

Distribution and species composition of *Laccaria* (Agaricales) in tropical and subtropical America

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Abstract: Species of *Laccaria* (Agaricales) form a conspicuous component of forests dominated by Pinaceae and Fagaceae in tropical and subtropical America. Seventeen species have been reported from this region. Five species are widely distributed in the region with the others being more narrowly distributed. *Laccaria fraterna* is an introduced species associated with *Eucalyptus*. Species have not been reported from other forest types in the Neotropics following extensive field work by a number of workers in many areas of tropical South America and the Caribbean. Similarities among mycotas (fungal equivalent of flora and fauna) were assessed by comparing taxon lists and by calculating the Simpson Coefficient of Similarity between pairs of areas. Similarities between North America north of Mexico and Colombia/Costa Rica were calculated as 80% and 71.5%, respectively. This is higher than coefficients for other compared areas. Species composition in a particular area within this region appears to be influenced by the available ectomycorrhizal hosts, along with climatic and geographic factors and history.

Key words: Agaricales, Basidiomycetes, Biogeography, Fungi, *Laccaria*, Neotropics

Mueller and Halling (1995) discuss the importance of obtaining data on species composition, distribution and potential host specificity of various groups of fungi for understanding the formation and ecology of forest ecosystems, including tropical systems. They also emphasize the need for such data to test current estimates on world-wide species numbers of fungi (*e.g.* Hawksworth 1991, 1992).

One group especially amenable to such studies is the genus *Laccaria* (Agaricales). The genus has been the focus of intensive study in many areas of the world (see discussion in Mueller 1992), and importantly for this type of study, the author of this paper has studied the genus throughout the Americas and Europe thus reducing the problem of interpreting different workers species concepts.

Laccaria is a cosmopolitan genus of mushrooms (Agaricales) consisting of 30-35 species (Mueller 1992). The genus has been reported from many types of habitats extending from arctic tundra to tropical zones to subantarctic regions. Species of *Laccaria* form ectomycorrhizae with species of Fagaceae, Pinaceae, and *Eucalyptus*, and they constitute a conspicuous component of the macrofungal biota of forests dominated by these trees. As discussed below, species of *Laccaria* have been reported from many regions of the Americas.

MATERIALS AND METHODS

Field work was carried out by the author in southern Canada, continental United States, northeastern Mexico, Honduras, Costa Rica, Colombia, Ecuador, Venezuela, Brasil, Argentina, and Chile. Additional distributional data were obtained from the literature (Singer and Digilio 1952, Singer 1963, Singer 1969, Dennis 1970, Aguirre-Acosta and Pérez-Silva 1978, Horak 1979, Pegler 1983, Singer *et al.* 1983, Montoya-Bello *et al.* 1987, Garrido 1988, Mueller and Singer 1988, Mueller 1992). Voucher specimens are housed at Field Museum of Natural History and in University of Costa Rica, University of Honduras, University of Antioquia (Medellin, Colombia), Venezuela National Herbarium, and INPA (Manaus, Brasil).

Species concepts used in this paper are taken from Mueller (1992). Descriptions and keys to the included species also can be found there (Mueller 1992).

Two methods were employed for comparing the composition of *Laccaria* from these different regions. These are: 1) direct comparisons of species lists from each of the regions, and 2) calculations of the similarity of species between pairs of regions that have

been adequately surveyed using Simpson's Coefficient of Similarity ($C/N_1 \times 100$) where C = number of shared taxa and N_1 = total number of taxa reported from smaller of the two mycotas being compared. This index was used instead of other similar indices (e.g. Sørensen's and Jaccard's) because it is not susceptible to differences in sample size (Simpson 1960, Flynn 1986). Five phytogeographic regions were used in these comparisons: North America (does not include Mexico), montane Costa Rica, montane Colombia, the Lesser Antilles, tropical South America (all of South America north of the tropic of Capricorn excluding montane Colombia), and temperate South America.

