

Inocybaceae and affiliated taxa from West Africa

Hyppolite L. AIGNON

Research Unit Tropical Mycology and Plant-Soil Fungi Interactions, Faculty of Agronomy, University of Parakou, Benin

Arooj NASEER

Department of Botany, University of the Punjab, Quaid-e-Azam Campus, Lahore, Pakistan

Azize A. BOUKARY

Research Unit Tropical Mycology and Plant-Soil Fungi Interactions, Faculty of Agronomy, University of Parakou, Benin

Nourou S. YOROU

Research Unit Tropical Mycology and Plant-Soil Fungi Interactions, Faculty of Agronomy, University of Parakou, Benin

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.

Key words: Checklist, Ectomycorrhizal fungi, *Inocybe*, Distribution, *Pseudosperma*, West Africa

Introduction

Inocybaceae Jülich, 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, Levvari 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 Masee* 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 *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.

Discussion

Up till now, only six species of Inocybaceae, *Inocybe ghanaensis* (Pegler, 1969), *Mallochybe 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 Ducouso, 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 Ducouso, 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*, *Anthonotha* 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 Ducouso, 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.

References

- Aignon H.L., Naseer A., Matheny B.P., Yorou N.S., Ryberg M. (2021). *Mallocybe africana* (Inocybaceae, Fungi), the first species of *Mallocybe* described from Africa. *Phytotaxa*, 478: 49-60.
- Bâ A.M., Duponnois R., Moyersoën B., Diédhiou A.G. (2012). Ectomycorrhizal symbiosis of tropical African trees. *Mycorrhiza*, 22: 1-29.
- Beeli M. (1938). Etude de la Flore Mycologique africaine Note sur des Basidiomycetes récoltes à Sierra Leone par F. C Deighton. *Bulletin du Jardin botanique de l'État a Bruxelles*, 15: 25.
- Boa E.R. (2004). Wild edible fungi. A global overview of their use and importance to people. *Non-Wood Forest Products*, FAO. Vol. 17, Roma, 147 p.
- Buyck B., Eyssartier G. (1999). Two new species of *Inocybe* (Cortinariaceae) from African woodland. *Kew Bulletin*, 54: 675-681.
- Dade H. (1940). A revised list of Gold Coast fungi and plant diseases. *Bulletin of Miscellaneous Information*, 1940: 205-247.
- Gardens R. B., Kew, M. B. G. (2017). The plant list. A working list of all plant species.
- Holden M. (1970). List of agarics recently recorded in Ghana. *Journal of the West African Science Association*, 15, 25pp
- Horak E. (1978). Fungi agaricini Novaezelandiae VI. *Inocybe* (Fr.) Fr. and *Astrosporina* Schroeter. *New Zeland J. Bot.*, 15: 713-747.
- Jülich W. (1982). Higher taxa of Basidiomycetes. *Bibliotheca Mycologia*, 85. Cramer, Vaduz. 485 pp.
- Kuyper T.W. (1986). A revision of the genus *Inocybe* in Europe I. Subgenus *Inosperma* and the smooth-spored species of subgenus *Inocybe*. *Persoonia*, 3: 1-247.
- Massee G. (1901). *Fungi Exotici*. III. *Bull. Misc. Inf. Kew*, 1901: 150-169.
- Matheny B., Liu Y.J., Ammirati J.F., Hall B.D. (2002). Using RPB1 sequences to improve phylogenetic inference among mushrooms (*Inocybe*, Agaricales). *American Journal of Botany*, 89: 688-698.
- Matheny P., Watling R. (2004). A new and unusual species of *Inocybe* (*Inosperma* clade) from tropical Africa. *Mycotaxon*, 89:497-503.
- Matheny P. B. (2005). Improving phylogenetic inference of mushrooms with RPB1 and RPB2 nucleotide sequences (*Inocybe*; Agaricales). *Molecular phylogenetics and evolution*, 35: 1-20.
- Matheny P.B., Aime M.C., Bougher N.L., Buyck B., Desjardin D.E., Horak E., Kropp B.R., Lodge D.J., Soyong K., Trappe J.M., Hibbett D.S. (2009). Out of the Palaeotropics? Historical biogeography and diversification of the cosmopolitan ectomycorrhizal mushroom family Inocybaceae. *Journal of Biogeography*, 36: 577-592.
- Matheny P.B., Henkel T.W., Séné O., Korotkin H.B., Dentinger B.T.M., Aime M.C. (2017). New species of *Auritella* (Inocybaceae) from Cameroon, with a worldwide key to the known species. *IMA Fungus*, 8: 287-298.



