American Journal of Plant Sciences, 2024, 15, 441-454
https://www.scirp.org/journal/ajps
ISSN Online: 2158-2750
ISSN Print: 2158-2742

Taxonomic Study of Five Parasitic Polypores of the Hymenochaetaceae Family of TIN Vegetation in Western Burkina Faso

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How to cite this paper: Andjièrèyir, K.S., Samson, N., Sylvie, N.R., Benovana, B., Edouard, S.K.J., Kounbo, D. and Elise, S. (2024) Taxonomic Study of Five Parasitic Polypores of the Hymenochaetaceae Family of TIN Vegetation in Western Burkina Faso. *American Journal of Plant Sciences*, **15**, 441-454.
https://doi.org/10.4236/ajps.2024.156031

Received: January 15, 2024
Accepted: June 18, 2024
Published: June 21, 2024

Abstract

The aim of this work is to inventory and study the lignicolous parasitic macrofungi of the Tin plant formation. The mycological outings from July to September 2018 and 2019, collected forty-four (44) basidiomes through a random sampling device over an area of 40,000 m^2 including 1000 m long by 40 m^2 wide. The standard methods and techniques used in mycology for taxonomic studies were used to describe and classify the carpophores collected in three families: Hymenochaetaceae, Ganodermataceae and Polyporaceae, into eight genera: *Onnia* (4.55%), *Amauroderma* (4.55%), *Ganoderma* (20.45%), *Phellinus* (52.27%), *Inonotus* (4.55%), *Phellinopsis* (6.82%), *Grammothele* (2.27%) and *Trametes* (4.55%). The genera *Phellinus* and *Ganoderma* were the most abundant. Finally, eight species were identified: *Inonotus* cf. *ochroporus, Inonotus* cf. *pachyphloeus, Phellinus* cf. *cryptarum, Phellinus* cf. *hartigii, Phellinus* cf. *hippophaecola*; *Phellinus* cf. *robustus*, *Phellinus* cf. *igniarius*, et *Amauroderma* cf. *fasciculatum*. Seven fungal species belong to the family Hymenochaetaceae and only the species *Amauroderma* cf. *fasciculatum* is a Ganodermataceae. However, all these fungal species are shown to be parasites of trunks and/or branches of the following woody: *Parkia biglobosa* (50%), *Anogeissus leiocarpus* (25%), *Annona senegalensis* (12.5%) and *Mangifera indica* (12.5%). Authors attest that the presence of phytoparasitic polypores in a plant formation is an indicator of aging hence the urgency to put in place the appropriate measures to safeguard and restore Tin's plant

formation.

Keywords

Identification, Macrofungi, Lignicolous Parasites, Vegetation, Tin, Burkina Faso

1. Introduction

In the context of climate change, where sustainable management and the development of increasingly limited resources are involved, the study of fungi is essential, as they are one of the pioneers in the colonization of ecosystems and indicators of the health of the ecosystems in which they live. Each type of vegetation has its own fungal community, which changes according to age, the state of health of the stands and site management [1]. According to the same author, mycotrophic species promote ecosystem regeneration with a strong positive correlation between plant and fungal biodiversity. Because of their ecology and the remarkable morphogenetic adaptations they display, polypores have long been of interest to many scientists, ever since the pioneering work of [2] and [3]. Ecologically, lignivorous polypores are the main agents of decomposition of woody matter, along with insects. They have developed nutritional and biological strategies to colonize the different ecological niches present and colonize the whole range of substrates: stems, dead or living trunks, living lianas or the root system of trees [4]. Most polypore taxa have a tropical distribution [5] [6]. Unfortunately, the first scientific data available on this fungal group in tropical Africa was compiled by European mycologists. Among these mycologists are Leif Ryvarden [7] [8] [9]; Cony Decock [10] [11] and recently in Central Africa Alphonse Balezi in Congo [12] [13] and Prudence Yombiyeni in Gabon [14]. In West Africa, work on polypores has been made in Benin by Olou [15] and in Burkina Faso by Nankoné Samson [16] [17] and [18].

The aim of this study is to provide scientific information on the diversity and taxonomy of lignivorous parasitic polypores in the vegetation of the village of Tin in the province of Kénédougou (Orodara).

