Plant parasitic Asterinaceae and Microthyriaceae from the Neotropics (Panama)

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Table of contens .... I-V

1 Introduction

Asterinaceae and Microthyriaceae are two families of inconspicuous and poorly studied fungi assigned to the Dothideomycetes (Ascomycota, Dikarya), one of the classes of ascomycetes with bitunicate asci. The bitunicate ascus is a meiosporangium with two distinct wall layers that separate from each other during spore release. The unitunicate ascus, present in members of Sordariomycetes, differs from the bitunicate ascus by the presence of a single functional wall layer. Members of Asterinaceae, Microthyriaceae and few other families produce a special type of fruitingbody called thyriothecium, a small shield-shaped (dimidate) and flat structure developing superficially on the substrate. Thyriothecia-producing ascomycetes, or thyriothecioid ascomycetes, are assigned to different families of Dothideomycetes and are characterized by variable ecological and morphological characteristics. Asterinaceae and Microthyriaceae are the most species-rich families of thyriothecioid ascomycetes.

1.1 The bitunicate ascomycetes

Bitunicate ascomycetes are a large group of lichenized and non-lichenized fungi with more than 7300 species in over 800 genera (Barr and Huhndorf 2001). The group contains many important plant pathogens, superficial epiphytes, saprotrophs on dead leaves, wood, dung, and plant debris and hyperparasites on superficial fungi and insects. They are characterized by bitunicate asci and ascomata with ascolocular development.

1.1.1 The ascomata

Ascoma formation in bitunicate ascomycetes is initiated with the development of an undifferentiated stroma composed of a mass of compact hyphae or pseudoparenchymatic cells (Eriksson 1981). Within the stromatic tissue cavities or locules are formed via lysis of stromatal cells and inside the locules bitunicate asci develop. No additional wall structures separate the locules from the stromatic tissue and, therefore, the entire structure can be called ascostroma (Kirk et al. 2001, Sierra Lopéz 2006). During ascolocular development the ascomata or locules within the stroma are formed prior to nuclear pairing in the diakaryon. On the contrary, for ascomycetes with ascohymenial development the ascoma formation is initiated after nuclear pairing (Barr and Huhndorf 2001, Schoch et al. 2006a).

The most common type of ascostroma among bitunicate ascomycetes is the *pseudothecium* which can vary in shape from globose, ovoid, obpyriform, conical to flask-shaped (Sierra Lopéz 2006). Pseudothecia are closed structures that liberate their ascospores through a periphysate ostiole (Pleosporales), a lysigenous, non-periphysate pore (= pseudopore, Dothideales), an operculum, by cracks, or by slimy disintegration of the ascomal wall (Englerulaceae) (Eriksson 1981). *Apothecioid asco-stromata* are orbicular, cup-shaped or discoidal in outline. Elongated, lip-shaped apothecioid ascostromata that open with longitudinal slits are called *hysterothecia* and are typical for members of Hysteriaceae. The *cleistothecium* is a non-ostiolate globose ascostroma that rupures at maturity with irregular fissures (Zopfiaceae). The *thyriothecium* is a strongly flattened ascoma with a dark upper wall called scutellum and with or without a lower wall. The scutellum is composed of radially arranged cells, or more irregularly meandrical cells and opens with a central pore or with star-shaped or irregular fissures (Microthyriaceae, Asterinaceae and others).

In general the ascostromata of bitunicate ascomycetes are small and dark pigmented, although bright coloured ascomata occur as well, e.g. within Tubeufiaceae (Eriksson 1981). The ascostromata are glabrous or setose and uni- or multilocular. Unilocular ascostromata are solitary or grouped together above a stroma, or embedded in a pseudostroma (= synascoma). Ascostromata with uniascal locules occur as well and are typical for members of Myriangiales. The position of the ascostromata can be completely superficial, erumpent, more or less immersed or completely immersed in the substrate. Sometimes the ascostromata show indeterminate growth and can extend and enlarge even though the original ascus-bearing region has developed asci and ascospores (Seuratiaceae, Barr and Huhndorf 2001).

Ascostroma morphology together with the type of centrum development is an important criterion to separate families in the bitunicate ascomycetes (Crous et al. 2003).

1.1.2 The hamathecium

The term hamathecium was proposed by Eriksson (1981) and defines the sterile pseudoparenchymatous tissue between the asci or that proliferates into the ascostromatic locule or the ostiolar channel. Due to development and place of origin of the sterile hyphae, various types of hamathecia can be recognized. The ***interascal pseudoparenchyma*** consists of primary tissue that remains unchanged or becomes depressed between developing asci (Fig. 1.1f, e.g. *Pseudosphaeria*, *Wettsteinina*). *Paraphyses* are unbranched hyphae originating from the bottom of the locule and usually are not anastomosing (Fig. 1.1h, e.g. Pyrenulaceae). *Paraphysoids* or trabeculate pseudoparaphyses are derivated from the interascal stroma that streches during asoma development (Fig. 1.1k, e.g. Melanommataceae). *Pseudoparaphyses* originate from the apical region of the locule and grow downwards until they reach the bottom of the locule (Fig. 1.1j, e.g. Pleosporales). They can fuse with the cells of the basal part of the locule and sometimes get detached at the apical part of the locule. Pseudoparaphses can be branched and anastomosing and show a regular septation. *Periphysoids* are short hyphae that grow downwards from the apical part of the locule without reaching the bottom (Fig. 1.1g, e.g. Capnodiales). *Periphyses* are unbranched hyphae in the ostiolar channel that are not anastomosing (Fig. 1.1i, e.g. Pyrenulaceae). Periphyses can occur in ascomata together with paraphyses, pseudoparaphyses or periphysoids. In some bitunicate ascomycetes the hamathecium is lacking completely (Fig. 1.1l, e.g. Dothideales).

The composition of the hamathecium is an important criterion to delineate orders or families within the bitunicate ascomycetes (Lumbsch and Lindemuth 2001, Schoch et al. 2006a, Lumbsch and Huhndorf 2007b).

1.1.3 The bitunicate ascus

The bitunicate ascus is composed of a thin, non-elastic outer wall called ectotunica and a thick, elastic inner wall called endotunica (Eriksson 1981). At maturity of the ecto- and endotunica separate from each other, the endotunica swells and extends to actively discharge the ascospores (Luttrell 1973). Ultrastructural analyses of the bitunicate ascus indicate that the wall structures are even more complex and both ecto- and endotunica can be composed of several sublayers (Bellemère 1971, Bellemère and Hafellner 1982, Letrouit-Galinou et al. 1994, Au et al. 1999).

Among the species of bitunicate ascomycetes the dehiscence mechanisms of asci can vary. Eriksson (1981) recognized seven different types of ascus dehiscence and

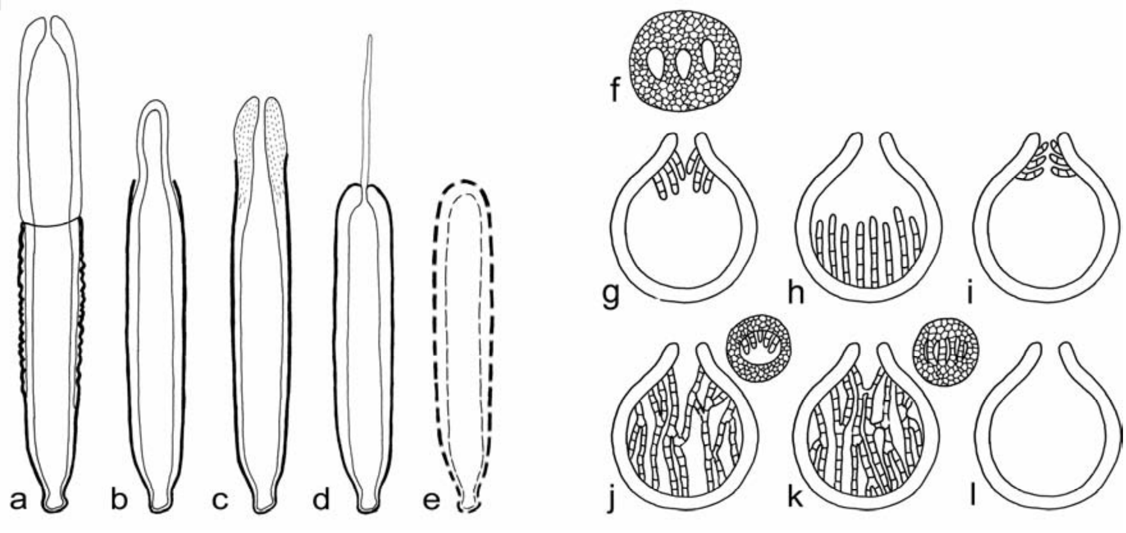

Figure 1.1: Ascus and hamathecium types of bitunicate ascomycetes after Eriksson (1981) and Bellemère (1994). a-e: Ascustypes. a: fissitunicate. **b:** semifissitunicate. **c:** rostrate. **d:** pseudofissitunicate. **e:** pseudoprototunicate. **f-l: Hamathecium types. f:** interascal pseudoparenchym. **g:** periphysoids. **h:** paraphyses. **i:** periphyses. **j:** pseudoparaphyses. **k:** paraphysoids. **l:** no hamathecial hyphae.

even more types were proposed by others (Reynolds 1989, Bellemère 1994). The most important dehiscence types for bitunicate asci are described as follows. During the *fissitunicate dehiscence* or the "jack in the box" type of dehiscence the ectotunica ruptures in the apical part of the ascus and slides down towards the base, whereas the endotunica swells and streches upwards to duplicate or even triplicate the orginal ascus length (Fig. 1.1a). The fissitunicate dehiscence is the most common type of ascus dehiscence among bitunicate ascomycetes *sensu stricto* (Sierra López 2006). During *semifissitunicate dehiscence* the upper part of the endotunica separates from the ectotunica and is extruded as a long rostrum (Fig. 1.1b). The semifissitunicate dehiscence is an intermediate type between fissitunicate and rostrate dehiscence. During *rostrate dehiscence* the apical part of the ectotunica ruptures and the central part of the endotunica protrudes, however, both ecto- and endotunica do not separate from each other (Fig. 1.1c). During *pseudofissitunicate dehiscence* both ecto- and endotunica rupture and only the epiplast with surrounding plasmalemma is extruded (Fig. 1.1d). This type of dehiscence is also seen in squash mounts of species that have fissitunicate dehiscence (Eriksson 1981). Few bitunicate ascomycetes have thin-walled asci that do not open but deliquesce at maturity and are called *pseudoprototunicate* asci (Fig. 1.1e, Barr and Huhndorf 2001).

The systematic value of ascus dehiscence is uncertain in the classification of bitunicate ascomycetes (Bellemère 1994) because bitunicate asci are not exclusively fissitunicate (Reynolds 1987). The numerous dehiscence types are probably a result of functional adaptation of structures to environmental conditions (Bellemère 1994).

Bitunicate asci are mostly arranged in a hymenial layer or they are irregularly scattered in the ascostroma (e.g. Myriangiales). The shapes of bitunicate asci are variable and range from globose to sublogose, saccate and wider at the base, to oblong, claviform or cylindrical, sessile or stalked, or thickened apically (Sierra López 2006).

1.1.4 The ascospores

The morphology of the ascospores of bitunicate ascomycetes is variable and there exist globose, ellipsoidal, ovoid, obovoid, fusiform, oblong, cylindrical, or filiform shapes. Ascospores can be straight, curved or asymmetrical. Sometimes the spores are unicellular (amerosporous), however, most of the species have septate ascospores with one septum (didymosporous) or various transversal septa (phragmosporous) or various transversal and longitudinal septa (dichtyosporous). The ascospores can be hyaline, or slightly pigmented at maturity, yellowish, light brown, greenish to olivaceous, or intensively pigmented, reddish brown to dark brown or blackish. The surface of mature spores is smooth or covered with small warts (Sierra Lopéz 2006).

Ascospore septation is a classical characteristic in many ascomycete systems (Barr 1987), however, results of molecular phylogenetic studies indicate that ascospore septation is an unreliable feature to define certain genera of bitunicate ascomycetes (Crous et al. 2003). Therefore, ascospore septation is of lower systematic value than assumed before.

