Fungi at the Kafa Biosphere Reserve

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Highlights

- → This is the first time a mycological survey has been conducted in the Kafa area.
- → Nearly 350 species of fungi were recorded, but most were identified as morphospecies or could only be determined at the genus level.
- → At least 30 species are new to Ethiopia, but this number may increase to more than 100 after all collections have been analysed.
- → At least three species are already known to be new to science (*Ascocoryne kafai* ined., *Cerinomyces bambusicola* ined., *Coniolepiota kombaensis* ined.), but this number will most likely increase, at least in some genera of the Agaricales (*Cystolepiota, Entoloma, Psathyrella*) and Xylariales (*Hypoxylon* s. l.) orders.
- → Two species are probably endemic to Ethiopia (*Cerinomyces bambusicola* ined., *Sarcoscypha* spec. nov. ined.).
- → Many of the species are endangered by biotope loss, as they are believed to be confined to natural montane rain forests. The exact number cannot be estimated due to lack of comparative data.
- → The bamboo forest seems to be home to several endemic species, but more studies are needed to confirm this.
- → Compared to the wetlands and bamboo forests, the montane forests (coffee forests) at 1700 to 2000 m a.s.l. seem to be the most species-diverse biotope.
- → *Sarcoscypha javanensis* and *Coniolepiota kombaensis* ined. could be a good indicator species for the status of natural montane cloud forests. *Cerinomyces bambusicola* ined. could serve as an indicator species for habitat quality in the bamboo forests. Finally, *Dentipellis fragilis* is an indicator for undisturbed forests in general.

1. Introduction

Knowledge of fungi in tropical regions worldwide is very limited compared to the Mediterranean and boreal regions of the Northern hemisphere. Several scattered inventories exist for certain countries and areas, usually in the form of a commented list of fungi found over a number of years. However, there is currently no single publication offering deeper insight into the ecological needs of tropical fungi or the decline or increase of certain species and the reasons for such developments. Therefore, it is almost impossible to assess the status of most species in terms of being endangered, declining or as possible indicator species for natural and/or endangered habitats.

There are two older publications related to Ethiopia. The first is a checklist by Castellani & Cifferi (1938; 1950), who mainly collected in areas around Addis Ababa, the southeast and in Eritrea. The data from the western part of the country originates from Jimma. More recently, Hjortstam & Ryvarden (1996) listed some polyporoid and corticioid fungi, which provided the first step towards the recently published preliminary checklist of wood-inhabiting fungi in Ethiopia by Bitew & Ryvarden (2011). They collected at Lake Tana, in the Bale Mountains and in central Ethiopia. Lindemann collected in Ethiopia several times, beginning in 2008, but most of his records have not yet been published, nor is there a species list.

Further collections from Ethiopia are integrated into publications on the fungus flora of Eastern Africa, e.g., by Dring & Rayner (1967, gasteromycetes), Ash (1976, several agarics and gasteromycetes), Pegler (1977, agarics), Ryvarden & Johansen (1980, polypores) and Hjortstam (1983, 1987, corticoid fungi). Very few scattered data from Ethiopia can be found in contributions by Hennings (1901; 1904; 1905), but his identifications and descriptions should be viewed with a certain caution.

None of the publications listed above cover the Kafa region. The NABU assessment in December 2014 is the first time fungi have been researched in this area and in the Kafa BR. The assessment in the Kafa BR was carried out during the first two weeks of December, three months after the main rainy season. This explains the nearly complete lack of terrestrial fungi, and it was not surprising to find that 95% of all fungi found were growing on wood or plant debris. Terrestrial fungi were only found in the flood plains along the riverbanks of the Gummi River. Nevertheless, an interesting range of fungi was found in the forests, as the moist nights and limited rainfall during one day of the assessment helped keep the biotopes from drying out too much.

In the wetlands, the search for fungi was limited to two sample sites, both of which were very unsuccessful. The wetlands are either too wet for fungi (flooded areas), or intensely grazed by cattle, making it impossible for terrestrial fungi to develop. No fungi were found colonising dead remnants of grass or herbs lying on the wet ground. This is because grazing doesn't leave much dead plant material and the wetlands are disturbed by the hooves of cattle.

