Inocybaceae and affiliated taxa from West Africa

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Abstract

Inocybaceae and affiliated taxa reported in West Africa were examined through a survey of available publications coupled with field data collections. Twenty-eight Inocyboid taxa have been reported in the region, including six species validly described in the genera *Inocybe*, *Inosperma* and *Mallocybe*. All taxonomic names have been confirmed in Index Fungorum (http://www.indexfungorum.org/names/names.asp). Among them, four taxa were synonyms of other species of Inocybaceae, Crepidotaceae or Chromocyphellaceae. Consequently, only six taxa, *Inocybe ghanaensis*, *Mallocybe africana, Inosperma africanum, I. bulbomarginatum, I. flavobrunneum* and *Pseudosperma squamatum* make the diversity of Inocybaceae from West Africa. Here the distribution of known taxa has been reported along with checklist. In addition, results of BLAST searches including any potential environmental matches (>97%) similarity is reported.

Keywords: Checklist, Ectomycorrhizal fungi, *Inocybe*, Distribution, *Pseudosperma*, West Africa

INTRODUCTION

Inocybaceae Julich, is monophyletic family and occurs worldwide. It encompasses about 1 050 species (Matheny *et al.*, 2020). Species of Inocybaceae are found in forests (from woodland, gallery or dense forests), more rarely in grasslands, wetlands or agricultural lands (Ov, 2015). Most species of Inocybaceae are ectomycorrhizal and associate with 23 families of vascular plants (Matheny *et al.*, 2020). Recently, Matheny *et al.* (2020) suggested a revised phylogeny for the family Inocybaceae. Thereafter, *Inocybe, Inosperma* (Kühner) Matheny & Esteve-Rav. and *Mallocybe* (Kuyper) Matheny & Esteve-Rav., are raised up to genera level. *Nothocybe* Matheny & K.P.D. Latha, too, has been established at the rank of a genus as *Nothocybe* whilst the former *Inocybe* sect. Rimosae (Fr.) Quél. has become the genus *Pseudosperma* Matheny & Esteve-Rav. Thus, according to Matheny *et al.* (2020), the family Inocybaceae now comprises seven genera.

Even being ectomycorrhizal, Inocybaceae is a sister family of Crepidotaceae (Matheny, 2005), that is exclusively a saprotrophic one. However, due to similarity and lack of molecular analyses, a large number of Inocybaceae species were classified in Cortinariaceae Singer (Horak, 1978; Singer, 1986, 1975). In the literature, most of the pre-molecular classifications merged not only Inocybaceae with affiliated taxa, Crepidotaceae, Tubariaceae Vizzini and Chromocyphellaceae Knudsen. The first taxonomic evaluation within Inocybaceae was based on morphological and microscopic characters for the distinction of genera earlier (Kuyper, 1986). Only relatively Jülich (1982) placed Inocybe (Fr.) Fr. in Inocybaceae together with the genus *Astrosporina* Schröt which is now known to be polyphyletic and nested within *Inocybe* (Matheny *et al.*, 2002; Matheny, 2005). Historically, many taxonomic arrangements have been proposed for *Inocybe* (Matheny *et al.*, 2002, 2020; Matheny, 2005).

Except some scarce publication (Aïgnon *et al.*, 2021; Buyck and Eyssartier, 1999; Gardens, 2017; Matheny and Watling, 2004) taxonomic documentation of the family Inocybaceae from tropical Africa is scant. About 78 taxa of Inocybaceae were sampled from Africa. Inocybaceae are less studied in West Africa and most of species, though the diversity is high. Recent mycological prospections reported numerous specimens, among them new species to science (Aïgnon *et al.*, 2021). Though taxonomic works are still progressing, it is of paramount importance to provide a state-of-art related to the divers known in West Africa, in order to establish a reference guide for detecting new species.

In this paper, we provide a checklist of known species of Inocybaceae and affiliated taxa from West Africa based on the literature, observation and field data collection between 2013 to 2018.

MATERIALS AND METHODS

Study area

West Africa includes 10 West African countries. The data sets analyzed, along with sampling trips undertaken recently are from the different countries of West Africa as outline in figure 1.

Data compilation

The data were assembled from literature related to Inocybaceae from West Africa. All scientific names have been cross-checked against Index Fungorum (IF) and synonymous names have been separated.

Data from literature were coupled with field observations. We made field surveys from 2013 to 2018. Specimens were collected in Benin (Wari Maro forest reserve, Ouémé Supérieur forest reserve, Okpara forest and Toui-Kilibo forest reserve). Additional surveys were carried out in Burkina Faso (Toussianbandougou gallery forest, Dan gallery forest and Niangoloko forest reserve), Mali (Farako forest reserve), Guinea (Kouraouletediene forest reserve, Levari forest, Baroforest reserve, Moussaya forest reserve, Haut Niger National Park, Telaya forest, Tindo forest and Ivory Coast (Kekrekouakoukro forest and Kouadianikro forest). The sampling route and sites are presented in figure 1.

