

Biodiversity in polypore fungi. A comparison between tropical Africa and America

Leif Ryvar den

Botany Department, University of Oslo, P.O. Box 1045, Blindern, N-0371 Oslo, Norway

Abstract: Tropical Africa and America have each about 400 species and 70 genera of polypore fungi. There are seven endemic genera in tropical America, three in Africa. The number of brown rotting species is low, only 3% in both areas, compared with about 25% in boreal conifer forests; 13% of the African polypores are endemic, no number is as yet known from tropical America. *Amauroderma* has an endemism of about 90% on both continents, which contrasts with other groups of polypores. In *Phellinus* there are about 60 species out of which about 60% are endemic in tropical America while the numbers are about 30 and 5% respectively in Africa. It is suggested that the reason for these differences is the isolated position of tropical America while Africa has been connected to tropical Asia through more or less continuous forests in previous geological periods.

Key words: Polypores, biodiversity, endemism, *Amauroderma*, Hymenochaetaeaceae.

Before a proper comparison of polypore fungi diversity in Africa and America can be performed, it is necessary to give a statement concerning the knowledge of polypores in the two continents. For East Africa there is a preliminary polypore floral list (Ryvar den & Johansen 1980) with 330 African species. Later, more intensive collecting -especially in South Central Africa- increased the number of species to nearly 400, excluding species of *Ganoderma*. There are still important areas of the continent which are mycologically poorly known, especially the large Congo basin. Very little systematic collecting has been done there in recent time due to unstable political conditions. Thus, more undescribed species are to be expected from this area, although I would be surprised if we are speaking of more than 50 species. Most polypores have a wide distribution and collecting in rain forests in Cameroon, Ghana and Uganda has probably given a fairly good overview of the polypores growing in the lowland rain forest. Thus, our knowledge of the African polypores is fairly good, at least to make a first comparison with other continents.

There are no floral works covering the polypores of tropical South America. Dennis (1970) provides a compilation of reported polypores, but there are numerous double reports and synonyms, which makes the polypore part of the book almost useless. Few mycologists interested in the Aphyllophorales have

collected in the Amazon basin, and again a number of new species are to be expected from this area. Some lists have been published from tropical America such as Ryvar den (1987), David & Rajchenberg (1985) and from Costa Rica we have a fairly good knowledge due to Carranza Morse intensive collecting (Carranza & Sáenz 1984, Carranza-Morse 1991, 1992 and 1993).

However, no flora has been published, but my private checklist for tropical America includes approximately 360 species. It is my estimate that the number of polypores will be about 400 after more collecting and examination of the large collections in the Sao Paulo herbarium from the Amazon basin. Thus, I see no striking differences in the number of polypores from the two areas even with the reservations mentioned above.

Species only exclusively found on planted gymnosperms in Africa have been omitted from the numbers given above.

Generic biodiversity : Generic nomenclature is according to Ryvar den & Johansen 1980 and Gilbertson & Ryvar den 1986-87. The result: Tropical America 70, Tropical Africa: 73. The two areas are almost equal in biodiversity on this level.

Endemic polypore genera:

America: *Lamelloporus* Ryv. *Fuscocerrena* Ryv. *Murrilloporus* Ryv. *Nigrohydnum* Ryv. *Stiptophyllum* Ryv. (stipitate), *Hydnopolyporus* Reid (stipitate) and *Melanoporiella* Murr.

Africa: *Xerotus* Fr. (stipitate) *Pseudopiptoporus*, Ryv. and *Rigidoporopsis* Ryv.

In addition, *Microporus* Kunth (stipitate) *Lignosus* Torr. (stipitate) and *Amylonotus* Ryv. occur also in tropical Asia, but are not known from America.

Almost half of the endemic genera are stipitate. To me this indicates, as stated in Ryvarde (1991), that the stipitate basidiocarp in general is an advanced character.

Common polypores between the continents:

A comparison based on the literature mentioned above and my personal checklists between the polypores common to the different continents reveals interesting differences.

The percentages given next indicate how many polypores from the first continent are common with the second. When examining the numbers, the reader has to keep in mind that about 40% of the tropical polypores are Pantropical.

