Fungicolous Hypocreaceae (Ascomycota: Hypocreales) from Khao Yai National Park, Thailand

Kadri Põldmaa¹ & Gary J. Samuels²

Institute of Zoology and Botany, Estonian Agricultural Academy, Riia 181,
 EE-51014 Tartu, Estonia, and Estonian Biocenter, Riia 23, EE-51010, Tartu, Estonia
 United States Department of Agriculture, Agricultural Research Service,
 Systematic Botany and Mycology Lab., Rm. 304, B-011A, BARC-W, Beltsville,
 MD 20705, U. S. A.

Põldmaa, K. & G. J. Samuels (2003). Fungicolous Hypocreaceae (Ascomycota: Hypocreales) from Khao Yai National Park, Thailand. – Sydowia 56 (1): 79–130.

An amazingly high diversity of members of the Hypocreaceae (Ascomycetes: Hypocreales) was found in the course of two mycological expeditions (1997, 2001) to the Khao Yai National Park in Thailand, an ASEAN National Heritage Site. In the present publication members of the Hypocreaceae that are exclusively, or primarily, fungicolous are described. The specimens found belong to the genera Hypomyces (16 species), Cladobotryum (6), Sphaerostilbella (4), Sporophagomyces (2), and Hypocrea (2). Here we describe four new species in Hypomyces, two in Cladobotryum and two in Sphaerostilbella. Most of the remaining species listed represent new records for tropical Asia. These poorly known species are characterized in detail and illustrated. LSU rDNA was sequenced from several Thai and some other tropical isolates of Hypomyces and Cladobotryum (presumed asexual Hypomyces). The sequences were added to an existing data matrix, the analysis of which provides a preliminary understanding of the relationships of the studied species with other members of Hypocreaceae. Molecular data were also considered in species delimitation while describing new taxa.

Keywords: Hypomyces, Cladobotryum, Sphaerostilbella, Sporophagomyces, Hypocrea, Gliocladium, Aphyllophorales, ASEAN National Heritage Site, systematics.

The Khao Yai National Park ('Khao Yai'), Thailand, is situated 200 km northeast of Bangkok in Nakhorn Nayok and Prachinburi Provinces. It is Thailand's second largest National Park, covering 2,168 sq km, and was recently designated an ASEAN National heritage Site. It is one of the largest remaining areas of intact forest in tropical mainland Asia, consisting of different types of forests. Most of the ascomycetes reported for Thailand have been collected in Khao Yai. Overviews of the ascomycetes occurring in Thailand deal mainly with representatives of the Xylariales (Whalley & al., 1995, 1998), Sordariales (Chaetosphaeriaceae, Réblová & Seifert, 2003), lignicolous freshwater ascomycetes (Sivichai & al., 2002), or Pezizales and other discomycetes (Dissing, 1963; Phanichapol, 1968). Except

for the entomopathogenic clavicipitalean fungi (Hypocreales: Clavicipitaceae) of Thailand, extensively studied in recent years by Nigel L. Hywel-Jones (e.g. Hywel-Jones, 1997; Hywel-Jones & Samuels, 1998), the Hypocreales of Thailand have not yet been accounted for.

We visited Khao Yai during two three-week expeditions in 1997 and in 2001. Approximately 400 specimens of hypocrealean fungi (Hypocreaceae, Nectriaceae, Bionectriaceae, sensu Rossman & al., 1999) were collected mostly from a moist seasonal tropical broadleaved forest, dominated by members of the Dipterocarpaceae at altitudes of 700-1000 m. Most of the collections were lignicolous and corticolous species of Hypocrea Fr. and various nectrioid fungi. Hypomyces (Fr.) Tul., which, together with closely related anamorphic species, encompasses the majority of fungicolous Hypocreaceae, was the second most frequently encountered genus of this family in the park. The remaining fungicolous Hypocreaceae, species of Sphaerostilbella Sacc., Sporophagomyces K. Põldmaa & Samuels and 'Hypocrea' pallida Ellis & Everh., were less common. About ten collections of fungicolous Hypocreaceae, included in this study, were collected during one-day trips in 1997 and 2001 to the Kaeng Krachan National Park, southwest of Bangkok in Phetchaburi Province, on the border with Myanmar.

Collections from Southeast Asia of fungicolous Hypocreaceae as well as of other hypocrealean fungi have high biogeographic value because the region is, relative to tropical America, little explored with respect to these fungi. Hypomyces species from tropical areas were first described from Cuba and French Guiana by, respectively, Berkeley and Curtis, and Montagne in the middle of the nineteenth century. More recent explorations in these countries as well as in Brazil, Colombia, Guyana, Puerto Rico, Venezuela, and Indonesia by various mycologists have discovered many species of Hypomyces. These collections, including several new species, are described by Rogerson & Samuels (1993) and Põldmaa & al. (1997). With respect to Hypomyces, including anamorphic species that are classified in Cladobotryum Nees, the most intensively studied tropical country is Cuba. In a series of papers Arnold (1985, 1986, 1987, 1988) and Castañeda-Ruíz (1986, 1987; Arnold & Castañeda-Ruíz, 1987) reported 10 species of Hypomyces and 10, mostly new Cladobotryum species from Cuba. The only recent study conducted in Southeast Asia that included also *Hypomyces* is a preliminary inventory of Indonesian fungi (Samuels & al., 1990). Six Hypomyces species as well as one species from the closely related genus Sphaerostilbella, were reported in that work.

The approximately 80 specimens of fungicolous Hypocreaceae found in Khao Yai belong to four genera, viz. *Hypomyces/Cladobotryum*, *Sphaerostilbella*, *Sporophagomyces*, and '*Hypocrea*' pallida.

Almost all of the species were found on basidiomata of various aphyllophoralean basidiomycetes. Exceptions to this were 'H.' triseptatus Rogerson & Rossman, which produces its ascomata on perithecia of ascomycetes, and two Hypomyces species on Auricularia delicata (Fr.) Henn. The latter findings are remarkable because, except for Hypocrea sulphurea (Schwein.) Sacc., which grows on Exidia spp., there are only a few records of the occurrence of Hypomyces/Cladobotryum species on 'jelly fungi' ('heterobasidiomycetes'). We did not find any parasitic Hypocreaceae on members of other groups of potential hosts, e.g. agarics, boletes and discomycetes. Unexpectedly, old fruitbodies of Ganoderma hosted five species of fungicolous Hypocreaceae, while previously mainly Sporophagomyces chrysostomus (Berk. & Broome) K. Põldmaa & Samuels was known to inhabit this group of hosts. Overview of the genus Hypomyces, interactive key to its species, list of related literature as well as short descriptions of other genera of fungicolous Hypocreaceae, treated in this paper, are presented in the Hypomyces website (http://nt.ars-grin.gov/taxadescriptions/keys/HypomycesIndex.cfm).

The majority of the fungicolous collections from Thailand belong to Hypomyces with sixteen species recorded, including four new species. Overall, Hypomyces has been considered to be more common in temperate than in tropical regions, but species that grow on polypores are more diverse in the tropics than in temperate regions (Samuels, 1996). Teleomorphs of several aphylloricolous species are common in tropical regions while only their anamorphs are found in temperate regions. The Thai collections confirm these trends. Most of the species that we report are new for tropical Asia, while H. polyporinus Peck and H. sympodiophorus Rogerson & Samuels have not been recorded outside North America and Europe. Hypomyces mycophilus Rogerson & Samuels has been found only from North America and Japan. We found only one red teleomorphic Hypomyces collection that belongs to the aurofusarin-producing group as defined by Helfer (1991). While its anamorph resembled C. virescens, the identification remained ambiguous because of the lack of a living culture. The specimen will be discussed in a treatment of aurofusarin-producing species in a subsequent publication.

Cladobotryum is the name adopted for the anamorphs of the aphylloricolous Hypomyces species. Because no other teleomorph has been linked to any Cladobotryum species, we take this genus to be taxonomically equivalent to Hypomyces (Põldmaa, 2000) but treat the species separately after the teleomorphic species. Species of Cladobotryum grow on aphyllophoralean as well as on agaricoid basidiomycetes. Half of the 24 species in the genus are known only from the tropics, mostly as single records. Three of these were found in Khao Yai National Park, viz. C. caribense R. F. Castañeda, C. odorum

G. Arnold, and *C. virescens* G. Arnold, all previously collected only once or twice in Cuba. Two new species of *Cladobotryum* are described from Khao Yai.

Four species of Sphaerostilbella were found in Khao Yai. Sphaerostilbella aureonitens (Tul.) Seifert & al. is a common species worldwide but we are not aware of it having been collected previously in tropical Asia. The anamorph of Sphaerostilbella lutea (Henn.) Sacc., Gliocladium aurifilum (Gerard) Seifert & al., is probably cosmopolitan (Seifert, 1985), but its rarely collected teleomorph has only been found in tropical West Africa, Indonesia and, now, Thailand despite extensive collecting in tropical America. The specimen found in Khao Yai is only the third teleomorphic collection known to us. Two species of Sphaerostilbella are described as new, with one of them being common in Khao Yai. Sporophagomyces chrysostomus, found in Khao Yai, is known from many locations worldwide, while Spo. lanceolatus (Rogerson & Samuels) K. Põldmaa & Samuels was previously known only from two closely situated localities in Puerto Rico. The fungicolous 'Hypocrea' pallida is cosmopolitan on the basidiomata of aphyllophores. It is now known not to be a true member of Hypocrea with unclear position in Hypocreaceae (Rehner & Samuels, 1994; Põldmaa, 2000) and is therefore treated as the last taxon in this paper. We also found six Hypocrea specimens growing on aphyllophoralean basidiomycetes. Two of these specimens were identified as H. lixii Pat. on Ganoderma with one selected as an epitype; the descriptions presented by Chaverri & Samuels (2002) are not repeated in this paper. Hypocrea lixii and its anamorph, T. harzianum, are common and cosmopolitan species and occur on a wide range of substrata. The holotype of H. lixii was described from a Ganoderma species in Papua New Guinea. The remaining species of *Hypocrea* found on fungal hosts do not seem to be specifically fungicolous and they will be dealt with in a future study.

Several specimens could not be reliably identified, either because we did not succeed in isolating them into pure culture or because the cultures died before they could be studied. Identification is further complicated by the fact that often only a few specimens of tropical species are known for comparison. The problematic specimens indicate the need for a more detailed study in the taxonomy of the *H. australis-H. subiculosus* and aurofusarin-producing species complexes.

Broad outlines of the phylogeny of *Hypomyces* and related fungicolous hypocrealean fungi were presented recently by Põldmaa (2000) and Põldmaa & al. (1999). These studies were based on the analyses of the large subunit of the ribosomal DNA of collections from temperate areas. This gene region is not suitable for producing

robust phylogenies of hypocrealean fungi. However, we continued analyzing this gene region because of the presence of a tentative phylogenetic framework and sequences for comparison. LSU rDNA sequences were obtained from cultures of new and poorly known taxa sampled in Thailand as well as from some additional tropical species that morphologically resembled the ones studied. The results were used mainly in the delimitation of new species and finding out the close relatives of the several tropical taxa. It was not our intention to investigate large-scale phylogenetic relationships of fungicolous Hypocreaceae in the present paper.

Materials and methods

Morphological characterization

Ascospores or conidia were isolated onto cornmeal dextrose agar (CMD, Difco cornmeal agar + 2% dextrose) or 1.5% malt extract agar (MEA, BioMerieux). The descriptions and illustrations of species are made of cultures grown on MEA in darkness at 22–25° C if not stated otherwise. Colony diameters (grown at 25° C) were measured from 9 cm-diam plastic Petri dishes into which a 4 mm-diam plug taken from the edge of an actively growing colony was placed. In mature specimens 30 ascospores and conidia from nat. substrate and/or culture were measured. The measurements given for ascospores (length taken as including the apiculus) and conidia represent the range of mean values of specimens (the two innermost numbers) and the limits of the 90% range of estimated normal distribution observed in the most divergent specimens (the two outermost numbers). For other structures the absolute ranges are presented.

Unless other citations are given, the information about the distribution of the pleomorphic species is based on the papers by Rogerson & Samuels (1993) and Põldmaa & Samuels (1999). Color references are taken from Kornerup & Wanscher (1967). KOH+ and KOH- indicate the presence or lack of a reaction to 3% aqueous potassium hydroxide solution. Specimens are deposited at one, or all, of the following herbaria: U.S. National Fungus Collections, Beltsville, MD, U.S.A. (BPI); Institute of Zoology and Botany, Tartu, Estonia (TAA); National Science and Technology Development Agency, Bangkok, Thailand (BBH). The names of most frequently cited collectors are abbreviated as follows: P. C. – Priscila Chaverri, K. P. – Kadri Põldmaa, M. R. – Martina Réblová, R. N. – Rungtip Nasit and G. J. S. – Gary J. Samuels.

Isolates used for sequencing

The EMBL/GenBank accession numbers for the 19 new rDNA LSU sequences obtained in this study are: *C. arthrobotryoides* TFC

97-16 - AJ583468; C. asterophorum CBS 676.77 (de Hoog, 1978) -AJ583469; C. cubitense G. Arnold i1361 (Arnold & Castañeda-Ruíz, 1987) - AJ583470; C. dimorphicum TFC 96-70 (Põldmaa, 1996) -AJ583471; C. multiseptatum CBS 173.89 (Helfer, 1991) – AJ583472; C. odorum G. Arnold i1371 (Arnold, 1988) – AJ583473, TFC 97-22 – AJ583474; C. simplex TFC 97-19 - AJ583475; 'H.' cf. amaurodermatis G.J.S. 97-84 - AJ583476; H. australbidus TFC 97-18 -AJ583477, TFC 97-45 - AJ583478; Hypomyces sp. C. T. Rogerson 71-163 (H. australis in Rogerson & Samuels, 1993) - AJ583479, TFC 97-141 (on Trametes sp., Costa Rica, Guanacaste Conservation Area, 20 Oct 1997, leg. P. Chaverri) – AJ583480; Hypomyces khaoyaiensis TFC 97-25 - AJ583481, TFC 97-30 - AJ583482, G.J.S. 01-304 -AJ583483; H. siamensis TFC 97-159 - AJ583484; H. sibirinae TFC 97-29 - AJ583485, TFC 97-158 - AJ583486. The references cited above include further information of respective specimens. Data for the 34 earlier published sequences from the *Hypocrea-Hypomyces* clade, included in this study, are available in papers dealing with the phylogeny of this group (Rehner & Samuels, 1994, 1995; Põldmaa & al., 1999; Põldmaa 2000, 2003).

DNA extraction, amplification and sequencing The protocols followed are described by Põldmaa (2003).

Phylogenetic analysis

Sequences comprising approximately 1320 bp from the 5' end of the LSU rDNA were edited using Sequencher 4.1.4 (Gene Codes, Ann Arbor, Michigan) and aligned manually using the program Genedoc 2.6 (Nicholas & al., 1997). An ambiguously aligned region of 7 bp, approximately 60 bp from the beginning of the sequences, was excluded from the analyses. The aligned sequences of the 56 taxa examined are available in the EMBL-Align database (ALIGN 000620).

Maximum parsimony (MP) and maximum likelihood (ML) analyses were performed with PAUP* 4.0 b10 (Swofford, 1999), using unweighted characters, stepwise addition (addition sequence random, 1000 replications) and tree bisection-reconnection (TBR) swapping. Gaps were treated as missing data. The outgroup was chosen to represent the main three families of Hypocreaceae: Cordyceps capitata (Holmsk.) Link (Clavicipitaceae), Nectria cinnabarina (Tode) Fr. (Nectriaceae) and Nectriopsis violacea (J.C. Schmidt) Maire (Bionectriaceae). Support for clades was evaluated by heuristic MP bootstrap analysis of 1000 pseudoreplications. ML bootstrap analysis consisted of 100 pseudoreplicates with 'fast' stepwise addition.

Using ModelTest 3.06 (Posada & Crandall, 1998), the likelihood ratio test found the TrN+I+G and the AIC test the TrN+I+G model as the best fit for the data. Both models imply gamma-distributed rates and proportion of invariant sites, but base frequencies are equal in the former but estimated in the latter model. The ML analysis was run with the parameters of the TrN+I+G model. It consisted of 4 iterative heuristic searches; the parameters were estimated and reoptimized between the searches until their values remained constant.