2. Study Area

Tin Village, located about 12 km from Orodara on the Orodara-Djigouèra road, is in the department of Orodara, capital of the province of Kenedougou (**Figure 1**) in the upper basins region of western Burkina Faso. It is located at 11˚04'922'' North and 04˚57'139'' West, at an altitude of 472 m. The indigenous people are the Siamus, who live in community with the Peulhs and other minority ethnic groups.Average annual rainfall varies from 900 to 1200 mm of water. The vegetation on the site is of the wooded savannah to tree type [19], with *Parkia biglobosa*, *Vitellaria paradoxa*, *Khaya senegalensis*, *Butyrospermum parkii*, *Terminalia* sp. There are also numerous orchards of *Mangifera indica*, *Anacardium*

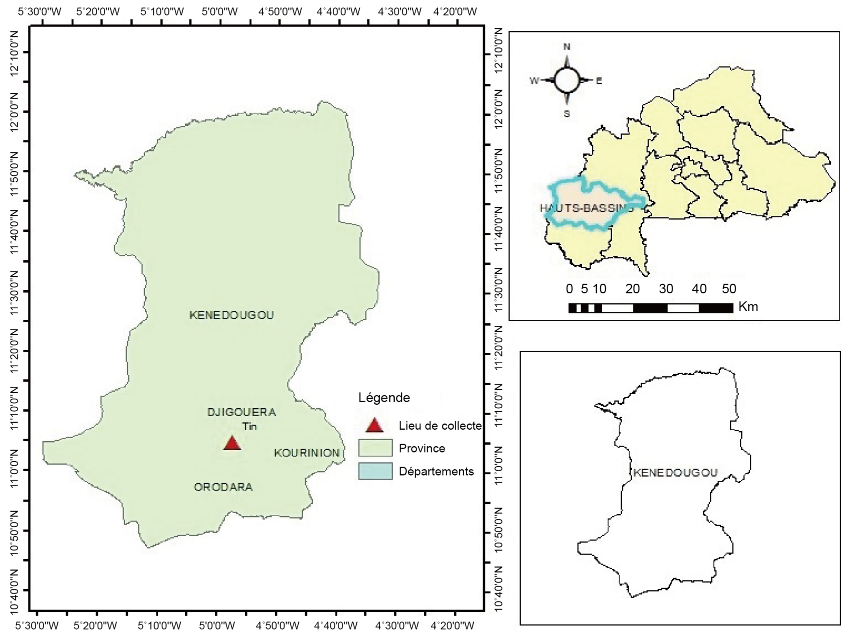

Figure 1. Location of the village of Tin on the map of Burkina Faso. Source: [20].

occidentale and a wide range of citrus trees.

3. Prospecting, Sample Collection and Storage

Our inventory work on phytopathogenic macromycetes took place over two rainy seasons, *i.e.* from July to September 2018 and 2019. The survey was carried out in the Tin landscape, an area of 40,000 m^2 (*i.e.* 1000 m long by 40 m wide). A random sampling plan was used to collect all the basidiomes encountered. These mycological outings consisted of walking through the plant formation concerned and collecting all the fungi that had developed on the crown, trunk or stem and on the twigs of the woody species. Each basidiome encountered was labelled, photographed using a Canon DS126621 camera, the fleeting characteristics noted, the geographical coordinates recorded using a Garmin 64S Global Positioning System (GPS) and the host plants identified. Finally, using a machete, the basidiome has been detached from its substrate and wrapped in aluminium foil.

Once at the base camp, each carpophore was described macroscopically, followed by a technical photograph of the different parts of the cap and/or stipe.

Once the specimens had been described and photographed, they were dried in a Dorrex electric desiccator for 24 hours. The exsiccata were stored in hermetically sealed mini-grip bags with their labels and sent to the Phytopathology and Tropical Mycology laboratory at Joseph KI-ZERBO University for further analysis.

