HAGENIA ABYSSINICA AND ITS FUNGAL DECAYERS IN NATURAL STANDS

T. NIEMELÄ*, P. RENVALL† & K. HJORTSTAM‡

Hagenia abyssinica J.F. Gmel. (*Rosaceae*) is an Afromontane endemic, whose range extends from Ethiopia in the north to Zimbabwe and Mozambique in the south. This thick-stemmed but low-growing tree is restricted to East African high mountains, and is one of the dominants of upper montane forests, often making up the timberline. In this paper 17 aphyllophoroid basidiomycetes are reported on *Hagenia* from Tanzania. Trees which have been partly debarked by elephants are often troubled by *Hymenochaete ochromarginata* Talbot. A new species, *Hyphodontia submucronata* Hjortstam & Renvall is described. *Dendrothele griseocana* (Bres.) Bourdot & Galzin is reported for the first time from Africa.

Keywords. Basidiomycetes, East Africa, *Hymenochaete*, *Hyphodontia*, wood-rotting fungi.

INTRODUCTION

Hagenia abyssinica

The genus *Hagenia* J.F. Gmel. is monotypic, comprising only the species *H. abyssinica* (Bruce) J.F. Gmel. It has an isolated position in the family of the *Rosaceae*, and is most closely related to the monotypic genus *Leucosidea* Eckl. & Zeyh. of South Africa (Friis, 1992).

Hagenia abyssinica (Fig. 1) is a good example of an Afromontane endemic. The distribution starts from the Ethiopian highlands as far north as Tigre (Friis, 1992; Ethiopian distribution mapped). The tree is also found in southernmost Sudan (Imatong Mts), but not on isolated western and central massifs, for instance Jebel Marra (Wickens, 1976). The distribution touches easternmost Zaire, Rwanda and Burundi. *Hagenia* is widespread in Uganda (Eggeling, 1952, Hamilton, 1991), Kenya (Dale & Greenway, 1961; Noad & Birnie, 1990) and the Tanzanian mountains (Iversen, 1991; our own observations). The range reaches the Nyika plateau of Zambia (Fanshawe, 1971) and Malawi in the south (White, 1962, 1983). Jansen (1981) claims *Hagenia* to extend as far south as Mozambique and Zimbabwe, and to occur as introduced in Madagascar. The tree is not found on the Cameroon Mts of the Guinea Bay, where many other montane plants of East Africa have a disjunct outlier.

Hagenia abyssinica is a tree of high-altitude montane forests. In most cases it makes up the timberline next to ericaceous scrub, where low night temperatures exclude most other tree species and the competition is low (Lind & Morrison, 1974).

* Botanical Museum, University of Helsinki, PO Box 47, FIN–00014 Helsinki, Finland.
† Kuopio Museum of Natural History, Myhkyrinkatu 22, FIN–70100 Kuopio, Finland.
‡ Målaregatan 12, S 44100 Alingsås, Sweden.

FIG. 1. *Hagenia abyssinica* in western Mt. Meru, Tanzania. Upper montane forest belt, altitude 2800m.

It is fairly tolerant to variations of rainfall, and can be found both on dry slopes together with *Juniperus procera* and *Podocarpus* species, and in more moist sites intermixed with *Rapanea melanophloeos* (*R. rhododendroides*), *Prunus africana*, *Erica arborea*, *Schefflera* species, and other angiosperm trees. It even intermingles with *Arundinaria alpina* in the bamboo belt of the wettest slopes, which are characterized by deep, fertile soils. In many cases it is a dominant tree species and can make up almost pure stands close to its upper limit, like on Mt Kenya (Noad & Birnie, 1990) and Mt Meru 70km west of Mt Kilimanjaro. Contrary to the statement of Lind & Morrison (1974), it is common also on Kilimanjaro, especially along its southern slopes (Lamprey *et al.*, 1991; Mwasanga, 1991; Pócs, pers. comm.).