1.1.5 Anamorphs of bitunicate ascomycetes

A large number of bitunicate ascomycetes produce anamorphic stages including both hyphomycetes and coleomycetes (Schoch et al. 2006a). Many of these anamorphs are important plant pathogens on agricultural crops and are studied with great interest. The anamorphs can uncover morphologically and phylogenetically relevant characters where the respective teleomorphic stages are of lower variability and, therefore, the asexual stages are important for the modern classification of certain groups of bitunicate ascomycetes. For example, the genus *Mycosphaerella* (Mycosphaerellaceae, Capnodiales) is connected to about 30 different anamorph genera and was found to be polyphyletic due to the morphological variability of its anamorphs and molecular data (Crous et al. 2007a). However, for many bitunicate ascomycetes the respective anamorphs are still unknown and some already known associations have to be reviewed carefully because these could be hyperparasitic or coincidental (Barr 1987).

In the classification of bitunicate ascomycetes the arrangement of conidium-bearing structures and the type of conidiogenesis of anamorphic stages are thought to be valid and importat features (Barr and Huhndorf 2001).

1.1.6 Classification of bitunicate ascomycetes

Bitunicate ascomycetes were originally thought to represent a monophyletic group of ascomycetes on the basis of ontogenetic and morphological characteristics of the sexual stage (Lumbsch and Lindemuth 2001, Schoch et al. 2006a). A detailed overview to the history of the classification of bitunicate ascomycetes was given by Sierra López (2006). The importance of ontogenetic characteristics was proposed by Nannfeldt (1932), who defined the “Ascoloculares” for ascomycetes with ascolocular development. The Ascoloculares according to Nannfeldt, were subdivided in the orders Myriangiales, Pseudosphaeriales, Hemisphaeriales and Trichothyriales. Luttrell (1955) highlighted ascus morphology and dehiscence as well as the composition of the interascal tissue and introduced the class “Loculoascomycetes” for ascomycetes with bitunicate asci and ascolocular development. The Loculoascomycetes *fide* Luttrell were subdivided in the Myriangiales, Dothideales, Pseudosphaeriales, Hysteriales and Trichothyriales. Characteristics such as ascus shape and ascoma opening mechanisms were emphazised by Arx and Müller (1975) who accepted only one order Dothideales with two suborders Dothideineae and Pseudosphaeriineae with a total of 34 families. The interascal tissue within the ascostromata, termed hamathecium by Eriksson (1981) was used by Barr (1987) as a reliable character amongst others to define subclasses within the Loculoascomycetes. Barr (1987) mainly followed Luttrells`s concept of Loculoascomycetes and divided the class in four subclasses due to the indeterminate or determinate growth of the ascostromata, the presence or absence of a hamathecium and the type of hamathecium. Barr’s classification of Loculoascomycetes was accepted by many mycologists (Sierra López 2006) until phylogenetic studies based on molecular data fundamentally changed the system of the bitunicate ascomycetes.

The primary molecular phylogenetic analyses with rDNA sequences proved the paraphyly of the Loculoascomycetes (Berbee 1996) and the order Chaetothyriales was found to be related more closely to the Eurotiales (Plectomycetes, with unitunicate asci) than to Dothideales and Pleosporales. Thereupon, bitunicate ascomycetes were assigned to distinct classes namely Dothideomycetes, Chaetothyriomycetes and lichenized Arthoniomycetes (Eriksson and Winka 1997). Within the Dothideomycetes the orders Dothideales and Pleosporales were shown to represent two sistergroups due to the absence or presence of pseudoparaphyses (Berbee 1996, Lumbsch and Lindemuth 2001). The Chaetothyriomycetes were found to be closely related to the Eurotiomycetes and were placed as subclass Chaetothyriomycetidae next to Eurotiomycetidae in the class Eurotiomycetes (Kirk et al. 2001, Lutzoni et al. 2004). Multigene-based phylogenies demonstrated that the presence or absence of pseudoparaphyses is of high significance for the segregation of orders and families amongst the Dothideomycetes (Schoch et al. 2006a). Within the Dothideomycetes Schoch et al. (2006a) proposed a new subclass Pleosporomycetidae for paraphysate Pleosporales next to the subclass Dothideomycetidae with aparapyhsate Dothideales, Capnodiales and Myrangiales.

Today, the Loculoascomycetes *sensu* Luttrell (excluding lichenized taxa) are found among two different classes of ascomycota: (1) Dothideomycetes with the subclasses Dothideomycetidae and Pleosporomycetidae next to numerous orders, families and genera with a yet uncertain placement, and (2) Eurotiomycetes with three subclasses Chaetothyriomycetidae, Eurotiomycetidae and Mycocaliciomyxcetidae in which the bitunicate ascus became subsequently lost (Hibbet et al. 2007).

1.2 Asterinaceae, Microthyriaceae and other thyriothecoid ascomycetes

Thyriothecioid ascomycetes are a group of bitunicate ascomycetes with mostly dimidiate ascomata developing superficially on plants (Fig. 1.2). The ascomata can be easily removed from the substrate and resemble insect exudates due their small size. Therefore, the group sometimes is referred to as “fly-speck-fungi” (Hofmann and Piepenbring 2006). The “fly-speck fungi” or thyriothecioid ascomycetes represent single, probably not closely related groups of morphologically similar fungi that share the same ecological niche.

1.2.1 Families of thyriothecioid ascomycetes

Ascomycetes with dimidiate ascomata are placed in numerous families mostly based on morphological differences in the structure of ascomata, their location and opening mechanisms, the shape of the asci and the presence or absence of a surface mycelium or hypostroma (compare Chapter 7.2, Table 7.1). Families of thyriothecioid ascomycetes are assigned to the Dothideomycetes, one of the major classes of ascomycetes with bitunicate asci and therein to the subclass Dothideomycetideae (Kirk et al. 2008). Within the subclass the Asterinaceae are assigned provisionally to the Capnodiales as well as the Schizothyriaceae for which a relationship to Mycosphaerellaceae was supported by molecular data (Batzer et al. 2008). The Aulographaceae, Microthyriaceae and Leptopeltidaceae although probably polyphyletic, are grouped in the order Microthyriales which is provisionally included in the Dothideomycetes as molecular data are still missing (Kirk et al. 2008). The Micropeltidaceae along with various morphologically and ecologically similar families such as Brefeldiellaceae, Englerulaceae, Parmularicaeae, Polystomellaceae and Vizellaceae (compare Table 7.1), are not assigned yet to any dothideomycetous group as molecular data are missing (Kirk et al. 2008).

The most species-rich families of thyriothecioid ascomycetes are the Asterinaceae and Microthyriaceae that both include an excessive amount of genera (see Chapter 7.1) from which many are probably artificial (Kirk et al. 2001).

1.2.2 Ecology

Thyriothecioid ascomycetes are associated with a broad range of substrates, including living leaves, stems and fruits, dead and decaying plant material and other fungi. They are plant parasites, saprotrophs, commensals or mycoparasites with a worldwide distribution although many families are most species-rich and diverse in tropical and subtropical regions.

Asterinaceae and plant parasitic members of Microthyriaceae are mostly associated with the surface of living leaves, more rarely with living stems or other plant organs. Most of the species are obligate biotrophic pathogens dependent on a living host plant and, therefore, are thought to be host specific. Asterinaceous and microthyriaceous plant parasites show various strategies for plant infection including penetration of cuticular, subcuticular, epidermal or subepidermal plant tissues or host stomata and glands by the formation of haustoria, hypostromata, inter- or intracellular hyphae. They have a typical tropical and subtropical distribution with main diversity centers in the paleo- and neotropics of the southern hemisphere. In the temperate northern hemisphere plant parasitic members of Asterinaceae and Microthyriaceae are almost absent.

Saprotrophic Microthyriaceae are commonly found superficially or subcuticularily on dead decaying leaves and stems. They are probably less host specific and are distributed worldwide in temperate and tropical regions (Ellis 1976, 1977, 1980, Spooner and Kirk 1990). Saprotrophic species and genera have thyriothecioid or catathecioid ascoma types and are also found in the Aulographaceae and Leptopeltidaceae.

Some members of Microthyriaceae are hyperparasitic on plant pathogenic ascomycetes of the Meliolales, Asterinaceae, Englerulaceae and Microthyriaceae or parasitize on foliicolous lichens. Microthyriaceous hyperparasites are mostly not host specific but they depend on the distribution of their pathogenic host fungus or lichen and, therefore, are often found in tropical and subtropical regions were their hosts occur. Hyperparasitic species of Microthyriaceae belong to genera such as *Actinopeltis*, *Lichenopeltella*, *Trichothyriopsis* and *Trichothyrium*, and have catathecioid ascomata with distinct upper and lower ascomatal walls. Therefore, the genera were formerly separated into an own family Trichothyriaceae (Theissen 1914a, Höhnel 1917, Ellis 1977, Spooner and Kirk 1990).

Commensalistic thyriothecioid ascomycetes grow epiphytically on living leaves, stems and fruits and show the typical fly-speck habitus (Hofmann 2005). They are thought to feed on plant exudates or other nutrients available on leaf surfaces (Batista 1956b, 1959, Batzer et al. 2008). Commensals do not penetrate the host cuticle (Gilbert et al. 1997, Belding et al. 2000, personal observations) and are thought to be unspecific on a broad range of host plants (Williamson and Sutton 2000, Reynolds and Gilbert 2006). They are very common and diverse in the tropics and subtropics worldwide (Batista 1956a, 1959), but are also known from the temperate zone in regions with mild climate and a relative high humidity (Johnson and Sutton 2000, Cooley et al. 2004). Typical commensals or “fly-speck fungi” belong to the Schizothyriaceae and Micropeltidaceae (Hofmann and Piepenbring 2006).

1.2.3 Morphology

Surface mycelia: Most thyriothecioid ascomycetes develop a branched surface mycelium composed of septated hyphae. Saprotrophic and commensalistic species have inconspicuous hyaline or slightly pigmented surface mycelia that cover large leaf and fruit parts like a net (saprotrophic Microthyriaceae, Micropeltidaceae and Schizothyriaceae) and may become evanescent during ascoma development. Plant parasitic species form conspicuous and darkly pigmented surface mycelia with or