4. Description of Samples

The description of macroscopic characteristics consisted of describing the morphological characteristics of the basidiome in the fresh state. It took into account the growth habit, habitus, shape, consistency, margin of the carpophore, coating of the carpophore and stipe as well as their dimensions (diameter, thickness and length), characteristics of the hymenophore (tubes, spines and pores). This description was based on the macromycete description sheet of [21], which was simplified and adapted for the description of polypores. The characters described enabled an initial discrimination between genera. The microscopic description concerned the exsiccata. An optical microscope fitted with a NIKON H 550 S drawing tube was used. Depending on the consistency of the carpophore, different sectioning techniques were used: a longitudinal section was made through the hymenium for the search of the silks, hyphae and basidia, and a scraping of the hymenial surface was made for the search of basidiospores. The resulting cuts were deposited in a drop of 10% KOH to swell the structures. Ammoniacal Congo red (1%) was then used to color cell walls such as generative and skeletal hyphae, basidia and cystids. A few drops of Melzer's reagent were used to check the amyloidicity of the basidiospores.

Each of the elements observed was drawn at the highest magnification (G = 1000×) of the microscope, then measured (length and width) using a micrometer (µm) incorporated into one of the eyepieces and the ratio (Q) of spores (Q = L/l) was calculated using the Excel spreadsheet. This allowed the shape of basidiospores to be determined using the scale [22].

5. Results

5.1. Diversity of Parasitic Macromycetes

At the end of the mycological outing, forty-four (44) parasitic fungi were inventoried in the plant formation and in some orchards in the village of Tin and are divided into three families: Hymenochaetaceae, Ganodermataceae and Polyporaceae and into eight genera (**Figure 2**): *Onnia* (4.55%), *Amauroderma* (4.55%), *Ganoderma* (20.45%), *Phellinus* (52.27%), *Inonotus* (4.55%), *Phellinopsis* (6.82%), *Grammothele* (2.27%) and *Trametes* (4.55%). The genera *Phellinus* and *Ganoderma* are the most abundant. Eight species of these basidiomata have been identified on the basis of various descriptions, namely *Inonotus* cf. *ochroporus, Inonotus* cf. *pachyphloeus, Phellinus* cf. *cryptarum, Phellinus* cf. *hartigii, Phellinus* cf. *hippophaecola*; *Phellinus* cf. *robustus, Phellinus* cf. *igniarius,* and *Amauroderma* cf. *fasciculatum* (**Table 1**).

5.2. Diversity of Host Plants Identified

All eight polypore species were collected either from the trunk or branches or from the trunk and branches of living plants. Four of them, namely *Inonotus pachyphloeus*, *Phellinus cryptarum, Phellinus hippophaecola* and *Phellinus robustus* were collected on *Parkia biglobosa* of the Mimosaceae family, two fungal species: *Phellinus igniarius* and *Phellinus hartigii* on *Anogeissus leiocarpus* (Combretaceae), *Inonotus ochroporus* collected on *Mangifera indica* (Anacardiaceae) and *Amauroderma fasciculatum* was collected on *Annona senegalensis*

Table 1. List of parasitic fungi species identified with their geographical coordinates.

Order	Families	Genera	species	Tin village (geographical coordinates)
Hymenochaetales	Hymenochaetaceae	*Inonotus*	*Inonotus ochroporus*	10˚58'24.54"N 04˚54'24.72"W
			Inonotus pachyphloeus	11˚05'4.08"N 04˚57'24.72"W
		Phellinus	*Phellinus cryptarum*	11˚04'55.32"N 04˚57'8.34"W
			Phellinus hartigii	11˚11'59.7"N 04˚26'21.42"W
			Phellinus hippophaecola	11˚05'11.82"N 04˚57'28.02"W
			Phellinus igniarius	11˚11'8.82"N 04˚26'28.14"W
			Phellinus robustus	11˚05'09.0"N 04˚57'15.0"W
Polyporales	Ganodermataceae	*Amauroderma*	*Amauroderma fasciculatum*	10˚55'34.68"N 04˚52'50.3"W

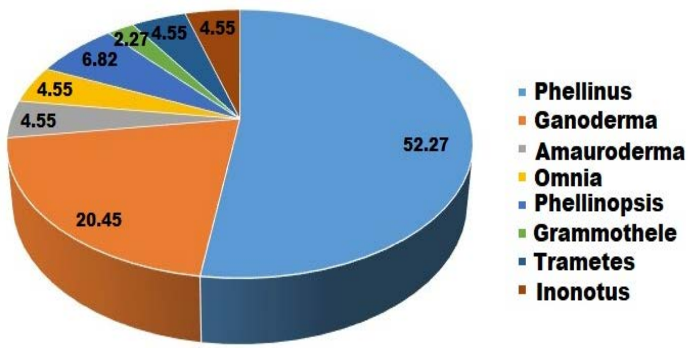

Figure 2. Distribution ratio of different specimens according to genus.