Key to teleomorphs of fungicolous Hypocreaceae found in Khao Yai National Park

1.	Ascospores apiculate, finely verrucose to grossly warted
1*.	As cospores non-apiculate, smooth-walled or finely spinulose
	(H. sibirinae, H. sympodiophorus, species of Sphaerostilbella and Sporophagomyces, 'Hypocrea' pallida)
2.	Ascospores 3-septate; growing on black carbonized pyrenomycetes
2*.	Ascospores 1-septate or aseptate; growing on polypores, other aphyllophoroid basidiomycetes, 'jelly fungi' (<i>Auricularia</i> , <i>Exidia</i> , <i>Tremella</i>), wood or bark
3.	Subiculum usually lacking, perithecia seated directly on host's hymenophore
3*.	Subiculum effused over the host 5
4.	Perithecia in their upper part covered with amorphous warts; ascospores fusiform, coarsely warted, apiculi $1-2~\mu m$
4*.	$\begin{array}{cccccccccccccccccccccccccccccccccccc$
5.	Subiculum and perithecia in bright colors (yellow or orange), turning purple, red or pink in KOH solution 6
5*.	Subiculum white to cream or buff, perithecia not in bright colors, not changing color or turning bright yellow or only the base of papilla turning pale pink in KOH solution 7
6.	Subiculum chrome to lemon yellow (with many free ends at the surface, their wall covered with granular incrustatations;) perithecia bright yellow, in KOH solution turning brownish red or pink, especially in the upper part of the venter

6*.	Subiculum and perithecia orange, turning purple in KOH solution
7. 7*.	Ascospores aseptate
8.	Ascospores $>$ 15 μm long, $>$ 6 μm wide; apiculi $<$ 3 μm long
8*.	
9.	Ascospores 24–32.5 μm long, apiculi 4.5–5.5(–7) μm long
9*.	Ascospores mostly $<$ 25 μm long, apiculi $<$ 4.5 μm long 10
10.	Ascospores smooth to finely verrucose/spinulose, apiculi absent
10*.	or < 1 μm
	Ascospores finely verrucose
12. 12*.	As cospores with a piculi $> 2~\mu m.$ 6. H. khaoyaiensis As cospores with a piculi $< 2~\mu m.$
13.	Perithecia amber; ascospores averaging more than 4 μm in width
13*.	Perithecia salmon, peach or orange brown; ascospores averaging less than $4~\mu m$ in width 8. H. polyporinus
	As cospores with a piculi $> 2 \mu m$
15.	Ascospore apiculi acute, with length more than two times of width; ascospore wall verrucose; perithecia yellow to yellow-brown, not reacting to KOH solution or the base of papilla turning pink
15*.	Ascospore apiculi with blunt tips, with length almost equal to width; ascospore wall grossly warted; perithecia grayish to brownish orange, not reacting to KOH solution
16.	Perithecia salmon, peach or buff to light brown
16*.	Perithecia brownish yellow or orange yellow
17. <i>A</i>	Ascospores disarticulating into two subglobose part-spores inside
17*.	of asci

18. 18*.	Subiculum formed as an easily separable fan radiating from one point of attachment under host's hymenophore, trapping brown basidiospores of the host (<i>Ganoderma</i> spp.); ascospores often disarticulating into two part-spores after discharge	
10		
19. 19*.	$\begin{array}{llllllllllllllllllllllllllllllllllll$	
20. 20*.	$ \begin{array}{llllllllllllllllllllllllllllllllllll$	
21.	Ascospores $<$ 15 μm long; growing on fruit bodies of $\mathit{Stereum}$	
21*.	spp	
22.	Subiculum absent, perithecia seated directly on host's (mostly <i>Microporus xanthopus</i>) hymenophore 26. <i>Sph. micropori</i>	
22*.	Perithecia formed in a cottony subiculum, hosts other than M. xanthopus	
23. 23*.	Perithecia sulphur yellow, turning violaceous in KOH solution; yellow hyphae with free ends arising from the perithecial papilla, their walls covered with spines 25. <i>Sph. lutea</i> Perithecia buff or pale yellow, not turning violaceous in KOH solution; free hyphal ends if present not covered with spines 24	
24.	Ascospores aseptate, $4.85.5\times2.12.6~\mu m$, on Ganodermataceae	
24*.	Ascospores 1-septate, $7.5-10\times2.5-3.2~\mu m$, on Stereum spp	
Key to anamorphs of fungicolous Hypocreaceae found in Khao Yai National Park		
1.		
1.	radiating heads or long chains at each conidiogenous locus; conidiogenous cell or branch forming one or several loci 2 (Cladobotryum anamorphs of Hypomyces species)	
1*.	Conidia held in drops of liquid or slime, one drop joining conidia formed from one conidiogenous cell (phialide) or from several phialides of one penicillus; conidiogenous cell forming one conidiogenous locus at the tip	

	(Gliocladium or acremonium-, gliocladium- and verticillium- like anamorphs of 'H.' cf. amaurodermatis, Sphaerostilbella species, Sporophagomyces chrysostomus and 'Hypocrea' pallida
2. 2*.	Each conidiogenous cell/branch forming one conidiogenous locus or rarely 2 loci
	idiogenous locus
3. 3*.	Conidiogenous cells integrated as the terminal cell of singly placed conidiogenous branches
4.	First formed conidia clavate, obovate or obpyriform, with a central hilum, $1-2(-3)$ -septate; subsequent conidia cylindrical ellipsoidal or campanulate, with hilum laterally placed, $0-1(-2)$ -septate
4*.	Conidia mostly cylindrical or ellipsoidal to clavate, their form not clearly differentiated according to the sequence of formation
5.	Conidia within the chain campanulate, with a lateral protuberance (suggesting a second hilum) opposite to the lateral hilum basal width 9–10 μ m
5*.	Conidia within the chain cylindrical, with a laterally placed hilum, basal with $<7~\mu m$ H. siamensis and H. subiculosus their delimitation based on the anamorphs is impossible
6.	Chlamydospores composed of a single, globose, $> 20~\mu m$ diam cell at the end of a supporting cell or on long hyphal branches their wall covered with prominent warts, to $7~\mu m$ high
6*.	Chlamydospores, if present, with cells $<$ 20 μm diam, their wall smooth
7. 7*.	Conidia always cylindrical
8.	Conidia narrowly cylindrical, $16-35 \times 4.6-7.5 \mu m \dots$
8*.	Conidia broadly cylindrical, $16-27.5\times6.5-11~\mu m$
9. 9*.	Conidia green, lower parts of conidiophores red 21. <i>C. virescens</i> Conidia and conidiophores hyaline
10.	More than 4 (>20) conidia formed from a conidiogenous locus conidia held in imbricate chains 6. <i>H. khaoyaiensis</i>

10*.	1–4 conidia formed from each locus, short imbricate chains of conidia appearing as radiating heads
11.	Conidia uniform in size, 9.5–15.5 \times 4.5–5.5 $\mu m,$ 2–4 at each conidiogenous locus
11*.	Conidia very variable in size, $7.5-32\times3.5-7.5$ µm, solitary or rarely 2 at each conidiogenous locus 12. <i>H. sibirinae</i>
12.	Tips of conidiogenous cells/branches swollen, bearing denticles/protrusions each of which terminates in a conidiogenous locus
12*.	Tips of conidiogenous cells/branches not swollen, terminating in a single conidiogenous locus, additional loci formed on denticles located near the tip of the cell or distributed over several integrated cells on the conidiogenous branch
13.	Conidiophores branched dichotomously; conidiogenous cells solitary, paired or in verticils of three, 30–40 μm long, 2.5–4 μm wide, tip globose (to 7 μm diam), or ellipsoidal (11 \times 7 μm), forming up to 20 denticles with conidiogenous loci; conidia (1–)2(–3)-septate
13*.	Conidiophores unbranched; conidiogenous branches solitary, to 300 long, 2–3 μm wide; conidiogenous cell integrated, terminal, forming to 12 small protrusions with loci at the slightly swollen tip; conidia (0–)1(–2)-septate 20. <i>C. simplex</i>
14.	Conidiogenous cells integrated into long (50–400 μm) conidiogenous branches that are solitary, paired or in verticils of three, usually forming $>$ 3 loci distributed over some or all of the integrated conidiogenous cells; conidiogenous loci formed on small denticles lacking a refractive area; conidia ellipsoidal to clavate
14*.	Conidiogenous cells paired or in verticils of 3–10, 15–30 (–50) μm long, forming 1–3 loci near the tip of the cell; conidiogenous loci formed on prominent refractive denticles; conidia cylindrical to obovate
15.	Conidiogenous branches forming to 50 loci, each locus forming one conidium (except for the first formed locus that may produce up to 5 conidia) 7. <i>H. mycophilus</i>
15*.	Conidiogenous branches forming to 8 loci, with each locus forming to 20 conidia
16.	Conidiogenous locus forming to 20 conidia; conidia to 30 μm long
16*.	Conidiogenous locus forming to 5 conidia; conidia to 40 µm long 9. <i>H. pseudopolyporinus</i>

17.	Conidia 1–3(–5)-septate, 16–34 μm long, cylindrical
17*.	Conidia 1-septate, 10–19 μm long, cylindrical to obovate 4. H. sympodiophorus and 15. H. thailandicus their delimitation based on the anamorphs is impossible
18.	Anamorph forming feathery fans on the pore surface of <i>Ganoderma</i> , fans brown due to the trapped basidiospores of the host; conidiophores acremonium-like; phialides solitary, integrated; conidio 0.2 contate 10.20(.27) um long
18*.	conidia 0–3-septate, 10–20(–27) μm long 27. Spo. chrysostomus Feathery fans not formed; conidiophores synnematous or mononematous, gliocladium-like with phialides, metulae and supporting branches appressed towards the tip of the well-differentiated stipe of the conidiophore, or verticillium-like with phialides divergent in verticils and stipe not strongly differentiated; conidia mostly aseptate and $<$ 10 μm long 19
19. 19*.	$\begin{array}{llllllllllllllllllllllllllllllllllll$
20. 20*.	$ \begin{aligned} & \text{Conidia} < 1.6 \; \mu\text{m wide} \; \dots & & 21 \\ & \text{Conidia} > 1.6 \; \mu\text{m wide} \; \dots & & 22 \end{aligned} $
21. 21*.	Conidiophores synnematous, synnemata yellow, turning purple in KOH solution
22.	Main stipe of the conidiophore verruculose
22*.	$\begin{tabular}{ll} $\text{Main stipe of the conidiophore smooth} & & 23. Sph. aureonitens \\ \end{tabular}$
23.	Conidiophores in nature with a well-differentiated main stipe, covered with prominent, globose warts; conidiophores in culture indistinct, stipes, if present, without warts; conidia 0(–3)-septate, $4.011.4\times1.84.4~\mu\text{m}.\dots\dots\dots1.$ 'H.' cf. amaurodermatis
23*.	Conidiophores without a differentiated stipe, warts lacking, conidia 0(–1)-septate, 4.4 – 9.1×1.6 – $2.9 \mu m$ 26. $Sph.$ $micropori$

Taxonomy

1.'Hypomyces' cf. amaurodermatis Rogerson & Samuels, Mycologia 85: 243. 1993. – Figs. 1a, 2a–h.

Anamorph: gliocladium-like.

Subiculum absent, perithecia seated on an inconspicuous basal stroma composed of small thin-walled cells (not observed in

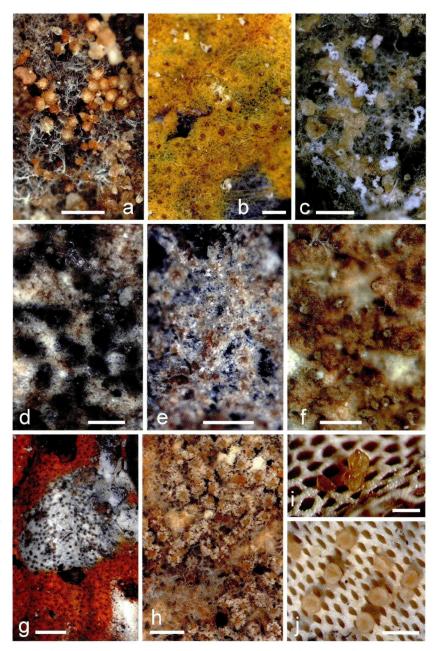


Fig. 1. Species of *Hypomyces* and *Sphaerostilbella*. Subiculum and/or perithecia on hosts. – a. 'H.' cf. amaurodermatis. Conidiophores among perithecia. – b. *H. auriculariicola*. – c. *H. australbidus*. White masses of extruded ascospores at the tips of perithecia. – d. *H.* cf. australis. – e. *H. khaoyaiensis*. – f. *H. siamensis*. – g. *H. subiculosus*. Albinotic are in the middle of the subiculum with perithecia. – h. *Sph. ganodermatis*. Conidiophores among perithecia. – i, j. *Sph. micropori*. – a = G.J.S. 9195; b = 9219B; c = TAA 169685; d = G.J.S. 9070; e = G.J.S. 9050; f = G.J.S. 8277b; g = G.J.S. 9083; h = G.J.S. 9189; i = G.J.S. 8278; j = G.J.S. 8279. – Scale bars: a, g = 1mm; b, d, i = 250 μm; c, e, f, h, j = 500 μm.



G.J.S. 8249) on the host hymenophore, scattered to gregarious. – Perithecia yellow or orange-brown, in G.J.S. 9195 becoming blackish in age, KOH-, $550\text{-}640\times350\text{-}535~\mu\text{m}$; perithecial wall ca 35 μm thick, not differentiated into layers, composed of very tightly arranged subglobose to angular thick-walled cells, $13\text{-}18\times10\text{-}12~\mu\text{m}$. Warts, composed of amorphous material, surround the wall near the top of the perithecia, just below the ostiole or the papilla. Papilla absent or conical, $100\text{-}200~\mu\text{m}$ high, attenuating from 85–150 μm at the base to 40 μm at the tip; in G.J.S. 9195 outgrowths from the top of the papilla suggesting initials of new perithecia. – Asci cylindrical $100\text{-}180\times6.5\text{-}10~\mu\text{m}$; ascospores uniseriate with ends overlapping. – Ascospores fusiform, $12\text{-}14.2\text{-}14.5\text{-}17\times3.3\text{-}4.3\text{-}4.8\text{-}6.1~\mu\text{m}$, l/w 2.3-3.1-3.4-4.1, septum median or sometimes lacking, wall coarsely warted; apiculi $1\text{-}2~\mu\text{m}$ long, with blunt tips, lacking in some ascospores.

A gliocladium-like anamorph, consisting of pure white bundles of conidiophores present between the perithecia as well as forming separate patches in G.J.S. 8249 and G.J.S. 9195. - Conidiophores 250-560 μm long and 3-6 μm wide, unbranched or producing one side branch, frequently septate. Conidiophore stipes (except for the uppermost parts) bearing prominent, globose, warts; warts $1.5 \, \mu m \times 0.8 - 1.3 \, \mu m$, constricted below to form a narrow 'neck'; ornamentation becoming partly detached but not totally dissolved in KOH. Branching at top of conidiophore mono- to biverticillate; metulae, if present, cylindrical, 15-20 µm long, 2.5-3.0 µm wide, smooth, with 2-4(-5) phialides formed from one point. - Phialides cylindrical, 13-43 μm long, attenuating from 1.6-2.2 μm at the base to $0.8-1.5 \, \mu m$ at the tip. Conidia held in globose masses in a $10-43 \, \mu m$ diam drop of liquid. - Conidia cylindrical to ellipsoidal, sometimes flat at one side to bean-shaped, $4.2-6.5-6.6-9.0 \times 1.8-2.4-2.8-3.6 \mu m$, hyaline, aseptate.

Characteristics in culture. – Colonies spreading moderately fast on MEA, reaching 80 mm diam in 7 d; translucent, reverse uncolored; aerial mycelium scant, hyphae mostly submerged, 5–8 μm wide, frequently septate, sometimes aggregated and forming fine ropes on the surface of the agar. – Conidiophores mostly indistinct with stipes 90–180 μm long and 3.4–5.0 μm wide at the base or lacking with phialides arising from submerged or aerial hyphae or on short lateral branches. – Phialides held singly or by 2–4 in verticils or indistinct penicillate heads, subulate, 25–60 μm long, 2.3–3.5 μm wide at the base, attenuating to 0.8–1.4 μm at the tip, with a minute collarette at the tip. – Conidia ellipsoidal to cylindrical, irregular in shape, mostly equilateral with tips rounded, 4.0–7.5–11.4 \times 1.8–3.1–4.4 μm , l/w 1.5–2.2–2.8, mostly aseptate or 1–3-septate, held in clear drops of liquid.

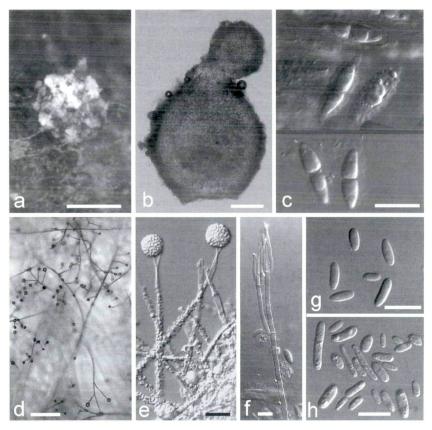


Fig. 2. 'Hypomyces' cf. amaurodermatis. – a. Perithecium with white amorphous warts covering the upper part of the venter. – b. Perithecium with an outgrowth from the top of the papilla. – c. Ascospores; the two ascospores in the lower half without apiculi and ornamentation. – d. Anamorph. – e, f. Conidiophores. – g, h. Conidia. – a, c, e–g = G.J.S. 8249; b = G.J.S. 9195; d, h = G.J.S. 97-84. a–c, e–g from natural substratum; d, h on MEA. – Scale bars: a = 200 μ m, b, d = 100 μ m, c, f–h = $10~\mu$ m, e = 20 μ m.

Specimens examined. – THAILAND: Khao Yai, Nature trail at km 33, Nong Pak Chi, on *Amauroderma* sp., 1 Aug 1997, G. J. S. 8249, K. P. & P. C. (BPI 745798, BBH, TAA; culture G. J. S. 97-84, TFC 01-23, CBS 113174); Mo Sing To trail from shops near Park Headquarters, on *Amauroderma* sp., 4 Sep 2001, G. J. S. 9195 & R. N. (BPI 842046). Phetchaburi Prov., Kaeng Krachan National Park, vic. Torthip Falls, between 12°51'N, 99°19'E, elev. 671 m and 12°51'N, 99°18'E, elev. 401 m, in primary forest on a ridge top, on *Amauroderma* sp., 26 Aug 2001, G. J. s. 9159, M. R. & R. N. (BPI 842041).