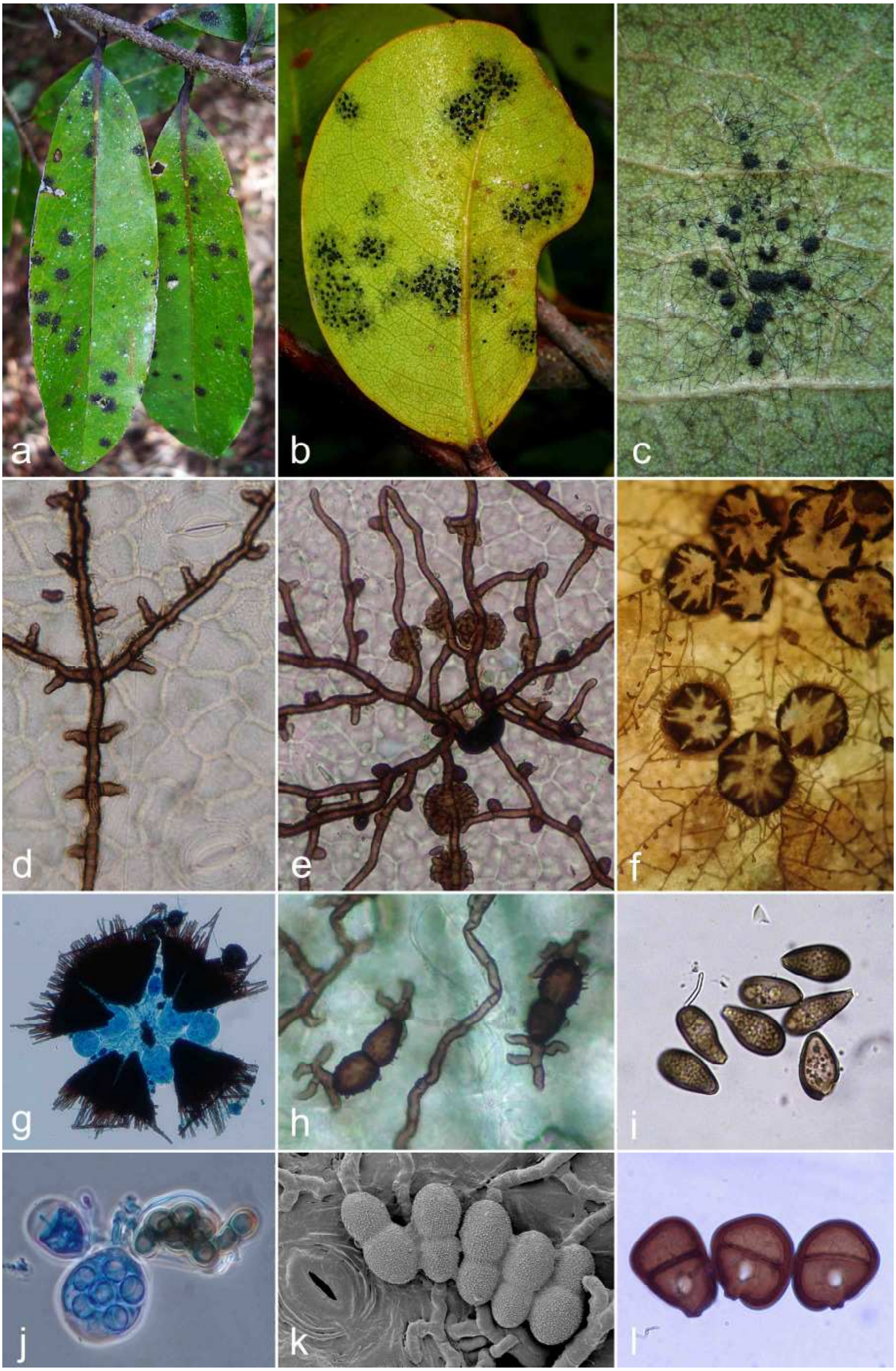
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Figure 1.2: Morphological characteristics of Asterinaceae. a: Epiphyllous colonies of *Asterolibertia nodulosa* on leaves of *Oxandra venezuelana* (Annonaceae). **b:** Hypophyllous colonies of *Halbanina* sp. on *Chrysobalanus icaco* (Chrysobalanaceae). **c:** Single, superficial colony of *Homalopeltis chrysobalani* on *C. icaco* (Chrysobalanaceae). **d:** Surface hyphae of *Asterina zanthoxyli* with lateral appressoria on *Zanthoxylum scheryi* (Rutaceae). **e:** Appressoriate surface mycelium and ascoma initials of *Asterina ciferriana* on *Caesalpinia bonduc* (Fabaceae). **f:** Surface mycelium and mature thyriothecia of *Asterina phenacis* on *Phenax mexicanus* (Urtiaceae). **g:** Squashed thyriothecium of *Prillieuxina winteriana*, asci and ascogenous hyphae are stained in lactophenol with water blue. **h:** Germinating ascospores of *Asterina* sp. on *Compsoneura sprucei* (Myristicaceae). **i:** Conidia of *Asterostomella dilleniicola*. **j:** Asci of *Asterina manihotis* in different developmental stages, stained in lactophenol with water blue. **k:** SEM photrograph of mature ascospores and surface hyphae of *Asterina zanthoxyli* on *Z. scheryi* (Rutaceae). **l:** Conidia of *Hemisphaeropsis magnoliae*, note the hyaline germpore in the center of each lower cell.

without typical infection structures to penetrate the host cuticle (Asterinaceae and plant parasitic Microthyriaceae, Fig. 1.2). However, some species do not form any surface mycelia and develop from an epidermal hypostroma.

Infection structures: Plant parasitic Asterinaceae and Microthyriaceae develop different strategies to invade their host organism, like the formation of appressoria and haustoria, infectious surface hyphae and hypostromata. Appressoria are mostly formed laterally or intercalary on a distinct brown surface mycelium or by germinating ascospores and conidia (Fig. 1.2c-f, h). Species of Asterinaceae and Microthyriaceae exhibit diverse appressorial morphologies. Position and shape of the appressoria are used as important criteria for the delimination of species and genera. With the help of appressoria the fungus penetrates the plant cuticle and forms intracellular haustoria or compact hypostromata. Arbuscular haustoria are normally restricted to single host cells that remain vital, whereas hypostromata can spread locally and sometimes lead to the death of large leaf areas. Infectious surface hyphae are able to penetrate the host stomata and grow intercellularly in the stomatal cavity and adjacent plant tissue.

Thyriothecia: The small, typically flattened and shield shaped (dimidiate) ascomata of Asterincaeae and Microthyriaceae are called thyriothecia. The “shield” is composed of a darkly pigmented upper plate of cells referred to as scutellum, whereas a lower wall is missing completely (Fig. 1.3). A variation of the thyriothecium is the catathecium present in some species of Microthyriaceae, which is characterized by both an upper and lower pigmented ascoma wall.

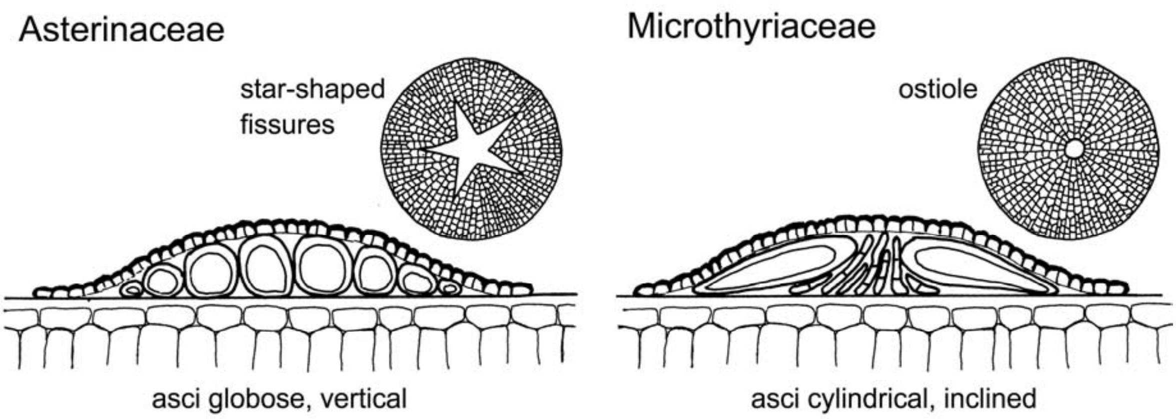

Figure 1.3: Ascoma morphology of Asterinaceae and Microthyriaceae.

The cells of the scutellum are of pseudoparenchymatous origin and are mostly arranged in radiating rows that branch dichotomously at the periphery forming a continous plate of cells. The morphology of the cells can vary from isodiametric to cylindrical, meandrical or epidermoidal. The composition and development of the scutellum is similar to the one of the discoidal thalli produced by the freshwater green algae *Coelochaete orbicularis* (Charophyceae, Coelochaetales, Cook 2004) and the epiphytic algae *Phycopeltis* spp. (Trentepohliaceae, Trentepohliales, Thomson and Wujek 1997, Neustupa 2003). The dimidiate ascoma habit of Asterinaceae, Microthyriaceae and other thyriothecioid ascomycetes is more probably a response to the superficial habitat (Luttrell 1973), than a classification criterion for this group of fungi.

Thyriothecia develop directly below or on lateral branches of the surface mycelium or from an internal hypostroma when a surface mycelium is absent. Below the scutellum bitunicate asci develop and the scutellum opens when the asci become mature. Opening mechanisms vary among thyriothecioid ascomycetes and are important criteria for the segregation of families and genera. Thyriothecia of the Micropeltidaceae and Microthyriaceae open with central pores that develop when the most central and oldest scutellum cells break down or dissolve irregularly (Fig. 1.3). Thyriothecia of the Asterinaceae open with central star-shaped or irregular fissures that are created when the wall-to-wall contact along the lateral walls of the scutellum cells breaks apart (Fig. 1.2f, Fig. 1.3). Thyriothecia of other thyriothecioid ascomycetes like those of the Schizothyriaceae open with the irregular breakdown or dehiscence of central scutellum cells. Elongated thyriothecia of some Asterinaceae and the Aulographaceae open with central slits.

Thyriothecia grow mostly superficially or rarely subcuticularily (Vizellaceae), being usually very small and not reaching more than 1 mm in diameter. They are circular or elongated and are unilocular (most Asterinaceae, Micropeltidaceae, Microthyriaceae and Schizothyriaceae) or multilocular (Brefeldiellaceae, Polystomellaceae). The scutellum of multilocular thyriothecia can expand irregularly with an indeterminate growth.

Hamathecium: The hamathecium of Asterinaceae, Microthyriaceae and other thyriothecioid ascomycetes is insufficiently studied because of the small size of the ascomata and internal hyphal elements. The interascal tissue of Asterinaceae is variable and can be very inconspicuous or disintegrates during ascus development, or is completely absent (Eriksson 1994). Luttrell (1973) states, that hamathecial elements of thyriotheciod ascomycetes can be compared with characteristics of Dothideales, Hysteriales, Myriangiales or Pleosporales. However, intense morphological studies on hamathecial structures are missing for most of the genera and species of Asterinaceae, Microthyriaceae and other thyriothecioid ascomycetes.

Asci: The asci of thyriothecioid ascomycetes are functionally bitunicate with a thin ectotunica and a typically thickened endotunica in the apical part of the ascus (Fig. 1.2j). In some species the ascus apex contains a distinct ocular chamber, but apical zonations or rings are absent (Eriksson 1981). The ascus morphology and dehiscence as well as ascus development within the ascoma varies among the different families of thyriothecioid ascomycetes. Species of Asterinaceae, Aulographaceae, Leptopeltidaceae and Schizothyriaceae form short and globose asci which develop more or less parallel and vertical within the thyriothecium (Fig. 1.3). Species of Microthyriaceae and Micropeltidaceae have typically elongated and cylindrical asci developing inclined towards the center of the thyriothecium (Fig. 1.3).

Only few investigations on ascus dehiscence of selected members of thyriothecioid ascomycetes are published so far. According to Eriksson (1981), the Asterinaceae develop asci with distinct ocular chambers and open probably with a pseudofissitunicate dehiscence. However, Reynolds (1987) describes the asci of *Asterina* spp. as nonbitunicate because during dehiscence and subsequent spore release the expanding endotunica does not separate from the ectotunica. The asterinean deshiscence type is comparable with the rostrate dehiscence described by Eriksson

(1981). Microthyriaceae and Aulographaceae contain asci without ocular chambers and reveal fissitunicate dehiscence (Eriksson 1981). According to Tyson and Griffiths (1976), the mature asci of *Placoasterella bailey* (Berk. & Broome) Arx (Microthyriaceae) elongate before they become detached from the ascocarp cell and release their ascospores passively after the ascospore-enclosing sheath dissolves. The mechanism of spore discharge of *Placoasterella bailey* corresponds to the pseudofissitunicate dehiscence type described by Eriksson (1981). The asci of Micropeltidaceae and Schizothyriaceae form asci with or without ocular chambers and open probably with a fissitunicate dehiscence (Eriksson 1981). However, the knowledge of the ascus dehiscence of members of thyriothecioid ascomycetes is very fragmentary and intense ultrastructural analysis of type species are necessary. No studies of the ascus morphology of members of Aulographaceae, Micropeltidaceae and Schizothyriaceae are available so far.

Ascospores: The ascospores of thyriothecioid ascomycetes are mostly septate. The majority of the plant pathogenic and saprotrophic members of Asterinaceae, Aulographaceae and Microthyriaceae and have ascospores with one transversal septum in the center or upper third of the spore (= didymospore, Fig. 1.2h, k). Ascospores of commensalistic species of Micropeltidaceae and Schizothyriaceae are often phragmosporous with more than 1 transversal septum. Occasionally, muriform ascospores with transversal and logitudinal septa occur, e.g. in *Pleiostomellina* (Asterinaceae) (Batista and Bezerra 1964), or unicellular ascospores e.g. in *Muyocopron* (Microthyriaceae) are reported (Luttrell 1944). Mature ascospores of plant parasitic Asterinaceae and Microthyriaceae are mostly darkly pigmented, whereas ascospores of commensalistic, mycoparasitic and saprotrophic species of Microthyriaceae and other families remain hyaline or show a light brown pigmentation. The walls of mature ascospores are mostly smooth, however, darkly pigmented ascospores of species of Asterinaceae often have a warty, capitate or spiny ornamentation. Many ascospores do not carry appendages or mucous sheaths but appendaged ascospores occur frequently in saprotrophic and mycoparasitic species of Microthyriaceae (Müller and Arx 1962, Gremmen and Kam 1969, Ellis 1976, 1977, Aptroot 1997).