(Annonaceae). The results of the mycological survey showed that *Parkiabiglobosa* has been the woody species most parasitized (50%), especially by polypores of the genus *Phellinus* (Table 2).

5.3. Taxonomic Description of Some Parasitic Polypore Species of the Hymenochaetaceae Family

Of the eight polypore species identified, only five species of the Hymenochaetaceae family will be described, because the other three have already been described by Nankoné *et al.* 2020 and 2021.

5.3.1. *Inonotus* cf. *pachyphloeus*

Inonotus pachyphloeus **(Pat.)** T. Wagner & M. Fisch., Mycologia (2002) 94 (6): 1009

Basidiocarp: Console-shaped basidiomata widely attached to the substrate,

Table 2. List of woody species parasitized by polypores.

Host plant family	Host plant species	Infected parts	Fungal species
Mimosaceae	*Parkia biglobosa*	trunk	*Inonotus pachyphloeus*
		trunk	*Phellinus cryptarum*
		trunk	*Phellinus hippophaecola*
		trunk and branches	*Phellinus robustus*
Combretaceae	*Anogeissus leiocarpus*	trunk and branches	*Phellinus hartigii*
		trunk	*Phellinus igniarius*
Anacardiaceae	*Mangifera indica*	trunk	*Inonotus ochroporus*
Annonaceae	*Annona senegalensis*	trunk	*Amauroderma fasciculatum*

ungulate, 15 - 24 cm wide, projecting 5 - 12 cm, 6 - 10 cm thick, with an acute, whitish margin. Surface of cap wavy and concentrically zoned, crusty, cracked, grey then grey-blackish, blackish. Hymenial surface, with rounded pores, 4 - 6 per mm, yellow-brown, cinnamon-brown, rusty-brown, indistinctly stratified tubes, 3 - 5 mm long. Suberous flesh, 2 - 4 cm thick, dark rusty brown, blackening in contact with KOH.

Hyphae system: dimitic, generative hyphae septate, not looped, thick-walled brown skeletal hyphae.

Basidiospores: globose, thick-walled, smooth, subglobose, often broadly ellipsoid, (5.00-6.72-9.00) × (4.00-5.60-7.00) µm; (Q = 1.00-1.15-1.33, n = 64). Setae subulate, brown thick-walled, short, apex acuminate (65-162) × (13-25) µm (Figure 3, Figure 4).

Ecology: species specific to the landscape of the village of Tin, it grows on fallen trunks, but frequent parasite on the trunk of *Parkia biglobosa* living.

Materials examined: Burkina Faso, Kénédougou Province, Tin Landscape, no. KSA 029; coordinates: 11˚05'4.08"N; 04˚57'24.72"W, 490 m altitude, harvested on 12/08/2019.

5.3.2. *Inonotus* cf. *ochroporus*

Inonotus ochroporus (Van der Byl.) Pegler Trans. Brit. Mycol. Soc. 47 (2): 183 (1964)

Basidiocarp: Perennial fruiting body, ungulate, bumpy crust, hoof-shaped, 15 - 32 cm in diameter, 7 - 15 cm in projection, 5 - 18 cm thick, acute margin, light grey. Surface of cap concentrically wavy, crusty, slightly zoned and cracked, grey-blackish. Hymenial surface with rounded pores, 5 - 6 per mm, rusty brown, brownish grey, indistinctly stratified tubes 2 - 3 mm long. Flesh 2 - 5 mm thick, suberous, tough, dark grey, blackening on contact with KOH.

Hyphae system: dimitic, generative hyphae septate, uncurled, skeletal hyphae brown. Dark brown, thick-walled hymenial bristles. There are two types of setae with acuminate apices: very long setae and short, subulate setae, (55-115) × (12-25) µm.