Species of *Laccaria* that have been reported from

tropical and subtropical America are listed in Table 1. Five species occur throughout the region. These are *Laccaria amethystina* Cooke, *L. laccata* var. *pallidifolia* (Peck) Peck, *L. ohiensis* (Mont.) Singer, *L. proxima* (Boud.) Pat. and *L. trichodermophora* Mueller. *Laccaria fraterna* (Cooke & Massee: Saccardo) Pegler is also widely distributed, but this species is not native to the region and is restricted to *Eucalyptus*. Five additional species of *Laccaria*, *L. oblongospora* Mueller, *L. ochropurpurea* (Berk.) Peck, *L. tortilis* (Bolt.) Cooke, *L. trullissata* Ellis, and *L. vinaceobrunea* Mueller have been reported from the Gulf Coast region of the United States (Mueller 1992).

RESULTS

TABLE 1

Comparisons of species composition of *Laccaria* in different geographic regions of subtropical and tropical America

<i>Laccaria</i> species ³	Regions ^{1,2}			
	Gulf Coast, USA	Mexico	Costa Rica	Colombia
<i>L. amethystina</i>	X	X	X	X
<i>L. bullulifera</i>		X		
<i>L. fraterna</i> ⁴				
<i>L. glabripes</i> ⁵		X		
<i>L. gomezii</i>			X	X
<i>L. laccata</i> var. <i>pallidifolia</i>	X	X	X	X
<i>L. major</i>			X	
<i>L. masonii</i> var. <i>brevispinosa</i> ⁵		X		
<i>L. oblongospora</i>	X			
<i>L. ochropurpurea</i>	X	X		
<i>L. ohiensis</i>	X	X	X	X
<i>L. proxima</i>	X	X	X	X
<i>L. tortilis</i>	X			
<i>L. trichodermophora</i>	X	X	X	
<i>L. trullissata</i>	X			
<i>L. vinaceobrunea</i>	X			
<i>L. violaceoniger</i> ⁵		X		

¹ Gulf Coast includes the southern regions of the states of Alabama, Louisiana, and Mississippi plus Florida; Costa Rica and Colombia data are limited to *Quercus* dominated forests; all data except those from Mexico are based on the author's collection and herbarium studies. Mexican data are from Aguirre-Acosta and Pérez-Silva (1978) and Montoya-Bello *et al.* (1987).

² Species of *Laccaria* have not been reported from native lowland neotropical forests.

³ See Mueller (1992) for species concepts and descriptions.

⁴ This is an introduced species; only reported from under planted *Eucalyptus* trees.

⁵ The accuracy of these names have not been verified. These taxa are known only from New Zealand with the exception of these reports.

TABLE 2

Comparisons of species composition of *Laccaria* in different geographic regions using the Simpson Coefficient of Similarity. Numbers in parenthesis = number of species reported from that region.

	Regions ¹					
	North America	Costa Rica	Colombia	Lesser Antilles	Tropical South America	Temperate South America
	(19)	(7)	(5)	(0)	(0)	(4)
Costa Rica	71.5					
Colombia	80	100				
Lesser Antilles	0	0	0			
Tropical South America	0	0	0	0		
Temperate South America	50	50	50	0	0	

¹ North America = reports from North America excluding Mexico (Mueller 1992); Costa Rica = reports from Costa Rican *Quercus* forests (Mueller 1992, unpub.; Mueller and Singer 1988). Colombia = reports from Colombian *Quercus* forests (Singer 1963, Mueller 1992, unpub.; Mueller and Singer 1988). Lesser Antilles = reports from the Lesser Antilles (Pegler 1983). Tropical South America = reports from tropical South America excluding montane Colombia (Singer and Digilio 1952, Dennis 1970, Singer *et al.* 1983). Temperate South America = reports from southern Argentina and Chile (Singer 1969, Horak 1979, Garrido 1988, Mueller 1992, unpub.).

Ten species of *Laccaria* have been reported from Mexico (Aguirre-Acosta and Pérez-Silva 1978, Montoya-Bello *et al.* 1987). Four of these, *L. bullulifera* Singer, *L. glabripes* McNabb, *L. masonii* var. *brevispinosa* McNabb, and *L. violaceoniger* Stevenson are either known only from Mexico (*L. bullulifera*) or have a disjunct distribution with New Zealand (the other three species). These latter reports, however, have not been verified by the author.