1.2.4 Life cycle of plant pathogenic Asterinaceae

The obligate biotrophic life cycle of species of Asterinaceae exemplified by an *Asterina* species (Fig. 1.4) begins with a mature, brown ascospore attaching to a leaf of a compatible host. The haploid spore develops a primary appressorium which penetrates the cuticle and infects an epidermal host cell by the formation of a haustorium. When nutrient uptake through the haustorium is realized, surface hyphae with lateral appressoria develop from the spore to strengthen the establishment of the fungal colony on the leaf. When sufficient nutrients are available, ascoma formation is initiated by surface hyphae. A flat thyriothecium is formed with an upper, thick ascoma wall (scutellum), composed of isodiametrical to cylindrical cells. During ascoma growth scutellum cells divide downwards into the ascomatal cavity between the scutellum layer and the host cuticle and initiate the development of internal ascocarp hyphae. Due to the lack of ontogenetic studies, it is still speculative how plasmogamy is achived and if ascogonia are formed. However, during this process ascogenous hyphae with continuously proliferating croziers and sometimes interascal tissue are produced. Some croziers develop into ascus initials where karyogamy (diploid stage) with a subsequent

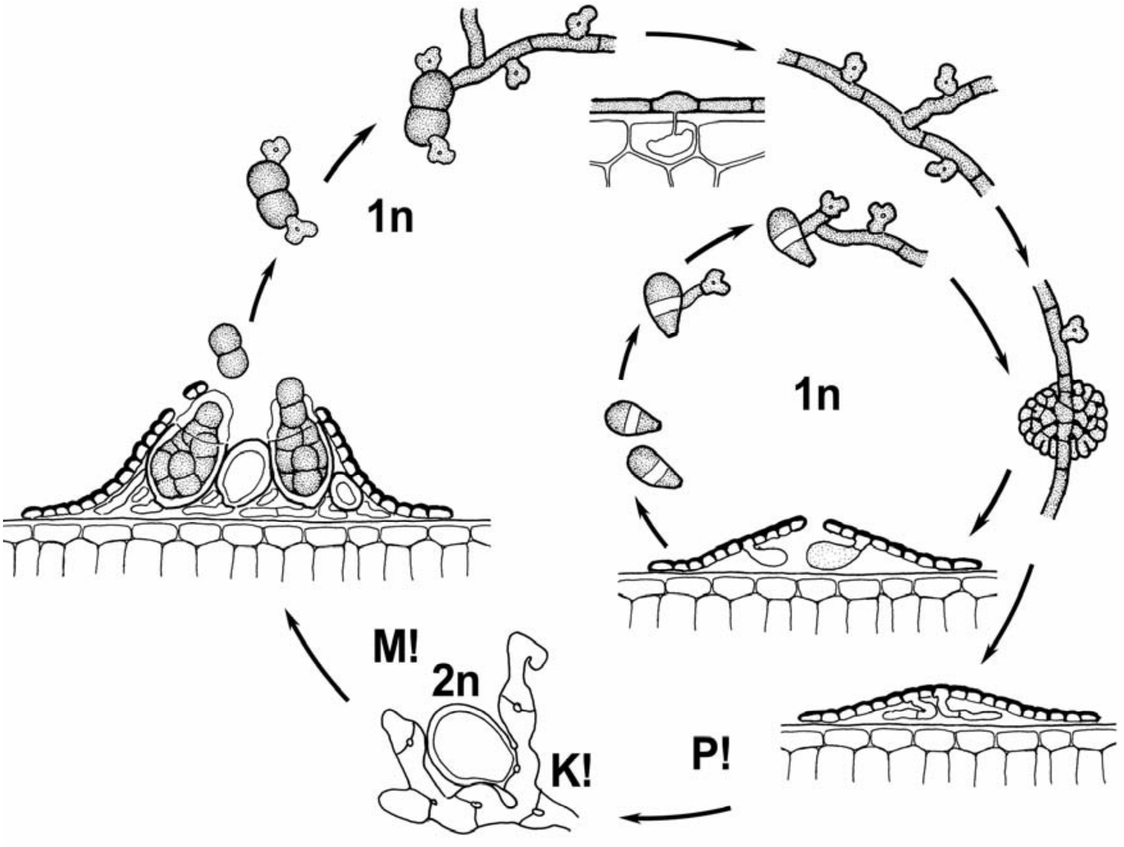

Figure 1.4: Obligate biotrophic life cycle of *Asterina* and its anamorphic *Asterostomella* state. Abbreviations: 1n = haploid, 2n = diploid, K! = karyogamy, M! = meiosis, P! = plasmogamy.

meiosis takes place. After an additional mitosis and the further growth of the bitunicate ascus, eight ascospores are formed. At ascoma maturity, central scutellum cells rupture along their lateral walls and form star-shaped openings in the ascoma. Mature asci now liberate their ascospores by fissitunicate (rostrate?) dehiscence. The surface mycelium of some *Asterina* may also give rise to pycnothyria in which conidia develop from single cells of the inner part of the scutellum layer. Mature pycnothyria open like thyriothecia with star-shaped fissures and liberate brown conidia with or without hyaline central bands or germpores. Haploid conidia germinate with primary appressoria and develop surface mycelia with lateral appressoria identical to the ones of the teleomorphic state. Both the teleomorphic *Asterina*-state and the anamorphic *Asterostomella*-state can occur independently from each other.

1.2.5 Anamorphs of thyriothecioid ascomycetes

Some genera of Asterinaceae, Englerulaceae, Micropeltidaceae, Microthyriaceae, Schizothyriaceae and Vizellaceae have anamorphic stages (Table 1.1). The anamorphs are ecologically similar to their respective teleomorphs, with similar host specificities and distribution patterns. Anamorphs of thyriothecioid ascomycetes are either Coelomycetes or Hyphomycetes (Table 1.1) and reveal diverse morphological characteristics.

Coelomycetous anamorphs develop their conidia within flattened, dimidiate pycnidia called pycnothyria (Höhnel 1910, Tehon 1940). The pycnothyria strongly resemble thyriothecia in structure and composition and are either connected to a surface mycelium or arise from an internal hypostroma. Inside the pycnothyrial cavity the conidia are formed from the lower part of single scutellum cells or on short conidiophores situated below the scutellum layer. Hyphomycetous anamorphs develop their conidia on stalked conidiophores arising from a hyaline or darkly pigmented surface mycelium. The conidiogenous cells of both pycnothyrial and hyphomycetous anamorphs are mostly terminal and mono- or polyblastic, the conidiogenesis is mostly holoblastic. However, the *Manginula* anamorph of species of *Vizella* is characterized by conidiogenous cells with phialidic conidiogenesis (Swart 1971). The conidia can be one-celled or contain one to various transversal septa and are variable in shape from globose to ellpsoidal, clavate, pyriform, cylindrical, rod-shaped or filiform (Fig. 1.2i, l). Appendaged three-dimensional and multicellular conidia, so called isthmospores, are formed by the *Isthmospora* anamorph of species of *Trichothyrium* (hyperparasitic

Microthyriaceae, Hughes 1953). Conidia of anamorphic Asterinaceae, Englerulaceae and Vizellaceae are mostly brown when fully mature and often have hyaline bands or germ pores. Conidia of Micropeltidaceae, Microthyriaceae and Schizothyriaceae stay mostly hyaline or become light brown.

In the past, some authors tried to classify pycnothyrial fungi, like Arnaud (1918) who characterized some anamorphs of plant parasitic Asterinaceae and Microthyriaceae and grouped them in a separate family Microthyriopsidaceae. Within the family the genera were divided in three subfamilies, Polystomellopsideae for species with multilocular pycnothyria without a surface mycelium, Asterostomellopsideae for species with unilocular pycnothyria and a surface mycelium and Seynesiellopsideae for species with unilocular pycnothyria and hypostromata (Arnaud 1918). Batista and Ciferri (1959) classified numerous pycnothyrial anamorphs by the introduction of the new order Peltasterales with six new families (Asterinothyriaceae, Manginulaceae, Peltasteraceae, Plenotrichaceae, Rhizothyriaceae) whose genera and species can be correlated with members of the Asterinaceae, Micropeltidaceae, Microthyriaceae, Polystomellaceae (now partly Parmulariaceae) and Stigmateaceae (now Vizellaceae). For sterile mycelia and thalli, the authors introduced the dubious family Trichopeltulaceae (Batista and Ciferri 1959). Sutton (1977) listed the hitherto described 147 genera of imperfect fungi with superficial pycnothyria under the unaccepted order 'Pycnothyriales' in his survey on coelomycetous genera. About 80 of the listed genera of the 'Pycnothyriales' were described as monotypic and for many species the respective connection to a teleomorph remained unknown. Therefore, numerous pycnothyrial genera were thought to be artificial (Farr 1986).

Table 1.1: Teleomorph-anamorph connections in different families of thyriothecioid ascomycetes and similar fungi known from literature. Families with similar ecological and morphological characteristics are given in brackets. Abbreviations: C = Coelomycetes, H = Hyphomycetes.

Family	Teleomorph genus	Associated anamorph genus	Reference
Asterinaceae	*Asterina*	*Asterostomella* (C) *Clasterosporium*-like (H) *Mahanteshamyces* (C)	Sivanesan (1984), Hofmann and Piepenbring (2008)
	Asterinella	*Asterostomula* (C)	Batista and Ciferri (1959)
	Asterodothis	*Asterostromina* (H) *Clasterosporium*-like (H)	Arx and Müller (1975), Sivanesan (1984)
	Aulographina	*Thyrinula* (C)	Petrak and Sydow (1924)
	Batistinula	*Triposporium* (H)	Sivanesan (1984)
	Eupelte	*Sporidesmium* (H)	Sivanesan (1984)
	Maurodothina	*Pirozynskia* (H)	Subramanian (1972)

Family	Teleomorph genus	Associated anamorph genus	Reference
	Morenoina	*Acarella* (C) unnamed (C)	Sydow (1927) Sivanesan (1984)
	Placosoma	unnamed (H)	Sivanesan (1984)
	Prillieuxina	*Leprieurina* (C)	Arnaud (1918), Müller and Arx (1962)
	Uleothyrium	*Septothyrella* (C)	Arx and Müller (1975), Sivanesan (1984)
	Yamamotoa	*Mitteriella* (H), *Clasterosporium* (H) *Sarcinella* (H)	Arx and Müller (1975), Sivanesan (1984)
Englerulaceae	*Rhytidenglerula*	*Capnodiastrum* (C)	Arx and Müller (1975)
	Schiffnerula	*Mitteriella* (H) *Questieriella* (H) *Sarcinella* (H)	Hughes (1983), Sivanesan (1984)
Micropeltidaceae	*Cyclopeltis*	*Cyclopeltella* (C)	Petrak (1953)
Microthyriaceae	*Arnaudiella*	*Xenogliocladiopsis* (H)	Crous and Kendrick (1994)
	Microthyrium	*Zalerion* (H)	Ramaley (1999)
	Trichothyrium	*Hansfordiella* (H) *Isthmospora* (H)	Hughes (1951, 1953)
Schizothyriaceae	*Schizothyrium*	*Zygophiala* (H)	Batzer et al. (2008)
Vizellaceae	*Vizella*	*Manginula* (C)	Arnaud (1918), Swart (1971)

1.2.6 History of the classification of Asterinaceae and Microthyriaceae

The classification of ascomycetes with dimidiate ascomata is almost exclusively based on morphological characters. Classification concepts of families and orders of thyriothecioid ascomycetes changed frequently during the last 150 years and numerous authors contributed to this process.