Europe - Africa 14%

Europe - North America 70%

Africa - Asia 60%

Africa - South America 50%

The numbers clearly indicate that as long as we consider the same climatic zones, the number of common polypores is rather high, much higher than for most other groups of organisms, indicating either an old common origin or effective dispersal. As soon as we move across climatic zones, such as between Europe and Africa, the number of common species falls drastically. The number of common species between Europe and North America is very high and indicates that the more or less coherent circumpolar conifer forest has acted as an effective bridge for

dispersal of polypores. The number of common species between the different tropical areas indicates that there has been much more independent evolution in each tropical area even if the climate is the same. The Atlantic and the dry and more or less treeless Middle East have been sufficient to keep the new species separate.

As pointed out by Ryvarde (1991), the number of brown rot species decreases dramatically when moving from the boreal conifer forests to the tropical rain forests. This tendency, as shown above, is similar on both continents.

Endemic polypores from Africa (Exclusive of Ganodermataceae and Hymenochaetaceae): The number of endemic polypores in Africa is about 13%. This is very low compared for example with vascular plants. The main reason is probably the completely different life strategy that prevails in the two groups. Many vascular plants are dependent on insects for their pollination, and in a tropical rain forest many of them also depend on birds or monkeys for seed dispersal. Thus, they have to coevolve with two different groups of organisms. This exerts a strong evolutionary pressure on the plants. Additionally, most of their biomass is above the ground, and thus, exposed to daily and yearly climatic changes. A fungus on the other hand, has almost all its biomass either inside a host (dead or alive) or in the soil, and therefore is far less exposed to climatic changes. The evolutionary pressure for fungi is probably more on the molecular level, such as production of toxic compounds to keep other species away and enzymes for degrading living or dead tissue. Personally I feel that this is the main reason for the generally low endemism among fungi.

Endemic species in *Amauroderma* (Ganodermataceae) (scattered details only are available for *Ganoderma*):

Africa: *Amauroderma argenteofulvum* (Van der Byl) Doidge, *A. conjunctum* (Lloyd) Torrend, *A. ealaensis* (Beeli) Ryv., *A. expallens* (Bres.) Furtado, *A. fasciculatum* (Pat.) Torrend, *A. fuscoporia* Wakef., *A. infundibuliformis* Wakef., *A. kwiluensis* (Beeli) Ryv. *A. oblongisporum* Furtado, *A. preussii* (Henn.) Stey., and *A. sericatum* (Lloyd) Wakef. Of the 12

known African *Amauroderma* species, 11 are endemic which gives an endemism of over 90%.

Table 1 . Brown rotting species in tropical America and Africa

Name	America	Africa
<i>Antrodia albida</i> (Fr.) Donk	X	X
<i>Daedalea sprucei</i> Berk.	X	X
<i>Daedalea africana</i> Ryv.		X
<i>Laetiporus sulphureus</i> (Fr.) Murr.	X	X
<i>L. persicinus</i> (Berk. & Curt.) Gilbn.	X	X
<i>L. baudonii</i> (Boud.) Ryv.		X
<i>Fistulina radicata</i> Schw.	X	
<i>Fomitopsis carneus</i> (Blume & Nees) Imaz.		X
<i>F. nivosa</i> (Berk.) Gilbn. & Ryv.	X	X
<i>F. rhodophaeus</i> (Lev.) Imaz.		X
<i>F. spraguei</i> (Berk. & Curt.) Gilbn. & Ryv.	X	X
<i>F. feei</i> (Fr.) Kreisel	X	
<i>F. lilacino-gilvus</i> (Berk.) Wright. & Desch.	X	
<i>F. widingtoniae</i> Masuka & Ryv.		X
<i>Gloeophyllum striatum</i> (Fr.) Murr.	X	X
<i>G. trabeum</i> (Fr.) Murr.	X	X
<i>G. mexicana</i> (Mont.) Ryv.	X	
<i>Stiptophyllum erubescens</i> (Berk.) Ryv.	X	
<i>Melanoporiella carbonacea</i> (Berk.) Murr.	X	
	13 (3%)	12 (3%)

America: *Amauroderma boleticeum* (Pat. & aill.) Torrend, *A. calcigenum* (Berk.) Torrend, *A. meriarium* (Berk.) Furtado, *A. exile* (Berk.) Torrend, *A. macrosporum* Furtado, *A. omphalodes* (Berk.) Torrend, *A. praetervisum* (Pat.) Torrend, *A. pseudoboletus* (Spegazz.) Furtado, *A. renidens* (Bres.) Torrend, *A. schomburgkii* (Mont. & Berk.) Torrend, *A. sprucei* (Pat.) Torrend and *A. trichodermatum* Furtado..