The Thai specimens deviate from the type as well as other known collections of H. amaurodermatis in having considerably larger perithecia and rather a pseudoparenchymatous than hyphal

perithecial wall that is covered with warts in the upper part, in the lack of a subiculum and possession of a basal stroma. The ascospore morphology of the Thai specimens, on the other hand, corresponds to that described earlier for the other collections. In G.J.S. 8249 the sheath, composed of the ornamentation and the apiculi, that covers the ascospores often becomes detached or dissolved leaving the ascospore 'naked'. Such ascospores are suggestive of *Sporophagomyces chrysostomus* and sometimes they are seen to disarticulate at the septum in a similar way.

No anamorph was previously known for *H. amaurodermatis*. The anamorph found in the two Thai specimens is of a gliocladium-type but differs from the *Gliocladium* anamorphs of *Sphaerostilbella* in having coarsely ornamented long conidiophores, the penicillus of which is only mono- to biverticillate. In the simple branching pattern in culture the anamorph is suggestive of the acremonium-like anamorph of *Spo. chrysostomus* which, however, lacks clearly differentiated conidiophores in nature. The same gliocladium-like anamorph is present also in the type collection of *H. amaurodermatis*.

Hypomyces amaurodermatis has previously been known only as a few collections from French Guiana and Guyana, in northeastern South America.

2. **Hypomyces auriculariicola** K. Põldmaa & Samuels, **sp. nov.** – Figs. 1b, 3a-e.

Anamorph: Cladobotryum sp.

Subiculum effusum, flavum, ex hyphis 3.5–5 µm latis compositum quae saepe liberae in superficiem exeunt, parietibus granulis incrustatis. Perithecia obpyriformia, $300-400\times250-340$ µm, in subiculo quasi tota immersa, gregaria, lutea, parte immersa KOH ope ad roseum vertentia; papilla acuta, 70-100 µm alta. Asci cylindrici, $100-125\times5-9$ µm, octospori, apice incrassato. Ascosporae fusiformes, $15-16.9-18.8\times4.2-4.7-5.3$ µm, hyalinae, aeque bicellulares, verrucosae, apiculatae; apiculi 1.2-1.7 µm longi. Conidia $24.7-27.3\times7-7.5$ µm. Chlamydosporae abundantes, subglobosae, 2-3-cellulares, cellulae 10-15 diam, hyalinae vel dilute melleae.

Subiculum effused over the hymenial surface of several fruit-bodies of the host, chrome to lemon yellow (3 A–B 6–7); hyphae 3.5–5 μm wide, cells not swollen; many free ends at the surface, their wall covered with granular incrustatations; in KOH at first no change of color, with yellow coloration partially fading later and the incrustations mostly dissolving; hyphae surrounding the perithecia hyaline and smooth, KOH-. – Perithecia densely gregarious, immersed in the subiculum with papilla free; obpyriform, 250–360 \times 170–270 μm ; in water bright yellow, in KOH turning brownish red or roseous, especially in the upper part of the venter, with the

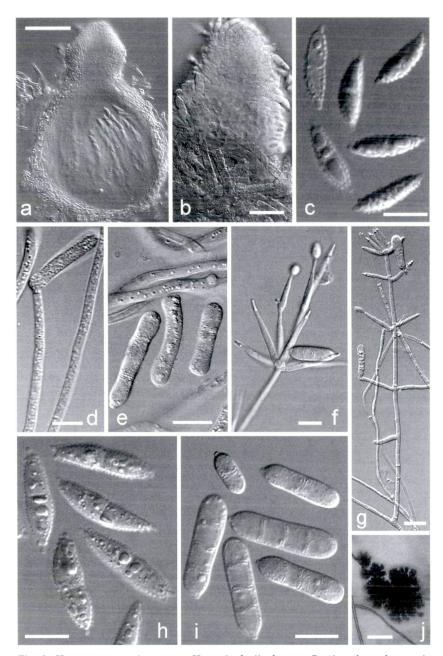


Fig. 3. Hypomyces species. – a–e. H. auriculariicola. – a. Section through a perithecium. – b. Perithecial papilla with incrusted hyphae at the base. – c. Ascospores. – d. Conidium at the tip of a conidiogenous cell. – e. Conidia. – f–j. H. australbidus. – f. Conidiogenous cells in a verticil at the tip of a conidiophore. – g. Conidiophore. – h. Ascospores; two ascospores with two apiculi at one end. – i. Conidia. – j. Chrystals.– a–e = GJS 9219B; f, i, j = TFC 97-45; g = TFC 97-18; h = TAA 169685. a–c, h from natural substratum; d, e on CMD; f on PDA; g, i, j on MEA. – Scale bars: a = 100 μ m; b, g = 20 μ m, c–f, h, i = 10 μ m; j = 50 μ m

color fading in time; perithecial wall 15–20 µm thick, formed of several layers of flattened cells in the outer part with 1.5–2.0 µm thick walls, becoming progressively thin-walled inwards, cells 5.5–13.0 × 2–4 µm; papilla conical, 70–100 µm high, width decreasing from up to 75 µm to 35–42 µm at the tip, cells at surface 5.7–7.8 × 2.7–3.7 µm. – Asci cylindrical, $100-125\times5-9$ µm, apex thickened to 1 µm and with a ring; ascospores uniseriate with overlapping ends. – Ascospores fusiform, 15–16.9–18.8 × 4.2–4.7–5.3 µm, l/w 2.9–3.6–4.7, hyaline; medianly 1-septate; covered with <0.7 µm high warts; apiculate, apiculi 1.2–1.7 µm long, 1–1.5 µm wide at the base with blunt tips. – Chlamydospores abundant in the subiculum, hyaline to pale brown, 2–3-celled, cells subglobose, 10–15 µm diam, smooth-walled, wall 1.4–1.6 µm thick. – Conidia rare, cylindrical, 24.7–27.3 × 7.0–7.5 µm.

Characteristics in culture. – Colonies on CMD spreading moderately fast, reaching 75 mm diam at 20 C in 2 weeks; cottony; no pigmentation. – Odor absent. – Conidiophores arising from aerial mycelium, as erect, undifferentiated branches, unbranched, multiseptate; attenuating gradually from 3.0–4.5 μm at the base to approx. 2 μm at the tip, conidiogenous cells integrated as the topmost cell, with one terminal conidiogenous locus, forming several conidia in imbricate chains; proliferation of conidiogenous cells retrogressive. – Conidia cylindrical, straight, hyaline, 16–25–35 \times 4.6–6–7.5 μm , l/w 2.8–4.2–5.6, (0–)2–3(–4)-septate, with a protuberant central or laterally displaced basal hilum. – Chlamydospores not observed.

 $\tt Holotype.-THAILAND:$ Khao Yai, Princess Trail, 4 km S of park head-quarters in disturbed forest, $14^\circ28'N,\ 101^\circ22'E,\ elev.\ 720$ m, on $Auricularia\ delicata,\ 6$ Sep. 2001, G.J.S. 9219B, M.R.& R.N. (BPI 842048, isotype TAA).

Hypomyces auriculariicola is easily distinguished by its bright yellow subiculum and perithecia and the incrustated free ends of the subicular hyphae. Among aphyllophoricolous Hypomyces species, a yellow subiculum can sometimes be seen in H. aurantius and H. subiculosus, but in these species the perithecia are deep orange. The size and morphology of the ascospores are similar to those in H. pseudopolyporinus and H. subiculosus. Unfortunately, the culture died before we managed to examine it more closely. The anamorph resembles that of H. pseudopolyporinus and H. puertoricensis but differs in the absence of intercalary conidiogenous loci and the smaller size of the conidia, respectively.

The occurrence of *H. auriculariicola* on a species of *Auricula* is noteworthy because species of *Hypomyces/Cladobotryum* are only occasionally found on heterobasidiomycetes. The reports in literature include *H. semitranslucens* G. Arnold on *Auricularia delicata*. *Exi*

dia glandulosa Fr.: Fr., and Tremella reticulata (Berk.) Farlow (Rogerson & Samuels, 1993); the anamorph of H. polyporinus (Helfer, 1991) and C. stereicola G. Arnold (as Cladobotryum sp. in Gams & Hoozemans, 1970) on A. auricula (= Hirneola auricula-judae); the anamorphs of H. aurantius and H. semitranslucens on Auricularia mesenterica (Põldmaa, 1999) and C. longiramosum R. F. Castañeda and C. pinarense R. F. Castañeda on Auricularia sp. (Castañeda-Ruíz, 1986).

3. **Hypomyces australbidus** K. Põldmaa & Samuels, **sp. nov.** – Figs. 1c, 3f–j.

Anamorph: Cladobotryum sp.

Subiculum effusum, pallidum. Perithecia obpyriformia, $280-360\times210-240~\mu m$, succinea, KOH ope colore immutata, fere superficialia, solitaria; papilla usque ad $100~\mu m$ alta. Asci cylindrici, $120-140\times6-8~\mu m$, octospori, apice paulum incrassato. Ascosporae fusiformes, $19.0-22.3-25.6\times4.4-5.1-5.9~\mu m$, aeque bicellulares, raro tricellulares, prominenter verrucosae, apiculatae, apiculi usque ad $1.5~\mu m$ longi. Coloniae in agaro dicto 'MEA' byssaceae, albae; conidiophora a hyphis aeriis haud distincta. Cellulae conidiogenae verticillatae, subulatae, $20-30~\mu m$ longae, ad basim $3.5-4.5~\mu m$ latae, 1-3 locis conidiogenis e protrusionibus refringentibus ortis. Conidia cylindrica, $16.0-22.1-27.6-34.0\times5.0-6.3-8.7-10.1~\mu m$, 1-3(-5)-septata, hyalina. Chlamydosporae absentes.

Subiculum scarce, buff, KOH-, effused over part of the host hymenophore. – Perithecia obpyriform, $280\text{--}360\times210\text{--}240~\mu\text{m},$ amber, KOH-; immersed at the base or almost entirely superficial on subicular hyphae, mostly solitary or in groups of a few; papilla obtuse, to $100~\mu\text{m}$ high, width decreasing from $80\text{--}120~\mu\text{m}$ to $80~\mu\text{m}$ at the tip, cells at the surface swollen, $9\text{--}10\times6~\mu\text{m}$. – Asci cylindrical, $120\text{--}140\times6\text{--}8~\mu\text{m}$, apex thickened to $1.2~\mu\text{m}$. – Ascospores fusiform, some inequilateral, $19.0\text{--}22.3\text{--}25.6\times4.4\text{--}5.1\text{--}5.9~\mu\text{m}$, l/w 3.6--4.3--5.1, 1(-2)-septate, septum median; wall finely warted; apiculate, apiculi less than $1.5~\mu\text{m}$ long, with blunt tips, occasionally split at the tip into two or three smaller apiculi.

Characteristics in culture. – Colonies moderately fast-growing, reaching 30–80 mm diam in 7 d; mycelium cottony, white; margin irregular, reverse uncolored or cream, no odor. – Conidiation moderate but perithecia produced in abundance. Submerged mycelium dense and fasciculate. – Conidiophores arising from aerial hyphae, little differentiated from these, bearing conidiogenous cells in verticils of 2–10; conidiogenous cells subulate, 20–30 long, 3.5–4.5 wide near the base, attenuating to ca 1 µm at tip, with 1–3 conidiogenous loci near the tip, each formed on a refractive 2.5–5.5 µm long protrusion. – Conidia cylindrical, 16.0–22.1–27.6–34.0×5.0–6.3–8.7–10.1 µm, 1/w 2.5–3.2–3.5–4.6, 1–3(–5)-septate, with a central

hilum at the base, borne singly on each locus. - Chlamydospores not observed. Subglobose white crystals formed in abundance in the agar medium.

Holotype. – Khao Yai, a trail near Visitors' Center, on *Amauroderma* sp., 30 Jul 1997, G.J.S. 8204, K.P. & P.C. (isotypes TAA 169685, BBH; cultures TFC 97-45, CBS 100359).

Anamorph specimen examined. – THAILAND: Khao Yai, Wang Jumpee trail to Lap Tha Kong Creek, on small agarics on a branchlet, 31 July 1997, K. P. (TAA 169699, culture TFC 97-18).

The species is very similar to *H. albidus* that is known only from Europe, where its teleomorph is found mostly on Stereum sanguinolentum but the anamorph forms on diverse aphyllophores. In both species the conidiogenous cells bear 1-3 loci that are formed at the tip of a refractive area. Similar conidiogenous cells are found only in three other species growing on Stereaceae (Põldmaa, 2003). Hypomyces australbidus differs from H. albidus in having more slender ascospores, comparatively high and cottony colonies that lack brownish coloration, and the growth rate about twice as fast as in H. albidus. Remarkable is the formation of long, 2-septate ascospores. As a rule, ascospores of *Hypomyces* species are 0–1-septate. We also noted two apiculi at the ends of some ascospores, not observed earlier in *Hypomyces*. The conidia in the culture from the anamorphic collection are much larger $(21.3-27.6-34.0\times7.4-8.7-$ 10.1 μ m) than those in the ex-holotype culture (16.0–22.1–28.2 \times 5.0– $6.3-7.6 \mu m$).

4. Hypomyces cf. australis (Mont.) L.-R. Tulasne, Ann. Sci. Nat., Bot., Sér. IV, 13: 12. 1860. – Figs. 1d, 4a–c.

Anamorph: Cladobotryum sp.

Subiculum effused over parts of the host hymenium, thin, white to buff, KOH-, hyphae densely interwoven, some with free ends at the surface. – Perithecia immersed in the subiculum except for the papilla, older ones sometimes free on the subiculum; $250-300\times225-250~\mu m$; at first pale yellow or buff with a brown disk at the papilla, older perithecia dark brown appearing almost black, KOH-; papilla low, $63-67~\mu m$ high, $67-87~\mu m$ wide, flat at the top. – Asci cylindrical, ascospores uniseriate with ends overlapping. – Ascospores fusiform, with one side often flat, $24.3-26.8-28.4-32.4\times4.8-5.6-5.9-6.8~\mu m$, l/w 4-4.8-5.7, septum median, wall grossly warted, warts to 1.5 high and confluent; apiculi $4.5-5.5(-7)~\mu m$ high, $1.7-2.5~\mu m$ wide at the base, with tips acute.



Fig. 4. *Hypomyces* species. – a–c. *H.* cf. *australis*. – a. Perithecium. – b. Ascospores. – c. Conidia. – d, e. *H.* cf. *favoli*. – d. Ascospores. – e. Chlamydospores. – f–j. *H. khaoyaiensis* – f. Ascospores. – g. Anamorph with 'ordinary' (indicated by arrows) and 'secondary' conidiogenous cells bearing small conidia in imbricate chains. – h. Top of a conidiophore. – i. Chlamydospores. – j. ordinary and small 'secondary' conidia. – a–c = G.J.S. 9070; d = G.J.S. 8305; e = G.J.S. 9079; f = G.J.S. 9050; g, j = G.J.S. 01–304; h, i = TFC 97–24; a–f from natural substratum; g, j on MEA; h on PDA; i on CMD. – Scale bars: a = 50 μ m; b–f, j = 10 μ m; g = 100 μ m; h, i = 20 μ m.

Anamorph arising from a dense buff mycelium. A few single broad subulate and septate conidiogenous cells seen, 20–100 μm long, 7–9 μm wide. – Conidia abundant, (broadly) cylindrical, 16–21.6–27.5 \times 6.3–9–11 μm , l/w 1.2–2.7–4.2; (0–)1(–3)-septate, hilum central and narrow but mostly laterally displaced and broad, indicative of retrogressively proliferating conidiogenous cells with conidia being held in imbricate chains. – Chlamydospores in mycelium, hyaline, one-celled, 13–19.5 μm diam, wall 1.5–3 μm thick, smooth.

Specimens examined. – THAILAND: Khao Yai, Khlong E Thao, along river, ca. 3.5 km W of Nong Pak Chi, $14^\circ 28$ 'N, $101^\circ 20$ 'E, elev. 705 m, on *Rigidoporus microporus* (Fr. : Fr.) Overeem, 17 Aug 2001, G. J. S. 9070 (BPI 842034); in primary forest between $14^\circ 28$ 'N, $101^\circ 22$ 'E, elev. 800 m and Bun Pai $(14^\circ 29$ 'N, $101^\circ 22$ 'E, elev. 760 m), on *R. microporus*, 18 Aug 2001, G. J. S. 9082 & R. N. (BPI 842037).

The teleomorph of these Thai specimens resembles the type specimen of H. australis but the anamorphs are different. On the examination of specimens cited as H. australis by Rogerson & Samuels (1993) we came to the conclusion that their characterization is based on morphologically diverse specimens. The type material of H. australis is composed of reddish brown to almost black perithecia in a whitish subiculum, accompanied by 7-8-celled Blastotrichum chlamydospores and aseptate ellipsoidal to obovate conidia, similar to those found in *H. armeniacus*. The ascospores in the type measure $24.3-29.1-33.9 \times 4.5-5.2-6.6 \mu m$, l/w 4.6-5.6-6.6. A similar specimen, Rossman 4049, depicted in Figs. 99–102 in Rogerson & Samuels (1993) has ascospores of approximately the same size and amber to pale yellow or orange-brown perithecia. In culture the colonies are pink or red, forming 1-3-septate cylindrical conidia and chlamydospore aggregations suggestive of papulaspores similar to those found in C. cubitense. Rest of the cited specimens are not conspecific with the type of H. australis and are discussed under H. siamensis which they resemble most.

5. Hypomyces cf. favoli Samuels, K. Põldmaa & Lodge, Sydowia 49: 82. 1997. – Fig. 4d, e.

Anamorph: Cladobotryum sp.