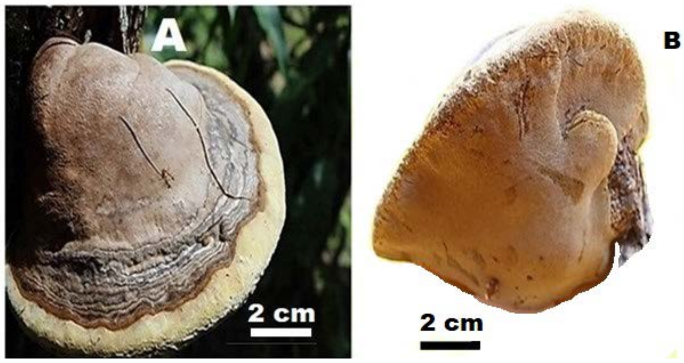

Figure 3. Morphology of *Inonotus* cf. *pachyphloeus*. (A) Upper surface of the basidiome, (B) Hymenial surface of the basidiome.

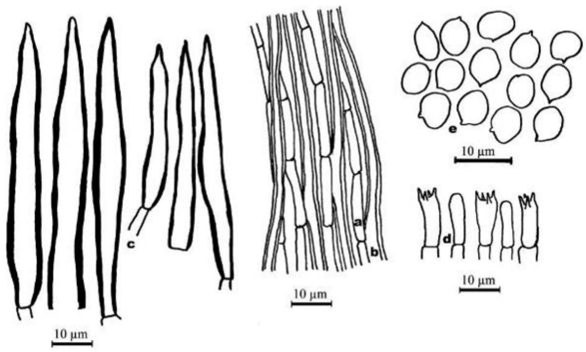

Figure 4. Microscopic structures of *Inonotus* cf. *pachyphloeus*. (a) Partitioned generative hyphae, (b) Double-walled skeletal hyphae, (c) Long, thick-walled bristles, (d) Tetrasporic basidia, (e) Smooth, globose basidiospores (scale = 10 µm).

Basidiospores: smooth, hyaline, broadly ellipsoid, but sometimes globose, (5.00-6.56-8.00) × (4.00-5.33-6.00) µm (Q = 1.00-1.24-1.60 n = 60) (**Figure 5**, **Figure 6**).

Ecology: Parasite of the trunk of living *Mangifera indica.*

Materials examined: in Burkina Faso, Kenedougou Province, Tin, no. KSA 005. Coordinates: 10˚58'24.54''N; 04˚54'24.72''W, Alt.: 487 m. Harvested on 26/08/2019.

5.3.3. *Phellinus* cf. *cryptarum*

Phellinus cryptarum Quél., 1888

Basidiocarp: Perennial carpophore totally nodular at first, but generally with an irregular, nodular crust with rounded or ungulate margins, 15 - 20 cm wide, 6 - 10 projecting, 7 - 12 thick, Margin obtuse, rusty yellow, olive-red. The surface of the cap is covered by a thin membrane that is slightly corky, rough, cracked, crusty, reddish, brownish-grey, then light brown at the end. Lower surface with slightly oval, fine and sometimes irregular pores, 6 - 8 per mm, olive-brown then reddish-brown, tubes 10 - 15 mm long, with no weft between strata in older individuals. Flesh woody, hard, yellowish-brown to dark brown, then blackish-brown to blackish in contact with KOH.

Figure 5. Morphology of *Inonotus* cf. *ochroporus* on a *Mangifera indica* trunk. (A) General view of the basidiome on a *Mangifera indica* trunk; (B) Hymenial surface of the basidiome.