Seven species are currently known from Costa Rica and Colombia. All of these are restricted to montane areas and appear to be limited to *Quercus* dominated forests. Two species, *L. gomezii* Singer and Mueller and *L. major* nom. prov. are known only from this region. Based on extensive surveys of Agaricales by Rolf Singer and others, including this author, *Laccaria* does not occur in lowland neotropical forests.

The results of comparing species composition of *Laccaria* from different regions in North, Central, and South America using the Simpson Coefficient of Similarity are presented in Table 2. Costa Rica and

Colombia show a 100% similarity. North America (excluding Mexico) has a high similarity with Costa Rica and Colombia (71.5 and 80%, respectively). Two of the four species reported from South Temperate South America, *L. laccata* and *L. ohienensis*, occur throughout the region while the other two species, *L. galerinoides* Singer in Singer and Moser and *L. proximella* Singer in Singer and Moser, are endemic to *Nothofagus* forests in southern South America.

DISCUSSION

The genus *Laccaria* is relatively well known in the Americas. However, as is the case for all Agaricales, work remains to document species composition in many Central American countries and in the Greater Antilles. Additional field and herbarium work in Mexico is also needed to verify the putative Mexican - New Zealand disjunct distributions and to survey uncollected forest types and regions. While these data will be important to further clarify and refine

our knowledge of diversity and distribution patterns in the genus, I do not believe that the patterns elucidated here will significantly change.

Based on current data, the diversity and species composition of *Laccaria* appears to be influenced by the diversity of available ectomycorrhizal hosts, along with climatic and geographic factors and history. The number of species decreases as the number of hosts decreases. Thus, North America and Mexico, with numerous species of Fagaceae and Pinaceae, have the largest number of *Laccaria* species. Costa Rica has two more species of *Laccaria* than does Colombia, and Costa Rica has 12 species of *Quercus* (Burger 1977) as compared to one species in Colombia. Additionally, pollen data suggests that extensive *Quercus* forests in Colombia only were formed 340 000 B.P. (H. Hooghiemstra, pers. comm.) so there was considerably more time for the establishment and diversification of oak associated fungi in Costa Rica than in Colombia. Based on the literature, Mexico's *Laccaria* species composition is fairly distinct from the other regions. Until the identity of the New Zealand disjuncts are verified, however, I view this comparison as tentative.

The data in this paper are concordant with data presented in Mueller and Halling (1995). Species of *Laccaria* are abundant in relation to the number of available mycorrhizal hosts, and most of the species exhibit discrete distribution ranges with only five of the 17 species known from the Americas occurring in all regions.

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Laccaria and as the person who introduced me to tropical field work during my first trip to Costa Rica in 1986.

RESUMEN

Las especies de *Laccaria* (Agaricales) son un componente conspicuo de los bosques dominados por miembros de las familias Pinaceae y Fagaceae en América tropical y subtropical. Diecisiete especies han sido comunicadas para esta región. Cinco de estas especies están ampliamente distribuidas, mientras que las otras presentan una distribución más restringida. *Laccaria fraterna* es una especie introducida asociada con *Eucalyptus*. No se han comunicado otras especies en diferentes tipos de bosques en el Neotrópico a pesar del trabajo de campo extenso llevado a cabo por micólogos en muchas áreas de Sur América tropical y el Caribe. La similitud entre grupos de hongos se llevó a cabo por comparación de listas de táxones y por medio de cálculos del Coeficiente de Similitud de Simpson entre pares de áreas. Se calculó las similitudes entre América del Norte-norte de México-Colombia/Costa Rica en 80% y 71.5%, respectivamente. Este resultado es más alto que otros coeficientes calculados para otras áreas comparadas. La composición de especies en un área particular dentro de esta región, parece estar influenciada por la disponibilidad de hospederos ectomicorrízicos, así como por el clima, factores geográficos y la historia del lugar.

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