In the 19th century, the genera of ascomycetes with dimidiate and superficial ascomata were scattered in different and heterogeneous groups. Saccardo (1883) made the first attempt to unite some of these genera and defined the family Microthyriaceae. The Microthyriaceae *sensu* Saccardo included nine genera with dimidiate, superficial ascomata that were separated due to ascospore color and septation (Saccardo 1883, Theissen 1913d). In 1891, Saccardo expanded the family concept and included eight more genera in the family. However, some important plant pathogenic taxa like *Asterina* were treated separately from the Microthyriaceae in the subfamily "Asterinei" within the "Perosporiacei", a family that included ascomycetes without a clearly defined ostiole (Fries 1849, Arnaud 1918). Other genera were placed in the Hysteriaceae and Hemihysteriaceae, families with ascomycetes that form elongated ascomata (Theissen 1913d). In 1899, *Asterina* was included in the Microthyriaceae and the family was split into two subfamilies, Asterineae and Microthyrieae due to the presence or absence of a free surface mycelium (Theissen 1913a, d). From 1899 to 1905 additional genera were assigned to the Microthyriaceae until the family received numerous intensive revisions by Höhnel (Theissen 1913a, d).

In 1913, Theissen defined the order Hemisphaeriales for ascomycetes with dimidiate ascomata developing completely superficially (Theissen 1913d). The order was divided into three families, the Trichopeltulaceae with multilocular ascomata covered by a radiate thallus-like scutellum, the Microthyriaceae (incl. Asterinaceae) with unilocular ascomata with a radiate scutellum and a more or less developed surface mycelium and the Hemisphaeriaceae with unilocular ascomata with a non-radiate scutellum (Theissen 1914b). The concept of the order Hemisphaeriales was expanded by Theissen and Sydow (1917) and next to the three families with superficially developing species the authors included two more families, the Stigmateaceae and the Polystomellaceae, with species with ascomata that are somehow immersed in or connected to its respective substrate. The Stigmateaceae contained species with subcuticular dimidiate ascomata and the ascomata of members of the Polystomellaceae develop on hypostromata. The Hemisphaeriales *sensu* Theissen and Sydow included 5 families with a total of 111 genera (Theissen and Sydow 1917).

Arnaud (1918) merged the Polystomellaceae with the Microthyriaceae and removed them from the Hemisphaeriales to a separate new order Microthyriales. The Microthyriales *sensu* Arnaud contained two families, notably the asci-producing and teleomorphic Microthyriaceae (incl. Asterinaceae) and the conidium-forming, anamorphic Microthyriopsidaceae (Arnaud 1918). According to Arnaud (1918), the Microthyriaceae were divided into several tribes and subdivisions due to ascoma composition, presence or absence of a surface mycelium or hypostromata and hamathecium characteristics.

Clements and Shear (1931) used the order Microthyriales in the sense of Theissen and Sydow`s Hemisphaeriales with three families Polystomellaceae, Microthyriaceae (incl. Asterinaceae) and Micropeltidaceae. The Polystomellaceae were divided in three subfamilies Parmulineae, Polystomelleae and Stigmateae (Clements and Shear 1931).

Luttrell`s concept (1973) was based upon the system of Theissen and Sydow with the order Hemisphaeriales divided into 11 families, Aulographaceae, Asterinaceae, Brefeldiellaceae, Leptopeltidaceae, Micropeltidaceae, Microthyriaceae, Munkiellaceae, Parmulariaceae, Schizothyriaceae, Stephanothecaceae and Trichopeltinaceae.

Arx and Müller (1975) defined the Hemisphaeriales as a phylogenetically heterogeneous group and did not adopt the order concept in their classification of bitunicate ascomycetes. Indeed, all families with dimidiate ascomata were placed next to other bitunicate ascomycetes in the order Dothideales wich is subdivided two groups the Dothideineae and Pseudosphaeriineae according to ascoma opening mechanism and ascus shape. The Dothideineae included families that are characterized by non-ostiolate ascomata, that rupture or disintegrate irregularly at maturity and by clavate to nearly spherical asci (like Asterinaceae, Brefeldiellaceae, Englerulaceae, Parmulariaceae, Schizothyriaceae). The Pseudosphaeriineae contained families characterized by ostiolate ascomata and elongated and cylindrical asci (Micropeltidaceae, Microthyriaceae).

Barr (1987) placed the Asterinaceae together with Englerulaceae, Parmulariaceae and Parodiopsidaceae in the order Asterinales within the subclass Loculoparenchymatomycetidae. The subclass was characterized by ascomata without a hamathecium and asci pushing up among disintegrating cells in the ascomatal center (Barr 1987). The Schizothyriaceae were included in the Myriangiales within the subclass Loculoplectoascomycetidae due to the indeterminate growth of the ascomata and the irregularly scattereded asci within the ascomata. According to Barr (1987), the Microthyriaceae belonged in the order Melanommatales and the Micropeltidaceae in the order Pleosporales, both within the subclass Loculoedaphomycetidae due to the presence of paraphysoids or pseudoparaphyses.

Kirk et al. (2001) reestablished the order Microthyriales including the families Aulographaceae, Leptopeltidaceae, Microthyriaceae and Schizothyriaceae. The order is placed next to other orders within the subclass Dothideomycetidae. The placement of Asterinaceae and some other families of ascomycetes with dimidiate ascomata remained uncertain. Kirk et al. (2008) placed the Asterinaceae and Schizothyriaceae within the Capnodiales. For Schizothyriaceae, the relationship to Mycosphaerellaceae was supported by molecular data (Batzer et al. 2008), the true affinity of Asterinaceae to Capnodiales, however, remained uncertain because molecular data were unavailable for this family. The Microthyriales with Aulographaceae, Leptopeltidaceae and Microthyriaceae were kept provisionally within the Dothideomycetidae. Kirk et al (2008) suspected the order to be probably polyphyletic, although molecular data were missing. The positions of other families of thyriothecioid ascomycetes and similar families like the Englerulaceae, Micropeltidaceae and Parmulariaceae remained completely uncertain.

1.2.7 Molecular phylogenetic studies of thyriothecioid ascomycetes

Molecular phylogenetic approaches including members of thyriothecioid ascomycetes are very rare and restricted to species that can be grown in culture, like *Schizothyrium pomi* and *Zygophiala*-anamorphs (Schizothyriaceae). The Schizothyriaceae are saprotrophic or commensalistic epiphytes associated with living leaves, stems and fruits in warm and humid areas of the northern and southern hemisphere. *Schizothyrium pomi* and its *Zygophiala*-anamorph are causatives of the flyspeck disease on apples (Cooley et al. 1997, 2004) and, therefore, are studied recently with great effort. Apple fruits with flyspeck disease are covered with small black spots that resemble masses of inscet exudates (Batzer et al. 2002), whereas each spot corresponds to a single, completely superficial thyriothecium. The thyriothecia are connected by a hyaline net-like mycelium that does not penetrate the cuticle of the plant but submerges into the surface of the epicuticular wax layer (Belding et al. 2000). Fly-speck disease does not result in a yield loss of apple fruits but causes an economic loss to apple growers as fruit quality and value are reduced (Williamson and Sutton 2000, Batzer et al. 2002, 2005). Based on 28S rDNA phylogeny, *Schizothyrium pomi* and four different species of *Zygophiala* cluster with members of Mycosphaerellaceae within the Capnodiales (Batzer et al. 2008). *Schizothyrium pomi* and *Zygophiala*-anamorphs are not host specific and have a wide host range, including trees, shrubs or vines near orchards (Williamson and Sutton 2000, Batzer et al. 2008).

Molecular phylogenetic studies of plant parasitic thyriothecioid ascomycetes belonging to Asterinaceae and Microthyriaceae are still missing, because obligate biotrophs cannot be grown in culture and fresh DNA material is almost inaccessible to most of the scientists, as the majority of these pathogens are restricted to tropical regions of the world.

1.2.8 Thyriothecioid ascomycetes in Western Panama

In Panama, thyriothecioid ascomycetes are insufficiently studied by scientists and are almost unknown to the public. This situation is due to several facts. Thyriothecioid fungi are inconspicuous, very small in size and hardly visible with the naked eye (Hofmann 2005). Most species are associated with wild, native plants and only few species occur on agricultural crops without causing visible damages. In the past, the few foreign mycologists that focussed on these fungi, obtained their material from other tropical countries than Panama, e.g. from Argentina, Brazil, Costa Rica, Cuba, Puerto Rico or Venezuela.

Until today, only 17 species of thyriothecioid ascomycetes are known to occur in Panama, most of the records were published by the author in the last four years (Table 1.2). Five species were described exclusively from Panama and are probably endemic (Table 1.2), ten are plant parasitic Asterinaceae, six are epiphytic, commensalistic Micropeltidaceae and Schizothyriaceae and one species is saprotrophic. Records of species of Microthyriaceae are still lacking. As thyriothecioid ascomycetes are very diverse and omnipresent in the tropics, we expect a much greater number of species of Asterinaceae, Microthyriaceae and Micropeltidaceae to exist in Panama (Hofmann 2005, Hofmann and Piepenbring 2006, 2008).

Table 1.2: Thyriothecioid ascomycetes known from Panama. Families and species are listed in alphabetical order with respective record citation. Species indicated with an asterisk were described exclusively from Panama and are probably endemic to Panama.

Family, species	Record citation
Asterinaceae	
Asterina ciferriana Petr.	Hofmann and Piepenbring 2008
Asterina consobrina Syd.	Hofmann and Piepenbring 2008
Asterina fuchsiae Syd.	Hofmann and Piepenbring 2008
Asterina gaiadendricola T.A. Hofmann*	Hofmann and Piepenbring 2008
Asterina killipii Dearness & House*	Piepenbring 2006
Asterina manihotis Syd.	Hofmann and Piepenbring 2008
Asterina phenacis Syd.	Hofmann and Piepenbring 2008
Asterina schlegeliae T.A. Hofmann*	Hofmann and Piepenbring 2008
Asterina sphaerelloides Speg.	Hofmann and Piepenbring 2006
Morenoina epilobii (Lib.) E. Müll. & Arx	Hofmann and Piepenbring 2006
Yamamotoa carludovicae (Bat.) Arx & E. Müll.*	Piepenbring 2006
Micropeltidaceae	
Chaetothyrina panamensis (F. Stevens & Dorman) Arx*	Piepenbring 2006
Micropeltis lecythisii Bat. & I.H. Lima	Hofmann and Piepenbring 2006
Scolecopeltidium bakeri (Syd. & P. Syd.) F. Stevens & Manter	Piepenbring 2006
Scolecopeltidium mayteni Bat. & I.H. Lima	Piepenbring 2006
Schizothyriaceae	
Myriangiella roupalae (Syd.) Arx & E. Müller	Hofmann and Piepenbring 2006
Schizothyrium rufulum (Berk. & M.A. Curtis) Arx	Hofmann and Piepenbring 2006

1.3 Plant parasitic micromycetes of Panama (ppMP Project)

The objective of the ppMP project was the investigation of the biodiversity of tropical plant parasitic microfungi, including ascomycetes, imperfect fungi, smut fungi and rust fungi. For an almost complete survey of the diversity and seasonal changes in development, the microfungi were collected in different seasons during various years. The collected plant parasitic microfungi were identified and classified with the help of morphological characteristics as well as molecular methods. Results on ecology, morphology and systematics of tropical plant parasitic microfungi were completed with observations on the abundance of different species, their distribution among the systematical groups and their occurrence in the different ecosystems.

In the ppMP project in Western Panama, the author focussed on the monitoring of the diversity of plant parasitic Asterinaceae, Microthyriaceae and other groups of plant parasitic bitunicate ascomycetes (Englerulaceae, Micropeltidaceae p.p., Parmulariaceae, ‘Pycnothyriales’ p.p., Vizellaceae).