Altitudinal range of *Hagenia abyssinica* is from 1850 to 3700m in Ethiopia (Friis, 1992) and from about 2300 to 3500m in Uganda (Hamilton, 1991). The highest recorded altitude is that by Engler (1892), 4300m in Ethiopia. *Hagenia* descends on western Mt Elgon as low as 1800m (Dale, 1940; Hamilton & Perrott, 1981). The lowermost occurrences coincide with the highest-rainfall slopes and the tree has a pioneer character there, growing in seral forests. Fanshawe (1971) considers

H. abyssinica to be a member of secondary montane forest on the Nyika plateau (2150–2455m), eastern Zambia, forming belts of variable width around the primary forest patches.

Close to the timberline *Hagenia abyssinica* is a climax tree. Annual rainfall range of the species is between 1000 and 1500mm (Friis, 1991), but especially at higher altitudes mistiness has a great effect on water economy and it is not visible in rainfall measurements. In the mist zone *Hagenia* trees are often covered with cushions of epiphytic bryophytes. The abundance of epiphytes is favoured by the structure of the tree: boughs and branches are very thick and often almost horizontal, and the bark is rough, flaking raggedly.

The tree does well even in exposed sites. For instance on the Ethiopian mountains *Hagenia abyssinica* can be seen as a solitary tree amongst cultivations; often it has been left to grow as the only remaining resemblance of the former forest. Such single trees are usually female ones, and the reason for their saving is that dried inflorescences are commonly used for their anthelmintic properties in both human medicine and veterinary (Noad & Birnie, 1990). In old times every Ethiopian expelled tapeworms once in one to three months with an infusion made out of female *Hagenia* flowers (Jansen, 1981).

The timber of *Hagenia* is dark red in colour. Its handsome appearance makes this 'poor man's mahogany' fit for furniture and flooring, but it is not especially resistant against termites, borers or decay. Twisted trunk shape and low growth (usually less than 20m) decrease its economical value. *Hagenia*-dominated climax forests are seldom exploited for timber, but are cut in order to gain land for cultivation and grazing.

Hagenia *from a mycological point of view*

The restricted and fragmented distribution of *Hagenia abyssinica* in East Africa, its isolated systematic position, and its occurrence in extreme high-altitude forests make the species interesting from a mycological point of view. Old stands and tree individuals can be found on many East African mountains, for instance on Mt Meru of northern Tanzania, and hence wood-rotting fungi of living trees can easily be studied.

Lush foliage makes *Hagenia* an effective firebreak in pure stands or if planted by forestry for the purpose (Pócs, pers. comm.). Groves of such trees make up fire refugia on mountain slopes that are elsewhere impoverished by wildfires and intentional burning. Such fire avoidance surely has an effect on the fungal and bryophyte flora of the trees. Unfortunately, fallen trunks have often been taken away for fuel, which limits our knowledge on saprotrophic fungi.

This paper is a continuation to an earlier work (Renvall & Niemelä, 1993), in which we studied fungi that decay *Ocotea usambarensis* in East Africa. Host trees are very seldom mentioned in papers dealing with the mycology of tropical areas. We felt it important to publish information on this essential facet of wood-inhabiting fungi.

MATERIALS AND METHODS

The paper is based on specimens collected by the authors Niemelä (abbreviated as TN) and Renvall (PR) in East Africa, and the data on the fungal pathogenicity is based on personal field notes. TN made field studies in Ethiopia in October–November 1982 (duration of the expedition 4 weeks), and in Tanzania in May 1988 (2 weeks). Together with PR stands of *Hagenia* were studied jointly in Tanzania in December 1988 (3 weeks) and December 1989 (4 weeks). The specimens derive from Tanzania; they are deposited in the Botanical Museum of the University of Helsinki (H), and to a lesser extent in the reference collections of the authors. Corticioid fungi were determined and discussed by the author Hjortstam. Polypores and the Hymenochaetales were identified, and the text was otherwise written by TN and PR. The nomenclature of polypores mostly follows the manual of Ryvarden & Johansen (1980).

In presenting the variation of the basidiospore size, 5% of the measurements have been excluded from each end of the range, and are given in parentheses. The following abbreviations are used: **L** = the mean spore length (arithmetical mean of all the spores), **W** = the mean spore width (arithmetical mean of all the spores), **Q** = quotient of the spore length and the spore width (L/W ratio), (**n = x/y**) = x measurements of spores from y specimens. In less critical cases only general variation is given, based on a few measurements.