Of the 14 known American *Amauroderma* species, 12 are endemic, giving an endemism of over 90%

It is remarkable that just this genus is so extremely endemic when Polyporaceae of Africa has

only 13% of endemism. The reason is probably that most of the investigated *Amauroderma* species in Africa are parasitic as shown by Alan Mswaka, Zimbabwe University (pers. comm.). It seems that *Amauroderma* species infect the host when alive, and that fruiting starts from the roots when the host is dead. Some tree species in the Miombo forest of South Central Africa seem to be more susceptible to attack than others, and apparently there is an effect of host specialization. The completely different sets of hosts on the two continents have resulted in an evolution of completely different species. Further, as the hosts continuously changed over time due to climatic modifications, and the fungus had to adapt

itself or face extinction; and the result is a high degree of endemism.

Hymenochaetaceae: Species and genera of Hymenochaetaceae reported from the two continents are listed in Table 2.

The numbers are taken from Larsen & Cobb-Pouille (1992) for *Phellinus* Quél., for *Inonotus* Karsten, they are taken from a synopsis of the genus being published by R.L. Gilbertson and Ryvarden (in prep.), while the numbers for *Hydnochaete* Bres. and *Stiptochaete* Ryv. are taken from Ryvarden 1982 and 1985, respectively. Those for *Coltricia* Murr. are taken from Masuka & Ryvarden 1994, Gilbertson & Ryvarden 1986-87 and Ryvarden & Gilbertson 1993-94.

Table 2. Species of different genera in Hymenochaetaceae from tropical Africa and America. Details not available for *Hymenochaete* Lev. The number of endemic species are given in parentheses.

	Africa	America
<i>Hydnochaete</i>	0	2 (2)
<i>Stiptochaete</i>	0	2 (2)
<i>Coltricia</i>	4 (1)	4 (1)
<i>Coltriciella</i>	1	0
<i>Inonotus</i>	7 (5)	7 (5)
<i>Phellinus</i>	28 (1)	57 (33)

The genus *Hydnochaete* can be considered as a hydroid *Hymenochaete* because microscopical characters are similar in the two genera, and it has only developed in America. Thus, there has been an independent evolution to a more advanced hymenophore in America compared with Africa. Otherwise *Hydnochaete* is known from Australia and Asia.

Stiptochaete is peculiar as it is a stipitate variant of *Hymenochaete* and to me, its endemic distribution in tropical America is an indication of its late development that points again to the stipitate basidiocarp as an advanced evolutionary character.

There is only a small number of species of *Inonotus* because the genus is predominantly boreal-

temperate. However, the genus is highly endemic on both continents, suggesting that *Inonotus* is a genus with distinct species, without the many species complexes so common in *Phellinus*. Also, *Inonotus* has a remarkable high degree of endemism in other parts of the world, much higher than in most other polypore genera.

All seven *Inonotus* species registered in Australia for example are endemic to the continent.

Phellinus is interesting because there are striking differences between the two areas. While tropical Africa has only less than half of the species registered for tropical America, only one species is endemic compared with 33 for tropical America.

One reason for this difference, seems to be that almost all African *Phellinus* species are also known from Asia. As known from other groups of fungi, there is a strong connection between East Africa and India, Sri Lanka and Malaysia with these areas sharing a very high number of fungal species.