RESULTS

Inocybaceae and affiliated/Allied taxa in west Africa

A significant number of species of the Inocybaceae have been reported from West Africa. In addition, it is possible now to distinguish these families due to taxonomic revisions. Several synonyms could be reported from the literature for example, *Crepidotus mollis* f. minor Bres is synonymous with *Crepidotus mollis* (Schaeff.) Staude; *Cyphellalilacina Massee* and *Cyphella variolosa* Kalchbr are also synonymous names of *Phaeosolenia inconspicua* (Sacc.) Donk. Some taxa still hold invalid names such as *Inocybe gbadjii* which is invalid name due to lack of consequent publication. Table 1 summarizes the different species of Inocybaceae as well as the affiliated taxa of West Africa. The species are mainly collected in Caesalpinioideae DC dominated forests and seem to be associated remain in association with *Afzelia africana* Sm. ex Pers. and *Afzelia bracteata* T. Vogel ex Benth in gallery forests, semi-deciduous forests and woodlands.

Existing data show that Inocybaceae species and affiliated taxa have been reported from six countries from West Africa i.e., Sierra Leone, Nigeria, Ghana, Senegal, Benin and Nigeria. Recent investigations have shown that these species are mainly found in vegetations dominated by

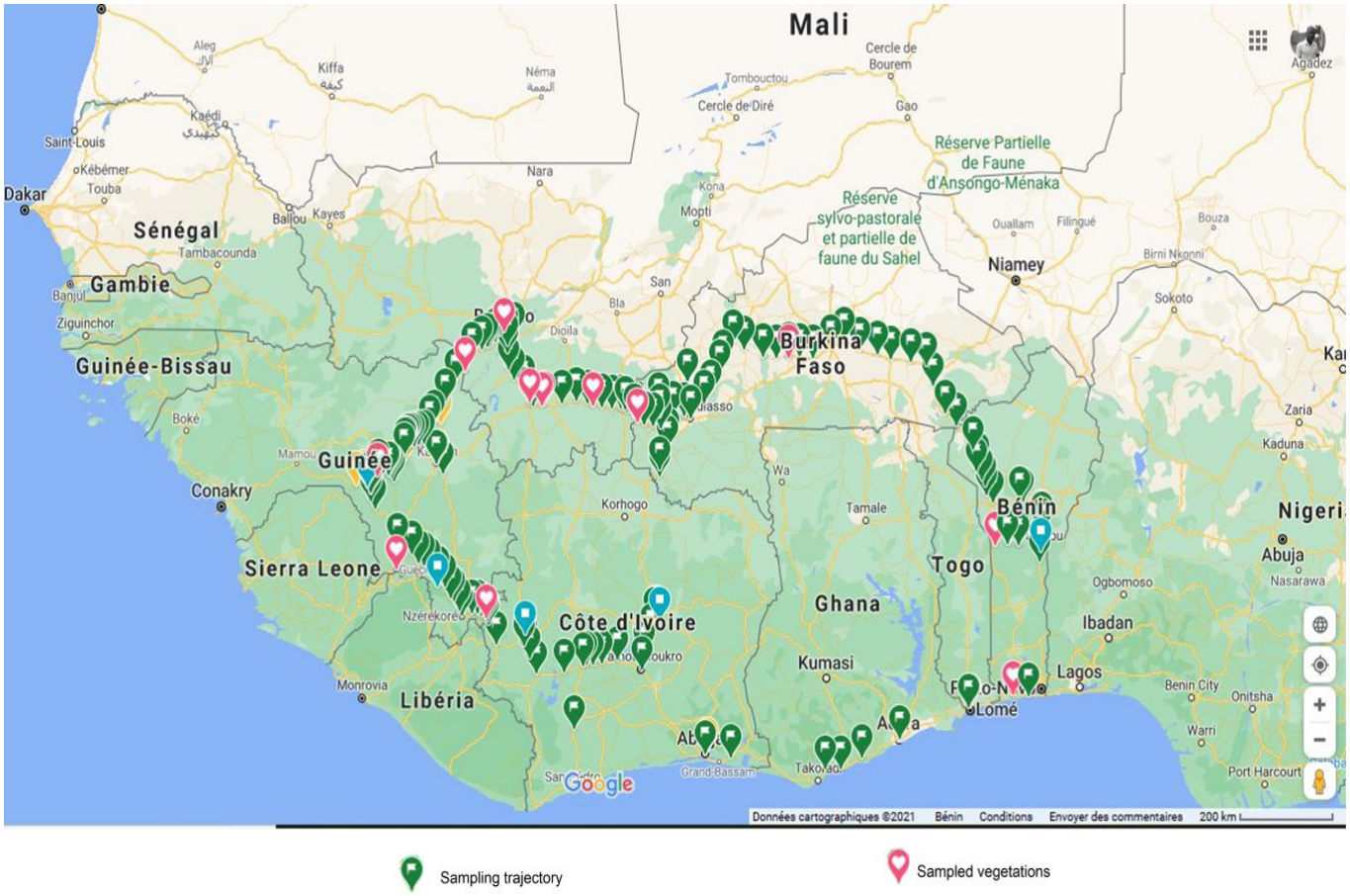

Figure 1: Map showing the studied areas

Isoberlinia doka Craib & Stapf, *I. tomentosa* (Harms) Craib & Stapf, *Uapaca togoensis* Pax, *U. guineensis* Müll. Arg., *Monotes kerstingii* Gilg and *Berlinia grandiflora* Hutch. & Dalziel. These plants are distributed in six countries of West African. At the 97% threshold, after BLAST searched at NCBI (www.blast.ncbi.nlm.nih.org), few species of *Inocybe* showed the resemblance with our species. These include the undescribed species from Zambia, *Inocybe* sp. PC96082, *Inocybe* sp. PC 96204 and *Inocybe* sp. PC 96013 which showed similarity with our West African collections.

Table 1. Checklist of Inocybaceae and allied taxa from West Africa

Family	Species	Authority	Host Plant	Distribution	Observations	References
Crepidotaceae	*Crepidotus applanatus*	(Pers.) P. Kumm.	*Adenia lobata*	Sierra Leone	Field observation: Collected from dead trunks of *Adenia lobata*	(Beeli, 1938)
	Crepidotus caspari	Velen.	-	Sierra Leone	-	(Holden, 1970)
	Crepidotus mollis	(Schaeff.) Staude	-	Nigeria	Dead decaying wood (Tree stump and fallen logs), Decay trees, Dead decaying wood (Tree stump and fallen logs)	(Beeli, 1938) (Osemwegie and Okhuoya, 2011) (Osemwegie *et al.*, 2006) (Osemwegie *et al.*, 2010)