Study sites

In Ethiopia, *Hagenia abyssinica* was studied in Shewa Province west of the capital, in localities Menagesha Forest Reserve and Chomen, and in southern Ethiopia in Bale Province, Bale Mts National Park. Altitude range was c.2600–3200m. Vegetation in both areas is dry montane forest, *Hagenia* intermixed with *Rapanea melanophloeos, Juniperus procera, Podocarpus gracilis* and others.

In Tanzania, the tree was studied and fungi collected in Arusha District, Mt Meru, mostly along upper slopes of western side (Olmotonyi, Laikinoi) and to a lesser extent in the Arusha National Park of the eastern slope. Forests were natural, mossy, upper montane mist forests, often of pure *Hagenia* stands close to the timberline, but in some sites intermixed with *Rapanea, Juniperus* and other trees. Altitude range was c.2600–3000m.

RESULTS

Polypores and the Hymenochaetales

Datronia scutellata (Schw.) Gilb. & Ryvarden
in Mycotaxon 22: 364 (1985). *Polyporus scutellatus* Schw. in Trans. American Phil. Soc. 2 (4): 157 (1832).

Collection: *PR* 1584, fallen branch.

This is a cosmopolitan species, widespread in the tropical zone (Ryvarden & Gilbertson, 1993). Ryvarden & Johansen (1980) report it (as *Fomitopsis scutellata*) from Kenya, Tanzania and Malawi.

Hymenochaete cinnamomea (Pers.: Fr.) Bres.
in Atti Imp. Regia Accad. Rovereto, Ser. III. 3: 66 (1897). *Thelephora cinnamomea* Pers., in Mycol. Eur. 1: 141 (1822).
Collection: *T. Renvall* 485, bark of living tree.

The specimen fits well the description given by Job (1987).

Hymenochaete ochromarginata Talbot. **Fig. 2.**
in Bothalia 4: 943 (1948).
Collections: *TN* 5114, 5115, 5117, 5122, 5300, *PR* 1597, *T. Renvall* 483, living tree trunks; *PR* 1586, stump.

New to East Africa. The species was described from South Africa and is also known from the Cameroon (Talbot, 1951). According to Job (1987) the species is similar to *H. rigidula* and *H. rubiginosa* but differs by its shorter setae and oblong-elliptical

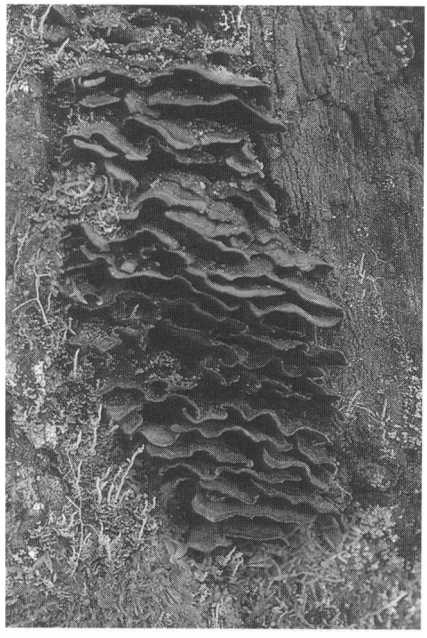

FIG. 2. *Hymenochaete ochromarginata* Talbot on living *Hagenia abyssinica*, trunk partly debarked by elephant. Specimen *TN* 5122, ×0.3.

spores. According to our observations ($n=12$) *H. ochromarginata* is an important decayer of living *Hagenia* trees. Basidiocarps were often found on trunks at places which had been partly debarked by elephants.

Perenniporia medulla-panis (Jacq.: Fr.) Donk s. lat.
in Persoonia 5: 76 (1967). *Polyporus medulla-panis* Jacq.: Fr., in Syst. Mycol. I: 280 (1821).
Collection: *PR* 1580, fallen branch.

According to Ryvarden & Johansen (1980) this is a common species in East Africa. However, the African specimens differ somewhat from the European material. In Europe the walls of the skeleto-binding hyphae are nonamyloid (Niemelä *et al.*, 1992) while in the present African specimen they are locally amyloid (pink-grey) both in subiculum and in trama. In the European material the hyphal cavities of the skeleto-binding hyphae are distinctly amyloid, especially in branched areas, while our specimen totally lacks that character. In addition, spores are strongly dextrinoid in the European material, but in our African collection only faintly reddish brown in IKI. Despite these differencies we are so far inclined to include our specimen in *P. medulla-panis*. The specimen fits well with the description under that name in Ryvarden and Johansen (1980).