It is difficult to give a good explanation of the different species number in *Phellinus* between the two continents. Does the high number of species in tropical America reflect a center of origin for the genus? However, it seems reasonable that the dimitic hyphal system of *Phellinus* has arisen several times and that different groups of *Phellinus* have evolved independently from *Inonotus*-like species, thus making *Phellinus* a polyphyletic genus. The two genera have different life strategies. *Inonotus* has adopted a "hit and run" strategy - the basidiocarps of tropical African species at least, are rather quickly eaten, and I suspect that insect dispersal is involved. *Phellinus*, with its dimitic hyphal system has developed a "stay and endure" strategy, an adaptation to stay on and sporulate whenever possible. The cost however is high: producing a basidiocarp totally dominated by vegetative skeletal hyphae. Nevertheless, the strategy has been a success if we use the number of species as an indication (over 240, see Larsen & Cobb-Pouille 1992) as well as its ability to live wherever there are trees.

ACKNOWLEDGMENTS

G. Mueller, Field Museum, Chicago, has kindly read the manuscript and suggested linguistic improvements for which I am grateful.

RESUMEN

En la parte tropical de Africa y América se encuentran alrededor de 400 especies y 70 géneros de hongos poliporales. De estos géneros, siete son endémicos de América y tres de Africa. La cantidad de hongos poliporales causantes de podredumbre café es baja, solo un 3% en ambas zonas, comparado con un 25% en los bosques boreales de coníferas; un 13% de los poliporales en Africa son endémicos, se desconoce aún el porcentaje para América. El género *Amauroderma* tiene un endemismo de alrededor de 90% en ambos continentes, lo que contrasta con otros grupos de poliporales. En el género *Phellinus* se han comunicado alrededor de 60 especies en América tropical, de las cuales un 60% son endémicas, mientras que en Africa se han comunicado 30 especies, con un endemismo de 5%. Se ha sugerido que la razón para tales diferencias ha sido la posición aislada de América tropical, mientras que Africa se mantuvo conectada con Asia tropical a través de bosques más o menos continuos en anteriores períodos geológicos.

Larsen, M. & L. A. Cobb-Poullé. 1992. *Phellinus* (Hymenochaetaceae). A survey of the world taxa. *Syn. Fung.* 3: 1-206.

Ryvarden, L. 1982. The genus *Hydnochaete*. *Mycotaxon* 15: 425-447.

Ryvarden, L. 1985. *Stiptochaete* gen. nov. Hymenochaetaceae. *Trans. B. Mycol. Soc.* 85: 535-539.

Ryvarden, L. 1987. New and noteworthy polypores from tropical America. *Mycotaxon* 28: 525-541.

Ryvarden, L. 1991. Genera of polypores. *Syn. Fung.* 5: 1-363.

Ryvarden, L. & I. Jøhansen. 1980. A preliminary polypore flora of East Africa. *Fungiflora*, Oslo, Norway, 626 p.

Ryvarden, L. & R. L. Gilbertson. 1993-94. European Polypores. *Syn. Fung.* 6-7: 1-743.

REFERENCES

Carranza-Morse, J. 1991. Pore fungi of Costa Rica 1. *Mycotaxon* 41: 345-370.

Carranza-Morse, J. 1992. Pore fungi of Costa Rica 2. *Mycotaxon* 43: 351-369.

Carranza-Morse, J. 1993. Pore fungi of Costa Rica 3. *Mycotaxon* 48: 45-58.

Carranza, J. & J. A. Sáenz. 1984. Wood decay fungi of Costa Rica. *Mycotaxon* 19: 151-166.

David, A. & M. Rajchenberg. 1985. Porefungi from French Antilles and Guiana. *Mycotaxon* 22: 285-325.

Dennis, R.W. G. 1970. Fungus flora of Venezuela and adjacent countries. *Kew Bull. Add. Ser.* 3: 1-531.

Gilbertson, R. L. & L. Ryvarden. 1986-87. North American Polypores 1 & 2. *Fungiflora*, Oslo, Norway, 885 p.

Holmquist, O., L. Bracamonte & A. Cadenas. 1995. Poliporos (Basidiomycetes) de Venezuela I. Lista preliminar. *Rev. Forestal Latin Amer.* 17: 116-126.

Masuka, A. & L. Ryvarden. 1992. Two new polypores from Malawi. *Mycol. Helv.* 5: 143-148.