

The status of mycology in Africa: A document to promote awareness

Marieka Gryzenhout^{1*}, Joyce M. Jefwa², and Nourou S. Yorou³

¹Department of Plant Sciences, University of the Free State, Bloemfontein, South Africa, 9301; Corresponding author email: Gryzenhoutm@ufs.ac.za

²International Centre for Tropical Agriculture (CIAT), P.O. Box 823-00621, Nairobi, Kenya

³Faculty of Agronomy, University of Parakou, BP 123, Parakou, Benin

Abstract: The African Mycological Association (AMA) promotes mycology amongst members in Africa and globally. The AMA has about 200 members, mostly from African states but also with strong representation from Europe and USA, amongst others. Recent efforts by members of the AMA focused on reviving and developing mycological research and networking in Africa. A great deal must, however, still be done to promote the AMA under African mycologists, and those elsewhere with interests in Africa. African mycologists also experience challenges typical of the developing world and a great deal of fungi still needs to be discovered. This can also be seen as representing great opportunities for research and collaboration. Several issues pertinent to mycology in Africa were discussed during Special Interest Group sessions of the 9th International Mycological Congress in 2010, and through several opinion pieces contributed by AMA members in the AMA newsletter, *MycAfrica*. This contribution serves as a document to summarise these in a form that can be presented to fellow mycologists, biologists and other scientists, relevant government departments, funding bodies and Non-Governmental Organizations and that pins down the importance of mycology, the status thereof in Africa and the need to promote it more.

Key words:

Africa
challenges
mycology
opportunities
threats
uses

Article info: Submitted: 27 May 2012; Accepted: 12 June 2012; Published: 27 June 2012.

THE IMPORTANCE OF FUNGI CONTRASTED TO THE LIMITED CAPACITY TO STUDY THEM

In the wide and diverse field of biology, it is necessary to study fungi. Fungi are an incredibly speciose, and biologically and morphologically diverse group, with estimates indicating at least a predicted 1.5 million species on Earth. Some of these fungi are visible to humans as larger fungi, such as mushrooms, but others are microbial with incredibly high numbers of species and individuals present in any substrate on earth, for instance soil, water, air, or in dead or living plants. They exist as saprotrophs that break down organic material, parasites causing diseases, and various types of symbionts of all types of larger organisms. It is evident that fungi play an irreplaceable role in the ecology and micro-ecology of any ecosystem, and contribute to the health of living organisms in either a positive or negative way. More directly in the lives of humans, fungi play an incredibly important role as sources of food or in processing food, novel sources of industrially important enzymes and compounds, human, animal and plant pathogens, spoiling or contaminating food with mycotoxins, agents for biological control, and ecological indicators.

In Africa that is endowed with high biodiversity and unique but vulnerable ecosystems, mycology is an endangered discipline. Fungal components of any ecosystem are seldom characterised and almost never included in biodiversity data. Proper fungal inventories and databases are largely non-existent, while those that exist contain only scanty and basic

information. Due to the lack of human capacities, national monographs of biodiversity in many African countries rarely encompass fungi. This not only leads to an unfortunate bias in the complete assessment of biodiversity, but also pertains to the unawareness of public and decision makers of fungi as important organisms. Needless to say fungal biodiversity does not feature in biological checklists and red data listings of countries.

The problem is worsened due to large numbers of new taxa still awaiting description and numerous areas and niches that are unexplored. In South Africa alone, over 171 000 fungal species are estimated to exist based only on the modest assumption that an average of seven new fungal species are associated with each of the plant species known (Crous *et al.* 2006). Of these, only 780 represented new species (Crous *et al.* 2006). In Egypt, only 4.6% of the recorded fungi were newly described (Abdel-Azeem 2011). This dilemma is largely compounded by an enormous lack of human capacity and resources.

Africa is third-world with numerous typical problems such as poverty and overpopulation. These have put excessive pressures on the environment and also on already limited food sources, compounded by threats of plant pathogens and pests. Livestock and humans are equally threatened by fungal diseases or fungal toxins. Even for quarantine purposes against plant pathogens, comprehensive lists of pathogens do not exist for most African countries. Despite these threats, the study of pathogenic fungi is also generally

© 2012 International Mycological Association

You are free to share - to copy, distribute and transmit the work, under the following conditions:

Attribution: You must attribute the work in the manner specified by the author or licensor (but not in any way that suggests that they endorse you or your use of the work).

