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Distribution of pore fungi (*Aphyllophorales: Basidiomycotina*) in the biotic units of Costa Rica

Julieta Carranza

Escuela de Biologia, Universidad de Costa Rica, San José, Costa Rica

Abstract : Two hundred and thirty-one species of pore fungi within 72 genera have been reported from Costa Rica. Based on Herrera d Gómez´s 1993 Biotic Unit Map, the majority of the pore fungi are present in the Tropical-Tropical Unit (51 genera, 100 spp.), followed Temperate-Tropical (46 gen. 85 spp.), Subtropical-Tropical (40 gen. 83 spp.) and Temperate-Cold (15 gen. 19 spp.). Only three genera : known from the Boreal-Tropical Unit. Many of these genera are cosmopolitan (45.8%), followed by 33.4% tropical and 20.8% boreal. cty-four cause white rot on hardwood trees and eight cause brown rot on hardwood and softwood trees. *Amauroderma* appears to be the ly genus restricted to a specific unit (Tropical-Tropical) and *Fistulina* and *Bondarzewia* to have a narrow host range (*Quercus* sp. and *Alnus* .).

Key words: Costa Rica, pore fungi, biotic units, geographic distribution, mycoflora, mycogeography, Aphyllophorales.

Few studies have been carried out on Costa Rican ycoflora, particularly on higher fungi.

A total of 231 species (72 genera) of pore fungi olyporaceae, Ganodermataceae, Hymenochaetaceae ıd Corticeaceae) have been reported since the ginning of the century (Murrill 1915, Sydow 1925, owe 1963, 1966, 1976, Covington 1980, Carranza 82, Carranza and Sáenz 1984; Gómez and Ryvarden 85, Carranza-Morse 1991, 1992, 1993, Nuñez 1995, ıiz 1995).

Many of the reported species are also known from mperate regions (Gilbertson and Ryvarden 1986, 87) while others are more restricted to tropical areas yvarden and Johansen 1980).

Costa Rica has been classified into different ological zones by several authors (Holdridge 1967, si 1969, Herrera 1985, Gómez 1986). According to errera and Gómez (1993), there are different biotic ıits based on physiographic and climatic factors ltitude, annual rainfall, temperature) and on the stribution of flora and fauna. Plants and animals are ıt evenly distributed throughout the country, but me groups seem to form associations in particular ographic areas. Herrera and Gómez (1993) suggest at these associations may be used to characterize otic units as follows:

Tropical-Tropical (up to 900 m), Subtropical-opical (640-1340m [Pacific coast] and 340-1100m ıtlantic coast]), Temperate-Tropical (1350-2200m acific coast] and 1100-2100m [Atlantic coast]), Temperate-Cold (2200-3000m [Pacific coast] and 2000-3000m [Atlantic coast]) and Boreal-Tropical (3000m) (Fig.1).

More than 50% of the total biodiversity of the country is generally considered to be found, within the Temperate-Tropical Unit, which has the greatest microclimatic diversity and macroclimatic variation (Herrera and Gómez 1993).

The purpose of this paper is to correlate recorded pore fungi with Herrera and Gómez's Biotic Units (1993) and to determine whether some of the species can be used as unit indicators.

MATERIAL AND METHODS

The species reported here were collected by the author and others and specimens of all species are deposited in the Herbarium (USJ), Escuela de Biología, Universidad de Costa Rica, San Pedro, Costa Rica.

Based on Herrera and Gómez's 1993 Biotic Unit Map (Fig. 1), each specimen was assigned a specific number according to where it was collected. The data were then analyzed with the Borland´s Paradox (TM) Data Base Program.

RESULTS AND DISCUSSION

The majority of the 231 species are found in the Tropical-Tropical Unit. This biotic unit includes areas that differ considerably as to annual precipitation, with some areas having no dry periods at all, while others have five to six dry months; therefore, the vegetation varies from scanty forest in some areas to others with very lush tropical rainforests.

Approximately 75% of the country's area falls within this unit, made up chiefly by the Pacific and Atlantic lowlands (Fig. 1).

A total of 100 species (42.85%) in 51 genera were collected in this unit. The area with the most fungi was #46 (40 of the 230 specimens collected). Some places of the locations within this area are: La Selva and La Virgen, Heredia; Esquinas and Golfito, Puntarenas; Siquirres and Tortuguero, Limón (Fig. 1).