Phellinus contiguus (Pers.: Fr.) Pat.
in Ess. Tax.: 97 (1900). *Polyporus contiguus* Fr., in Syst. Mycol. 1: 378 (1821).
Collection: *PR* 1578, fallen branch.

Phellinus ferruginosus (Schrad.: Fr.) Bourdot & Galzin
in Hym. France: 625 (1928). *Polyporus ferruginosus* Schrad.: Fr., in Syst. Mycol. 1: 378 (1821).
Collections: *TN* 5121, *PR* 1598, branch of living tree; *PR* 1603, living tree; *PR* 1605, fallen trunk; *T. Renvall* 482, fallen branch.

The specimens resemble fairly closely the European material. However, spores are somewhat bigger and more thick-walled in the African collections; the measurements overlap. The bigger spore size of *P. ferruginosus* in Africa places it very close to *P. contiguus*, and the division between the two must be made mainly according to the pore and setae size.

Trametes socotrana Cooke
in Grevillea 11: 39 (1882).
Collection: *PR* 1582, fallen branch.

Evidently a common species in tropical Africa. Ryvarden & Johansen (1980) reported this saprotroph from Ethiopia, Kenya, Tanzania, Burundi and Malawi.

Corticioid fungi

Asterostroma medium Bres.
in Bull. Trimest. Soc. Mycol. France 36: 46 (1920).
Collection: *TN* 5298, living tree trunk.

First time *A. medium* was reported from Africa (Zimbabwe) by Masuka & Ryvarden (1992). Some mycologists prefer to use the name *A. cervicolor* (Berk. & M.A. Curtis) Massee and place *A. medium* and *A. ochroleucum* as synonyms. See further Hallenberg (1985) with a fine illustration by John Eriksson of *A. cervicolor*. The present specimen has slightly larger spores and bears more distinct aculei than what is usual for *A. cervicolor*.

Cystidiodontia isabellina (Berk. & Broome) Hjortstam
in Mycotaxon 25: 549 (1986). *Kneiffia isabellina* Berk. & Broome in J. Linn. Soc. Bot. 14: 62 (1875).
Collection: *PR* 1579, fallen branch.

C. isabellina was described from Sri Lanka and was confused with *Cystidiodontia laminifera* (Berk. & M.A. Curtis) Hjortstam (*Hydnum artocreas* Berk. & M.A. Curtis ex Cooke by Hallenberg & Ryvarden, 1975). *Cystidiodontia laminifera* has been found in South and Central America, whereas *C. isabellina* has been collected only in Sri Lanka, Taiwan and Africa [Burundi, Cameroon, Ethiopia, Kenya, Malawi, Rwanda (as *Hypochnicium grandinioides* Ryvarden), Tanzania]. The present strongly hydnoid specimen is greyish white in colour and has 0.7–1mm long and apically finely fimbriate aculei.

Basidiocarp resupinate, effused, closely adnate. *Hymenophore* variable, odontioid to strongly hydnoid, greyish to light brown, *aculei* 3–6 per mm and 0.2–1(–1.5)mm long, smooth or apically fimbriate, *margin* thinning out or slightly byssoid. *Hyphal system* dimitic (and sometimes also with a few binding hyphae). *Generative hyphae* thin-walled, hyaline, intermingled with skeletal hyphae, with clamp connections. *Skeletal hyphae* strongly dextrinoid and cyanophilous, thick-walled, without clamp connections, occuring both in the subiculum and in the middle part of the aculei. *Cystidia* few to rather common, mainly hyaline or sometimes with yellowish colour in KOH, sulpho-negative, tubular, about 25–35 × 6–7μm. Projecting hyphal ends abundant in some specimens, rarely branched. *Basidia* about 20 × 4–5μm, with four sterigmata and a basal clamp. *Basidiospores* almost globose, smooth, thick-walled, 3–3.5μm diam., indextrinoid, slightly or sometimes more strongly cyanophilous.