Non-commercial: You may not use this work for commercial purposes.

No derivative works: You may not alter, transform, or build upon this work.

For any reuse or distribution, you must make clear to others the license terms of this work, which can be found at <http://creativecommons.org/licenses/by-nc-nd/3.0/legalcode>. Any of the above conditions can be waived if you get permission from the copyright holder. Nothing in this license impairs or restricts the author's moral rights.

neglected despite their importance, and again limited and pressured human and resource capacity exist to address this.

Mycology presents vast opportunities to address the various challenges in Africa. Sustainable ethnomycology provides valuable food and medicines and conserves such knowledge (e.g. Lowore & Boa 2001, Bloesch & Mbago 2008). The cultivation of mushrooms on waste products such as straw is practised in numerous rural communities and provides valuable sources of protein and income. Africa's fungal biodiversity represents potential opportunities to develop valuable products or by-products to address third world environmental and food security related problems, or to discover biological control methods to combat diseases.

CAPACITY - WHAT ARE THE NEEDS AND RESOURCES FOR MYCOLOGY

Mycology is a diverse biological field. It can be broadly divided into medical mycology, food mycology, industrial mycology, aspects of plant pathology, symbioses, ecology, biodiversity, and systematics, with numerous overlaps between fields and expertise. Specific needs and processes for each of these fields may differ. However, the following broad activities underlie each.

Specific fungi need to be collected and isolated using the specialised techniques known for the different groups of fungi and for different fields of mycology, unless these are obligate parasites that cannot be cultured. Collecting trips largely involve the same procedures as those for other organisms, but for many groups of fungi, a great deal of additional effort is necessary to first isolate and purify these fungi in culture before identification can be attempted. Whereas the larger fungi, such as mushrooms, are more tangible and countable, it is especially these cultured fungi that are more numerous but difficult to comprehend by non-mycologists. Furthermore, even with the larger fungi, the absence of fruiting bodies does not necessarily imply the absence of the fungus, but are merely tied to the absence of special environmental conditions conducive to the production of fruiting bodies.

Ideally, living isolates and biologically inactive herbarium specimens of fungi should be preserved in culture collections and herbaria, respectively, where these will continue to be available for study by other mycologists. The needs to do this are quite different from those of preserving various types of animals and plants, and in general are more costly, labour and time intensive, and specialised. Sadly, very few such official collections exist, while large numbers of these fungi are kept in private research collections under immense financial pressure and largely linked to the presence of the particular researcher or the particular research project.

Various steps of identification and special expertise are necessary to either identify known fungi, for instance in the case of pathogens where the correct identity is vital, or to be able to obtain a sensible designation for unknown fungi. Such identifications are often very difficult due to the large degree of variation in the fungal kingdom, the specialization and techniques required to identify different groups, and limited human expertise. Even internationally, fewer mycologists and funding are available to actually identify and describe new fungi.

Several specific needs and resources have been identified for mycology in Africa, although these may by no means be unique to this continent. Physical needs such as funding and infrastructure are quite delimiting, and both are usually necessary for sustainable research. Even with increasing interest from global funding organizations in Africa, mycologists usually have to compete with other biologists working with more understandable and visible organisms. Resources such as checklists are lacking. Whereas physical needs can be met, human needs such as support by experts and mentors to provide guidance and training, and available students interested and funded to do projects, are more difficult to meet. Experts willing to assist in identifications and coaching are difficult to find, usually overloaded themselves, and are often not on the African continent.

THREATS TO FUNGI IN AFRICA

The same problems existing in Africa affecting diversity and numbers of animals and plants, apply to fungi. These problems include slash and burn, overgrazing, alien plant invasions, reforestations with non-native trees, encroachment, fragmentation, poor land management, degradation, and transformation (Gryzenhout *et al.* 2010, Ngala & Gryzenhout 2010). However, the difference is that fungi are not at all included in any such assessments, nor are the effects and impact on these fungi known. Their diversity and functionality are understudied, and hence the impact of anthropogenic activities is unknown and the need for conservation overlooked. The invasiveness of non-native fungi is seldom studied, except for plant pathogens proven to be introduced, and the displacements of native fungi are thus unknown.