Inocybaceae	*Inocybe beninensis*	Aïgnon, Yorou & Ryberg	*Isoberlinia doka and I. tomentosa*	Benin,	Field observations: on soil	In press
	I. flavipes	Aïgnon, Yorou & Ryberg	*Isoberlinia doka and I. tomentosa*	Benin, Togo	Field observations: on soil	In press
	I. fuscobrunnea	Aïgnon, Yorou & Ryberg	*Berlinia grandiflora*	Burkina Faso, Ivory Coast	Field observations: on soil	In press
	I. ghanaensis	Pegler	-	Ghana	Field observations: on bare soil	(Pegler, 1969) (Holden, 1970)
	I. pallidiangulata	Aïgnon, Yorou & Ryberg	*Berlinia grandiflora*	Burkina Faso, Ivory Coast	Field observations: on soil	In press
	Inocybe sp.		-	Benin	-	(Boa, 2004)
	Inocybe sp.		*Afzelia africana*	Senegal	Field observations: Appeared on lateral roots of *Afzelia africana*	(Bâ *et al.*, 2012)
	Inocybe sp.		*Afzelia bella*	Senegal	Field observation: Appeared near of *Afzelia bella*	(Redhead, 1968)
	Inocybe sp.		*Anthonotha crassifolia, Uapacachevalierie*	Senegal	Test synthesis mycorrhizae in vitro or in semi-axenic condition	(Thoen and Ducousso, 1989)
	Inocybe sp.		*Afzelia africana*	Senegal	Rootlets fixation in formaldehyde-acetic acid	(Thoen and Bâ, 1989)
	Inocybe sp.		*Afzelia africana*	Senegal	Rootlets fixation in formaldehyde-acetic acid	(Thoen and Bâ, 1989)
	Inosperma africanum	Aïgnon, Yorou & Ryberg	*Isoberlinia doka and Berlina grandiflora.*	Benin, Burkina Faso, Guinea, Ivory Coast, Togo	Field observations: on soil	In press
	I. bulbomarginatum	Aïgnon, Yorou & Ryberg	*Isoberlinia doka, I. tomentosa*	Benin,	Field observations: on soil	In press
	I. flavobrunneum	Aïgnon, Yorou & Ryberg	*Isoberlinia doka and I. tomentosa*	Benin,	Field observations: on soil	In press
	Mallocybe africana	Aïgnon, Yorou & Ryberg	*Isoberlinia doka and I. tomentosa*	Benin, Togo, Burkina Faso, Ivory Coast	Field observations: on soil	(Aïgnon *et al.*, 2021)
	P. afrofibrosum	Aïgnon, Yorou & Ryberg	*Isoberlina doka*	Benin,	Field observations: on soil	In press
	P. beninense	Aïgnon, Yorou & Ryberg	*Isoberlina doka*	Benin,	Field observations: on soil	In press
	P. fragilipes	Aïgnon, Yorou & Ryberg	*Isoberlina doka*	Benin,	Field observations: on soil	In press
	P. squamatum	(J.E. Lange) Matheny &Esteve-Rav.	-	Benin	-	(Boa, 2004)
Chromocy-phellaceae	*Phaeosolenia inconspicua*	(Sacc.) Donk	-	Ghana and Nigeria	On dead herbaceous stems	(Dade, 1940; Massee, 1901; Talbot, 1956)