Dendrothele griseocana (Bres.) Bourdot & Galzin
in Bull. Trimest. Soc. Mycol. France 28: 354 (1913). *Corticium griseocanum* Bres., in Fungi Tridentini 2: 58 (1898).
Collection: *PR* 1619, bark of living tree.

New to Africa. The species was originally described from Italy and it is rather well known in southern Europe. Ginns & Lefevbre (1993) report it from several states

in the USA and from Canada. It is known from Mexico, but has not been reported from the tropics. It has normally two sterigmata in a basidium, but also four are reported in some specimens.

Basidiocarp resupinate, effused, closely adnate. *Hymenophore* ornamented, with sterile hyphal pegs, greyish to almost ochraceous. *Hyphal system* monomitic; hyphae thin-walled, (1.5–)2μm wide, without clamp connections. *Dendrohyphidia* abundant, branched. *Cystidia* absent. *Basidia* with four sterigmata and without a basal clamp. *Basidiospores* short ellipsoid, thin-walled or with slightly thickened walls, about 9–10 × 6–7μm.

Dichostereum kenyense Boidin & Lanq.
in Bull. Trimest. Soc. Mycol. France 96: 394 (1980).
Collections: *TN* 5128, *PR* 1606, living tree trunk, at places debarked by elephant; *PR* 1618 bark of living tree.

Dichostereum kenyense belongs to a somewhat difficult group of about ten closely related species. Separating characters are the size of the spores, the colour of dichohyphae in KOH, and the shape and size of the (sulpho)cystidia. *D. kenyense* is a pale-coloured species, having spores up to 8μm diam., and incised dichohyphae which are never coralloid. It is somewhat similar to *D. effuscatum* (Cooke & Ellis) Boidin & Lanq., but that species has less abundant dichohyphae (they are mostly difficult to find) and smaller spores.

The species is also known from Zimbabwe (Masuka & Ryvarden, 1992).

Gloiothele lactescens (Berk.) Hjortstam
in Windahlia 17: 58 (1987). *Thelephora lactescens* Berk. in J.E. Smith, English Flora 5: 169–170 (1836).
Collection: *PR* 1599, fallen branch.

This is probably a cosmopolitan, but variable species. Recently several species of *Gloiothele* were described by Wu (1996), mainly separated by the spore shape.

Hyphoderma aff. **puberum** (Fr.: Fr.) Wallr.
in Fl. Crypt. Germ. 2: 576 (1833). *Thelephora pubera* Fr., in Elench. Fung. 1: 215 (1828).
Collection: *PR* 1585, fallen branch.

Probably a cosmopolitan species. It is closely related to *Lopharia cinerascens* (Schwein.) G. Cunn. and *L. ayresii* (Berk. ex Cooke) Hjortstam sharing the same type of hyphae, basidia, cystidia and spore morphology. The former is dimitic and has large (10–16 × 6–7.5μm) spores. The latter is monomitic and has spores c.12–14 × 6–7μm. The present specimen has dense, monomitic structure; hymenophore is strongly pilose by long, projecting cystidia, and spores are slightly larger [(9.6–)9.8–12(–12.1) × 4.9–6(–6.1), L = 10.8, W = 5.5, Q = 1.6–2.2 (n = 30/1)] than what is normal (9–10 × 4–5μm) for *Hyphoderma puberum*.

Hyphodontia arguta (Fr.) J. Erikss.
in Symb. Bot. Upsal. 16: 104 (1958). *Hydnum argutum* Fr., in Syst. Mycol. 1: 424 (1821).
Collection: *PR* 1601, bark of living tree.

A cosmopolitan species.

Hyphodontia submucronata Hjortstam & Renvall spec. nov. **Fig. 3.**
Habitu et textura Hyphodontia spathulata similis, sed aculeis plus minus conicis, raro complanatis, cystidiis submucronatis. Basidia suburniformia, 20–25 × 4–4.5μm, 4–sterigmatibus, sporis anguste ellipsoideis, 5–6.3 × 3.2–4μm.
Holotype: Tanzania, Arusha (Northern) Province, Arusha District, western side of Mt. Meru above Laikinoi, ridge between the streams Engare Olmotonyi and Engare Narok, in *Hagenia abyssinica* forest, alt. 2800m, fallen branch of *Hagenia abyssinica*, 14 xii 1988, *Pertti Renvall* 1602 (H, isotypi in K, KUO, GB).