Subiculum covering almost the whole hymenophore of the host, white to cream-colored, KOH-, composed of densely interwoven hyphae; hyphae 4–5 μ m wide, cells not swollen. – Perithecia gregarious, immersed in the subiculum except for the papilla, yellowish or orange brown, KOH-, 337–360 × 230–240 μ m wide; wall pseudoparenchymatous. Papilla conical, 87–117 μ m high, attenuating from 75–100 μ m wide at the base to 50–75 μ m at the top, surface cells 10–13 × 7–10 μ m. – Ascospores broadly fusiform, hyaline to pale yellowish or

greenish brown, 17–20.6–21.0–24.2 \times 6.2–7.1–7.5–8.6 μ m, l/w 2.4–2.7–3–3.5, aseptate; wall grossly warted; apiculate, apiculi 1.5–2.5 μ m long with blunt tips. – Chlamydospores among the subicular hyphae, subglobose, hyaline, 20–30 \times 15–25 μ m, smooth-walled.

Specimens examined. – THAILAND: Khao Yai, Phakrajai, 6 Aug 1997, on *Ganoderma* sp., G. J. S. 8305 (BPI 745851, TAA 169773, BBH); between 14°28'N, 101°22'E, elev. 808 m and Bun Phai (14°29'N, 101°22'E, elev. 760 m), in primary forest, 18 Aug 2001, on *Ganoderma* sp., G. J. S. 9079 & R. N. (BPI 842036).

Hypomyces favoli was previously known only from two collections on Polyporus tenuiculus in Puerto Rico. The two Thai collections differ from these in slightly longer and more slender ascospores and in the lack of a KOH reaction at the base of the papilla. Another aphyllophoricolous Hypomyces with aseptate ascospores is H. puertoricensis that has smaller ascospores with longer apiculi and chlamydospores with prominent warts. It is noteworthy that all specimens from both of these species collected in Thailand were found on basidiomata of Ganoderma sp., a host on which these species had previously not been recorded. Moreover, species of Ganoderma do not usually host species of Hypomyces although they are often parasitized by Sporophagomyces chrysostomus.

In both Thai collections a gliocladium-like anamorph was seen growing all over the subiculum and the perithecia. The conidiophores of the 2 collections differed, however, from each other in the differentiation and coloration of the main stipe, the branching pattern and the ornamentation of the conidiophore, as well as in the size of the conidial mass and individual conidia. The sequence from the anamorph isolate obtained from G.J.S. 8305 is most closely related to the Nectriaceae, disproving thus the conspecificity of the anamorph with the closely associated *Hypomyces* teleomorph.

6. Hypomyces khaoyaiensis Põldmaa & Samuels, sp. nov. – Figs. 1e, 4f–i.

Anamorph: Cladobotryum sp.

Subiculum effusum, pallidum; hyphae hyalinae, 4–6 μ m latae. Perithecia solitaria vel gregaria, semiimmersa vel fere superficialia, obpyriformia, 275–310 × 180–220 μ m; bubalina vel dilute brunnea, KOH ope colore immutata; papilla acuta, 82–100 μ m alta, 62–90 lata. Asci cylindrici, 120–140 × 5–7 μ m, octospori, apice paulum incrassato. Ascosporae fusiformes, 18.8–21.4–23.9 × 3.6–4.2–4.8 μ m, aeque bicellulares, hyalinae, verrucosae, apiculatae; apiculi 3.4–4.3 μ m longi. Anamorphosis in natura haud visa. Coloniae in agaro 'MEA' dicto byssaceae, albae; conidiophora a hyphis aeriis haud distincta, irregulariter ramosa. Cellulae conidiogenae verticillatae, subulatae, 25–50 μ m longae, ad basim 2–3 μ m latae, ex uno loco ad 20 conidia producentia, conidia catenis imbricatis adhaerentia. Conidia cylindrica, ellipsoidea vel clavata, 14.9–21.0–24.4–31.4 × 5.1–6.1–8.6–10.0 μ m, (1–)3(–4)–septata, hyalina. Chlamydosporae hyalinae, subglobosae, 12–14 μ m diam.

Subiculum effused over almost the whole fruit body of the host; scarce, thin, arachnoid, white to buff, KOH-; hyphae hyaline, 4–6 μm wide. – Perithecia solitary to gregarious, semi-immersed in the subiculum to almost free; obpyriform, 275–310 $\mu m \times 180-220~\mu m$ diam; buff to pale brown, KOH-; wall 15–20 μm thick, pseudoparenchymatous; papilla acute, 82–100 high, tapering from 62–90 μm wide at the base to 30–50 μm at the top, composed of diverging rows of cells, surface cells measuring 7–12 × 4–7 μm . – Asci cylindrical, 120–140 × 5–7 μm , tip thickened, no pore observed; ascospores uniseriate with overlapping ends. – Ascospores fusiform, sometimes flat on one side, 18.8–21.4–23.9 × 3.6–4.2–4.8 μm , l/w 4.3–5.1–5.9, hyaline, medianly 1-septate, verrucose, apiculate; apiculi 3.4–4.3 μm long with blunt tips. – Anamorph not observed.

Characteristics in culture. - Colonies spreading moderately fast, reaching 22-45 mm diam in 7 d; cottony, aerial mycelium scant or abundant, to 8 mm high; margin regular or uneven; white, reverse not colored or turning pale cream-colored or yellowish; submerged hyphae not swollen, 3.4-5.4 wide. - Odor lacking or sweetish. - Conidiation moderate to abundant. - Conidiophores arising from submerged or aerial hyphae, hardly differentiated, 3.5-3.8 µm wide near the base; unbranched or branching irregularly, bearing one or two verticils of conidiogenous cells near the top. Branches and conidiogenous cells held in verticils of 1-4, 25-50 µm long, 2-3 µm wide, attenuating to 1.0-2.5 µm at the tip, becoming gradually shorter and wider at their tip during retrogressive conidiogenesis; with one terminal locus, producing to 20 conidia. -Conidia cylindrical, ellipsoidal or clavate, often attenuated at the base, straight or sometimes slightly bent at the base, 14.9-21.0-24.4- $31.4 \times 5.1 - 6.1 - 8.6 - 10.0$ µm, 1/w 2.2 - 2.8 - 3.5 - 4.3, (1 -)3(-4)-septate, hyaline; with a protuberant central or Taterally displaced basal hilum; held in imbricate chains. Slender solitary or up to 4 verticillate conidiogenous branches, $20-55\times1.5-2$ µm, produced on the òrdinary' conidiogenous branches or on aerial hyphae, with the terminal locus producing conidia in imbricate chains; sometimes with 1-3 additional intercalary loci, each producing 1 conidium. – Conidia formed from these secondary condiogenous cells cylindrical or ellipsoidal, straight, $9.0-20.0 \times 4.0-5.5 \mu m$, 0-1(-3)-septate, held in imbricate chains. - Chlamydospores observed on submerged hyphae, intercalary, subglobose, 12-14 µm diam, hyaline, smooth-walled.

 $\rm H\,olot\,y\,p\,e.-THAILAND:$ Khao Yai, Khlong E Thao, ca. 3.5 km W of Nong Pak Chi, $14^\circ28'N,\ 101^\circ20'E,\ elev.\ 750$ m, on Nigroporus durus (Jungh.) Murrill, 16 Aug 2001, G.J.S. 9050 & R. N. (BPI 842031, isotypes TAA, BBH; culture G.J.S. 01–304, TFC 02–52, CBS 113175).

Anamorph specimens examined. — THAILAND: Khao Yai, a trail near Visitors' Center, on *Hymenochaete villosa* (Lév.) Bres., 30 July 1997 K. P. (TAA 169687); Nature trail, km 33, to Nong Pak Chi, on *Phellinus extensus* (Lév.) Pat., 1 Aug 1997, K. P. (TAA 169722); the same collecting data, on a polypore, K. P. (TAA 169730, cultures TFC 97-24, CBS 100365); a trail near Visitors' Center, on an aphyllophore, 2 Aug 1997, K. P. (TAA 169741, cultures TFC 97-25, CBS 100364); Phakrajai, on *Loweporus* sp. ?, 6 Aug 1997, K. P. (TAA 169763b, culture TFC 97-30).

The teleomorph of *H. khaoyaiensis* is a typical aphyllophoricolous *Hypomyces* with pallid, KOH– perithecia. However, the perithecia are somewhat darker (brownish) than in most of such species. The ascospore size overlaps with that of *H. orthosporus* K. Põldmaa but in that species the apiculi are much shorter, mostly 1.0–1.5 high; moreover, the anamorph is different.

The anamorph is distinguished from other Cladobotryum anamorphs of Hypomyces by comparatively wide 3-septate conidia that are held in imbricate chains and the white colonies with uncolored reverse. Conidiogenesis in these Thai collections is obviously retrogressive, as in older cultures the conidial hila become broader and more laterally displaced and the conidiogenous cells become shorter and their tips broader. The anamorph is most reminiscent of C. cubitense R. F. Castañeda, which also forms up to 3-septate conidia, held in long chains at the tip of the conidogenous cell. Conidia of this species are slightly more slender, 21-28 × 5 μm, according to the original description (Arnold & Castañeda Ruíz, 1987). In the extype culture we measured conidia $17.1-23.5-29.8\times5.2-6.4-7.6$ µm, with the width falling into the lower quartile of the variation observed in the Thai collections. Characteristic of C. cubitense is the irregular shape of conidia, which are often bent either at the base or at the top or both. We found much larger aggregations of chlamydospores in subcultures of the ex-type strain of C. cubitense than in the cultures of Thai collections grown on MEA. Moreover, in some subcultures of *C. cubitense* the colony reverse turns dark violet.

Another similar tropical anamorphic species is $\it C. curvatum$ de Hoog & W. Gams (de Hoog, 1978), which has 1–3(–4)-septate conidia, curved below the middle and measuring $20{\text -}30 \times 5{\text -}7.5~\mu m$. No culture is available for comparison. It is likely that $\it C. cubitense$ and $\it C. curvatum$ are conspecific with the anamorph of $\it H. khaoyaiensis$. However, we are not confident in synonymizing these taxa based on the data of single specimens in both anamorphic species.

The anamorphs in the Thai specimens resemble also *C. multi-septatum* de Hoog (Helfer, 1991; de Hoog, 1978) and *C. dimorphicum* K. Põldmaa (Põldmaa, 1996) in shape and size of conidiophores, conidiogenous cells and conidia. *Cladobotryum multiseptatum* has very fast spreading colonies that turn from yellow to purple due to

the production of aurofusarin. In this species the single terminal locus forms 1–3 conidia, held in radiating heads. In the strains from Thailand there is no hint of such a pigment and the conidia are held in long imbricate chains. In these characters, as well as in the production of two types of conidiophores and conidia, the Thai specimens are more similar to *C. dimorphicum*. Contrasting with this species, *H. khaoyaiensis* forms slender conidiogenous cells and conidia later than the 'ordinary' ones. The present strains differ from those of *C. dimorphicum* also in faster growth of their colonies and the lack of brown coloration characteristic of the latter species.

7. Hypomyces mycophilus Rogerson & Samuels, Mycologia 85: 241. 1993.

Anamorph *Cladobotryum polypori* (Dearn. & House) Rogerson & Samuels, Mycologia 85: 241. 1993.

Anamorph specimens examined. – THAILAND: Khao Yai, Nature trail, km 33, Nong Pak Chi, on *Loweporus* sp., 1 Aug 1997, K.P. (TAA 169724, culture 97-21); a trail near the park headquarters, on *Polyporus* sp., 2 Aug 1997, K. P. (TAA 169738); the same locality, on *Stereum* sp., 7 Aug 1997, K. P. (TAA 169769).

The teleomorph of this species is known only from North America (U. S. A.) but the anamorph has also been recorded from Japan.

8. Hypomyces polyporinus Peck, Bull. Buffalo Soc. Nat. Hist. 1: 72. 1873.

Anamorph: Cladobotryum clavisporum (D. J. Gray & Morgan-Jones) Rogerson & Samuels, Mycologia 85: 241. 1993.

Anamorph specimen examined. – THAILAND: Khao Yai, Wang Jumpee trail to Lap Tha Kong Creek, on a corticioid basidiomycete, 31 Jul 1997, K. P. (TAA 169693a, culture TFC 97-17).

The Thai specimen is a typical representative of the anamorph of *H. polyporinus*. Noteworthy, however, is the production of a secondary conidiogenous cell from conidia while they are still attached in a cluster on the top of the 'ordinary' conidiogenous cell (microcyclic conidiation). The secondary conidiogenous cells produce again a cluster of conidia that form a radiating head, characteristic of this species. *Hypomyces polyporinus* is common in North America. It has been positively identified from Europe only a few times, mainly as the anamorph. The only previous Asian record is from China, but the identity of that collection is doubtful because of its brief description (Teng, 1996). We have collected the teleomorph also from Australia (data unpublished).

9. Hypomyces pseudopolyporinus Rogerson & Samuels, Mycologia 85: 258. 1993. – Fig. 5a.

Anamorph: Cladobotryum arnoldii Rogerson & Samuels, Mycologia 85: 258. 1993.

Subiculum white to buff, cottony, effused over some parts of the host fruiting-body, subicular hyphae 3-8 µm wide. - Perithecia scattered or in groups to gregarious, almost totally immersed in the subiculum to mostly free, $220-300 \times 150-210 \mu m$, brownish or orange yellow, turning bright yellow in KOH; lateral wall 15–20 μm thick, composed of compressed cells $6-13 \times 2-6.4 \mu m$; papilla conical, 70-112 μm high, 50-70 μm wide at the base and 25-37 μm near the top; formed of diverging rows of narrowly clavate cells; terminal cells of each row $4.5-10\times3-5~\mu m$. – Asci cylindrical, $99-147\times6.5-$ 9.3 µm, apex thickened (1-1.4 µm) and with a pore; ascospores uniseriate, with ends overlapping. - Ascospores fusiform, medianly 1-septate, $16-17.7-18.2-20.5 \times 4.3-5.1-5.4-6.3$ µm, prominently warted, warts 0.5-1.0 μm high; apiculate, apiculi 1.3-2.5 μm high and 1.5-2 µm wide at the base, with blunt tips. - Conidia cylindrical, 2-3(-4)- but mostly 2-septate, $21-28-35 \times 6.8-8.6-10.5 \mu m$ (in G.J.S. 9219A), with a prominent central or often laterally displaced hilum. - Chlamydospores abundant, 1-3-celled, pale brown; cells subglobose, 8-15 diam, smooth.

Characteristics in culture. – Colonies on CMD > 50 mm diam within 7 d, aerial mycelium cottony; no diffusing pigment. – Conidiophores undifferentiated, unbranched, forming a radiating head of conidia at the tip. – Conidia narrowly clavate, $17.1-28.3-39.5\times5.8-7.3-8.7~\mu m$ (in G.J.S. 9240), (1–)2(–3)-septate, with a pronounced protuberant central basal hilum, sometimes curved aside. – Chlamydospores common, composed of up to 5 cells; cells subglobose, $11-15.7~\mu m$ diam, wall smooth. – White subiculum and yellow perithecia with mature ascospores produced in culture.

Specimens examined. – THAILAND: Khao Yai, Princess Trail, 4 km S of park headquarters in disturbed forest, 14°28'N, 101°22'E, elev. 720 m, on *Auricularia delicata*, 6 Sep 2001, G. J. S. 9219A, M.R. & R.N. (BPI 842048, TAA); trail from main road to Bun Phai, in disturbed forest, 14°28'N, 101°23'E, elev. 750 m, on *Auricularia* sp, 6 Sep 2001, G. J. S. 9240, M.R. & R. N. (BPI 842050).

Besides its type collection in Brazil, the telomorph of *H. pseudopolyporinus* has been collected in Florida, U. S. A. The anamorph has been found in Estonia (Põldmaa & Samuels, 1999) and New York State, U. S. A. (K. P., unpubl.). The Thai specimens differ from these in forming narrower conidia on CMD.

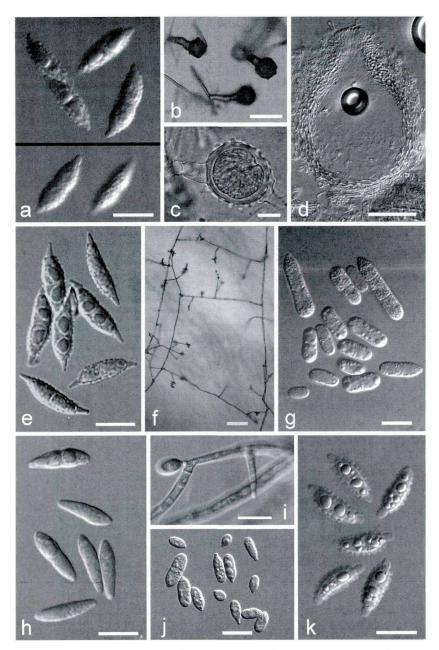


Fig. 5. Hypomyces species. – a. H. pseudopolyporinus. Ascospores. – b, c. H. puertoricensis. – b. Chlamydospores among aerial mycelium. – c. Chlamydospore with warted wall. – d–g. H. siamensis. – d. Section through a perithecium. – e. Ascospores. – f. Anamorph. – g. Conidia. – h–j. H. sibirinae. – h. Ascospores. – i. Intercalary conidiogenous locus bearing a conidium. – j. Conidia (mostly 'small' secondary conidia). – k. H. subiculosus. Ascospores. – a = G.J.S. 9219A; b = TFC 97–32; c = TAA 179717b; d, e = G.J.S. 8277b; f, g = TFC 97–159; h = G.J.S. 8327; i, j = TFC 97–29; k = G.J.S. 9241; a, d, e, h, k from natural substratum; b, c, f, g, i, j on MEA. – Scale bars: a, c, e, g–k = 10 μm; b = 50 μm; d, f = 100 μm.