Fungal communities were expected to be similar across the different forests, even forests at different altitudes. Species composition is affected by the composition of the trees and plants in the forest, the development of the forest understory and above all the moistness of the ground far more than altitude. In this respect, the bamboo forests are an unusual biotope, being home to many species which do not occur in other habitats. However, this is probably because no terrestrial fungi were found, limiting the listing almost entirely to fungi growing on dead parts of bamboo stems or leaves, which are hardly likely to be found in other forest types.

In general, all forests in Kafa are threatened by intervention in various regards. Deforestation causes the most severe change in habitat, and will lead to an almost total loss of forest-inhabiting fungi. Management (removal) of the understory to stimulate the growth of young coffee plants, as performed in Participatory Forest Management (PFM) sites, will reduce species diversity. Forest fragmentation by infrastructure such as roads or partial deforestation leads to an unfavourable change in the microclimate, not only near the disturbed sites but also deep within the forest itself.

2. Materials and Methods

2.1 Study area

Fungi sampling was mainly carried out in forest sites, as the wetlands were found to be nearly free of fungi. The following areas were studied, sometimes in multiple locations:

Table 1: Sampling sites of the fungi assessment at Kafa BR

Code	Sites	Habitat	Altitude (m a.s.l.)	Coordinates	No. of sites
AW	Awurada Valley (Gummi River)	Riverine vegetation	1400	7° 05' 18.0" N 36° 13' 05.9'' E	1
AW	Awurada Valley (PFM sites)	Montane forests	1500-1900	7° 05.146' N 36° 12.468' E	1
BA	Bamboo forest	Bamboo forests	2600	7° 14.610' N 36° 27.388' E	2
BK	Boka Forest	Bamboo forests	2450	7° 17.711' N 36° 22.555' E	1
BO	Boginda Forest	Montane forests	1950	7° 30.30' N 36° 06.42' E	1
KO	Komba Forest	Montane forests	1970	7° 18' 32" N 36° 5' 11" E	2
KO	Komba Forest	Montane forests	1900	7° 18' 26" N 36° 3' 31" E	1
KO	Komba Forest	Montane forests	1900	7° 18' 45" N 36° 2' 40" E	1
MA	Mankira Forest	Montane forests	1700	7° 12' 151" N 36° 17' 012" E	2
SHO	Shoriri Forest	Montane forests	1700	7° 30' 486" N 36° 12' 538" E	1
--- [1]	KDA Guesthouse	Garden	1800	7° 36' 10" N 35° 59' 59" E	
--- [1]	Gojeb River, near Saja	Riverside	1600	7° 26' 11" N 36° 22' 4" E	

[1] In addition to the regular sampling sites, a few fungi were recorded around the KDA Guesthouse in Bonga and by the Gojeb River near Saja. These are not included in the analyses because no standardised sampling was carried out in these two locations.

2.2 Sampling methods

Fungus sampling for the NABU assessment was carried out by collecting fruit bodies visible in the field. No cultures of soil, leaves or other material were created during this field work, and no soil or root samples were collected for further DNA analysis. Even the few dung fungi found were already fruiting in the field and were not obtained via moist chamber culture, as is often the case.

In the field, sampling was conducted using a time-standardised search method. Each location (sampling site) was searched by three people (ranger, field guide and the author) for one hour by sight. The search area was not delimited – the collectors were free to search wherever they chose in the sampling site. In an unpublished study (Siemianowski pers. comm.), sampling to saturation in small plots of standardised size did not produce better results than sampling for the same time in larger and non-standardised areas. Based on this result, the more easily applied time-standardised method was used in Kafa.

Sampling smaller plots to saturation presupposes the previous evaluation and installation of representative plots in each location, which could not have been carried out in the short time available for our assessment. An exception to the "one hour per location" method was granted for the two bamboo forest sites, as these were harder to search. Collection time here was extended to two hours. In addition, Excursion 4 in Komba Forest is not included in the analyses, because the goal was to search for particular species rather than a general search for fungi as in the other excursions.