DISCUSSION

Up till now, only six species of Inocybaceae, *Inocybe ghanaensis* (Pegler, 1969), *Mallocybe africana* (Aïgnon *et al.*, 2021), *Inosperma africanum*, *I. bulbomarginatum*, *I. flavobrunneum* and *Pseudosperma squamatum* (Boa, 2004) from West Africa are described, but many taxa are still out of description and need to be published like *Inocybe beninensis, I. flavipes, I. fuscobrunnea, I. pallidiangulata, Inosperma africanum, I. bulbomarginatum, I. flavobrunneum, Pseudosperma afrofibrosum, P. beninense and P. fragilipes*. However, *Inocybe* sp. "gbadjii" is registered in index fungorum but it is still unpublished data (Boa, 2004). In addition to these species there are many undescribed collections described as *Inocybe* spp. from Burkina-Faso, Guinea, Nigeria and Senegal (Bâ *et al.*, 2012; Redhead, 1968; Thoen and Ducousso, 1989) increase the diversity of Inocybaceae in West Africa to more than nineteen species. The Central and East Africa regions contain high diversity of Inocybaceae. The genus *Auritella* encompasses three species such as *Auritella hispida* Matheny & T.W. Henkel, *Auritella spiculosa* Matheny & T.W. Henkel and *Auritella aureoplumosa* (Watling) Matheny & Bougher from Cameroon, as well as two undescribed species *Inocybe* sp. TU112047 and *Inocybe* sp. TU112061 from Gabon (Matheny *et al.*, 2017, 2012). In *Tubariomyces*, there is an undescribed species *Tubariomyces* sp. 2 BB6018 (PC), from Zambia (Vizzini *et al.*, 2013). *Inosperma misakaense* (Matheny & Watling) Matheny & Esteve-Rav. is known from Zambia (Aïgnon *et al.*, 2021; Buyck and Eyssartier, 1999; Gardens, 2017; Matheny and Watling, 2004). As well, there are several undescribed species from Zambia including *Inocybe* sp. PC 96042, *Inocybe* sp. PC 96039, *Inocybe* sp. PC 96081, *Inocybe* sp. PC 96095, *Inocybe* sp. PC 96204, *Inocybe* sp. PC 96111, *Inocybe* sp. PC 96013, *Inocybe* sp. PC 96083, *Inocybe* sp. BB3233, *Inocybe* sp. BB6018 and *Inocybe* sp. PC 96073 (Matheny *et al.*, 2009).

The genera of family Inocybaceae are mostly ectomycorrhizal in nature. For example, *Anthonotha crassifolia* (Baill) J. Léonard and *Uapaca chevaleri* Beille are partner trees of some unidentified Inocybaceae species in the semi-deciduous forest of Senegal (Thoen and Ducousso, 1989), likewise for *Afzelia bella* Harms in the tropical forest of Nigeria (Redhead, 1968) and also *Afzelia africana* in wooded areas and gallery forest in Senegal (Thoen and Bâ, 1989). In addition, these ectomycorrhizal host trees are found in various vegetations such as Zambesian and Sudanian woodlands, semi-deciduous forests, Guineo-Congolean dense forests and gallery forests. The presence of Inocybaceae species in these vegetations is remarkable, and there is little doubt that other African species of *Afzelia, Anthonatha* and *Uapaca* are also ectomycorrhizal associated with *Inocybe* but it is difficult to confirm without consequent analysis.

Analysis of our recent collections have shown a wide distribution of Inocybaceae species in vegetations dominated by *Uapaca spp., Isoberlinia spp., Berlinia grandiflora* and *Anthonotha crasifolia*. These tree species are widely distributed in Benin, Burkina Faso, Guinea, and Senegal (Moyersoen and Fitter, 1999; Newbery and Stoll, 2013; Thoen and Ducousso, 1989).

The same is true for *Monotes kerstingii* often mixed with stands of *Isoberlinia* spp. (Sanon *et al.*, 1997). The species of Inocybaceae have not been sufficiently evaluated in West Africa and so there is need to study the biology and distribution of these species to determine specific host trees for conservation interventions.

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