2 Material and methods

2.1 Field work in Western Panama

2.1.1 The country Panama

Panama is the southernmost country of Central America with an area of about 75 517 km². It is located on the isthmus between North and South America and is bordered by the Atlantic Ocean in the North, the Pacific Ocean in the South, Costa Rica in the West and Colombia in the East (Fig. 2.1). Panama is a country with two extensive coast lines and over 1500 offshore islands and islets. About 70% of the country is dominated by lowlands and hills at less than 700 m a.s.l. The highlands are located in the central mountain chain of Western Panama, with the highest elevations Volcán Barú (3475 m) and Cerro Fábrega (3335 m). Various rivers originate from the central mountain range and irrigate the occidental and central regions of Panama. Panama is a country with a typical tropical climate with low variation in average temperature during the year (1 °C to 4 °C) and a diurnal variation of 4 °C to 12 °C or more depending on altitude (Correa et al. 2004).

The Provinces Chiriquí and Bocas del Toro are located in Western Panama and are bordered by Costa Rica in the West and the provinces Veraguas and Ngöbe-Buglé in the East (Fig. 2.1). The Provinces are separated by the central mountain chain called Cordillera de Talamanca which forms the continental divide. According to the Köppen climate classification system, Bocas del Toro on the Atlantic side of the continental divide exhibits an *Af* climate with sufficient precipitation in all months of the year (Palka 2005). Whereas Chiriquí on the Pacific side of the continental divide has an *Aw*

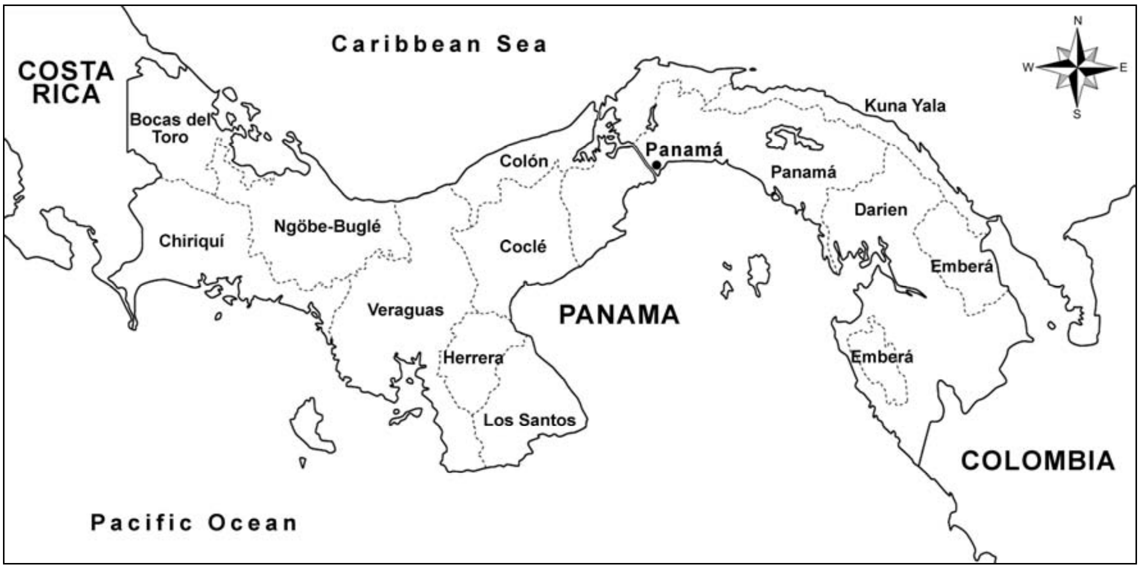

Figure 2.1: Map of Panama and its provinces (orig.: M. Cuevas and T.A. Hofmann).

climate with a prolonged dry season during winter (Palka 2005). On the Atlantic side the average temperatures range from 25 to 27 °C and the annual precipitation lies between 2500 and 4350 mm but decreases during February, September and October (Correa et al. 2004). On the pacific side the average temperature lies between 26.5 and 27.5 °C from 0 to 1000 m a.s.l and decreases successively to 20 °C while approaching 1000 m a.s.l. The annual precipitation ranges from 2450 to 3520 mm from 1 to 1000 m a.s.l. The dry season (verano) begins in December and reaches its highest intensity in March (Correa et al. 2004). In the regions of the central mountain chain between Chiriquí and Bocas del Toro, a fresh climate dominates above 1,000 m. a.s.l. with an average temperature at about 18 °C and high annual precipitation of 3700 mm. The lowest temperatures are reached above 3000 m a.s.l. and range from 7.8 to 10.2 °C during the year but in February in some areas the temperatures can reach 0 °C (Correa et al. 2004).

Detailed information on the characteristical vegetation types of the different collection areas in Western Panama are given in Table 2.1.

2.1.2 Field work in Western Panama

Plant parasitic Asterinaceae, Microthyriaceae and other families of thyriothecioid ascomycetes were collected during various field trips to Western Panama in the Provinces Chiriquí and Bocas del Toro from 2000 to 2008 by the autor, by participants of the ppMP project and by other contributors. An overview of private herbaria of the collectors and their acronyms is given in Chapter 2.11. The author herself collected plant parasitic thyriothecioid ascomycetes during four visits to Panama, 10 Sep. − 31 Oct. 2005, 16 Mar. − 29 Jul. 2006, 28 Dec. 2006 − 01 Mar. 2007, and 01 Sep. − 16 Nov. 2007. An overview of all collection areas in Western Panama visited by the author is given in Table 2.1. Contributors that collected plant parasitic thyriothecioid ascomycetes during other visits to Western Panama in 2000, 2003, 2007 and 2008 as part of the ppMP collections or their own collections, were M. Piepenbring, R. Mangelsdorff, T. Trampe, R. Kirschner and B. Koch.

For the ppMP Project, 15 collection sites with differences in vegetation type, gradient of disturbance, altitude and light exposure were chosen in Western Panama. 12 collection sites are situated in the Province Chiriquí and 3 collection sites in the Province Bocas del Toro (Table 2.1). Within the selected area, plant parasitic microfungi from all infected living leaves in eye height were collected by three trained mycologists for two hours. The collection events were repeated four times in different seasons during four years, whereas collection sites (M), (N) and (O) were visited only twice due to difficult access or limited collection permissions. The overall plant diversity within each collection site was roughly estimated by the participants of the ppMP project. The altitude and exact position of each collection site was determined with a global-positioning system (GPS). The overall size of the investigated area of each collection site was estimated with a standardized rope. Light intensity within and outside the investigated area was calculated from average light measurements made with two calibrated handheld light sensors (Roth). One sensor was positioned about 1.5 m above the ground in the collection area and the other one was used in the same way at the same time as reference outside the area in direct daylight. For each collection site, a total of 15 measurements were conducted along the distance of the investigated area and simultaneously reference measurements were made outside in direct daylight.

2.2 Identification of host plants

Host plants were identified as far as possible in fresh condition directly in the field or in the field laboratory with the help of botanical literature such as *Flora of Panama* (Woodson and Schery 1943-1980), Weber et al. (2001), Gentry (1996), Carrasquilla (2006) and Correa et al. (2004). Infected leaves were collected with representative plant material (e.g. flowers, fruits, stems and roots) to facilitate plant identification. Information on vegetative characteristics like leaf odor, presence or

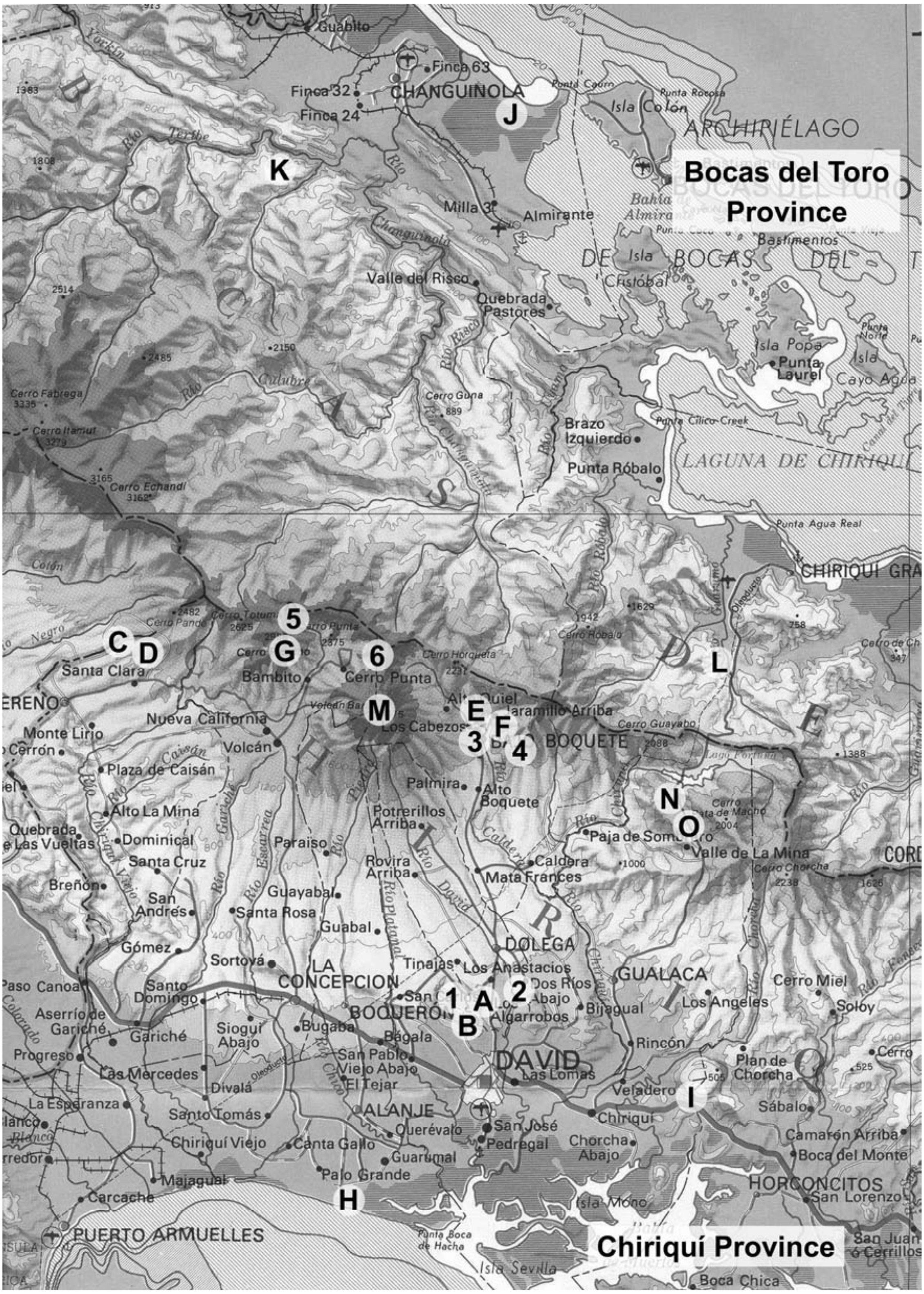

Figure 2.2: Map of Western Panama with marked collection sites. A-O: collection sites of the ppMP-project. 1-6: other collection sites. **A:** Los Algarrobos, path to Majagua river. **B:** Los Algarrobos, border of Majagua river. **C:** Road to Piedra de Candela, forest. **D:** Road to Piedra de Candela, road side. **E:** Boquete, forest. **F:** Boquete, Alto Lino. **G:** PILA, path to Cerro Picacho. **H:** La Barqueta, pacific coast. **I:** Chorcha, forest near path to plateau. **J:** Canal Changuinola **K:** Bonyik, Teribe river. **L:** Finca Celestine, El Valle. **M:** PNVB, Volcán Barú. **N:** Fortuna, forest. **O:** Fortuna, Quijada de Diablo. **1:** Los Algarrobos, Casa de la Alemana. **2:** Los Algarrobos, El Salto cascade, border of Lajas river. **3:** Boquete, Bajo Mono. **4:** Boquete, path to Pata de Macho. **5:** PILA, path to La Cascada. **6:** PNVB, trail Sendero Los Quetzales. Abbreviations: PILA = Parque International La Amistad, PNVB = Parque National Volcán Barú (orig.: part of a scanned Map of Panama, unknown publisher).