All fungal species found were collected in the necessary quantity and stored in numbered plastic boxes. If possible, the host was noted. In some cases photos were taken on-site, but light conditions were usually unfavourable. Sufficient sample material was collected to have extra to share with the authorities in charge and the herbarium at the University of Addis Ababa and to send to specialists where necessary. Some material was also kept back in case of future DNA analysis. No collections were determined macroscopically in the field – all fungi were sampled and verified via microscopic examination.

On returning to the camp, the day's samples were dried within a few hours, as many fungi begin to mould soon after collecting. Wherever possible, the fresh material was examined microscopically on the day of collection. An Olympus CH2 microscope and Breukhoven 125 stereo microscope were used for this purpose. The dried collections were split in two (one for the University of Addis Ababa, one for the author) and stored in airtight plastic bags.

2.3 Data analysis

The collected fungi were usually identified by microscopically examining the dried samples, which were properly prepared and exported following the regulations laid out by the Ethiopian Biological Institute (EBI). Half of each collection was exported to Germany, to continue the identification process and complete the species list. This standard, albeit somewhat inefficient, practice of determining species by comparing the microscopic details with the descriptions in scattered literature about tropical fungi from all parts of the world was sped up in some cases through collaboration with specialists in certain genera or other mycologists involved in researching tropical fungi (see list below). In several cases, DNA analyses have and will still be performed to receive a determination at the species or genus level. These analyses are carried out by Bálint Dima (Corvinus University, Budapest). In general, the ITS1 and ITS2 loci are used for fungi, although in some cases the LSU or rpb1 loci can also be of help. The obtained sequences will be matched against sequences in the GenBank database and/or with unpublished sequences acquired from specialists. The following mycologists collaborated in identifying parts of the collection:
Baral, H-O (Eberhard-Karls University, Tübingen); Lecuru, C (University of Lille); Lindemann, U (Ruhr-University Bochum); Melzer, A (Neukyhna); Ryvarden, L (University of Oslo); Stadler, M (Braunschweig Technical University); Vellinga, E (University of California, Berkeley); Forum AscoFrance.

Analysis of the species diversity and quality of the different sites can only be done with great restraint, as no comparative data is available for monitoring in tropical regions. Thus, while the sites visited in Kafa BR can be compared with each other to a certain extent, comparison of the whole area with other tropical areas is impossible. Nevertheless, some initial generalisations can be made (see Section 3.1).

3. Results and Discussion

3.1 Estimated species richness and diversity

Due to the small amount of data collected in this assessment, it is not possible to analyse species richness or diversity. At least 10 years of yearly monitoring at different times of year is necessary to be able to estimate the number of species in the selected forests. Even then it would be difficult to compare results, as there is no data from standard palaeotropical inventories, only scattered surveys for certain parts of tropical Africa. The work conducted by Einhellinger on a continental calcareous heathland biotope near Munich, Germany, exemplifies how time consuming fungal assessment can be. Einhellinger investigated this area for 25 years, making excursions at least every 14 days. After 10 years of inventories he had only found approximately 60% of the species he eventually recorded throughout his 25 years of research.

Bitew & Ryvarden (2011) mention approximately 250 species in their checklist of wood-inhabiting fungi, collected in several different sites in central and southeast Ethiopia since 1998, both in afromontane dry forests and montane cloud forests. In comparison, the approximately 300 to 350 different species we recorded in our 10-day fieldwork show a very high level of species richness in the montane cloud forests of Kafa. However, it must be admitted that only 50 of the 350 different species have been determined to date, and it is expected that only 150 to 200 will be determined in future. Still, this is nearly as many in 10 days as Bitew & Ryvarden (2011) collected over 12 years at different times of year and in more diverse biotopes. Therefore, we can at least conclude that the montane rainforests of Kafa exhibit exceptionally high species diversity and warrant further research.