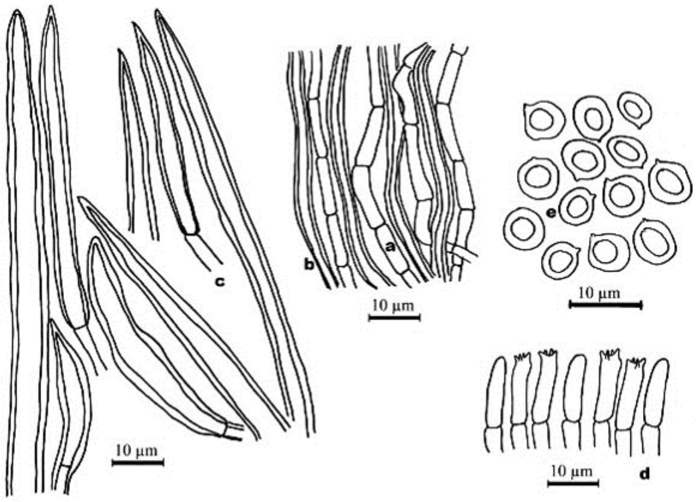

Figure 6. Microscopic structures of *Inonotus* cf. *ochroporus*. (a) Cloisonné generative hyphae, (b) Double skeletal hyphae, (c) Longer or shorter, straight, thick-walled setae, (d) Basidia, (e) Basidiospores (scale = 10 µm).

Hyphae system: dimitic, consisting of generative hyphae and skeletal hyphae. The generative hyphae are non-looped and the skeletal hyphae are thick-walled and sometimes branched. Brown bristles with thick and diverse walls, fairly long, (40-200) × (12-30) µm.

Basidiospores: broadly ellipsoid, smooth, (5.00-6.65-7.00) × (4.00-5.00-6.50) µm; (Q = 1.00-1.21-1.50, n = 64) (**Figure 7**, **Figure 8**).

Ecology: Parasite collected from the trunk of *Parkia biglobosa.*

Materials examined: Burkina Faso, Province of Kenedougou, Tin, n˚ KSA 008, Coordinates: 11˚04'55.32''North; 04˚57'8.34''West, and 472 m altitude, collected on 21/09/2019.

5.3.4. *Phellinus* cf. *hartigii*

Phellinus hartigii (Allesch. & Schnabl) Pat. 1903

Basidiocarp: Carpophore totally nodular at first, but generally in an irregular, nodular console with rounded or ungulate margins, 30 - 45 cm wide, 25 - 40

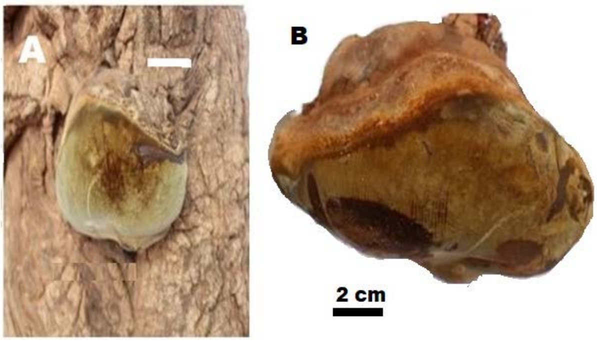

Figure 7. General morphology of *Phellinus* cf. *cryptarum*. (A) Photogaphy of the basidiome on the host plant, (B) Technical photograph of the carpophore.

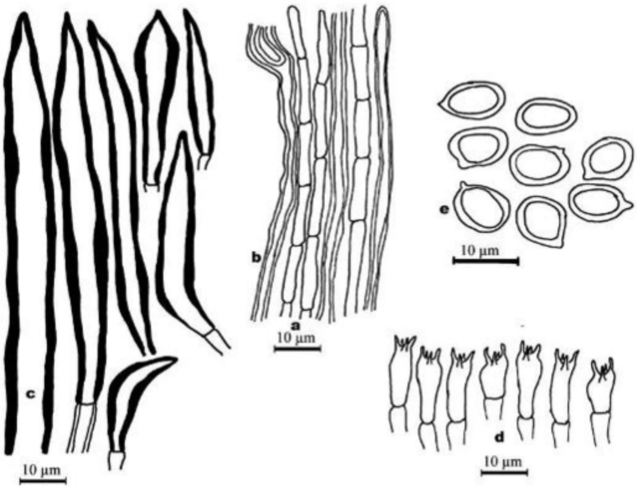

Figure 8. Microscopic structures of *Phellinus* cf. *cryptarum.* (a) Partitioned generative hyphae, (b) Skeletal hyphae, (c) Long thick-walled hymenial and tramial setae, (d) Basidia, e. Basidiospores (scale = 10 µm).

projected, 10 - 16 thick, obtuse margin, rusty yellow, olive-red. Surface of cap with concentric undulations, cracked, split, crusty, reddish, brownish-grey, then blackish-brown at the end. Lower surface with rounded, fine and sometimes filled pores, 4 - 6 per mm, yellowish-brown then reddish-brown, tubes 4 - 5 mm long, with no weft between strata in older individuals. Flesh woody, hard, yellow-brown to rusty-brown.