Table 1. *World distribution of Pore Fungi restricted to the Tropical-Tropical Unit*

Amauroderma boleticeum (Pat. & Gail.) Torr.	Central and South America
Amauroderma longipes (Lév.) Torr.	Central and South America; Africa; Asia
Amauroderma schomburgkii (Mont. & Berk.) Torr.	Central and South America; Africa; Caribbean Islands
Grammothele fuligo (Berk. & Br.) Ryv.	Central America; Africa; Asia
Trametes cubensis (Mont.) Sacc.	North, Central and South America
Wrightoporia tropicalis (Cke.) Ryv.	Central and South America

Of the 51 genera collected, 22 are cosmopolitan, 19 tropical and 10 circumpolar (Tables 1-2). The genus *Amauroderma* appears to be the only one restricted to a single unit (Tropical-Tropical Unit), since all other genera were collected in more than one unit.

Specimens from genera such as *Trametes, Ganoderma, Hexagonia, Cerrena*, and *Trichaptum* are often collected in exposed environments, as they are well adapted to withstand drought. Some have thin, pliable and sessile basidiocarps, thick masses of hairs or thick cuticles, that prevent water loss (Ryvarden 1991).

The Subtropical-Tropical and Temperate-Tropical Units have a similar number of fungi. There are also differences as to annual precipitation in the areas included in both units (five to six dry months or no dry periods).

The Subtropical-Tropical Unit is characterized by a high diversity of higher plants. However, more than 50% of the country's biodiversity is found in the Temperate-Tropical Unit (Herrera & Gómez 1993) (Fig.1).

Eighty-three species (36%) from 40 genera were found in the Subtropical-Tropical Unit. The area with the most fungi was #41 (48 of the 148 specimens collected) . Twenty of these genera are cosmopolitan, 15 tropical, and 5 boreal (Table 2). Some places of the locations within this area are: San José and Escazú, San José; San Luis and Santo Domingo, Heredia; Grecia and Río Segundo, Alajuela (Fig. 1).

The distribution of some species appear to be limited to this unit as they have not been collected elsewhere (Table 3). Two of the genera are pantropical (*Earliella* and *Nigroporus*) one tropical (*Tinctoporellus*) and the rest are cosmopolitan.

Eighty-five species (36.8%) from 46 genera were collected in the Temperate-Tropical Unit (Table 2), with 48 specimens collected in area #27 (of the 124 specimens collected). Twenty-five genera are cosmopolitan, 10 are tropical and 11 are boreal. Some places of the locations within this area are: Cervantes, Cartago; San José de la Montaña, Heredia; Santa María de Dota and Rancho Redondo, San José (Fig. 1).

The genus *Phellinus* appears to be well represented in this Unit, since 14 species out of the 33 known from the country were collected within this Unit. *Phellinus* is a cosmopolitan genus with 154 species and 67 forms and varieties that have been described worldwide (Larsen & Cobb-Poulle 1990), many of these species are tropical. *Phellinus* is the most species-rich genus among the pore fungi in Costa Rica.

The Temperate-Cold Unit is characterized by some areas without dry months and others with short dry periods (three to four months). The forest cover is very abundant and oaks are common (Fig. 1).

This unit yielded the least number of species, only 19 (8.22%) from 14 genera (Table 2). The locality with most species was #15 (10 of the 23 specimens collected). Ten genera are cosmopolitan, two tropical,

ınd two boreal.

All the species collected in this unit are commonly ound in *Quercus* forests. Some places of the locations vithin this area are: La Georgina and Cerro de la Muerte, San José; Volcán Irazú, Cartago (Fig. 1).