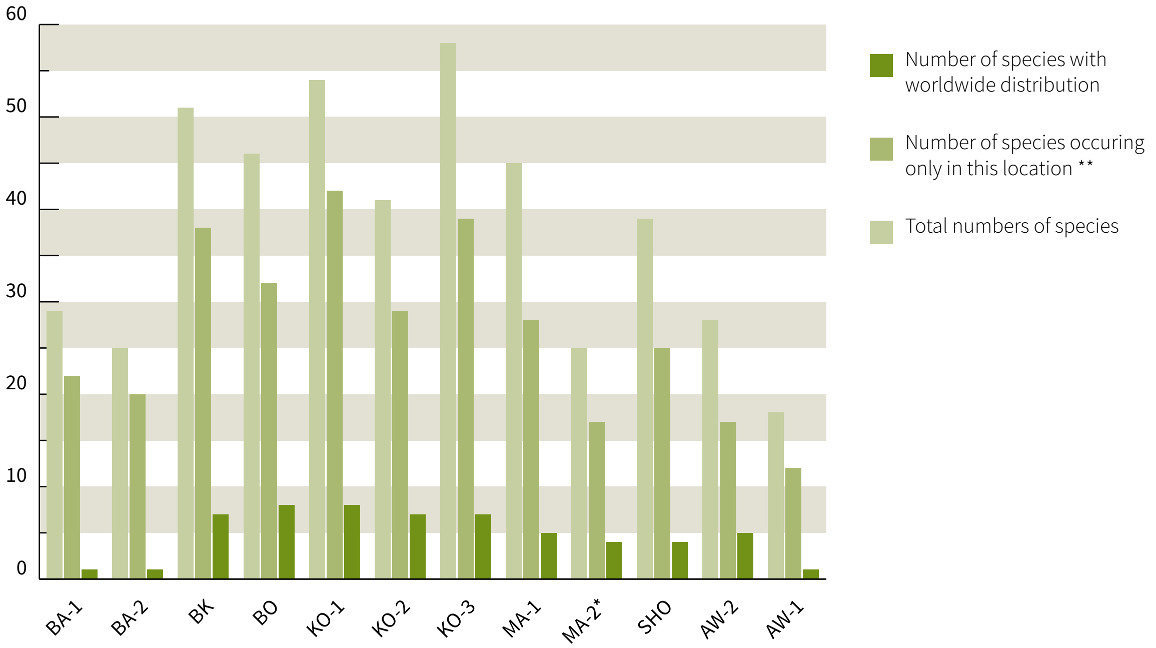

Figure 1: Species richness and composition of visited locations. * The low number of species in MA-2 is due to a) the loss of an excursion box containing approx. 10-12 collections and b) there being only two researchers there instead of the usual three. ** The inventories for BA-1, BA-2, KO-1, KO-2 and KO-3 were only compared to the inventories of the other areas, not with the excursion at the locations themselves.

Figure 1 shows that the montane cloud forests are home to significantly more species than the pure bamboo forests (BA-1, BA-2), the floodplain forest and the PFM site (AW-2). Site BK, at 2500 m a.s.l., which is split between bamboo forests and montane cloud forests, has the same high species diversity as the montane cloud forests at 1700 to 2000 m a.s.l., which supports the theory that differences in altitude are a much less important factor in species richness than differences in habitat.

3.2 Species composition

Identifying a constant, defined fungus community in a particular biotope requires many years of intense fieldwork. It is not possible to make even broad guesses about the typical species composition in certain biotopes. This is corroborated by the data from the three excursions in Komba Forest. Although the three locations were close to each other (approximately 1-2 km apart) and the research excursions were conducted within six days of each other, only seven of the 129 species found occurred in all three locations. Ten species were found in two of the three locations and nearly 90% were found in only one location. This suggests a high number of microhabitats across the three locations, although sites BO-1 and BO-2 looked superficially very similar. As fungi are often adapted to very narrow ecological niches, a high number of microhabitats will usually result in a high level of species diversity.

Nevertheless, two interesting results emerge when comparing the species composition of different locations. The first is that bamboo forests (e.g., BA-1) have more species unique to this biotope (see Figure 2). The second is that the number of species with worldwide distribution is very low (see Figure 3). Both results indicate the uniqueness of this biotope with regards to fungi. In addition, a comparatively high percentage of endemic fungi can be expected in the bamboo forest, not only because most of the species found there are obviously confined to bamboo as host, but because it seems they are also confined to the biotope itself, and do not occur in bamboo habitats in other parts of the world.

