. M., M. Camino, 2000. Riqueza fúngica en la Reserva Ecológica "Alturas de Banao", Sancti Spiritus. (Resumen) VI Simposio de Botánica, La Habana.
22. Recio G.; S. Maldonado, M. Benitez, 2000. Primer reporte de representantes de Ascomycota de "El Naranjal", reserva ecológica de Las Alturas de Banao, Cuba. Revista del Jardín Botánico Nacional, Universidad de la Habana 21:195-201
23. Schnittler, M., 2001. Ecology and Biogeography of Myxomycetes. Habilitationsschrift zur Erlangung des akademischen Grades doctor rerum naturalium habilitatus. Biologisch-Pharmazeutischen Fakultät der Friedrich-Schiller-Universität-Jena.)
24. Schnittler, M., S. L. Stephenson, 2000. Myxomycete biodiversity in four different forest types in Costa Rica. Mycologia 92: 626-637.
25. Schnittler, M., S. L. Stephenson, 2002. Inflorescences of Neotropical herbs as a newly discovered microhabitat for myxomycetes. Mycologia 94: 6-20.
26. Schnittler, M., C. Lado, S. L. Stephenson, 2002. Rapid biodiversity assessment of a tropical myxomycete assemblage—Maquipucuna Cloud Forest Reserve, Ecuador. Fungal Diversity 9: 135-167.
27. Stephenson, S. L., 1988. Distribution and ecology of myxomycetes in temperate forests. I. Patterns of occurrence in the upland forests of southwestern Virginia. Canadian Journal of Botany 66:2187-2207.
28. Stephenson, S. L., 1989. Distribution and ecology of myxomycetes in temperate forests. II. Patterns of occurrence on bark surface of living trees, leaf litter, and dung. Mycologia 81:608-621.
29. Stephenson, S. L., A. Estrada-Torres, M. Schnittler, C. Lado, D. Wrigley de Basanta, N. Ogata, 2003. Distribution and ecology of myxomycetes in

the forests of Yucatan. In: Gómez-Pompa, A., M. Allen, S. Fedick, J. Jimenez (eds.), Lowland Maya Area: Three Millennia at the Human-Wildland Interface. Haworth Press, New York. Pp. 241-259

30. Stephenson, S. L., H. Stempen, 1994. Myxomycetes: a Handbook of Slime Molds. Timber Press, Portland, Oregon.
31. Stephenson, S. L., M. Schnittler, C. Lado, 2004a. Ecological characterization of a tropical myxomycete assemblage—Maquipucuna

Cloud Forest Reserve, Ecuador. Mycologia 96: 488-497.

32. Stephenson, S. L., M. Schnittler, C. Lado, A. Estrada-Torres, D. Wrigley de Basanta, J. C. Landolt, Y. K. Novozhilov, J. Clark, D. L. Moore, F. W. Spiegel, 2004b. Studies of Neotropical mycetozoa. Systematics and Geography of Plants 74: 87-108.
33. Wrigley de Basanta, D., S. L. Stephenson, 2005. Myxomycetes from moist chamber cultures of lianas. Fourth International Congress on Systematics and Ecology of Myxomycetes Abstract Volume 1: 108.
34. Wrigley de Basanta, D., C. Lado, 2005. A taxonomic evaluation of the stipitate *Licea* species. Fungal Diversity 20: 261-314.