Table 2. Genera of Pore Fungi collected in the Biotic Units

.bortiporus (3,C)	*Inonotus* (2,C)
.mauroderma (1,T)	*Irpex* (1,3,C)
.nomoporia (1,2,3,B)	*Ischnoderma* (3,B)
.ntrodia (1,2,3,B)	*Junghuhnia* (3,C)
.ntrodiella (1,2,C)	*Laetiporus* (2,3,4,5,C)
.urificaria (1,3,T)	*Lenzites* (1,3,C)
Bjerkandera (3,4,C)	*Lindtneria* (1,C)
Bondarzewia (3,C)	*Loweporus* (1,2,3,T)
Ceriporia (1,2,C)	*Megasporoporia* (1,2,T)
Ceriporiopsis (1,B)	*Microporellus* (1,T)
Cerrena (1,2,3,B)	*Nigrofomes* (1,3,T)
Chaetoporellus (1,3,B)	*Nigroporus* (1,2,T)
Coltricia (1,2,3,4,5,C)	*Oligoporus* (1,B)
Coriolopsis (1,2,3,4,C)	*Oxyporus* (1,2,3,C)
Cyclomyces (1,2,3,4,T)	*Pachykytospora* (1,B)
Daedalea (1,2,3,4,C)	*Perenniporia* (1,2,3,4,C)
Datronia (1,2,3,5,C)	*Piptoporus* (3,B)
Diplomitoporus (3,B)	*Phellinus* (1,2,3,4,C)
Earliella (1,2,T)	*Phylloporia* (1,3,T)
Echinochaete (1,T)	*Physisporinus* (1,B)
Echinoporia (2,T)	*Polyporus* (1,2,3,4,C)
Fistulina (3,4,B)	*Porodisculus* (3,T)
Flavodon (1,T)	*Porogramme* (1,2,3,T)
Fomes (1,3,4,B)	*Pseudofavolus* (2,T)
Fomitella (1,2,T)	*Pycnoporus* (1,2,3,C)
Fomitopsis (1,2,3,B)	*Pyrofomes* (1,C)
Fuscocerrena (1,2,3,4,T)	*Rigidoporus* (1,2,3,C)
Ganoderma (1,2,3,4,C)	*Schizopora* (3,C)
Heloephyllum (1,2,C)	*Skeletocutis* (3,C)
Heloeporus (1,2,3,C)	*Spongipellis* (2,B)
Grammothele (1,3,T)	*Tinctoporellus* (1,2,T)
Haddowia (2,T)	*Trametes* (1,2,3,4,C)
Henningsia (2,T)	*Trechispora* (2,3,C)
Hexagonia (1,2,3,T)	*Trichaptum* (1,2,3,C)
Hydnopolyporus (1,2,T)	*Tyromyces* (1,3,C)
Incrustoporia (3,C)	*Wrightoporia* (1,C)

B= Boreal genera, C= Cosmopolitan genera, T= Tropical enera.

1= Tropical Tropical Unit, 2= Subtropical Tropical Unit, 3= Temperate Tropical Unit, 4= Temperate Cold Unit, 5= Boreal Tropical Unit.

Some genera were reported exclusively from the Temperate-Tropical or Temperate-Cold Units (Table 2). Four (*Diplomitoporus, Fistulina, Ischnoderma, Piptoporus*) are circumpolar in the northern boreal temperate zone, seven (*Abortiporus, Bjerkandera, Bondarzewia, Incrustoporia, Junghuhnia, Schizopora,* and *Skeletocutis*) cosmopolitan and one tropical *Porodisculus*).

There are four species that have only been collected in the Temperate-Tropical and Temperate-Cold Units (Table 4); but others have a wider distribution, since they were also collected in Tropical, Subtropical, and Temperate Tropical Units (Table 5). *Ganoderma applanatum* is one of the species with a wide distribution and has been collected in the four units mentioned above from sea level to 1853 m (Table 2). The species is cosmopolitan, and grows both on hardwood and softwood trees throughout the world.

Regarding host specificity, the genera *Fistulina* and *Bondarzewia* appear to have a very narrow host range, since they have only been collected on *Quercus* sp.and *Alnus* sp. which are commonly found in the Temperate-Tropical and Temperate-Cold Units. The remaining genera have wide host ranges.

Table 3. World distribution of Pore Fungi restricted to the Tropical and Subtropical Units.

Antrodiella liebmannii (Fr.) Ryv.	North and Central America; Africa; Caribbean Islands
Earliella scabrosa (Pers.) Gilbn. & Ryv.	North, Central and South America; Africa; Caribbean Islands
Nigroporus vinosus (Berk.) Murr.	North, Central and South America; Africa; Asia; Caribbean Islands
Polyporus dictyopus Mont.	Central and South America; Africa
Polyporus leprieuri Mont.	Central and South America; Africa; Caribbean Islands
Tinctoporellus epimiltinus (Berk: & Br.) Ryv.	North, Central and South America; Africa; Caribbean Islands

Table 4. World distribution of Pore Fungi restricted to Temperate-Tropical and Temperate-Cold Units