- Matheny P.B., Hobbs A.M., Esteve-Raventós F. (2020). Genera of Inocybaceae: New skin for the old ceremony. *Mycologia*, 112: 83-120.
- Matheny P.B., Pradeep C.K., Vrinda K.B., Varghese S.P. (2012). *Auritella foveata*, a new species of Inocybaceae (Agaricales) from tropical India. *Kew Bulletin*, 67: 119-125.
- Moyersoen B., Fitter A.H. (1999). Presence of arbuscular mycorrhizas in typically ectomycorrhizal host species from Cameroon and New Zealand. *Mycorrhiza*, 8: 247-253.
- Newbery D.M., Stoll P. (2013). Relaxation of species-specific neighborhood effects in Bornean rain forest under climatic perturbation. *Ecology*, 94: 2838-2851.
- Osemwegie, O. O., Eriyamremu, G. E., Abdulmalik, J. (2006). A survey of macrofungi in Edo/Delta region of Nigeria, their morphology and uses. *Global Journal of Pure and Applied Sciences*, 12: 149-157.
- Osemwegie O.O., Okhuoya J.A. (2011). Diversity and abundance of macrofungi in rubber agroforests in southwestern Nigeria. *Nordic Journal of Botany*, 29: 119-128.
- Osemwegie O.O., Okhuoya J.A., Oghenekaro A.O., Evueh G.A. (2010). Macrofungi community in rubber plantations and a forest of Edo State, Nigeria. *Journal of Applied Sciences*, 10:391-398.
- Ov P. (2015). *Inocybe* (Agaricales, Basidiomycota) in Kharkiv forest-steppe, Eastern Ukraine. *Current Research in Environmental & Applied Mycology*, 5: 408-417.
- Pegler D.N. (1969). Studies on African Agaricales: 2. *Kew Bull.*, 23: 219-249.
- Redhead J.F. (1968). Mycorrhizal associations in some Nigerian forest trees. *Transactions of the British Mycological Society*, 51: 377-387.
- Sanon K.B., Bâ A.M., Dexheimer J. (1997). Mycorrhizal status of some fungi fruiting beneath indigenous trees in Burkina Faso. *Forest Ecology and Management*, 98: 61-69.
- Singer R. (1986). *The Agaricales in modern taxonomy*, 4th Edition. Koeltz Scientific Books, Koenigstein, 981 pp
- Singer R. (1975). *The Agaricales in modern taxonomy*, 3rd Edition. J. Cramer, Vaduz, 912 pp.
- Talbot, P. H. B. (1956). New and Interesting Records of South African Fungi. *Bothalia*, 6: 489-499.
- Thoen D., Bâ A.M. (1989). Ectomycorrhizas and putative ecto-mycorrhizal fungi of *Azelia africana* Sm and *Uapaca guineensis* Mull. Arg. in southern Senegal. *New Phytol.*, 113: 549-559.
- Thoen D., Ducouso M. (1989). Champignons et ectomycorhizes du Fouta Djallon. *Bois et Forêts des Tropiques*, 221: 45-63.
- Vizzini A., Della Maggiora M., Tolaini F., Ercole E. (2013). A new cryptic species in the genus *Tubariomyces* (Inocybaceae, Agaricales). *Mycol. Progress*, 12: 375-381.

References