Numbers of microfungi and larger, visible fungi are disappearing without being noticed. Due to pressures to produce food, indiscriminate spraying of especially non-selective fungicides by farmers is detrimental to fungi occurring on non-agricultural crops. Africa prizes a number of local edible mushrooms, such as species of the truffle genus *Terfezia* and chanterelles (*Cantharellus*), but these are occasionally overharvested or traded illegally. The loss of habitat due to deforestation for settlement and cultivation in Africa is alarming and associated with the loss of local fungi. Furthermore, trees are destroyed for firewood, the making of charcoal, timber, and tourist ornaments, and thus the fungi occurring with them as natural pathogens or endophytes inside plant tissues, also disappear. Numerous fungal taxa are thus undergoing threats of extinction, along with their symbiotically associated plant species and generally in small sized hotspots. A recent Red List of threatened larger fungi of Benin totaling 30 species within two hotspots (Yorou & De Kesel 2011), gives evidence of the impact of human activities on fungal biodiversity and the need to elaborate ecosystems-based conservation strategies.

Africa has a rich tradition of ethnomycology that has not yet been documented in most parts. The traditional knowledge and practices are, however, declining from one generation to another, with older generations often still remaining the sole custodians. Simultaneously, a number

of negative or ignorant perceptions also exist, often among the public, other biologists or in government circles. These factors are compounded by poverty, land allocation, and land use practices, which usually take preference above the need to also study fungi.

The lack of capacity in mycology is due to several challenges. While funding is already difficult to obtain, funding for basic mycology is even scarcer, and can usually only be obtained for applied projects in fields where fungi play an important role, such as plant pathology, food microbiology, bioactive compounds, and/or applications in forest regeneration. Herbaria and living culture collections are battling to maintain high standards or even to survive, due to lack of interest for investment and scarcity of funds. The large numbers of cultures also housed in private culture collections and that are carried by research funds and the dedication of the particular researchers, are also under threat. These collections are in danger of being lost when these funds become unavailable or the researchers discontinue their work. Such private collections are not sponsored by government or other funding bodies.

Whereas institutes and research programmes with state-of-the-art infrastructure, capacity and excellence do exist in some African countries, these are usually absent. Training of new or practising mycologists is thus difficult. All of these issues are usually the reasons for the “brain drain” of talented mycologists to other continents, from which some never return.

There is a general consensus that there should be more scientific input by mycologists in political issues. This is difficult due to a lack of interest and ignorance in government, biodiversity, conservation, and public circles. Legislation and permits are often very difficult for fungi due to ignorance of the special needs of mycologists and the lack of general checklists, and these processes are also often coupled with corruption by officials. Political upheaval is a reality in many African countries, making the practice of any science difficult. Moreover, inner politics within scientific communities are also debilitating for significant progress and large scale projects. Often there is also a lack of collaboration and communication with other mycologists.

MANY OPPORTUNITIES IN AFRICA

The rich and unique biodiversity of Africa and indigenous knowledge systems present numerous opportunities for fungal bio-exploration, characterization of species, bio-prospecting, and potential downstream applications paired with capacity building. For fungi, this biodiversity is virtually untapped. Unlike the more developed, Northern Hemisphere countries with their extensive histories of mycology, Africa in a sense can start with a clean slate with not too many problems, such as taxonomical ambiguities, to first resolve. The majority of biodiversity data can also immediately be fed to the current global biodiversity initiatives and need not be harvested first from previous and extensive lists. Metagenetic approaches such as direct environmental sequencing or the use of other biochemical or molecular typing techniques of microbial communities, also present novel techniques to

investigate these communities, albeit these are usually costly.

Although numerous challenges exist, incredibly talented, passionate and diverse mycologists are practising their science with few resources, and often at an international level. A number of international centres of expertise already exist within some African countries. Much of this is achieved through a system of African and global connections and collaborations. Such expertise is actually playing a pioneering role to perpetuate mycological research and teaching locally. One most important but discrete opportunity is that numerous local students can be motivated and engaged to make a career in mycology, as fungal science is perceived to be a new and promising biological field for them. Numerous students also do their pre- and postgraduate studies at African centres or abroad, and often at acclaimed research groups where they actually act to promote mycology (brain gain) and, if they return, the expertise they gained is brought back (brain circulation). In some African countries, emerging good will towards biological sciences also may include more opportunities for mycology.