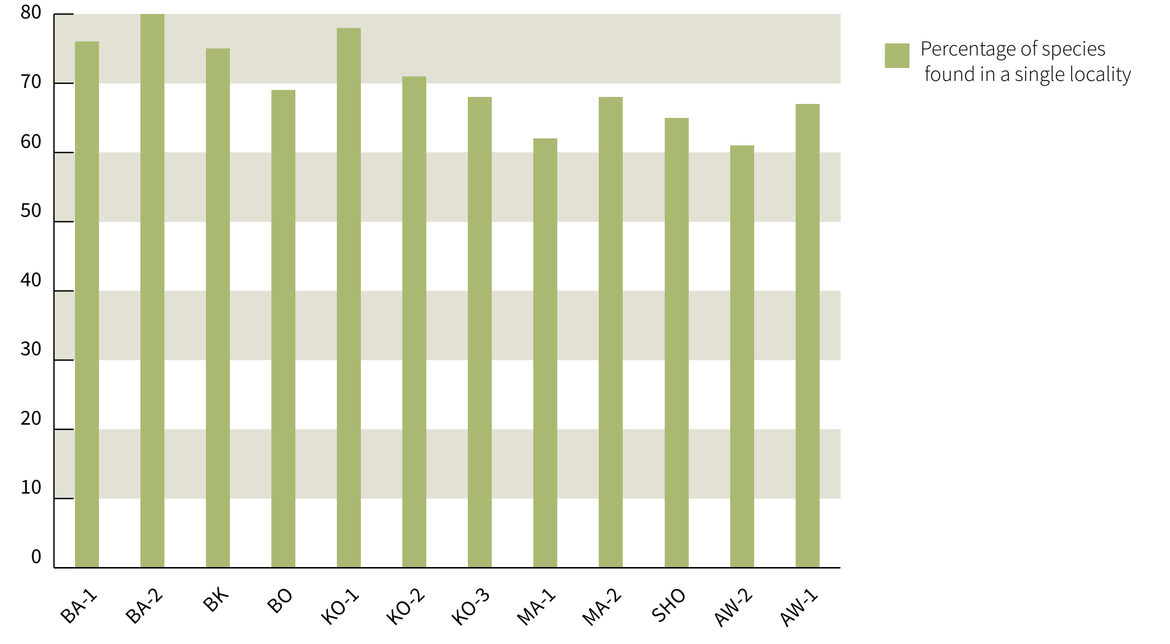

Figure 2: Comparison of species composition between areas

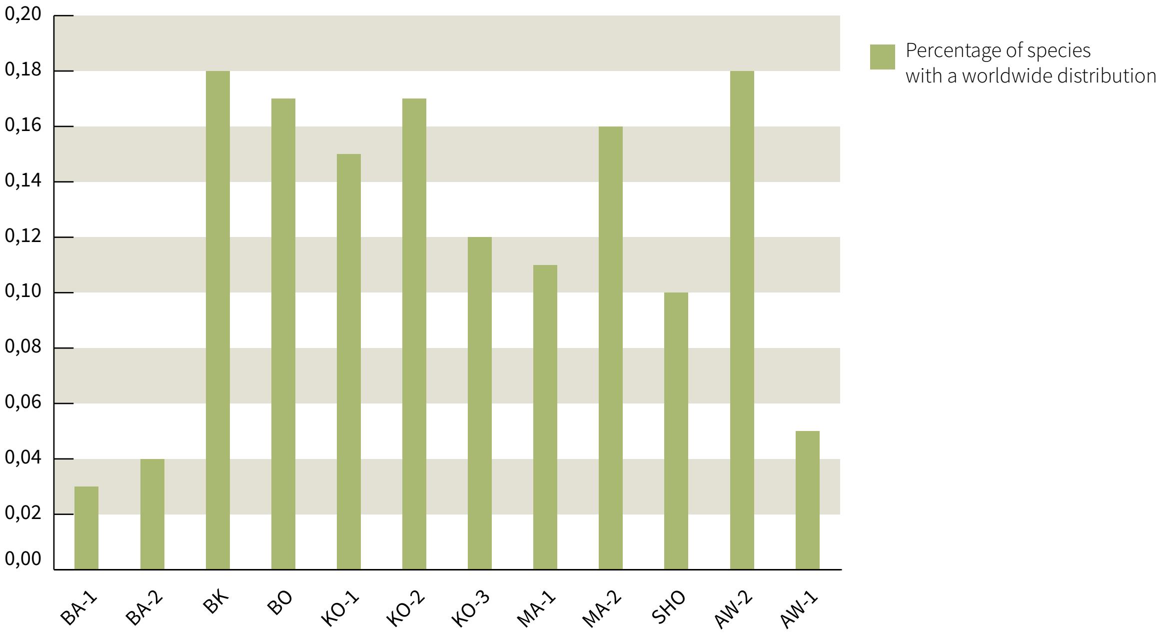

Figure 3: Species with worldwide distribution

Figure 3 suggests that both the bamboo forests and the floodplain vegetation are unique habitats, even at an international scale. But this information must be verified after more data for well-determined fungi are available for analysis. The small number of species on which this diagram is based may be causing an artificial unambiguity.

4. Conclusions and Recommendations for Conservation and Monitoring

4.1 Conclusions for the Kafa BR

Compared to the number of species found by other authors, overall biodiversity of fungi seems high to exceptionally high in the Kafa montane cloud forests. In addition, many species have been found which are not known to have a wide tropical distribution. Several of the species found are new to Africa, new to Ethiopia and even new to science. It is very likely that the near-natural montane cloud forests and even the very extensively managed coffee forests at Kafa BR (PFM sites) are hotspots of diversity for tropical fungi.

Conserving these last comparatively undisturbed forests is highly desirable, as over 90% of them have already been destroyed. A possible source of important fungal resources would vanish with these forests, without us ever having had knowledge of dozens or hundreds of undiscovered fungi species. Thus, it is essential to continue monitoring fungi here, at least in the forest core zones.

General threats to the forests include pressure of land use from the surrounding villages; the exploitation of the coffee forests and management of these forests to exclusively favour the coffee plants. The need for firewood is also a problem in the marginal forest zones, and in some cases (e.g., Komba) deeper inside. The bamboo forests in particular are seriously threatened by people cutting bamboo, changing the microclimate and thus threatening most of the fungi species which occur in this habitat, probably resulting in a dramatic decrease in species richness.