10. Hypomyces puertoricensis Samuels, K. Põldmaa & Lodge, Sydowia 49: 85. 1997. – Fig. 5b, c.

Anamorph: Cladobotryum sp.

Chlamydospores abundant on the host, with cells 20–30 μm diam and walls 2–3.5 μm thick, covered with obtuse warts, 2.0–4.5 μm high; supporting cell 12–20 \times 7–10 μm . – Conidia ellipsoidal, 19.8–26.8–33.9 \times 6.7–8.1–9.5 μm , l/w 2.5–3.3–4.1, 1(–2)-septate.

Characteristics in culture. – Colonies spreading moderately fast, 50 mm diam within 7 d, with reverse turning cocoabrown. – Conidiophores undifferentiated, unbranched, 96–110 μm long, 3.5–4 μm wide; each branch terminating with a cell that produces up to ten conidia from the terminal locus. – Conidia cylindrical to narrowly clavate, 21.8–35–51.2 \times 5.7–7.7–9.7 μm , l/w 2.1–5.0–7.7, 1–3-septate, with a central or laterally displaced basal hilum, held in short imbricate chains which appear as radiating heads. – Chlamydospores abundant, arising from 40–220 μm long branches of aerial hyphae and from the submerged mycelium, subglobose, 19–30 μm diam, wall covered with sparse, up to 7 μm high warts.

Anamorph specimens examined. – THAILAND: Khao Yai, Nature trail, km 33, to Nong Pak Chi, on *Ganoderma* sp., 1 Aug 1997, G. J. S. 8257 (BPI, TAA 169717b, BBH; cultures TFC 97-32, CBS 100361); Phakrajai, on *Ganoderma* sp., 6 Aug 1997, K. P. (TAA 169765).

TAA 169717b is a typical specimen of $H.\ puertoricensis$. The warts observed on the wall of the chlamydospores are unique in the Cladobotryum anamorphs and thus very characteristic of $H.\ puertoricensis$. However, the cultures from TAA 169717b differ from the ex-type culture of $H.\ puertoricensis$ in the cocoa-brown coloration of the colony reverse that is characteristic of $C.\ stereicola$ and $H.\ polyporinus$.

In TAA 169765 the mycelium forms ropes and traps the host basidiospores under the hymenophore. Thus its gross appearance is indistinguishable from that of *Sporophagomyces chrysostomus*. However, under the dissecting microscope, comparatively large conidia were seen in radiating heads at the tips of the conidiogenous cells. Moreover, part of the white mycelium that does not trap the host basidiospores is attached directly to the host hymenophore, a feature never observed in *Spo. chrysostomus*. The conidia are ellipsoidal, cylindrical to narrowly clavate, with some being slightly bent at their top or base, 23.2–31.6–40.0 × 6.3–7.5–8.7 μ m, (0–)1–4(–5)-septate. The lack of chlamydospores and a culture of this specimen do not allow unambiguous identification of this specimen. *Hypomyces puertoricensis* was previously known only on *Rigidoporus lineatus* (Pers.) Ryv. and a polypore from two closely situated localities in Puerto Rico but we have collected it also in Australia and Costa Rica (data unpublished).

11. *Hypomyces siamensis* K. Põldmaa & Samuels, **sp. nov.** – Figs. 1f, 5d–g.

Anamorph: Cladobotryum sp.

Subiculum effusum, pallidum; hyphae hyalinae, 3–7 μ m latae. Perithecia obpyriformia, $310{\text -}360 \times 200{\text -}300~\mu$ m; fere superficialia, gregaria, flavobrunnea; papilla $70{\text -}120~\mu$ m alta, basis KOH ope ad rubrum vertens. Asci cylindrici, $110{\text -}140 \times 5{\text -}8~\mu$ m, octospori, apice paulum incrassato. Ascosporae fusiformes, $16.2{\text -}18.6{\text -}19.7{\text -}22.5 \times 3.5{\text -}4.2{\text -}4.6{\text -}5.3~\mu$ m, aeque bicellulares, hyalinae, verrucosae, apiculatae; apiculi $2{\text -}4~\mu$ m longi. Anamorphosis *Cladobotryum* sp. Conidiophora in natura erecta, septata, hyalina. Rami conidiogeni $18{\text -}95~\mu$ m longi, ad basim $2{\text -}3~\mu$ m lati, singulo loco conidiogeno praediti. Conidia ellipsoidea, cylindrica vel clavata, $6.5{\text -}12.6{\text -}15.8{\text -}21.7 \times 3.1{\text -}4.0{\text -}5.1{\text -}6.2~\mu$ m, bi- vel tricellularia, hyalina.

Subiculum effuse, white to buff; hyphae hyaline, smooth, 3–7 μm wide, cells not swollen, KOH-. – Perithecia obpyriform, 310–360 \times 200–300 μm ; immersed except the papilla or semi-immersed, gregarious, yellow to yellow-brown, KOH-; papilla 70–120 μm high, tapering from 75–100 μm diam at the base to 35–50 μm at top, outer cells 5.0–7.5 μm diam or swollen to 11 \times 8 μm , base turning pink or reddish or not reacting in KOH. – Ascicylindrical, 110–140 \times 5–8 μm , apex thickened; ascospores uniseriate with ends overlapping. – Ascospores fusiform, 16.2–18.6–19.7–22.5 \times 3.5–4.2–4.6–5.3 μm , l/w 3.4–4.2–4.7–5.5, septum median; hyaline, sparsely but prominently verrucose, apiculate; apiculi 2–4 μm long, acute. – Chlamydospores hyaline, globose, 13–15 μm diam.

Conidiophores arising from the mycelium among perithecia, erect, septate, hyaline, 4 μm wide. – Conidiogenous cells or branches formed singly or in pairs, 18–95 μm long, attenuating from 2–3 μm wide at the base to 1.0–1.3 at the tip, with a few septa; with one terminal and occasionally one intercalary conidiogenous locus. – Conidia cylindrical or clavate, straight, 6.5–12.6–15.8–21.7 \times 3.1–4.0–5.1–6.2 μm , l/w 1.9–2.8–3.1–3.9, 1–2-septate, hyaline, with a central or laterally displaced basal hilum; held in imbricate chains. – Chlamydospores hyaline, globose, 13–15 μm diam.

Characteristics of G.J.S. 8277b in culture. – Colonies spreading moderately fast, reaching 55–80 mm diam in 7 d; cottony, to 1 cm high, with regular margin, white, reverse uncolored. – Aerial mycelium abundant or scant; hyphae hyaline, 4–5 μm wide, smooth. Submerged hyphae fasciculate, cells to 8 μm wide. – Odor absent. – Conidiation moderate. – Conidiophores arising as undifferentiated branches from aerial hyphae. Conidiogenous branches borne singly, cylindrical, 70–360 μm long, attenuated from 1.5–2.0 μm near the base to 1.0–1.5 μm at the tip; each branch ending with one integrated, conidiogenous cell, which releases up to 20 conidia from the terminal locus. – Conidia ellipsoidal, cylindrical or clavate, straight, 9.1–17.9–26.6 × 4.0–5.0–6.0 μm, 1/w 2.2–3.5–4.9,

1(-2)-septate, hyaline, with a protuberant central or laterally displaced basal hilum; produced in imbricate chains. – Chlamydospores borne on submerged hyphae, singly or by two in terminal position on lateral branches measuring $8-38.5\times4-5.5~\mu m$; cells $8-15~\mu m$ diam, wall smooth.

Holotype. – THAILAND: Khao Yai, on a trail near the park headquarters, elev. 700 m, on a resupinate polypore, 2 Aug 1997, G. J. S. 8277b, K. P. & P. C. (BPI 842417, isotype TAA 169720, BBH; cultures G. J. S. 97-191, TFC 97-159, CBS 113176).

Paratype. – THAILAND: Phetchaburi Prov., Kaeng Krachan National Park, vic. Torthip Falls, 12°51'N, 99°19'E, elev. 401 m, in primary forest on a ridge top, on *Trametes* sp.?, 26 Aug 2001; G. J. S. 9146, M. R. & R. N. (BPI 842040).

The ascospores of *H. siamensis* are similar to those of *H. aurantius* in morphology and size. The anamorph characters, such as the single conidiogenous branches, the formation of conidia in long imbricate chains, and the chlamydospores, strongly suggest H. subiculosus. As in H. subiculosus, the conidiogenous cells do not become conspicuously shorter during conidiogenesis, but the conidial hila are slightly broader in the basal conidia of the chain than in the distal conidia, suggesting the possibility of some incorporation of the wall of the conidiogenous cell in the newly formed conidia (retrogressive conidiogenesis). Besides the differences in teleomorph characters, G.J.S. 8277b differs from H. subiculosus in the fluffy colonies, faster growth and slightly larger conidia. Hypomyces aurantius and H. subiculosus both have orange perithecia that turn deep purple in KOH. While in the former species the whole perithecium reacts, in the latter only the papilla or its base usually changes its color. In G.J.S. 8277b the base of papilla of yellow to brown perithecia becomes faintly reddish or roseous in KOH with no change of color in G.J.S. 9146.

While H. siamensis is definitely not conspecific with the type of H. australis, two specimens cited as H. australis (C.T.R. 71-163, 71-164; Rogerson & Samuels, 1993) as well as some recent similar tropical collections are morphologically very similar. In these specimens the mean values of ascospore length and width range from $21.5-23.4\times3.4-4.8~\mu m$. The available cultures are white to yellow, conidia cylindrical and 1(-2)-septate and chlamydospores held in chains. More data are needed to clarify whether such collections belong to H. australis, H. siamensis or H. subiculosus or represent one or more undescribed species.

12. *Hypomyces sibirinae* Rogerson & Samuels, Mem. New York Bot. Gard. 59: 31. 1990. – Fig. 5h–j.

Anamorph: Cladobotryum hughesii Rogerson & Samuels, Mycologia 85: 241. 1993.

Subiculum absent (TAA 169703a, 169708) or scarce but effused over the whole hymenophore of the host. – Perithecia seated singly on the pores of the host or semi-immersed and mostly gregarious (TAA 169682, G.J.S. 8327, G.J.S. 8330); amber, $240-320\times160-240~\mu m$; papilla $<80~\mu m$. – Ascospores fusiform to naviculate with a median or submedian septum, $12.0-13.9-17.6-20.7\times3.0-3.7-4.5-5.2~\mu m$; with wall smooth to finely spinulose; and with apiculi absent.

Characteristics in culture. — Colonies spreading moderately fast, 40–55 mm diam in 7 d; cottony, white, reverse turning pale brown. — Aerial mycelium scarce. — Conidiophores not differentiated from mycelial hyphae, ascending to suberect, irregularly branched. — Conidiogenous cells in verticils of 2–8, 21–41 \times 1.7–3.3 µm, sometimes becoming septate; the terminal cell producing one or seldom two loci near its tip, each locus forming one, rarely two conidia. — Conidia cylindrical or sometimes oblong-clavate, 0–3-septate, very variable in size, 7.3–18.8–19.6–31.9 \times 3.6–5.4–5.5–7.4 µm.

Specimens examined. – THAILAND: Khao Yai, a forest near the park headquarters, on *Polyporus* sp., 30 Jul 1997, K. P., G. J. S. & P. C. (TAA 169682; culture TFC 97-157); Wang Jumpee trail to Lap Tha Kong Creek, on *Polyporus* sp., 31 July 1997, K. P., G. J. S. & P. C. (TAA 169703a; cultures TFC 97-46, CBS 100358); same collecting data (TAA 169708; culture TFC 97-158); Khao Yai, Phakrajai, on *Polyporus* sp., 6 Aug 1997, G. J. S. 8327, K. P. & P.C. (BPI 745872, TAA 169767); same collecting data, G. J. S. 8330 (BPI 745874).

Anamorph specimen examined. – THAILAND: Khao Yai, Phakrajai, on a polypore, 6 Aug. 1997, K. P. (TAA 169763a; culture TFC 97-29).

The anamorphic isolate TFC 97-29 is exceptional because of the additional abundant production of slender conidiogenous cells, 9.0– 21.0×1.6 –2.0 μm , either from the mycelium or on the few 'ordinary' conidiophores; they differ from the 'ordinary' conidiogenous cells in forming 1–3 intercalary loci and producing 0–1-septate conidia which are much smaller than the 'ordinary' ones, measuring 6.2–9.1–12.0 \times 2.9–3.7–4.6 μm . This unusual morphology is accompanied by the formation of distinct sectors in cultures, recognisable by different color, compactness and growth rate in comparison with the normal parts of the colonies. No chlamydospores were observed in any of the four isolates.

In addition to the Thai collections, $H.\ sibirinae$ is known only from its type location in Indonesia and one collection from North Carolina, U. S. A.

13. Hypomyces subiculosus (Berk. & M. A. Curtis) Höhn., Ann. Mycol. 8: 468. 1910. – Fig. 1g, 5k.

Anamorph: Cladobotryum sp.

Subiculum effused over the substratum, orange, turning purplish in KOH but quickly becoming hyaline. - Perithecia grega-

rious, $150-270\times120-220~\mu m$, concolorous with the subiculum or slightly darker, turning deep purple in KOH with the color fading in the lower part of the perithecium but remaining clearly visible at least in the papilla; papilla inconspicuous, $35-60~\mu m$ high and flat at the top. – Ascospores fusiform, $11.7-13.3-16.3-18.1\times3.5-4.4-5.2-6.0~\mu m$, medianly 1-septate; wall covered with low (<0.5 μm) but prominent warts; apiculate, apiculi $1.2-2~\mu m$ long, with tips blunt.

Characteristics in culture. - Colonies derived from ascospores spreading fast, reaching 7-8 cm diam or usually exceeding the 9 cm diam in 7 d; first white, turning deep orange (TFC 97-28 and G.J.S. 01-305 remaining colorless but the reverse in the latter turning pale yellow). - Conidiophores not differentiated from aerial hyphae, irregularly branched, forming long septate branches singly or sometimes 2-3(-5) branches in a whirl, with each branch 30-140(-300) µm long and 3.4-4 µm wide at the base, terminating in a conidiogenous cell with a single conidiogenous locus; rarely an additional locus seen on one of the intercalary cells in the branch. No clear evidence of the shortening of conidiogenous cells during conidiogenesis. – Conidia $5.5-12.7-17-24.6 \times 3.6-4.7-5.5-7.1$ µm. First formed conidia clavate, obovoid or obpyriform, 1-2(-3)-septate, sometimes constricted at septa and longer than the subsequent ones; with a narrow and central hilum. Subsequent conidia formed below the first one obliquely, cylindrical, 0-1-septate, shorter that the first conidium and with a broader laterally displaced hilum at their base. Formed in imbricate chains that contain up to 30 conidia. - Chlamydospores formed singly or in groups of 2 or 3 on short lateral branches on submerged hyphae; cells subglobose, hyaline (in TFC 97-28) or pale brown and often several are held in irregular clusters (G.J.S. 01-305). Subglobose aggregations of many small, white, needle-like crystals abundant on CMD and MEA in ascospore isolates. In 2-4 weeks the mycelium in the ascospore isolates turning into a compact subiculum usually producing perithecia and ascospores similar to those found in nature.

Specimens examined. – THAILAND: Khao Yai, vic. Bun Phai, in secondary forest, ca. 14°29'N, 101°22'E, elev. 793–819 m, on *Stereum* sp., 19 Aug 2001, G. J. S. 9083 & R. N. (BPI 842038; culture G.J.S. 01-305); N of park headquarters, trail from main road to Bun Phai, on decaying wood, 6 Sep. 2001, G. J. S. 9241, M. R. & R. N. (BPI 842051f, BBH; culture G.J.S. 01-243, TFC 02-46). Kaeng Krachan National Park, 1.3 km W of Bang Krang Camp toward Torthip Falls, on *Stereum ostrea* (Blume & Nees) Fr., 23 Aug. 2001, G.J.S. 9111, M. R. & R. N. (BPI 842039, BBH); road between Kaeng Krachan Dam and Torthip Falls, Bang Krang Camp, on *Stereum* sp., 27 Aug. 2001, G. J. S. 9157, M. R. & R. N. (BPI 842042, TAA, BBH; culture G.J.S. 01-261, TFC 02-48).

Anamorph specimen examined. – THAILAND: Khao Yai, a trail near the park headquarters, on an aphyllophoralean basidiomycete, 2 Aug 1997, K. P. (TAA 169740, TFC 97-28).

It seems that the orange pigment in the subiculum and perithecia that turns purple diffuses into the medium that remains purple around hyphae and perithecia. In G.J.S. 9083 there is a small area in the middle of the colony where the subiculum and perithecia are white, lacking any pigments and not reacting to KOH. However, these perithecia contain normal ascospores.

Hypomyces subiculosus is considered to be one of the most common aphyllophoricolous species of Hypomyces in tropical and subtropical regions. Perithecial collections were common in Khao Yai in 2001, while in 1997 at roughly the same time of the year and the same collecting sites only one anamorphic collection was found. This suggests that conditions of any given season can determine the extent of sexual reproduction of these Hypomyces species.

14. Hypomyces sympodiophorus Rogerson & Samuels, Mycologia 85: 241. 1993.

Anamorph: *Cladobotryum uniseptatum* (R. F. Castañeda) K. Põldmaa, Mycologia 91: 192. 1999.

This species appeared to be the most common species of the group in Khao Yai National Park, occurring exclusively on basidiomata of species of *Stereum*. The twelve specimens collected are cited along with a discussion of the characteristics and distribution of the species by Põldmaa (2003).

15. Hypomyces thailandicus K. Põldmaa, Mycologia 95: 929. 2003.

Anamorph: Cladobotryum sp.