Hyphae system: dimitic, consisting of generative hyphae and skeletal hyphae. The generative hyphae are non-looped septate and the skeletal hyphae have a thick wall. Brown, thick-walled, diverse bristles, (15-24) × (50-120) µm.

Basidiospores: broadly ellipsoid, smooth, (5.00-6.50-8.00) × (4.00-4.50-6.00) µm, Q = (1.20-1.25-1.50), n = 60.

Ecology: Parasitic basidiomata collected from the trunks and branches of living *Anogeissus leiocarpus* (Figure 9, Figure 10).

Material examined: Burkina Faso, Kenedougou province, Tin, No. NKS228. Coordinates: 11˚11'59.7''N; 04˚26'21.42''W, Altitude: 357 m. Collected on 14/08/ 2019.

Figure 9. Morphology of *Phellinus* cf. *hartigii*. (A) View of the basidiomata on the host plant, (B) Photograph of the basidiomata after detachment from the substrate.

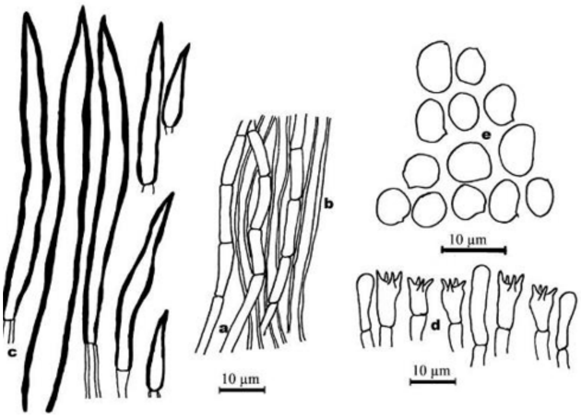

Figure 10. Microscopic structures of *Phellinus* cf. *hartigii*. (a) Partitioned generative hyphae, (b) Double-walled squelletic hyphae, (c) Brown and various setae, (d) Cylindrical to stubby basidia and basidiole, (e) Globose, smooth basidiospores (scale = 10 µm).

5.3.5. *Phellinus* cf. *hippophaecola*

Phellinus hippophaecola H. Jahn 1976

Basidiocarp: Perennial fruiting body, initially nodular, weeping, then bracket-shaped or hoof-shaped, broadly and firmly attached at the base, 16 - 22 cm in diameter, 12 - 20 cm wide, 6 - 15 cm thick, margin obtuse rusty brown. Surface of cap sublisse to finely velvety, concentrically zoned and furrowed, yellow-brown, russet, rusty-brown, cinnamon-russet, then greyish-brown, dark brown, beaded margin, cinnamon. Hymenial surface with small rounded pores, 5 - 7 per mm, rusty brown, tubes distinctly stratified, 2 - 3 mm long. Flesh woody, hard, concentrically zoned, cinnamon brown.

Hyphae system: dimitic, generative hyphae septate, not looped, thick-walled brown skeletal hyphae. Setae long and ventrally thick-walled, basidia tetrasporic, cylindrical and slightly stubby.

Basidiospores: smooth, hyaline, broadly ellipsoid, 5.00-6.64-8.00 × 4.00-5.04-6.50 µm; (Q = 1.00-1.30-1.50, n = 66).

Ecology: Basidiomata collected from the trunk of a living *Parkia biglobosa* (Figure 11, Figure 12).

Figure 11. Morphology of *Phellinus* cf. *hippophaeicola* on the host plant.

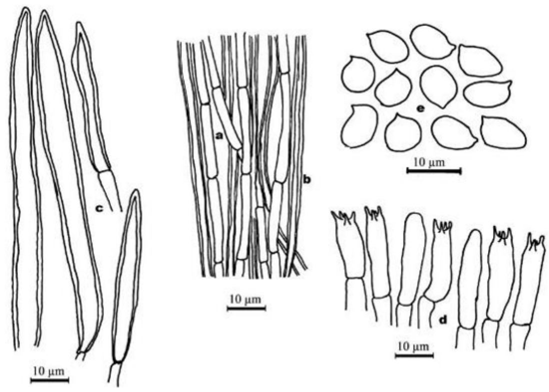

Figure 12. Microscopic structures of the elements of *Phellinus* cf. *hippophaecola.* (a) Partitioned generative hyphae, (b) Double-walled skeletal hyphae, (c) Thick-walled, long bristles with pointed apices, (d) Cylindrical tetrasporic basidia, (e) Smooth subglobose basidiospores (scale = 10 µm).