Fungi are very sensitive to environmental or climatic changes, so it is worth monitoring them in more detail. Continuing to monitor fungi in Kafa is very important. The species occurring there and their distribution in the Kafa forests cannot be evaluated in a single assessment, but require monitoring over several years, at different times and in different seasons. Without more knowledge of the species inventory of these forests and the ecological needs of these fungi, we cannot use them as indicator species.

4.2 Indicator species

There is a lack of publications on fungi species which could serve as indicator species for the status of tropical forest biotopes. Various monitoring programmes exist in different countries, mainly in South America, but these are mostly still in the species monitoring phase. Conclusions on species compositions and indicator species are yet to be drawn (or at least remain unpublished). Nevertheless, three species found during the Kafa assessment can be proposed as indicator species for its biotopes, with some prudence.

4.2.1 *Sarcoscypha javanensis*

The *Sarcoscypha* genus is distributed across the northern hemisphere, with approximately ten species occurring in Europe and North America. One species is endemic to Macaronesia. No tropical African species have been identified, apart from one recently described species from Tanzania (Tibuhwa 2010), *Sarcoscypha ololosokwaniensis*. It is unlikely that this is identical to our Ethiopian collections, but a type comparison is still pending, as the type collection has not been located yet.

This is chosen as an indicator species for undisturbed African montane rainforests because all species of *Sarcoscypha* are inhabitants of rich deciduous forests in a near-natural state. The central European species are often found in forests accompanied by threatened plants, e.g., *Leucojum vernum*, such as *Fraxino-Aceri pseudoplatani*, *Adoxo-Aceretum* or *Aceri-Tilietum platyphylli*. The Macaronesian *Sarcoscypha* macaronesica is confined to natural laurel forests. The species from North America are found in near-natural forest types, as is the African species *S. ololosokwaniensis*, which is reported to be found "in undisturbed habitats". This describes the Ethiopian locations. Therefore, it can be expected that *Sarcoscypha javanensis* is also confined to near-natural or natural, rich forests. The vivid scarlet fruit bodies are easy to find and the species (or at least the genus) is unmistakable.