Basidiocarp resupinate, effused, closely adnate. *Hymenophore* hydnoid, cream-coloured to ochraceous, aculei conical or rarely flattened, apically smooth to slightly fimbriate, 3–4 per mm and normally 0.5–1.5mm long, but may be longer. *Margin* not differentiated. *Hyphal system* monomitic; *hyphae* distinct, in the subiculum and in the middle part of the aculei thick-walled or with thickened walls, 2.5–3μm wide, richly branched. All hyphae with clamp connections. *Cystidia* apparently of one kind, few, almost ventricose and with a mucronate appearance, thin-walled or with slightly thickened walls, almost hyaline, 18–30μm long and 4.5–6μm in the middle part. *Basidia* suburniform, thin-walled or basally slightly thick-walled, 20–25 × 4–4.5μm, with four sterigmata and a basal clamp. *Basidiospores* narrowly ellipsoid, smooth, thin-walled, nonamyloid, indextrinoid and acyanophilous, (5–)5.1–6.2(–6.3) × 3.2–4μm, L = 5.6, W = 3.7, Q = 1.28–1.77 (n = 30/1).

This species is very close to *Hyphodontia spathulata* (Schrad.: Fr.) Parmasto, but generally bears almost conical aculei. The most significant separating characteristic is the spore shape. Spores are almost globose in *H. spathulata*, 4.5–5 × 4–4.5μm, whereas in the African species they are narrowly ellipsoid, longer and narrower. Further, capitate cystidia can nearly always be detected in *H. spathulata* and sparsely, more acutely shaped cystidia (gloeocystidia) mainly occur. Apparently, *H. submucronata* has only one kind of cystidia, which are typically acutely ventricose to submucronate.

Phlebia aff. **rufa** (Fr.) M.P. Christ.
in Dansk Bot. Ark. 19: 164 (1960). *Merulius rufus* Fr., in Syst. Mycol. 1: 327 (1821).
Collection: *PR* 1583, living tree.

Phlebia rufa is a cosmopolitan species. The spores of the present specimen are smaller than what is normal for this species, mostly 3.5–4.5μm long. In other respects it seems to fit within the concept. According to Ginns (1976) there are several synonyms involved in this name, including some described from the tropical areas.