Bondarzewia berkeleyi (Fr.) Bond. & Sing.	North and Central America; Europe; Asia
Coltricia perennis (Fr.) Murr.	North and Central America; Europe; Asia; Africa
Fistulina hepatica Schaeff.: Fr.	North and Central America; Europe
Phellinus sarcitus (Fr.) Ryv.	North, Central and South America; Africa; Caribbean Islands
Polyporus brumalis Pers.: Fr.	North, Central and South America; Europe; Asia; Africa

Table 5. World distribution of Pore Fungi present in Tropical, Subtropical and Temperate Tropical Units

Anomoporia myceliosa (Peck) Pouz.	North and Central America; Europe; Asia
Ganoderma lucidum (W. Curt.: Fr.) Karst	North, Central and South America; Africa; Europe; Asia
Hexagonia hydnoides (Fr.: Sw.) M. Fidalgo	North, Central and South America; Africa; Caribbean Islands
Phellinus gilvus (Schw.: Fr.) Pat.	North, Central and South America; Africa; Asia; Europe; Caribbean Islands
Polyporus guianensis Mont.	Central and South America; Caribbean Islands
Polyporus tricholoma Mont.	North, Central and South America; Africa; Caribbean Islands
Porogramme albocincta (Cke. & Massee) Lowe	North and Central America; Africa; Caribbean Islands
Pycnoporus sanguineus (L.: Fr.) Murr.	North, Central and South America; Africa; Asia; Caribbean Islands

The Boreal-Tropical Unit is characterized by scant vegetation and includes areas with no dry periods, and others with three to four dry months. Only three genera of pore fungi have been reported from this unit (*Datronia* sp. *Laetiporus* sp. and *Coltricia* spp. Gómez pers. comm. 1994, Table 2). Herrera & Gómez (1993) listed some coprophilous fungi (Ascomycotina and Agaricales) and Gómez mentioned the genus *Boletopsis* (Gómez pers. comm. 1994) as commonly found in this unit.

Of the 72 genera collected in Costa Rica, 33 (45.8%) are cosmopolitan, 24 (33.4%) tropical and 15 (20.8%) boreal. Sixty-four genera are white rotters (88.9%) and 8 genera are brown rotters (11.1%). Of the latter genera, four are boreal (*Antrodia, Fistulina, Fomitopsis, Piptoporus*) three cosmopolitan (*Daedalea, Gloeophyllum, Laetiporus*) and one tropical (*Loweporus*)

Most of the annual species seem to have a short sporulation period, especially those collected in areas with long dry periods; spores are probably produced and dispersed when the moisture and temperature conditions are right (July-August or October-November). Species with perennial basidiocarps retain some spores in old tubes, so spores appear to be dispersed over longer periods of time.

A total of 140 genera of pore fungi have been reported worldwide. The 72 genera known in Costa Rica represent 51.4% of the total. This large number of genera in such a small area is probably due to its geographical position and variable climate as well as migration of species from both North and South American mycoflora.

The majority of the pore fungi present in the country are cosmopolitan. Only one new species has been described from Costa Rica (Gómez & Ryvarden 1985). According to Ryvarden (1991), most of the genera of pore fungi have a wide distribution, either because they evolved before the break up of Gondwanaland or because they have effective spore dispersal mechanisms.

There are still some areas in the country where pore fungi have not been collected; therefore, the information gathered thus far is insufficient to warrant their use as indicators in specific biotic units.

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RESUMEN

Doscientas treinta y un especies incluídas en 72 géneros de hongos poroides han sido comunicadas para Costa Rica. Con base en el mapa de Unidades Bióticas de Costa Rica (Herrera y Gómez 1993), la mayoría de estos hongos (42.85%) se encuentran en la unidad Tropical-Tropical (51 géneros, 100 especies); seguida por Templada-Tropical (46 géneros, 85 especies); Subtropical-Tropical (40 géneros, 83 especies) y Templada-Fría (14 géneros, 19 especies). Solo tres géneros han sido comunicados en la unidad Boreal-Tropical. Un 45.8% de los géneros presentes en el país son cosmopolitas, seguido por un 33.4% tropicales y solo un 20.8% boreales. Un 88.9% producen podredumbre blanca en angiospermas y solo un 11.1% son causantes de podredumbre café en angiospermas y coníferas. El género *Amauroderma* parece ser el único que está restringido a una unidad particular (Tropical-Tropical), y *Fistulina* y *Bondarzewia* parecen tener un ámbito de hospederos muy limitado (*Quercus* y *Alnus sp.*)

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