The main threat to *Sarcoscypha javanensis* is disturbance to the ecosystem in which it occurs, especially in terms of humidity inside the forests. Tree felling, but also the construction of roads or even broad paths result in sun and wind encroaching into the forest, making the microclimate conditions drier. This prevents the fungus from fruiting and it is impossible for the mycelium to grow in dried-out wood. Any management of the locations involving fertilisers, pesticides and other chemicals is likely to immediately and drastically change the entire fungal system, turning it into a species-poor community of nitro-tolerant species.

4.2.2 *Cerinomyces bambusicola* spec. nov. ined.

Little is known about this as-yet-undescribed species. Nevertheless, it is chosen as an indicator species for the undisturbed bamboo forests, as it has been found several times in BA and in the bamboo forest part of

BK. Although it has also been collected on other hosts (most likely on *Hagenia abyssinica*) in BK, it has not been found at any other sites in Kafa. This implies that it is a species confined to the high-altitude bamboo forests, although without being specialised on bamboo as host. The new species is remarkable, with crust-like fruit bodies of several square decimetres in area, showing a bright orange merulioid to dentate surface.

The main threat to *Cerinomyces bambusicola* spec. nov. ined. is habitat loss or change through bamboo harvesting. Even if other hosts of this species are not affected directly, changes to the microclimate caused by bamboo harvesting will indirectly affect the substrate of this species.

4.2.3 *Dentipellis fragilis*

This rare species of cosmopolitan distribution is an indicator species for natural beech forests in Europe, and it is most likely confined to natural forest types in other parts of the world. The species develops long crusts (up to one metre long) on decaying voluminous hardwood and is characterised by a hymenium of long, tooth-like protrusions.

The characteristic species from Kafa BR is an indicator species for the undisturbed montane rainforests, containing a certain minimum amount of voluminous deadwood.

The main threat to *Dentipellis fragilis* – besides habitat loss caused by logging – is the removal of coarse stems or a shortage of coarse wood. As this species only inhabits stems or large branches with a minimum diameter of around 30 cm, it is an indicator species for extensive forest fragments.

4.3 Recommendations

The most important recommendation for these fungi is to keep the natural forests in the good condition they are in today. Harvesting wild coffee without site management seems to have not negative influenced these fungi. It is also important to maintain a certain quantity of deadwood of all qualities (standing and lying, fine and coarse). The forest sites must not be fragmented by roads, as this leads to a change in microclimate which is unfavourable for most of the fungi, including the three proposed indicator species. To increase our knowledge of these fungi, especially of the two as-yet-undescribed species, monitoring is necessary. All three proposed indicator species were chosen with this in mind, as they are comparatively easy to recognise.

One of the most important recommendations is to conduct regular inventories of the fungus flora of the Kafa BR.

- The bamboo forests and floodplain forest at the Gummi River strongly warrant an inventory, as these as completely unexplored habitats, even on a global scale, and it is possible that they contain many rare and endemic fungi.

- The montane cloud forests are also in urgent need of a thorough inventory, as it is important to have sound knowledge of species composition and species richness to be able to estimate changes and draw conclusions about the impact of management (comparison between undisturbed forests and PFM sites) on the habitat in general and the fungi in particular.
- Finally, there is no data available on the fungi occurring in African alpine vegetation and riverine shrub vegetation.

The assessment carried out in December 2014 was a first small step, but to obtain robust knowledge of the fungus composition across the different habitats, or simply to get a better impression of how many and which fungi exist at Kafa BR, further excursions must be made at different times of the year.