Several initiatives already exist in Africa to promote awareness of fungi. The use of ethnomycology is promoted under communities in attempts not to lose those skills and knowledge, and these are useful initiatives to show the value of mycology for government officials and funders. A number of groups for communities and amateur mycologists are driven by individuals or groups of mycologists, who are usually already pressured. These are essential to nurture interest in this poorly represented field or to promote awareness of the importance of including fungi in biodiversity and conservation initiatives. These groups often include biologists from other disciplines, non-governmental organizations (NGO's), nature conservationists, and from government, and thus play the important role of promoting mycology in the broader scientific community and disseminating interesting, useful or essential data.

CONCLUSION

When building a discipline on a continental scale, several things are essential. These include leading research, to promote the particular field of science across general scientific fields, to attract students with pertinent and stimulating teaching and research projects, and to build capacity through post-graduate training. Due to relatively limited capacity in Africa, strong ties must be sought and fostered with international collaborators, institutions and societies.

A choice must be made if mycology in Africa is to grow stronger and become more prominent, or if it will merely continue to exist. Strong and continued action with clear goals will be necessary to build mycology in Africa, and these must not be from a few individuals, but from numerous people and teams. Common goals for groups of mycologists from several countries may be a way to stimulate this.

In the open world we live in today, numerous ways of communicating, networking and collaborating is possible. Novel, different ways of doing things must be sought if current systems are not working. Ways must be found to reward passion and energy. This is especially true to retain young

talent and to enable it to become able mycologists. Ways must be sought to solve the challenges. These are difficult, but if even one of these challenges can be addressed and a solution established, it will make it possible to solve the next challenge and do more in future. For these, continuous advice is needed from fellow mycological societies, experienced mycologists, and those outside the field of mycology.

ACKNOWLEDGMENTS

We thank the various contributors to the "Opinion" features of the official newsletter of the AMA, *MycoAfrica* [vol 2(4), vol. 3 (1, 2, 4), vol. 4 (1, 2); www.africanmycology.org], for their views and stimulating further discussions. These include Levi Yafetto, Rosemary Tonjock (University of Buea, Cameroon), George Ngala (Bamenda University of Science and Technology, Cameroon), Jo Taylor (National Botanical Garden of Edinburgh) and Jonathan Jansen (Rector, University of the Free State, South Africa). Features published in the various issues of *MycoAfrica* also contributed to the content of this commentary and include various useful references. Referencing for this commentary was thus deliberately not comprehensive. We are also thankful to the Organising Committee of the 9th International Mycological Congress for presenting the AMA with an opportunity to have a stimulating session on mycology in Africa.

REFERENCES

- Abdel-Azeem AM (2011) The history, fungal biodiversity, conservation, and future perspectives for mycology in Egypt. *IMA Fungus* 1: 123–142.
- Bloesch U, Mbago F (2008) *The potential of wild edible mushrooms in the miombo woodlands of the Selous-Niassa Wildlife Corridor for the livelihood improvement of the local population*. Commissioned by the Deutsche Gesellschaft für Technische Zusammenarbeit and the Association for the Development of Protected Areas.
- Crous PW, Rong IH, Wood A, Lee S, Glen HF, Botha W, Slippers B, De Beer ZW, Wingfield MJ, Hawksworth DL (2006) How many species of fungi are there at the tip of Africa? *Studies in Mycology* 55: 13–33.
- Gryzenhout M, Roets F, de Villiers R (2010) Fungal conservation in Africa. *Mycologica Balcanica* 7: 53–58.
- Lowore J, Boa E (2001) *Bowa markets in Malawi: Local practices and indigenous knowledge of wild edible fungi*. Egham, UK: CAB International.
- Ngala GN, Gryzenhout M (2010) Biodiversity and conservation in Cameroon. *Mycologica Balcanica* 7: 65–72.
- Yorou NS, De Kesel (2011) Larger fungi. In: *Nature Conservation in West Africa: Red List for Benin* (P Neuenschwander, B Sinsin & G Goergen, eds): 47–60. Ibadan: International Institute of Tropical Agriculture.