The species was described based on material collected on Xylobolus cf. illudens in Khao Yai in 1997. It is very similar to H. sympodiophorus and H. xyloboli K. Põldmaa, the latter of which also grows on basidiomata of species of Xylobolus P. Karst.

16. 'Hypomyces' triseptatus Rogerson & Rossman, Brittonia 33: 382. 1981

Anamorph: cephalosporiopsis-like

Specimens examined. – THAILAND: Khao Yai, Nong Pak Chi, elev. 750 m, on vine, on a carbonaceous black ascomycete, 14 Aug. 1997, G. J. S. 8450 & P. C. (BPI 745777, BBH); Park Headquarters along nature trail, in highly disturbed forest, 14°26'N, 101°22'E, elev. 700 m, on immersed ascomycete on live liana, 3 Sep 2001, G. J. S. 9217 (BPI 842047, BBH). Phetchaburi Prov., Kaeng Krachan National Park, road between Kaeng Krachan Dam and Torthip Falls Bang Krang Camp, in disturbed forest, 12°48'N, 99°27'E, elev. 324 m, on bark of live liana, 1 Sep 2001, G. J. S. 9179, R. N. & M. R. (BPI 842043, BBH).

The Thai specimens are similar to the type collection (Rossman & Rogerson, 1981), from Gabon, and to other specimens from Cameroon, Indonesia and China preserved at BPI and NY. The main difference is that ascospores in most collections are somewhat shorter $(22-28\times5.5-6.6$ in Thai specimens) than was reported in the protologue to the species. Because of its 3-septate ascospores, the morphology of perithecia and occurrence on pyrenomycetes, we doubt that this species belongs to Hypomyces. The phialidic anamorph, not yet documented in literature, that produces large septate conidia would also be exceptional in Hypomyces. Molecular data are needed to test phylogenetic relationships of this species.

17. Cladobotryum arthrobotryoides K. Põldmaa, sp. nov. – Fig. 6a–d.

Coloniae in natura pallidae, effusae. Conidiophora erecta, septata, hyalina. Cellulae conidiogenae 2–3 verticillatae, 30–41 µm longae, 4 µm latae; sursum inflatae, ad 7 denticulos conidiiferos, ad 4 µm altos ferentes. Conidia ellipsoidea vel clavata, $12.5–15.0\times5.0–5.5$ µm, bi– ad quadricellularia, hyalina. Chlamydosporae absentes. Coloniae in agaro maltoso ad 50–55 mm diam post 7 dies, albae, reverso immutato vel luteo-ochraceo. Conidiophora erecta, dichotoma, cellulae conidiogenae 2–3 verticillatae, cylindricae, 30–37 µm longae, 3–4 µm latae, sursum inflatae ad 7 µm diam vel ellipsoideae, 11×7 µm, ad 20 denticulos conidiogenos ferentes. Conidia ellipsoidea vel clavata, $12.7–16.1–19.5\times4.8–5.9–7.0$ µm, bi– ad quadricellularia, hyalina, singula in quoque denticulo. Chlamydosporae absentes. Teleomorphosis ignota.

Colonies buff, effused over the whole hymenophore of the host. – Conidiophores arising from the mycelium, erect, septate, hyaline. – Conidiogenous cells held in verticils of 2–3, 30–41 μm long, 4 μm wide; the tip swollen and bearing up to 7 loci on up to 4 μm long denticles. – Conidia ellipsoidal to clavate, straight, 12.5–15.0 \times 5.0–5.5 μm , (1–)2(–3)-septate, hyaline, with a central hilum at the base. – Chlamydospores not observed.

Characteristics in culture. – Colonies spreading fast, reaching 50–60 mm diam in 7 d; cottony, with regular margin; white, reverse uncolored or pale yellowish ochraceous. Aerial mycelium scant; hyphae hyaline, smooth. – Odor absent. – Conidiation abundant. – Conidiophores arising from aerial hyphae, or often in a bundle from adjacent swollen cells in the agar, branching dichotomous. Conidiogenous cells held singly or in verticils of 2–3, cylindrical, 30–37 μm long, 2.5–4 μm wide, swollen at the tip, tip globose, to 7 μm diam, or ellipsoidal, 11 × 7 μm , bearing to 20 conidiogenous loci on denticles; each denticle producing one conidium. – Conidia mostly clavate or cylindrical to ellipsoidal, straight, 12.7–16.1–19.5 × 4.8–5.9–7.0 μm , l/w 2.2–2.7–3.3, (1–)2(–3)-septate, hyaline, with a protuberant central basal hilum; held singly at the tips of denticles. – Chlamydospores not observed.

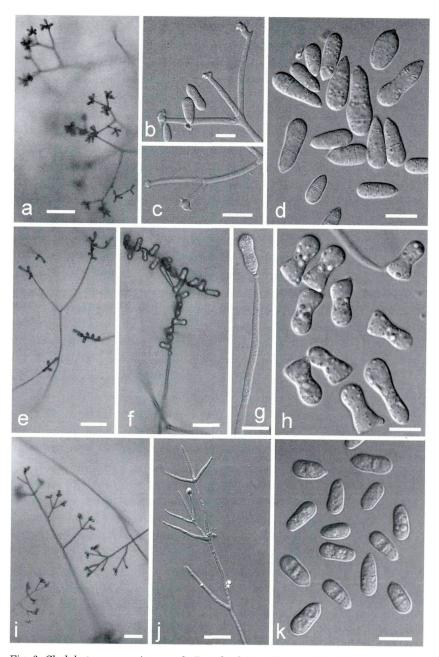


Fig. 6. Cladobotryum species. – a–d. C. arthrobotryoides. – a. Conidiophores. – b, c. Conidiogenous cells with swollen tips bearing denticles. – d. Conidia. – e–h. C. caribense. – e. Conidiophores. – f. Tip of a conidiophore with conidia held in imbricate chains. – g. Conidium on a tip of a conidiogenous cell. – h. Conidia. – i–k. C. odorum. – i. Conidiophores. – j. Tip of a conidiophore with conidiogenous cells and conidia. – k. Conidia. – a–d = TFC 97-16; e–h = TFC 97-31; i–k = TFC 97-22. a–d on PDA. e–k on MEA. – Scale bars: a, e, i = 50 μm ; b, d, g, h, k = 10 μm ; c, f, j = 20 μm .

Holotype. – THAILAND: Khao Yai, a trail near the Visitor's Center, on *Hymenochaete* sp., 30 Jul 1997, K. P. (TAA 169684; cultures TFC 97-16, CBS 100369).

The conidiogenous cells of C. arthrobotryoides differ from most members of Cladobotryum. Inflated tips of the conidiogenous cell and formation of conidia on closely disposed protrusions at the inflated tip of the conidiogenous cell have also been described also for C. asterophorum de Hoog (de Hoog, 1978) and the anamorph of H. dactylarioides G. Arnold (Arnold, 1971). These species also have the cymose or dichotomous branching pattern in common. In contrast to the two other mentioned species, the colonies of C. arthrobotryoides do not become purple, which is characteristic of the aurofusarin-producing group species (Helfer, 1991). Because of this and the mostly 2–3-septate conidia of *C. arthrobotryoides* we do not consider it to be conspecific with C. asterophorum although the morphology of conidiophores, conidiogenous cells and conidia of these two species is almost identical. On the other hand, C. arthrobotryoides is reminiscent of species of Arthrobotrys, a genus of nematode-trapping hyphomycetes. With the exception of the equally fungicolous Arthrobotrys superba Corda, which is frequently found covering corticiaceous fungi on twigs (van Oorschot, 1985; W. Gams, pers. comm.), nematode-trapping fungi do not normally grow on basidiomycetes.

18. *Cladobotryum caribense* Castañeda, Fungi Cubense: 3. 1986. – Fig. 6e–h.

Characteristics in culture. – Colonies growing moderately fast, reaching 25 mm diam in 7 d, compact, at first white, later turning cream yellow, with similar change in coloration of the reverse. – Odor slightly sweet. – Conidiophores arising as undifferentiated branches from aerial hyphae, 5.5 μm wide. – Conidiogenous cells or branches mostly solitary or in verticils of 2–3, 30–125 μm long and 3–4 μm wide at the base; producing up to 20 conidia from the single terminal locus. The first-formed conidia ellipsoidal to clavate, with a central hilum; those formed later campanulate, 13.7–17.3–20.9 \times 5.3–6.9–8.5 μm , l/w 1.7–2.6–3.4, 1(–2)-septate, hilum lateral, with another opposite lateral protuberance that suggests a second hilum, basal width 9–10 μm ; conidia held in long imbricate chains, connected by the 'double hila'. – Chlamydospores not observed.

Specimens examined. – THAILAND: Khao Yai, Wang Jumpee trail to Lap Tha Kong Creek, on a corticiaceous basidiomycete or wood, 31 Jul 1997, K. P. (TAA 169690; cultures TFC 97-31, CBS 100362).

Two species with campanulate conidia are described from Cuba, *C. campanisporum* G. Arnold (Arnold, 1987) and *C. caribense* R. F. Castañeda. According to Helfer's (1991) key for anamorphic *Hypomyces*, our strain fits better *C. campanisporum*. However, its differences from *C. caribense* are very small. Both species are known only from their type collections, neither of which we have examined. For the time being we prefer to use the earlier name for the Thai specimen.

19. Cladobotryum odorum G. Arnold, Feddes Repert. 99: 29. 1988. – Fig. 6i–k.

Specimens examined. – THAILAND: Khao Yai, Nature trail, km 33, to Nong Pak Chi, on *Stereum* sp., 1 Aug 1997, K. P. (TAA 169725; cultures TFC 97-22, CBS 100367).

The present strain corresponds well with the original description of this species (Arnold, 1988). The conidia in the Thai collection measure $9.3-12.5-15.7\times4.5-5.3-5.5~\mu m$, 1/w~1.9-2.4-2.9 and are thus slightly larger than was described for the species. Nevertheless, the conidia of *C. odorum* are smaller than in other *Cladobotryum* anamorphs of *Hypomyces*. The cultures also produce a typical, strong sweet odor, which, according to Arnold (1988) reminds carrots. After repeated transfers, however, subcultures of the Thai strain lost the odor. The ex-type culture as well as some other strains from Cuba that were obtained for comparison from Günter Arnold have also lost their odor.

20. Cladobotryum simplex K. Põldmaa, sp. nov. – Fig. 7a–d.

Coloniae in natura pallidae, effusae, substrato laxe affixae. Conidiophora simplicia, cylindrica, septata, ad 250 μm longa, 2–4 μm lata; in summo 4–6 emergentias parvas conidiogenas ferentia. Conidia clavata, 11.4–16.8–22.2 \times 4.4–6.3–8.2 μm , 1(–2)-septata, hyalina. Chlamydosporae absentes. Coloniae in agaro maltoso ad 15 mm diam post 7 dies, albae, reverso roseo. Conidiophora sparsa, simplicia, cylindrica, ad 300 μm longa, 2–3 μm lata, cellulam conidiogenam in apice inflato ad 12 emergentiis conidiiferis praeditam ferentia. Conidia ellipsoidea vel clavata, 8.4–15.0–21.5 \times 4.4–6.1–7.8 μm , (0–)1(–2)-septata, hyalina, singula in quoque loco. Chlamydosporae absentes.

Colonies buff, forming a thin, separable sheet over the hymenophore of the host. – Conidiogenous branches simple, septate, to 250 µm long, 2–4 µm wide, each terminating with one integrated conidiogenous cell; each conidiogenous cell bearing 4–6 loci on very small protrusions close to each other at the tip. – Conidia ellipsoidal to clavate, straight, $11.4-16.8-22.2\times4.4-6.3-8.2~\mu m, l/w~2.0-2.7-3.4,~1(-2)-septate,~hyaline,~with~a~central~hilum~at~the~base.~Chlamydospores~not~observed.$

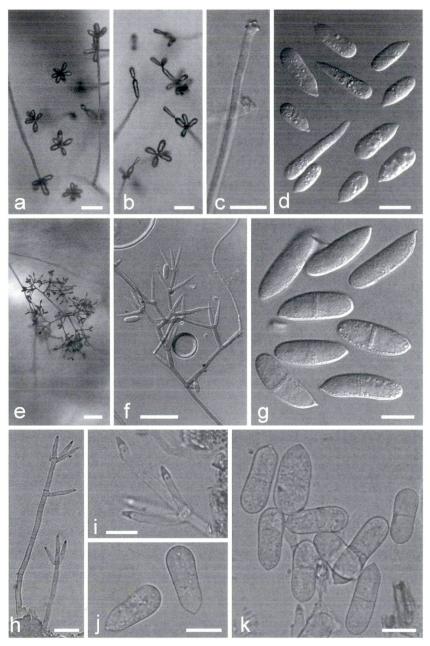


Fig. 7, Cladobotryum species. – a–d. C. simplex. – a, b. Conidiophores with clusters of conidia. – b with several conidia growing out from still attached conidia. – c. tip of a conidiophore bearing small denticles. – d. Conidia. – e–g. C. virescens. – e, f. Conidiophores. – g. Conidia. – h–k. Cladobotryum sp. – h. Conidiophores. – i. Conidiogenous cells with refractive areas at their tips. – j, k. Conidia. – a–d = TFC 97–19; e–g = TFC 97–23; h = TAA 169700; i, k = TAA 169707, j = TAA 169723. a–g on MEA; h–k on natural substrata. – Scale bars: a, b, h = 20 μ m; c, d, g, i–k = 10 μ m; e = 100 μ m; f = 50 μ m.

Characteristics in culture. – Colonies spreading very slowly, reaching 10–15 mm diam in 7 d; cottony, margin regular; white, reverse turning pink. Aerial mycelium scant; hyphae hyaline, smooth-walled. – Odor absent. – Conidiation scant or abundant. – Conidiophores arising from aerial hyphae, suberect to erect, simple, to 300 μm long, 2–3 μm wide, terminating in a single, 30–50 μm long conidiogenous cell. – Conidiogenous cells bearing up to 12 small protrusions at the slightly swollen tip, each protrusion producing one conidium. – Conidia ellipsoidal to clavate, straight, 8.4–15.0–21.5 \times 4.4–6.1–7.8 μm , l/w 1.5–2.5–3.5, (0–)1(–2)-septate, hyaline, with a central basal hilum; held singly at the small protrusions. – Chlamydospores not observed.

Holotype. – THAILAND: Khao Yai, Wang Jumpee trail to Lap Tha Kong Creek, on *Polyporus* sp., 31 Jul 1997, K.P. (TAA 169703b; cultures TFC 97-19, CBS 100368).

This species is an unusual member of *Cladobotryum* because of its simple, comparatively long and narrow conidiophores, production of a pink pigment and the restricted growth in culture. In its slow growth, *C. simplex* resembles *C. obconicum* W. Gams & Schroers (Gams & al., 1998), but apart from this there is not much similarity between these species. *Cladobotryum simplex* forms conidia on closely disposed small denticles, as was described for *C. arthrobotryoides* and two other species discussed under that species. In contrast to these species, the tips of conidiogenous cells of *C. simplex* are not more than slightly swollen; the taxa also differ in the morphology of conidia and in culture characteristics.

21. Cladobotryum virescens G. Arnold, Feddes Repert. 98: 351. 1987. – Fig. 7e–g.

Specimens examined. - THAILAND: Khao Yai, Nature trail, km 33, to Nong Pak Chi, on *Amauroderma* sp., 1 Aug 1997, K. P. (TAA 169719); the same collecting data, on an aphyllophoralean basidiomycete (TAA 169726; cultures TFC 97-23, CBS 100366).

Cladobotryum virescens is unique among the Hypomyces anamorphs in producing red colonies as in other aurofusarin-producing species and green conidia. The other species in Hypomyces (including Cladobotryum) that produce green conidia, Hypomyces viridigriseus K. Põldmaa & Samuels and H. xyloboli, differ in colony color and morphological characters.

In the Thai collections the conidia measure $17.9-23.0-25.7-31.2\times6.7-8.3-9.6-11.5$ µm, differing from the original description of *C. virescens* (width 4.5-5.5 µm) in having much broader conidia. However, conidial width in two other strains obtained from Günter

Arnold varied from 5.0 to $7.5 \,\mu m$. Contrasting with the other strains, in the Thai isolates 1-septate conidia predominate among 1–3-septate conidia. Several of the conidia are bent in the lower third, with older ones turning reddish brown and their wall becoming thick. We also noticed a strong odor that is suggestive of the camphour-like odor of H. odoratus G. Arnold.

Cladobotryum virescens was previously known only from Cuba.

22. Cladobotryum sp. - Fig. 7h-k.

Specimens examined. - Khao Yai, Wang Jumpee trail to Lap Tha Kong Creek, on *Xylobolus spectabilis* (Klotzsch) Boidin, 31 Jul 1997, K. P. (TAA 169700, 169706); same collecting data, on *Stereum hirsutum* (Willd. : Fr.) Gray (TAA 169707); Nature trail to Nong Pak Chi, on *Cymatoderma* sp., 1 Aug. 1997, K. P. (TAA 169723).

These collections contain only ananamorphs that are similar to the anamorphs of H. sympodiophorus and H. thailandicus. Similarly to these species, the conidiogenous cells that are arranged in dense verticils bear one to four loci at the tips of refractive outgrowths. The conidia are one-septate or, in TAA 169707 and 169723, 1–3-septate. In TAA 169700 and 169707 the mean values of conidial measurements are $18.7 \times 10~\mu m$ and $16.1 \times 9.6~\mu m$, respectively. In 169706 and 169723 the conidia are more slender, ($19 \times 7.6~\mu m$ and $20.2 \times 8~\mu m$, respectively), suggesting H. khaoyaiensis. Because the attempts to isolate these fungi into pure culture failed, their unambiguous identification is impossible.