Table 2: Current status of the study areas at the Kafa BR

Study area	Habitat/forest type	Altitudinal range (m a.s.l.)	Degree of habitat degradation	Main observed threats	Taxonomic group or species indicating good condition	Taxonomic group or species indicating poor conditions	Proposed indicator species	Proposed monitoring for indicator species?
Bamboo forest (BA)	Montane forests	2500-2600	Medium	Fragmentation by paths, felling of bamboo	*Cerinomyces bambusicola* spec. nov. ined.	-	*Cerinomyces bambusicola* spec. nov. ined.	Yes
Boka Forest (BK)	Montane forests	2400-2500	Low	As above, additionally through grazing in the wetlands affecting the forest border	*Cerinomyces bambusicola* spec. nov. ined.	-	*Cerinomyces bambusicola* spec. nov. ined.	Yes
Komba Forest (KO)	Montane forests	1900-2000	Medium-low	Fragmentation by paths, logging, extensive coffee harvesting	*Sarcoscypha javanensis* *Cookeina colensoi, Coniolepiota bongaensis* spec. nov. ined., maybe *Fomitopsis carnea*	*Pycnoporus sanguineus*	*Sarcoscypha javanensis*	Yes
Awurada Valley (AW)	Floodplain forest	1300-1400	Near undisturbed	Poaching				
Awurada Valley (AW)	Montane forests - PFM site	1500-1900	Medium	Poaching, logging, fragmentation by paths		*Pycnoporus sanguineus*		
Shoriri Forest (SHO)	Montane forests	1700	Medium	Fragmentation by paths, logging, extensive coffee harvesting				Yes
Mankira Forest (MA)	Montane forests	1700-1800	Medium-low	Fragmentation by paths, logging, cattle grazing	*Dentipellis fragilis*		*Dentipellis fragilis*	Yes
Boginda Forest (BO)	Montane forests	1900-2000	Medium-low	Unknown	*Pachyella pseudosuccosa*			Yes

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6. Appendix

6.1 Photos

Figure 4: Near-natural forest composition in a PFM site east of Ufa, showing a dense undergrowth of coffee plants and other shrubs, as well as trees in different age groups (photo: Andreas Gminder)

Figure 5: Fungi, lichens and plant epiphytes growing on an old tree at the PFM site between Ufa and the Gummi River (photo: Andreas Gminder)

Figure 6: Near-natural forest composition in a PFM site east of Ufa on the way down to the Gummi River, showing a dense undergrowth of coffee plants and other shrubs (photo: Andreas Gminder)

Figure 7: Floodplain forest at the Gummi River, east of Ufa (photo: Andreas Gminder)

Figure 8: Bamboo forest east of Boka at the river crossing on the road to Kaka, showing the northwest border of the core zone (photo: Andreas Gminder)

Figure 9: Searching for fungi in the bamboo forest east of Boka at the river crossing on the road to Kaka (photo: Andreas Gminder)

Figure 10: Natural montane cloud forest southeast of Saja, showing dense vegetation with a high deposit of deadwood in different stages of decomposition, resulting in a large number of microhabitats (photo: Andreas Gminder)

Figure 11: Creek in a natural montane cloud forest southeast of Saja, location of *Pachyella pseudosuccosa*, an indicator species for natural brooks and creeks (photo: Andreas Gminder)

Figure 12: Natural montane cloud forest southeast of Saja, showing dense vegetation covered by mosses and other epiphytes (photo: Andreas Gminder)

Figure 13: Southwest corner of the Boka Forest with highly disturbed wetland in front (photo: Andreas Gminder)

Figure 14: *Cymatoderma* cf. *elegans*, already known from African rain forests, but recorded for the first time in Ethiopia during this assessment (photo: Andreas Gminder)

Figure 15: *Cerinomyces bambusicola* spec. nov. ined., proposed indicator species for undisturbed bamboo forests in higher altitudes (> 2400 m a.s.l.) (photo: Andreas Gminder)

Figure 16: *Coniolepiota spongodes*, hitherto known only in Japan and Thailand, a potential indicator species for undisturbed montane cloud forests (photo: Andreas Gminder)

Figure 17: *Dentipellis fragilis*, indicator species for natural deciduous forests with cosmopolitan distribution (photo: Andreas Gminder)

Figure 18: *Dentipellis fragilis*, indicator species for natural deciduous forests with cosmopolitan distribution (photo: Andreas Gminder)

Figure 19: *Sarcoscypha* spec. nov. ined., proposed indicator species for natural montane cloud forests, showing the remarkable crenulate cup margin significant for this species (photo: Andreas Gminder)