Materials examined: Burkina Faso. Province of Kenedougou, Village of Tin, no. NKS240, collected on 21/08/2019, Coordinate: 11˚05'11.82''N; 04˚57'28.02''W, altitude 483 m.

6. Discussion

In ecology, according to [23], the study of diversity is a central property and is based on taxonomic richness (the number of taxa) and the relative abundance of each taxon within the community. Therefore, the specific richness corresponds to the number of species, and measures of richness and diversity are intimately linked to the definition of a species. Inventory work on plant-parasitic polypores has enabled us to list 44 fungal samples classified in two (2) orders: the Hymenochaetales and the Polyporales, in three families: the Hymenochaetaceae, the Ganodermataceae and the Polyporaceae, and in eight genera, the most important of which are: *Phellinus* and *Ganoderma*. From the different descriptions, eight species have been described, all of which are identified as parasites of trunks and/or branches of living woody species. This reinforces the assertion of [24] attesting to a great diversity of polypores in tropical forests because of their great richness in floristic composition. The dominant abundance of fungal species of the Hymenochaetaceae family on the Tin site could be explained by the climate, rainfall and vegetation type of the western part of the country. Indeed, the author suggests that a wide variety of wood resources (botanical diversity, substrate diversity) could result in a large number of ecological niches for polypores. The results of Ryvarden's work [8] confirm the theory that the wide distribution of lignicolous macrofungi in the tropics is due to its high plant diversity. Furthermore, [25] found that the type of vegetation was one of the factors linked to the appearance of polypore communities in forests. If we take into account the ratio of number of species/forest area. According to [26] the host plant would be identified as a factor in the production of fruiting bodies of plant-parasitic fungi, due to the need for certain nutrients to form sporophores. Thus, *Parkia biglobosa*, *Anogeissus leiocarpus*, *Mangifera indica* and *Annona senegalensis* would be sensitive and favourable hosts for the development of plant-parasitic polypores of the Hymenochaetaceae family. It should also be noted that polypores often have a wide range of host plants, which is confirmed by the results of work by [13], which show that *Inonotus pachyphloeus* and *Phellinus calcitratus* are also parasites of *Bikinia* sp. (Caesalpiniaceae), *Phellinopsis pinicola* with *Berlinia grandifolia*, *Piliostigma thonningui*, *Acacia dudgeoni* and even *Acacia polymorpha*. However, most of the woody plants parasitised were old strains, which corroborates the results of [27], which showed that fungal species of the Hymenochaetaceae family were parasites of ageing Caesalpiniaceae. They conclude by saying that macrofungi of the genera *Inonotus* and *Phellinus* would be indicators of the ageing state of plant formations. In short, it could be said that the presence of these plant-parasitic polypores constitute a pathological problem for the vegetation in the village of Tin, which, because the ageing of the woody species combined with human activity and the right climatic conditions, encourages the development of lignicolous parasitic polypores. *Parkia biglobosa*, which is an important utility plant, seems to be the most attacked. It is therefore urgent that phytosanitary measures are found to effectively combat these parasitic hymenochaetaceae, which are becoming a significant threat to the survival of certain woody species.

7. Conclusion

This study, which took place in the vegetation of the village of Tin, identified eight species of polypore, all of which are parasites of the trunks and/or branches of certain ligneous trees. The results of the work of numerous authors have shown that the presence of these lignicolous macro-fungi attests to the ageing of plant formations. Among the woody species identified as host plants, *Pakia biglobosa*seems to be the preferred host plant for these hymenochaetaceae parasites. The importance of this plant for the local population is well established, hence the urgent need to put in place appropriate phytosanitary measures to preserve these ageing trees in the short term, and to consider the renewal of these woody species in the medium term through reforestation campaigns.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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