23. Sphaerostilbella aureonitens (Tul.) Seifert, Samuels & W. Gams, Stud. Mycol. 27: 145. 1985.

Anamorph: $Gliocladium\ penicillioides\ Corda,\ Ic.\ Fung.\ 4:\ 31.\ 1840.$

Specimens examined. – THAILAND: Khao Yai, Wang Jumpee trail to Lap Tha Kong Creek, on $Stereum\ ostrea\ s.\ l.,\ 31\ July\ 1997,\ K.\ P.,\ G.\ J.\ S.,\ P.\ C.\ (TAA\ 169709;\ culture\ TFC\ 97-161);\ Tad\ Tha\ Phu\ Trail,\ on\ Stereum\ ostrea\ s.\ l.,\ 5\ Aug.\ 1997,\ G.\ J.\ S.\ 8293,\ K.\ P.,\ P.\ C.\ (BPI\ 74584,\ TAA\ 169748,\ BBH;\ culture\ G.J.S.\ 97-160);\ W\ of\ Khlong\ e\ Thao,\ 14°28'N,\ 101°20'E,\ elev.\ 770\ m,\ on\ Stereum\ ostrea\ s.\ l.,\ 17\ Aug\ 2001,\ G.\ J.\ S.\ 9059\ (BPI\ 842032a;\ culture\ G.J.S.\ 01-303,\ TFC\ 02-51).$

Anamorph specimens examined. – THAILAND: Khao Yai, Phaeodai, elev. 1100 m, on *Stereum ostrea* s. l. together with *H. sympodiophorus*, 12 Aug. 1997, G. J. S. 8408 & P. C. (BPI 745738); Darn Chang, elev. 750 m, on *Stereum ostrea* s. l. together with *H. sympodiophorus*, 15 Aug 1997, G. J. S. 8456 & P.C. (BPI 745780); Park Headquarters along nature trail, 14°26'N, 101°22'E, elev. 700 m, in highly disturbed forest, on *Stereum ostrea* s. l. together with *H. sympodiophorus*, 3 Sep 2001, G. J. S. 9191a, R. N. & M. R. (BPI 842045a).

All three cultures derived from ascospores are remarkable in producing bright chrome yellow and orange pigments. In G.J.S. 8293 the subiculum is reddish, turning bright yellow in KOH. The species was originally described from Europe but is common in many parts of the world; this is its first record from tropical Asia.

24. **Sphaerostilbella ganodermatis** Põldmaa & Samuels, **sp. nov.** – Figs. 1h, 8a–d.

Anamorph: Gliocladium sp.

Subiculum effusum, pallidum, hyphae 2 µm latae, supra superficiem liberae exeuntes. Perithecia obpyriformia, $250\text{--}280\times120\text{--}200$ µm, bubalina vel luteola, KOH ope colore immutato; semiimmersa, gregaria; papilla cylindrica, 80--110 µm alta; hyphae albae circa basim papillae radiantes, simplices, septatae, ca 25 µm longae, 5 µm latae, cristallis obtectae. Asci cylindrici, $45\text{--}70\times3.5\text{--}5$ µm, octospori, apice incrassato. Ascosporae naviculiformes, $4.8\text{--}5.1\text{--}5.5\times2.1\text{--}2.3\text{--}2.6$ µm, hyalinae, unicellulares, leves, non apiculatae. Conidiophora in natura erecta, septata, hyalina, 300--440 longa, ad basim 9.5-11 µm lata. Metulae cylindricae, 6.2-8.9-11.5 µm longae, 1.8--2.6--3.4 µm latae; phialides 4-6 verticillatae, cylindricae el 8.7-10.8-12.9 µm longae, ad basim 1.3-1.8-2.3 µm latae. Conidia cylindrica vel ellipsoidea, recta, $2.4\text{--}2.8\text{--}3.2\times1.2\text{--}1.4\text{--}1.6$ µm, unicellularia, hyalina. Chlamydosporae absentes.

Subiculum effused over almost the whole hymenophore of the host fruitbody; dense, cream-colored, KOH-; hyphae ca 2 µm wide, cells not swollen; with free ends standing out from the surface. -Perithecia obpyriform, 250–280 × 120–200 μm; buff to pale yellow, KOH-; gregarious, semiimmersed in the subiculum; perithecial wall 13-15 µm thick, hyphal to pseudoparenchymatous; cells flattened, $4.5-11 \times 1.5-2.5 \mu m$, with $1-2 \mu m$ thick walls, forming one region, the superficial cells often merging with cells of the subicular hyphae; free hyphal ends arising from the surface of the perithecial wall at the base of the papilla, white, unbranched, septate, sometimes constricted at the septa, ca 25 µm long and 5 wide, with blunt tips, thinwalled, wall covered with amorphous material, ornamentation remaining intact in water and KOH but dissolving in lactic acid. Papilla almost cylindrical, $80-110 \mu m$ high, surface cells $4-6 \times 2.5-$ 3 µm. – Asci cylindrical, sessile, $45-70\times3.5-5$ µm, apex slightly thickened, with a pore; ascospores uniseriate, ends sometimes overlapping. – Ascospores naviculate, $4.8-5.1-5.5\times2.1-2.3-2.6$ µm, 1/w1.9-2.2-5.5, hyaline, aseptate, with blunt ends, smooth or at most finely spinulose.

Anamorph arising from the subiculum among the perithecia as well as at the margin of the colony where no perithecia have formed. – Conidiophores erect, hyaline, $300-440~\mu m$ long, $9.5-11.0~\mu m$ wide at the base, gradually attenuating towards the tip; frequently septate with more than 10 septa; unbranched or bearing

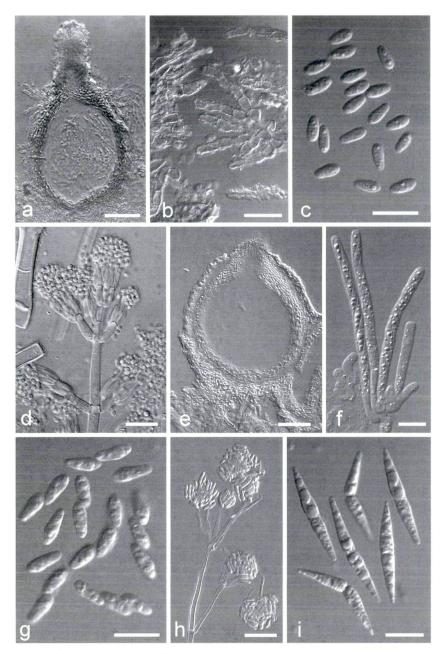


Fig. 8. Species of *Sphaerostilbella* and *Sporophagomyces.* – a–d. *Sph. ganodermatis.* – a. Section through a perithecium. – b. Free hyphal ends arising from the surface of the perithecial wall at the base of the papilla. – c. Ascospores. – d. Upper part of a conidiophore. – e–h. *Sph. micropori.* – e. Section through a perithecium. – f. Asci. g. Ascospores. – h. Upper part of a conidiophore. – i. *Spo. lanceolatus.* Ascospores, two starting to disarticulate. – a–d = G.J.S. 9189; e, f = G.J.S. 8278; g = G.J.S. 9262; h = G.J.S. 8279; i = G.J.S. 9071. h on CMD, all the rest on natural substrata. – Scale bars: a, e = 50 μm; b, h = 20μm; c, d, f, g, i = 10 μm.

one side branch; hyaline, smooth. Branching at the top bi- to terverticillate; metulae in whirls of 2–4, cylindrical, 6.2–8.9–11.5 μm long, 1.8–2.6–3.4 μm wide near the base. – Phialides in whirls of 4–6, appressed and bent inwards, cylindrical but constricted below the tip, 8.7–10.8–12.9 μm long, 1.3–1.8–2.3 μm wide near the base; conidia held in a single drop of clear, colorless liquid at the tip of each conidiophore. – Conidia cylindrical to ellipsoidal, straight, 2.4–2.8–3.2 \times 1.2–1.4–1.6 μm , l/w 1.5–2–2.5, aseptate, hyaline. – Chlamydospores not observed.

Holotype. – THAILAND: Khao Yai, Park Headquarters, along a nature trail, 14°26'N, 101°22'E, elev. 700 m, in highly disturbed forest, on Ganodermataceae, 3 Sep 2001, G.J.S. 9189, M.R. & R. N. (BPI 842044, isotypes TAA, BBH).

Sphaerostilbella ganodermatis is included in Sphaerostilbella because of its naviculate non-apiculate ascospores, the Gliocladium s. str. anamorph and the aphyllophoricolous habit. However, it differs from other members of the genus in having aseptate, mostly smooth-walled ascospores, while in all other species they are 1-septate and minutely echinulate/spinulose. In the hairy appearance of perithecia that is caused by hyphae growing out from the perithecial wall at the base of the papilla, Sph. ganodermatis suggests Sph. broomeana and Sph. lutea. The anamorph is similar to that of Sph. aureonitens; both species have a well differentiated main stipe of the conidiophore that is branched mainly at the top. In Sph. aureonitens it is yellowish and strongly warted, in Sph. ganodermatis conidiophores are wider, smooth, and the conidia shorter. The species lacks synnemata that are produced by the anamorphs of Sph. lutea and Sph. novaezelandiae and morphologically similar anamorphic species of Gliocladium (G. polyporicola (Henn.) Seifert & W. Gams, G. thaxteri Seifert & W. Gams). There is no living culture as the ascospores did not germinate on CMD at 20-21 C.

Ganoderma species have not been recorded as hosts of species of Sphaerostilbella or Gliocladium. While Sph. aureonitens and Sph. berkeleyana grow mainly on members of Stereum, and Sph. broomeana is found only on Heterobasidion species, the other species of the genus have been found on different aphyllophores. Members of Ganoderma serve as hosts to species of Sporophagomyces; Spo. chrysostomus and Spo. lanceolatus parasitize the discharged basidiospores of Ganoderma species, with their subiculum hanging loosely under the basidiocarps of the host. However, the perithecial wall in these species is hyphal, their ascospores are 1-septate and disarticulate into two part-spores after being discharged. The anamorph, known only in Spo. chrysostomus, is acremonium-like forming septate conidia.

25. Sphaerostilbella lutea (Henn.) Sacc., Syll. Fung. 17: 778. 1905.

Anamorph: Gliocladium aurifilum (Gerard) Seifert, Samuels & W. Gams, Stud. Mycol. 27: 148. 1985.

Specimens examined. – THAILAND: Khao Yai, a forest near the park head-quarters, elev. 700 m, 2 Aug 1997, on a resupinate polypore, 2 Aug 1997, G. J. S. 8277a, K.P., P.C. (BPI 745826, TAA 161739).

Characteristic of this species is the hyphal tomentum in which the perithecia are embedded. Hyphae with free tips arise from the perithecial papilla as mentioned also by Seifert (1985). We observed sparse spines on the wall of these hyphae. The synnemata were found growing close to the perithecia. Despite the probably cosmopolitan distribution of the anamorph, the teleomorph of *S. lutea* was previously known only from West Africa (Seifert, 1985) and Indonesia (Samuels & al., 1990).

26. **Sphaerostilbella micropori** Põldmaa & Samuels, **sp. nov.** – Figs. 1i, j; 8e–h.

Anamorph: verticillium-like.

Subiculum absens. Perithecia hymenophoro hospitis stromate basilari dense affixa, subglobosa, $170-250\times160-250~\mu m$, solitaria vel paula aggregata, bubalina vel luteola, KOH ope colore immutato; papilla inconspicua; paries 28-35 crassus, bistratosus. Asci cylindrici, $67-72\times3.9-5.2~\mu m$, octospori, uniseriati, apices anellum minutum praebentes. Ascosporae naviculares, $5.9-7.0-8.2-10.0\times2.1-2.6-2.9-3.3~\mu m$, hyalinae, uniseptatae, glabrae vel minute spinulosae, nonapiculatae; una cellula breviore quam altera. Conidia cylindrica vel ellipsoidea, recta, $4.2-5.8\times2.2-2.6~\mu m$, unicellularia, hyalina. Chlamydosporae absentes.

Subiculum absent. - Perithecia anchored firmly to the hymenophore of the host with a minute basal stroma, solitary and widely spaced or in small, scattered groups; subglobose to tympaniform, without a conspicuous papilla, 170–250 × 160–250 μm, amber, buff or pale yellow, KOH-, collapsing when dry by apical or lateral pinching; perithecial surface smooth, surface cells hyphal to pseudoparenchymatous (textura epidermoidea), 7-10 × 5-6 μm, thin-walled; perithecial wall 28–35 μm thick, comprising two distinct regions; the outer region ca 20 µm wide of textura epidermoidea with thickwalled cells, continuous with the minute stroma at the base of the perithecium; inner region 15–17 µm wide, cells elliptic in outline, $4-8\times2-3$ µm, becoming increasingly more flattened towards the locule; the outer and inner region appearing to be joined at the base by a layer of thin-walled cells, at the top the outer region pierced by a palisade of cylindrical cells originating from the inner region; stroma composed of thick-walled compact hyphal cells. - Asci narrowly cylindrical, $67-72 \times 3.9-5.2 \mu m$, tip thickened and with a ring; ascospores uniseriate. – Ascospores naviculate, 1-septate, lower cell narrower and longer or shorter than the upper one, 5.9–7.0–8.2– $10.0\times2.1–2.6–2.9–3.3~\mu m,$ l/w 2.1–2.7–3.2–3.9, hyaline, finely spinulose or smooth, non-apiculate.

Scarce white mycelium adjacent to the perithecia bearing heads of conidia, 15-30 μm diam. – Phialides subulate, 25-30 μm long, 2-2.5 wide near the base. – Conidia cylindrical, attenuated at the base, straight, 4.2-5.8 \times 2.2-2.6 μm , aseptate, hyaline. – Chlamydospores not observed.

Dried cultures on CMD. – Aerial mycelium scarce. – Conidiophores scattered, arising from the surface of the agar; 50–115 μm long and 4–7 μm wide at the base, unbranched or branched at the top; walls thick, hyaline, smooth. Branches supporting the phialides 20–52 μm long, 2.5–3.5 μm wide. – Phialides 25–50 μm long, 1.7–2.5 μm wide at the base, in divergent to appressed whirls of 2–6, conidia held in colorless, 12–30(–45) diam drops of clear liquid. – Conidia cylindrical to ellipsoidal, straight, 4.4–6.7–7.2–9.1 \times 1.6–2.3–2.4–2.9 μm , l/w 2.2–3.0–3.1–4, aseptate (1-septate in G.J.S. 97-97), hyaline, smooth, lacking a visible basal abscission scar.

Holotype. – THAILAND: Khao Yai, vicinity of the park headquarters, elev. 700 m, on *Microporus xanthopus* (Fr.) Kuntze, 2 Aug 1997, G. J. S. 8279 (BPI 745828, including dried culture from G.J.S. 97-97, isotype TAA).

Paratypes. – THAILAND: Khao Yai, nature trail km 33, Nong Pak Chi, elev. 715 m, on Stereum ostrea s.l., 1 Aug. 1997, G. J. S. 8255b, K. P. & P. C. (BPI 745805, BBH); vicinity of park headquarters along trail, on M. xanthopus, 2 Aug. 1997, G. J. S. 8278, K. P., P. C. (bpi 745827, TAA169733); Phakrajai, on M. xanthopus, 6 Aug 1997, K. P., G. J. S. & P. C (TAA 169755, 169756, 169764); along the trail from Haew Sawat to Haew Sai waterfall, on M. xanthopus, 11 Aug 1997, G. J. S. 8367 & P. C. (BPI 745699, including dried culture from G.J.S. 97-59); Darn Chang, elev. 750 m, on Stereum ostrea, 15 Aug 1997, G. J. S. 8466 & P. C. (BPI 745789, BBH); W of park headquarters from point where Mo Sing To and Nong Pak Chi trails separate to ridge leading to Nong Pak Chi, 14°26'N, 101°22'E, elev. 775 m, on M. xanthopus, 7 Sep 2001, G. J. S. 9262 (BPI 842052).

This new species is unusual in *Sphaerostilbella* because of the lack of any subiculum and having waxy perithecia that are often apically collapsed. The perithecial wall is two-layered, the outer region being continuous with the basal stroma. We have observed such perithecial wall structure in *Sph. aureonitens* and *Sph. berkeleyana* (Plowr. & Cooke) Samuels & Cand. The ascospores of most of the specimens showed no sign of germination and cultures derived from two specimens died. The phialidic anamorph observed in one specimen and from two dried cultures differs from typical *Gliocladium* anamorphs of *Sphaerostilbella* species. Verticillium-like conidiophores, however, are found among the synnemata in cultures of *Sph. lutea* and *Sph. novaezelandiae*.

27. Sporophagomyces chrysostomus (Berk. & Broome) K. Põldmaa & Samuels, Canad. J. Bot. 77: 1765. 1999.

Anamorph: Acremonium lindtneri (Kirschst.) Samuels & Rogerson, Mycologia 85: 241. 1993.

Anamorph specimen examined. – THAILAND: Khao Yai, Nature trail, km 33, to Nong Pak Chi, on *Ganoderma* sp., 1 Aug 1997, K.P. (TAA 169717a).

The morphology of *Spo. chrysostomus* is discussed under 'H.' cf. amaurodermatis, *Sph. ganodermatis* and *Spo. lanceolatus. Sporophagomyces chrysostomus* is probably a cosmopolitan species that is commonly found on the hymenophore of *Ganoderma* species. The type originated from Sri Lanka, which was the only previous record of the species in Asia.