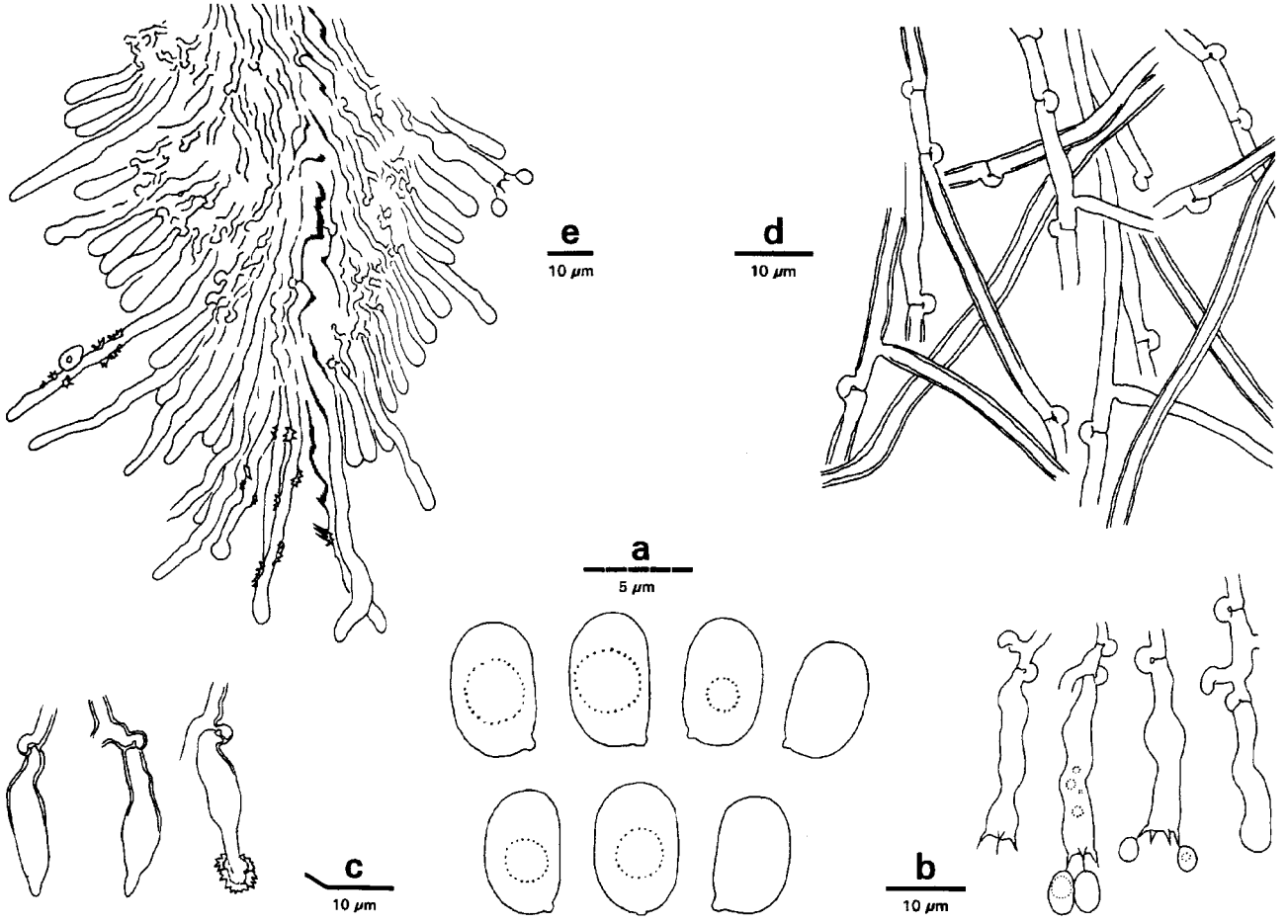

FIG. 3. *Hyphodontia submucronata* (Bourdot & Galzin) Hjortstam & Renvall a) basidiospores, b) basidia and a basidiole, c) cystidia, d) hyphae from subiculum, e) a vertical section from aculeal tip. Drawn from type in Cotton Blue.

Trechispora nivea (Pers.) K.H. Larsson
in Symb. Bot. Upsal. 30: 110 (1995). *Odontia nivea* Pers., in Neues Mag. Bot.: 110 (1794).
Collection: PR 2198a, bark of living tree.

The species has a world-wide distribution and it is common in tropical areas. It has been described several times, e.g., from Sri Lanka (*Hydnum hypoleucum* Berk. & Broome) and from Venezuela (*Hydnum cohaerens* Berk. & M.A. Curtis). For the typification and further information on this species see Larsson (1995).

ACKNOWLEDGEMENTS

Prof. Tamás Pócs (Vácrátót, Hungary) organized some of our field trips to Tanzania and introduced us to the montane vegetation; he also made some notes on the manuscript. Dr D.J. Job (Neuchatel, Switzerland) kindly identified one specimen of *Hymenochaete ochromarginata* for us.

REFERENCES

DALE, I. R. (1940). The forest types of Mt. Elgon. *J. East Africa Nat. Hist. Soc.* 36: 74–82.

DALE, I. R. & GREENWAY, P. J. (1961). *Kenya Trees and Shrubs*. Nairobi: Buchanan's Kenya Estates.

EGGELING, W. J. (1952). *The Indigenous Trees of the Uganda Protectorate*. 2nd edn, revised by I. R. DALE. Entebbe: Government Printer.

ENGLER, A. (1892). *Über die Hochgebirgsflora des tropischen Afrika*. Berlin: Königl. Preuss. Akad. Wiss.

FANSHAWE, D. B. (1971). The vegetation of Zambia. *Rep. Zambia Min. Rural Devel. Forest Res. Bull.* 7: 1–67.

FRIIS, I. (1992). Forests and forest trees of Northeast tropical Africa. *Kew Bull. Add. Ser.* 15: 1–396.