Table 2.1: Collection sites in Western Panama with vegetation types and altitudes. Collection sites are listed in alphabetical order, ppMP collection sites are indicated with acronyms in paretheses. Vegetation types are defined according to Correa et al. (2004) and own observations made in the field. Measurements of altitudes are estimated values given in m a.s.l. Abbreviations: PILA = Parque International La Amistad, PNVB = Parque National Volcán Barú.

Collection sites	Vegetation type	altitude
Bocas del Toro Province		
Canal Changuinola (J)	tropical evergreen ombrophile marsh forest dominated by *Raphia taedigera*, not disturbed	19
Bonyik, Teribe river (K)	tropical evergreen ombrophile latifoliate lowland forest, disturbed, with indigenous influence	64
Finca Celestine, El Valle (L)	tropical evergreen ombrophile latifoliate submontane forest, disturbed, with indigenous influence, understory is cut regularly, private property of N. de Penagos	600
Chiriquí Province		
Los Algarrobos, path to Majagua river (A)	roadside with natural woody or spontaneous vegetation, with ±5 months of dry season, very disturbed, intense cattle breeding, fire clearance and fumigation nearby	140
Los Algarrobos, border of Majagua river (B)	tropical semi-deciduous lowland gallery forest, natural woody or spontaneous vegetation with ±5 months of dry season, disturbed, intense cattle breeding, fire clearance and fumigation nearby	140
Los Algarrobos, El Salto cascade, border of Lajas river	tropical semi-deciduous lowland gallery forest, natural woody or spontaneous vegetation with ±5 months dry season, disturbed, intense cattle breeding and fire clearance nearby	150
Los Algarrobos, Casa de la Alemana	planted natural vegetation (wild and economic plants), disturbed, garden, private property of M. Piepenbring	140
La Barqueta, pacific coast (H)	coast vegetation with transition to recent marine soils, not disturbed, wild life refuge, since summer 2007 partly destroyed	5
Boquete, Bajo Mono	tropical evergreen ombrophile latifoliate montane forest, disturbed, understory is cut regularly	1550
Boquete, path to Pata de Macho	tropical evergreen ombrophile latifoliate montane forest, slightly disturbed, with human influence	1760
Boquete, forest (E)	tropical evergreen ombrophile latifoliate montane forest, disturbed, understory is cut regularly, private property of M.A. Amorùso	1750
Boquete, Alto Lino (F)	roadside with some trees, with unnatural rural vegetation, disturbed, understory is cut regularly, fumigation, cattle and horse breeding nearby	1270
Chorcha, forest near path to plateau (I)	tropical semi-deciduous lowland forest with ±5 months dry season, not disturbed	270
Fortuna, forest (N)	tropical evergreen ombrophile latifoliate montane forest on continental divide, slightly disturbed	1240
Fortuna, Quijada de Diablo (O)	tropical evergreen ombrophile latifoliate montane cloudforest on continental divide, influenced by strong winds, not disturbed	1278
Road to Piedra de Candela, forest (C)	secondary forest, natural woody or spontaneous vegetation with ±5 months of dry season, disturbed, intense coffee cultivation and fumigation nearby, private property of family Quintero Morales	1400
Road to Piedra de candela, road side (D)	road side with rural vegetation, very disturbed, intense coffee cultivation and fumigation nearby	1417
PILA, path to La Cascada	tropical evergreen ombrophile latifoliate montane cloudforest, not disturbed	2440

Collection sites	Vegetation type	altitude
PILA, path to Cerro Picacho (G)	tropical evergreen ombrophile latifoliate montane cloudforest, not disturbed	2550
PNVB, trail Sendero Los Quetzales	tropical evergreen ombrophile latifoliate montane cloudforest, not disturbed	2550
PNVB, Volcán Barú (M)	roadside of subalpine subpáramo dwarf forest, disturbed	3295

absence of latex, glands and stipules were recorded directly in the field or in the field laboratory. As far as climate conditions allowed, digital photographs from the plant habit, stems, flowers, fruits and fungal infections were made with a Canon PowerShot S3 IS camera or a Pentax Optio 330 GS camera, to save as much information as possible for the identification of the host plant.

Dried unidentified plant specimens were compared with herbarium specimens of plants deposited in the National Herbarium of the University of Panama (PMA). Botanists from the University of Panama, the Universidad Autonoma de Chiriquí (UNACHI), the J.W.-Goethe University in Frankfurt and from the Field Museum in Chigago helped with the identification of critical plant taxa. Special thanks to R. Mangelsdorff, D. Cáceres, R. Aizprua, A. Espinosa, J.A. Polanco, A. Somoza, V. Murillo, L. Zárate, M. Piepenbring, T. Trampe, R. Rincon and M.O. Dillon for the affirmation or identification of some plant taxa.

Plant systematics used in this study follows Mabberley (2008) and includes recent taxonomic changes on the level of host plant families and genera. Abbreviations of author names of plant species are cited according to Tropicos.org, Missouri Botanical Garden (www.tropicos.org)

2.3 Fresh leaf material

Blackish spots on living leaves were observed and selected macroscopically with a 5× hand lens. Infected leaves were collected separately in enclosed plastic bags and stored at 4-8 °C for minutes to serveral hours until further revision. Infected leaves were observed in the field laboratory with a Nikon SMZ645 stereomicroscope and a Leitz Dialux 20 microscope or a GE 3040 Euromex Holland microscope. From selected fungal specimens digital photographs of the macro- and microstructures were made with a Pentax Optio 330GS digital camera.

To prepare permanent microscopic slides from fresh material, thin horizontal sections and transversal sections of infected leaf parts were cut with a sharp razor blade and placed on a glass slide in lactic acid with water blue (embedding medium, *fide* Heinze 1952, modified after M. Göker; further instructions for light microscopy, see Chapter 2.4). Prepared permanent microscopic slides were air-dried and stored in a microscope slide box at room temperature.

For analysis of ultrastructure from selected fungi, small parts of infected leaves were cut out with a sharp razor blade, fixed in 0.1 M cacodylate buffer with 2 % gludaraldehyde and stored for several weeks at 4 °C (further protocol for TEM analysis, see Chapter 2.6).

For cultivation of selected fungi in the field laboratory, infected leaves were washed in water and gently dried with a Kimtech precision wipe. Single ascoma were picked under the stereomicroscope with a sterile hollow needle and were transferred in an Eppendorff cup with 20-50 µl of sterile water (furter instructions for cultivation from fresh leaves, see Chapter 2.7). For cultivation of selected fungi from air-dried leaves, fresh leaves were washed in water, placed between newspaper and air-dried in the sun for 1 to 3 days. Air-dried leaves were stored within newspaper in enclosed plastic bags with silica gel at 4 °C for several weeks (further instructions for cultivation from air-dried leaves, see Chapter 2.7).

For DNA isolation from fresh plant material in the field laboratory, infected leaves were washed in water, gently dried with a Kimtech precision wipe and observed under a Nikon SMZ645 stereomicroscope. Fungal colonies were checked for mites, hyperparasites and general state of maturity. For DNA isolation from dried plant material, selected entire fresh leaves or leaf parts were placed in glassine envelopes, dried on silica gel in enclosed plastic bags and stored at 4 °C for serveral weeks (further protocol for DNA isolation, see Chapter 2.9).

For conservation and further observation in Frankfurt, infected plant specimens were placed in sheats of newspaper between squares of corrugated cardboard and were pressed and dried in a woody plant press on top of a commercial Sigg Dörrex dryer (110 V). In the field laboratory, dried specimens were stored in enclosed plastic bags with silica gel to prevent moisturization of the plant material. In Frankfurt, dried specimens were freezed at -74 °C for at least 3 days to ensure that the imported organic material is dead and to prevent the introduction of foreign organisms.

2.4 Light microscopy

In the laboratory in Frankfurt, permanent microscopic slides from fresh material, pieces of dried plant material placed in water, KOH or lactic acid with water blue or scotch-tape preparations from herbarium specimens in lactic acid were observed with a Nikon Eclipse 50i or 80i microscope with drawing tube. Melzer`s reagent was used to test for iodine color reaction of asci after pretreatment with water, whereas Lugol’s solution was used after pretreatment with KOH. Measurements of morphological structures are given by extreme values in brackets and mean values ± standard deviation of 30 measurements. If more or less than 30 values were measured, the number is indicated in parentheses. Structures of additional specimens of identical species collected at different dates or localities were measured 10 times and values are only shown, when they differed significantly. Detailed drawings were made with a drawing mirror or freehand at a fixed scale.

2.4.1 Reagents used for light microscopy

5 % Potassium hydroxide

5 g potassium hydroxide (Fluka) in 100 ml distilled water

Lactic acid with water blue (150 ml) *fide* Heinze (1952), modified by M. Göker

60 ml distilled water
35 ml lactic acid (AppliChem)
10 ml glycerol (AppliChem)
10 g polyvinyl alcohol (Fluka)
50 g chloral hydrate (Roth)
0.015 g water blue (Fluka)

Lugol’s solution

Iodine-potassium iodide solution after Lugol (Roth)

Melzer`s reagent *fide* Moser (1983)

20 ml distilled water
1.5 g potassium iodide (Roth)
0.5 g iodine (Riedel-de Haën)
20 g chloral hydrate (Roth)

1 % Phloxine solution

1 g Cyanosine (Fluka) in 100 ml distilled water

2.5 Scanning electron microscopy (SEM)

Small pieces of dried leaves showing infections were cut out with a razor blade, fixed with double-sided carbon adhesive on aluminium stubs and sputtered with gold for 60 s in an Agar Sputter Coater. Photographs were made with a Hitachi S 4500 scanning electron microscope with 5 kV and processed with Digital Image Processing System 2.5. The digital images were saved in TIF format. SEM analysis was accomplished at the Department of Biological Sciences at the J.W. Goethe-University Frankfurt/Main in cooperation with M. Ruppel.

2.6 Transmission electron microscopy (TEM)

Small pieces of fresh leaves showing infections were cut out with a razor blade and fixed with 2 % gludaraldehyde in 0.1 M cacodylate buffer at pH 7.2. The samples were stored in small plastic tubes for several weeks at 4 °C. The glutaraldehyde was rinsed with 0.1 M cacodylate buffer 2 times for 10 min Samples were postfixed for 1 h in 1 % osmium tetroxide in 0.1 M cacodylate buffer, then washed twice with cacodylate buffer for 10 min and dehydrated in a series with 50, 70, 80, 90 % ethanol, and three times in 100 % ethanol. Samples were transferred twice into propylene oxide for 10 min and placed in a 1:1 mixture of propylene oxide and Araldite overnight. Samples were embedded in fresh Aralite and transferred to an oven at 60-65 °C for 48 h.

From the embedded samples semi-thin sections of 1-2 µm were cut with a glass knife, transferred to a glass slide and stained with crystal violet. Selected semi-thin sections were embedded in Entellan® for observation with a light microscope. Ultra-thin Sections of 50-60 nm were cut with a diamont knife and mounted on copper grids coated with pioloform (Plano). Grids were stained in uranyl acetate in 40 % methanol for 12 min, washed with 50 % and 25 % methanol and distilled water, stained with lead citrate (Reynolds 1963) for 8 min and washed with 0.01 M sodium hydroxide and distilled water. The sections were examined with a Philips CM12 transmission electron microscope at 80kV. Digital images were saved as TIF and DM3 format. TEM analysis was conducted at the Department of Biological Sciences at the J.W. Goethe-University Frankfurt/Main under the guidance of M. Stöhr and S. Münzner.

2.7 Cultivation experiments

In the field laboratory, fresh infected leaves were washed with water, gently dried with a kimtech precision wipe and preselected under a stereomicroscope. Single ascoma were picked from the leaf surface with a sterile injection needle and transferred to an Eppendorff cup with 20-50 µl sterile water. The ascoma were washed gently by agitating the Eppendorff cups. With the sterile injection needle single, washed ascoma were transferred to a petri dish with culture media (see 2.7.1). Cultivation experiments with ascomata from air-dired, infected leaves were performed as above in the laboratory in Frankurt.