28. Sporophagomyces lanceolatus (Rogerson & Samuels) K. Põldmaa & Samuels, Canad. J. Bot. 77: 1765. 1999. – Fig. 8i.

Anamorph: none known.

Specimens examined. – THAILAND: Khao Yai, along trail between Khlong E-Thao ($14^{\circ}28$ 'N, $101^{\circ}20$ 'E, elev. 750 m) and $14^{\circ}28$ 'N, $101^{\circ}12$ 'E, elev. 808 m, in primary forest, on Ganoderma sp., 18 Aug 2001, G. JS. 9071 & R. N. (BPI 842035).

The Thai specimen corresponds to the original description of the species, except for the ascospores being slightly smaller, measuring $22.8–26.7–30.6\times2.2–2.9–3.7~\mu m$, l/w 6.4–9.3–12.1. The hyphal mantle that surrounds the perithecia, leaving only the papilla free, turns bright sulphur-yellow in KOH. While *Spo. lanceolatus* is almost indistinguishable from *Spo. chrysostomus* in gross morphology, as both species form an easily separable mycelial mat below the host hymenophore, the spore sizes are very different. However, the discharged ascospores of *Spo. lanceolatus* were seen to disarticulate as is common in *Spo. chrysostomus*. Previously *Spo. lanceolatus* had been collected on *Rigidoporus microporus* from two closely situated localities in Puerto Rico.

29. 'Hypocrea' pallida Ellis & Everh., J. Mycol. 2: 65. 1886.

Anamorph: Gliocladium sp.

Specimens examined. – THAILAND: Khao Yai, Wang Jumpee Trail to Lap Tha Kong Creek, elev. 700 m, on decaying polypores, 31 July 1997, G. J. S. 8210 (BPI 745635, BBH; culture G.J.S. 97-135); nature trail km 33, Nong Pak Chi, on decaying polypores, 1 Aug 1997, G. J. S. 8237, K. P. & P. C. (BPI 745657, BBH); Klong E Thao along river, 14°28'N, 101°20'E, elev. 795 m, on decaying polypores, 17 Aug 2001, G. J. S. 9069 (BPI 842033, BBH).

The Thai material agrees well with the species as it was redescribed by Doi & Yamatoya (1989). 'Hypocrea' pallida is a cosmopolitan species, growing on polypores. According to Doi & Yamatoya (1989), it occurs mainly on Tyromyces species. The Gliocladium anamorph is morphologically very close to G. penicillioides Corda (see Seifert, 1985), the anamorph of Sphaerostilbella aureonitens but has hyaline and smooth-walled conidiophore stipes. DNA sequence analyses (Rehner & Samuels, 1994; Põldmaa & al., 1999; Põldmaa 2000) have shown that the species should be excluded from Hypocrea but its phylogenetic relationhips with other members fof Hypocreaceae are still obscure.

Analyses of the LSU rDNA data

The alignment of the LSU rDNA sequences consisted of 1325 characters, of which 114 were parsimony-informative. MP analysis resulted in 40 MP trees 668 steps in length (CI 0.4). The strict consensus tree (not shown) was unresolved in many parts. Two trees with concurrent topology (-ln 5387.31, 681 steps in length, CI 0.4) were obtained in the ML analysis, one of these is depicted in Fig. 9. As in previous studies of the phylogeny of Hypocreales using LSU rDNA (Rehner & Samuels, 1994, 1995; Põldmaa & al 1999; Põldmaa, 2000), the analyses did not result in a robust phylogeny. The results of the MP and ML analyses concurred in the taxon composition of several clades although the species relationships in these clades sometimes appeared different. Because of the weak support for the deeper clades in the ML tree, which were also unresolved on the MP trees, the relationships among these larger clades will mostly not be evaluated here.

In both analyses, the three strains of *H. khaoyaiensis* represent a well-supported clade with C. cubitense as its sister group. These two species, together with C. dimorphicum as the most basal branch, all of which are morphologically similar, form an unsupported group (clade II) on ML trees. Cladobotryum multiseptatum, which resembles H. khaoyaiensis, is part of the well-supported clade of aurofusarin-producing species (H. rosellus, C. rubrobrunnescens). Together with C. asterophorum and H. armeniacus, they comprise the moderately supported clade I. Clades I and II combine into a larger unsupported clade, recognizable in both analyses. Clade III comprises three tropical species that are hardly distinguishable morphologically, H. siamensis, H. subiculosus and Hypomyces sp. (isolates previously called H. australis, but which are not conspecific with its type, see the discussions under H. cf. australis and H. siamensis). On morphological grounds, it is hard to explain the occurrence of *C. arthrobotryoides* in this clade in the ML trees. The species is unique in the complex because of the formation of conidia on

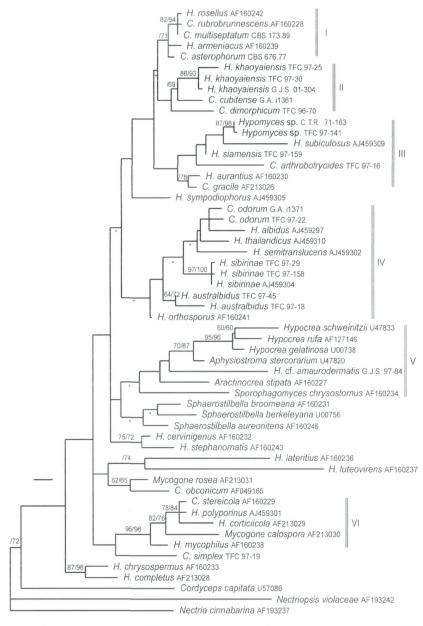


Fig. 9. One of the two trees obtained in the ML analysis. – Tree length = 681, CI = 0.4, –ln likelihood 5387.31. The roman numerals correspond to the numbers of the clades used in the text. The numbers above the branches indicate bootstrap values (shown for values >50%) obtained from 100 ML replicates with the TrN+I+G base-substitution model (left number) and bootstrap values obtained from 1000 parsimony replicates (right number). The asterisks below the branches mark the clades that are present also in the strict consensus of MP trees but have bootstrap values >50%. Scale bar = 0.005 substitutions/site.

denticles on a swelling at the tip of the conidigenous cell. *Cladoboy-tryum asterophorum* (in clade I) shares this type of conidial apparatus but is not closely related to *C. arthrobotryoides*.

Clade IV, distinct in both analyses, comprises the majority of pallid KOH-negative species of Hypomyces/Cladobotryum. The relationships among the seven species in this clade differ in the trees obtained in the two analyses. In both trees, the telomorphic and anamorphic isolates of H. australbidus described from Khao Yai form a group with moderate support that is not closely related to the morphologically very similar H. albidus, which has a temperate distribution. The conspecificity of the two morphologically distinct strains of H. sibirinae with the ex-type strain of this species is strongly supported. The Thai strain identified as C. odorum and the ex-type strain of this species are in unresolved (ML trees) or paraphyletic position (MP trees). Another morphologically unusual member of Cladobotryum, C. simplex, is a sister lineage to clade VI, well-supported in both analyses and comprising five aphyllophoricolous species of Hypomyces/Cladobotryum and Mycogone (anamorphic Hypomyces) in the ML trees. In the consensus of the MP trees, the position of *C. simplex* in Hypocreaceae is unresolved.

In both analyses, the three species of Sphaerostilbella form a weakly supported group that is in sister position to clade V in the ML trees, but with an unresolved position in MP trees. Clade V comprises a strongly supported subclade of three Hypocrea species, with Aphysiostroma stercorarium Barrasa & al. as a sister taxon. In the MP trees, Sporophagomyces chrysostomus and Arachnocrea stipata (Fuckel) Z. Moravec represent another subclade. The strain G.J.S. 97-144, an ascospore isolate of 'H.' cf. amaurodermatis, for which a gliocladiumlike anamorph is described in this study, is placed as a sister group to the six other species in clade V in the MP trees. In the ML trees, however, it is a sister branch to the clade of three Hypocrea species and Aphysiostroma. Based on the characters of perithecia and some similarities in the anamorph, 'H.' amaurodermatis resembles species of Sporophagomyces. The hosts of the latter genus (mostly Ganoderma spp.) are closely related to the hosts of 'H.' amaurodermatis (Amauroderma sp.), both being members of the Ganodermataceae. However, the ascospores of Sporophagomyces species are non-apiculate, smooth-walled and disarticulate after being discharged from the asci, while those of 'H.' amaurodermatis are apiculate, prominently warted and do not disarticulate. According to these results, it is evident that 'H.' amaurodermatis does not belong to Hypomyces and probably needs to be described in a genus of its own. We postpone this decision because of the uncertainty in the conspecificity of the Thai collections with 'H.' amaurodermatis and the unresolved relationships of the analyzed strain in the Hypocreaceae.

Acknowledgments

We thank Dr. Nigel Hywel-Jones (National Center for Genetic Engineering and Biotechnology (Biotech), Bangkok) for arranging our stay in Thailand. We are indebted to Prof. Walter Gams (Centraalbureau voor Schimmelcultures, Utrecht) for correcting the Latin descriptions and for commenting upon the manuscript, to Prof. Erast Parmasto (Institute of Zoology and Botany, Tartu) for identifying the aphyllophoralean host species and to Dr. Günter Arnold (Weimar) for providing us with several cultures for comparison. Dr. Priscila Chaverri (SBML, Beltsville) and Ms. Rungtip Nasit (Hua Hin, Thailand) are acknowledged for the help in collecting the material. Dr. Lisa Castlebury (SBML, Beltsville) gave valuable help in DNA sequencing and Dr. Keith Seifert (Ottawa, Canada) commented upon the parts of the manuscript describing the molecular analyses. The research was supported in part by a U.S. National Science Foundation 'PEET' grant to the Dept. of Plant Pathology, The Pennsylvania State University (Monographic Studies of Hypocrealean Fungi: Hypocrea and Hypomyces DEB-9712308) and the Estonian Science Foundation grant no 4994.

References

- Arnold, G. (1971). Über einige neue Taxa und Kombinationen der Sphaeriales. Z. Pilzk. 37: 187–198.
- (1985). Beitrag zur Kenntnis der Pilze Kubas II. Boletus 9: 49–56.
- (1986). Beitrag zur Kenntnis der Pilze Kubas. Feddes Repert. 97: 59–65.
- (1987). Beitrag zur Kenntnis der Pilze Kubas. III. Feddes Repert. 98: 351–355.
- (1988). Beitrag zur Kenntnis der Pilze Kubas. IV. Feddes Repert. 99: 27–31.
- & R. F. Castañeda-Ruíz (1987). Neue Hyphomyceten-Arten aus Kuba. II. Verticillium antillanum, Nakatea curvularioides und Cladobotryum cubitense. – Feddes Repert. 98: 411–417.
- Castañeda-Ruíz, R. F. (1986). Fungi Cubenses. Instituto de Investigaciones Fundamentales en Agricultura Tropical "Alejandro de Humboldt", La Habana, Cuba. 20 pp., 44 pl.
- (1987). Fungi Cubenses II. Instituto de Investigaciones Fundamentales en Agricultura Tropical "Alejandro de Humboldt", La Habana, Cuba. 21 pp., 29 pl.
- Chaverri, P. & G. J. Samuels (2002). *Hypocrea lixii*, the teleomorph of *Trichoderma harzianum*. Mycol. Prog. 1: 283–286.
- Dissing, H. (1963). Studies in the Flora of Thailand 25. Discomycetes and Gaster-omycetes. Dansk Bot. Ark. 23: 117–130.
- Doi, Y. & K. Yamatoya (1989). *Hypocrea pallida* and its allies (Hypocreaceae). Mem. New York Bot. Gard. 49: 233–242.
- Gams, W., K. O'Donnell, H. J. Schroers & M. Christensen (1998). Generic classification of some more hyphomycetes with solitary conidia borne on phialides. Canad. J. Bot. 76: 1570–1583.
- Helfer, W. (1991). Pilze auf Pilzfruchtkörpern. Untersuchungen zur Ökologie, Systematik und Chemie. Libri Botanici 1: 1–149.
- Hoog, G. S. de (1978). Notes on some fungicolous hyphomycetes and their relatives.
 Persoonia 10: 33–81.
- Hywel-Jones, N. L. (1997). *Hirsutella* species associated with hoppers (Homoptera) in Thailand. Mycol. Res. 101: 1202–1206.
- & G. J. Samuels (1998). Three species of *Hypocrella* with large stromata pathogenic on scale insects. Mycologia 90: 36-46.

- Kornerup A, Wanscher JH. 1967. Methuen Handbook of Color. 2nd Ed. London: Methuen & Co Ltd. 243 p., 30 pl.
- Nicholas, K. B., H. B. Nicholas Jr, & D. W. Deerfield II (1997). Genedoc: analysis and visualization of genetic variation. EMBNEW.NEWS 4:14.
- Phanichapol, D. (1968). The check-list of fungi in the Forest Herbarium. Nat. Hist. Bull. Siam Soc. 22: 263–269.
- Põldmaa, K. (1996). A new species of *Hypomyces* and three of *Cladobotryum* from Estonia. Mycotaxon 59: 389–405.
- (1999). The genus *Hypomyces* and allied fungicolous fungi in Estonia. I. Species growing on aphyllophoralean basidiomycetes. Folia Cryptogamica Estonica 34: 15–31.
- —— (2000). Generic delimitation of the fungicolous Hypocreaceae. Stud. Mycol. 45: 83–94.
- —— (2003). Three species of *Hypomyces* growing on basidiomata of Stereaceae. Mycologia 95: 921–933.
- ——, E. Larsson & U. Kõljalg (1999). Phylogenetic relationships in *Hypomyces* and allied genera, with emphasis on species growing on wood-decaying homobasidiomycetes. Canad. J. Bot. 77: 1756–1768.
- —— & G. J. Samuels (1999). Aphyllophoricolous species of Hypomyces with KOH-negative perithecia. Mycologia: 277–299.
- ——, —— & D. J. Lodge (1997). Three new polyporicolous species of Hypomyces and their Cladobotryum anamorphs. – Sydowia 49: 80–93.
- Posada, D. & K. A. Crandall (1998). Modeltest: testing the model of DNA substitutuion. Bioinformatics 14: 817–818.
- Réblová, M., & K. A. Seifert (2003). Six new species of Chaetosphaeria from tropical rain forests in Thailand and redescription of Chaetosphaeria hiugensis. – Sydowia 55: 313-347.
- Rehner, S. A. & G. J. Samuels (1994). Taxonomy and phylogeny of *Gliocladium* analyzed by large subunit rDNA sequences. Mycol. Res. 98: 625–634.
- & —— (1995). Molecular systematics of the Hypocreales: a teleomorph gene phylogeny and the status of their anamorphs. – Canad. J. Bot. 73 (Suppl. 1): S816–S823.
- Rogerson, C. T. & G. J. Samuels (1993). Polyporicolous species of *Hypomyces*. Mycologia 85: 231–272.
- Rossman, A. \overline{Y} & C. T. Rogerson (1981). A new species of Hypomyces (Hypocreaceae) with phragmosporous ascospores. Brittonia 33: 382–384.
- —, G. J. Samuels, C. T. Rogerson & R. Lowen (1999). Genera of Bionectriaceae, Hypocreaceae and Nectriaceae (Hypocreales, Ascomycetes). – Stud. Mycol. 42: 1–248.
- Samuels, G. J. (1996). Tropical Hypocreales. In: K. D. Hyde (ed.): Diversity of tropical microfungi. University of Hong Kong Press. 297–325.
- ——, Y. Doi & C. T. Rogerson (1990). Hypocreales. In: Samuels, G.J. (ed.). Contributions toward a mycobiota of Indonesia. Mem. New York Bot. Gard. 59: 6–108.
- Seifert, K. A. (1985). A monograph of *Stilbella* and some allied hyphomycetes. Stud. Mycol. 27: 1–235.
- Sivichai, S., E. B. Gareth Jones, N. L. Hywel-Jones (2002). Lignicolous freshwater higher fungi with reference to their teleomorph and anamorph stages. – In: Watling, R., J. C. Frankland, A. M. Ainsworth, S. Isaac & C. H. Robinson (eds.). Tropical mycology. Vol. 2. Micromycetes. CAB International, New York. 41–49.
- Swofford, D. L. (1999). PAUP* 4.0 Phylogenetic Analysis Using Parsimony (* and other methods), version 4.0b10. Sunderland, Massachusetts: Sinauer Associates, Inc.

- Teng, S. C. (1996). Fungi of China. Ed. R. P. Korf. Mycotaxon, Ltd., Ithaca, New York. 586 pp.
- van Oorschot, C. A. N. (1985). A review of *Arthrobotrys* and allied genera. Stud. Mycol. 26: 61-96.
- Whalley, A. J. S., N.L. Hywel-Jones, E. B. G. Jones & M. A. Whalley (1995). A preliminary account of the genera *Biscogniauxia* and *Hypoxylon* in the Chanthaburi and Chon Buri Provinces of South East Thailand. – Sydowia 47: 70–81.
- —, S. Thienhirun, M. A. Whalley & P. Sihanonth (1998). The genus *Rhopalostroma* (Xylariaceae) in Thailand. Bot. J. Scotland 50: 185–190.

 $(Manuscript\ accepted\ 8^{th}\ December\ 2003)$

ZOBODAT - www.zobodat.at

Zoologisch-Botanische Datenbank/Zoological-Botanical Database

Digitale Literatur/Digital Literature

Zeitschrift/Journal: Sydowia

Jahr/Year: 2004

Band/Volume: <u>56</u>

Autor(en)/Author(s): Poldmaa Kadri, Samuels Gary J.

Artikel/Article: Fungicolous Hypocreaceae (Ascomycota: Hypocreales) from

Khao Yai National Park, Thailand. 79-130