GINNS, J. H. (1976). *Merulius*: s.s. and s.l., taxonomic disposition and identification of species. *Can. J. Bot.* 54: 100–167.

GINNS, J. & LEFEBVRE, M. N. L. (1993). Lignicolous corticioid fungi (Basidiomycota) of North America. *Mycol. Mem.* 19: 1–247.

HALLENBERG, N. (1985). *The Lachnocladiaceae and Coniophoraceae of North Europe*. Oslo: Fungiflora.

HALLENBERG, N. & RYVARDEN, L. (1975). Studies in the Aphyllophorales of Africa. 5. *Cystostereum artocreas*, new to Africa. *Mycotaxon* 2: 135–141.

HAMILTON, A. (1991). *Ugandan Forest Trees*. Kampala: Makerere University.

HAMILTON, A. C. & PERROTT, R. A. (1981). A study of altitudinal zonation in the montane forest belt of Mt. Elgon, Kenya/Uganda. *Vegetatio* 45: 107–125.

HJORTSTAM, K. & RYVARDEN, L. (1986). Some new and noteworthy fungi (Aphyllophorales, Basidiomycetes) from Iguazu, Argentina. *Mycotaxon* 25: 539–567.

IVERSEN, S. T. (1991). The Usambara Mountains, NE Tanzania, phytogeography of the vascular plant flora. *Symb. Bot. Upsal.* 24 (3): 1–234.

JANSEN, P. C. M. (1981). Spices, condiments and medicinal plants in Ethiopia, their taxonomy and agricultural significance. *Agric. Res. Rep. (Versl. Landbouwk. Onderz.)* 906: 1–327.

JOB, D. J. (1987). South African species of *Hymenochaete* (Aphyllophorales). *S. Afr. J. Bot.* 53: 293–299.

LAMPREY, R. H., MICHELMORE, F. & LAMPREY, H. F. (1991). Changes in the boundary of the montane rain forest on Mount Kilimanjaro between 1958 and 1987. In: NEWMARK, W. D. (ed.) *The conservation of Mount Kilimanjaro,* pp. 9–15. Gland & Cambridge: IUCN.

LARSSON, K. H. (1995). Taxonomy of *Trechispora farinacea* and proposed synonyms I. Species with a grandinioid or hydnoid hymenophore. *Symb. Bot. Upsal.* 30: 101–118.

LIND, E. M. & MORRISON, M. E. S. (1974). *East African vegetation.* London: Longman.

MASUKA, A. J. & RYVARDEN, L. (1992). Aphyllophorales on *Pinus* and *Eucalyptus* in Zimbabwe. *Mycotaxon* 44: 243–250.

MWASANGA, B. C. (1991). The natural forest of Mount Kilimanjaro. In: NEWMARK, W. D. (ed.) *The Conservation of Mount Kilimanjaro*, pp. 17–20. Gland & Cambridge: IUCN.

NIEMELÄ, T., KOTIRANTA, H. & PENTTILÄ, R. (1995). New records of rare and threatened polypores in Finland. *Karstenia* 32: 81–94.

NOAD, T. & BIRNIE, A. (1990). *Trees of Kenya.* Nairobi: privately published.

RENVALL, P. & NIEMELÄ, T. (1993). *Ocotea usambarensis* and its fungal decayers in natural stands. *Bull. Jard. Bot. Nat. Belg.* 62: 403–414.

RYVARDEN, L. & JOHANSEN, I. (1980). *A Preliminary Polypore Flora of East Africa.* Oslo: Fungiflora.

TALBOT, P. H. B. (1951). Studies on some South African resupinate Hymenomycetes. *Bothalia* 6: 1–116.

WHITE, F. (1962). *Forest Flora of Northern Rhodesia.* London: Oxford University Press.

WHITE, F. (1983). The vegetation of Africa. *Unesco Natural Resources Res.* 20: 1–356.

WICKENS, G. E. (1976). The flora of Jebel Marra (Sudan Republic) and its geographical affinities. *Kew Bull. Add. Ser.* 5: 1–368.

WU, SHENG-HUA (1996). Studies on *Gloeocystidiellum* sensu lato (Basidiomycotina) in Taiwan. *Mycotaxon* 58: 1–68.

Received 9 September 1997; accepted 2 October 1997