2.7.1 Culture media

1.5 % Water agar

1000 ml distilled water
15 g agar-agar (Roth)

2 % Malt extract agar (MEA) with/without tetracycline

1000 ml distilled water
15 g agar-agar (Roth)
20 g malt extract (Roth)

with tetracycline:
0.5 g tetracycline (AppliChem) dissolved in 70 % ethanol

Spezieller nährstoffarmer agar (SNA) *fide* Nirenberg (1981, 1990)

1000 ml distilled water
15 g agar-agar (Roth)
1 g potassium dihydrogen phosphate (Roth)
1 g potassium nitrate (Roth)
0.5 g magnesium sulphate × 7 distilled water
0.2 g glucose (Fluka)
0.2 g sucrose (AppliChem)

2.8 Herbaria

For precise identification of critical specimens collected in Western Panama, fungal herbarium specimens from different herbaria were consulted. A list of the consulted herbaria and their acronyms according to Holmgren et al. (1990) are given in Chapter 2.11. It was intented to obtain type material or typical specimens from the examined taxa. If identification with literature was doubtful or not possible, type material of similar species described from the same plant family was consulted.

Identified specimens from Western Panama collected by the author, by others in private herbaria or by participants of the ppMP project, were deposited in Panama in the National Herbarium of the University of Panama (PMA). Duplicates were deposited in the Botanische Staatssammlung München (M), in the Forschungsinstitut Senckenberg Frankfurt (FR) in Germany or in the U.S. National Fungus Collections (BPI) in Beltsville, USA. For easy access, holotypes of newly described species were deposited in the Botanische Staatssammlung München (M) in Germany. The respective isotypes were deposited in the National Herbarium of the University of Panama (PMA).

2.9 Molecular analysis

For molecular analysis, genomic DNA from species of different families of thyriothecioid ascomycetes was isolated from fresh material or from material dried on silica gel. The analysis was partly accomplished in the field laboratory in Panama and at the Department of Mycology at the J.W. Goethe-University of Frankfurt in Germany.

2.9.1 Material used for molecular analysis

For molecular studies, a total of 91 specimens belonging to 60 different species of foliicolous thyriothecioid ascomycetes from 33 plant families were used (compare Table 2.2.). In the laboratory in Frankfurt, 31 specimens from dried leaf material (silica gel) were used for DNA isolation. In the field laboratoy in Panama, 60 specimens in fresh condition were used for DNA isolation. For 22 species, a LSU rDNA sequence could be obtained, for 6 species both LSU and SSU rDNA sequences were obtained.

2.9.2 Isolation of genomic DNA

Isolation of genomic DNA from fresh fungal material was realized in an isolated room of the field laboratory in Panama in a clean environment. To isolate genomic DNA from fresh leaf material, infected leaves were washed in water, gently dried with a

Table 2.2: List of species of plant parasitic thyriothecioid ascomycetes used for molecular analysis. Collected species indicated in bold type are presented in this contribution, those not treated in this contribution are indicated in regular type, unidentified species are indicated with (undet.) and are listed in numerical order. Abbreviations of ppMP collection sites are given in square brakets (compare Table 2.1). Voucher specimens used for molecular analysis are indicated with respective abbreviation of private herbaria (see Chapter 2.11), specimens were in fresh condition (*) or dried on silica gel. Voucher specimens in bold indicate successful DNA sequencing.

Collected species	Host plant	Collection site	Voucer specimens used for DNA analysis	Sequence rDNA
Asterinaceae				
Asterinaceae 1 (indet.)	*Rapanea myricoides* (Primulaceae)	Cerro Picacho [G]	ppMP 1335, **TH 565***	LSU
Asterinaceae 2 (indet.)	*Schlegelia parviflora* (Schlegeliaceae)	Fortuna, slope [O]	**ppMP 1378***	LSU
***Asterina cestricola* (R.W. Ryan) Hosag. & T.K. Abraham**	*Cestrum rugulosum* (Solanaceae)	Sendero los Quetzales	**TH 591***	SSU/LSU
***Asterina ciferriana* Petr.**	*Caesalpinia bonduc* (Fabaceae s.l.)	La Barqueta [H]	ppMP 1259	
***Asterina davillae* J.A. Stev.**	*Curatella americana* (Dilleniaceae)	Los Algarrobos [A]	ppMP 1198, TH 527*	
***Asterina diplocarpa* Cooke**	*Sida rhombifolia* (Malvaceae)	Chorcha, forest Los Algarrobos [A] Los Algarrobos, El Salto	**TH 536*** ppMP 1199, TH 598* TH 495	LSU
***Asterina ekmanii* Petr. & Cif.**	*Gonzalagunia rudis* (Rubiaceae)	Celestine, roadside	TH 326	
***Asterina fuchsiae* Syd.**	*Fuchsia paniculata* (Onagraceae)	Sendero los Quetzales	TH 312, **TH 590***	SSU/LSU
***Asterina manihotis* Syd.**	*Manihot esculenta* (Euphorbiaceae)	Los Algarrobos, garden	TH 534*, **TH 607***	LSU
***Asterina phenacis* Syd.**	*Phenax mexicanus* (Urticaceae)	Sendero los Quetzales	**TH 589***	SSU/LSU
***Asterina radiofissilis* (Sacc.) Theiss.**	*Acalypha arvensis* (Euphorbiaceae)	Boquete, Alto Lino [F]	ppMP 1216	
***Asterina schlegeliae* T.A. Hofmann**	*Schlegelia parviflora* (Schlegeliaceae)	Fortuna, slope [O]	TH 512-A, TH 587*	
***Asterina siphocampyli* Syd.**	*Burmeistera* sp. (Campanulaceae)	Fortuna, forest [N]	**ppMP 1324**	LSU
***Asterina stipitipodia* M.L. Farr**	*Davilla kunthii* (Dilleniaceae)	Los Algarrobos [A]	TH 496-B, TH 526*	
***Asterina weinmanniae* Syd.**	*Weinmannia pinnata* (Cunoniaceae)	Sendero los Quetzales	**TH 592***	SSU/LSU
***Asterina zanthoxyli* W. Yamam.**	*Zanthoxylum scheryi* (Rutaceae)	Cerro Picacho [G]	**TH 561***	SSU/LSU
***Asterina* sp. 3**	*Desmopsis bibracteata* (Annonaceae)	Los Algarrobos [B]	TH 499, TH 577*	
***Asterina* sp. 5**	*Clusia* sp. (Clusiaceae)	Fortuna, slope [O]	**ppMP 1376***	LSU
***Asterina* sp. 6**	*Alloplectus ichtyoderma* (Gesneriaceae)	Cerro Picacho [G]	ppMP 1276	
***Asterina* sp. 7**	*Compsoneura sprucei* (Myristicaceae)	Bonyik [K]	ppMP 1293, TH 569*	
***Asterina* sp. 8**	*Casearia commersoniana* (Salicaceae s.l.)	Los Algarrobos [B]	TH 524*	
Asterina sp. 1 (undet.)	*Besleria* sp. (Gesneriaceae)	Fortuna, forest [N]	ppMP 1348*	

Collected species	Host plant	Collection site	Voucer specimens used for DNA analysis	Sequence
Asterina sp. 2 (undet.)	*Witheringia* sp. (Solanaceae)	Fortuna, forest [N]	ppMP 1349*	
Asterina sp. 3 (undet.)	Melastomataceae 1 (undet.)	Fortuna, slope [O]	ppMP 1373*	
Asterina sp. 4 (undet.)	Melastomataceae 2 (undet.)	Sendero los Quetzales	TH 596*	
Asterinella sp. (undet.)	*Alibertia edulis* (Rubiaceae)	La Barqueta [H]	TH 605*	
Asterolibertia licaniicola Hansf.	*Licania arborea* (Chrysobalanaceae)	Los Algarrobos [B]	TH 597*	
Asterolibertia nodulosa (Speg.) Hansf.	*Oxandra venezuelana* (Annonaceae)	Los Algarrobos [B]	TH 528*	
Asterolibertia sp.	cf. Annonaceae	Fortuna, forest [N]	ppMP 1323	
Cirsosia splendens Bat . & H. Maia	*Chrysobalanus icaco* (Chrysobalanaceae)	La Barqueta [H]	ppMP 1146, ppMP 1264, TH 516-A*,-B*, TH 604-A*,-B*	
Halbanina sp.	*Chrysobalanus icaco* (Chrysobalanaceae)	La Barqueta [H]	**ppMP 1265**, TH 515*, **TH 603***	LSU
Lembosia sp. 1 (undet.)	*Psychotria* sp. (Rubiaceae)	Cerro Picacho [G]	ppMP 1279, **TH 562***	LSU
Lembosia sp. 2 (undet.)	*Randia aculeata* (Rubiaceae)	Los Algarrobos [B]	TH 576*	
Prillieuxina winteriana G. Arnaud	*Annona montana* (Annonaceae)	Los Algarrobos, garden	TH 474, TH 533*, TH 606*	
cf. *Prillieuxina* sp. 1 (undet.)	*Meliosma* cf. *idiopoda* (Sabiaceae)	Cerro Picacho [G]	TH 564*	
cf. *Prillieuxina* sp. 2 (undet.)	*Meliosma* sp. (Sabiaceae)	Fortuna, forest [N]	ppMP 1350*	
anamorphic Asterinaceae				
Asterostomella dilleniicola M.L. Farr	*Davilla kunthii* (Dilleniaceae)	Los Algarrobos [A]	**TH 496-A**, TH 525*	LSU
Mahanteshamyces sp.	*Schlegelia parviflora* (Schlegeliaceae)	Fortuna, slope [O]	TH 512-B, **TH 588***	SSU/LSU
Aulographaceae				
Aulographum hederae Lib.	*Phillyrea latifolia* (Oleaceae)	Botanical Garden Frankfurt	**TH 609***	LSU
Aulographum sp. (undet.)	*Stelis* sp. (Orchidaceae)	Cerro Picacho [G]	**TH 557***	LSU
Chaetothyriaceae				
Chaetothyrium vermisporum Hansf.	*Inga* sp. (Fabaceae s.l.)	Piedra Candela, forest [C]	**ppMP 1243**	LSU
Micropeltidaceae				
Micropeltis cf. *anthuriana*	*Ardisia* sp. (Primulaceae)	Los Algarrobos [B]	TH 575*	
	Hirtella triandra (Chrysobalanaceae)	Los Algarrobos [B]	**TH 602***	LSU
Micropeltis sp. 1 (undet.)	*Casearia* sp. (Salicaceae s.l.)	Canal Changuinola [J]	ppMP 1357*	
Micropeltis sp. 2 (undet.)	Fabaceae s.l.	Fortuna, forest [N]	**ppMP 1352***	LSU
Micropeltis sp. 3 (undet.)	*Anthurium* sp. (Araceae)	Fortuna, slope [O]	ppMP 1374*	
Micropeltis sp. 4 (undet.)	*Pithecellobium longifolium* (Fabaceae s.l.)	Los Algarrobos [B]	**TH 600***	LSU

Collected species	Host plant	Collection site	Voucer specimens used for DNA analysis	Sequence
Micropeltis sp. 5 (undet.)	Salicaceae s.l.	Los Algarrobos [A]	TH 601*	
Scolecopeltidium cf. *swartzianum*	Lauraceae	Los Algarrobos [B]	**TH 599***	LSU
cf. *Stomiopeltis* sp. 1 (undet.)	*Piper* sp. 1 (Piperaceae)	Fortuna, forest [N]	ppMP 1322, **ppMP 1352***	LSU
cf. *Stomiopeltis* sp. 2 (undet.)	*Piper* sp. 2 (Piperaceae)	Cerro Picacho [G] Sendero los Quetzales	ppMP 1322, **TH 559*** TH 593*	LSU
Microthyriaceae				
Cyclotheca sp.	*Solanum trizygum* (Solanaceae)	Alto Chiquero [E]	ppMP 1223, **TH 585***	LSU
Cyclotheca sp. 1 (undet.)	*Alloplectus ichtyoderma* (Gesneriaceae)	Cerro Picacho [G]	ppMP 1277, TH 563*	
Cyclotheca sp. 2 (undet.)	Acanthaceae	Fortuna, forest [N]	TH 509	
***Maublancia uleana* (Pazschke) G. Arnaud**	*Myrcia splendens* (Myrtaceae)	Los Algarrobos [B]	ppMP 1206	
Maublancia sp. (undet.)	*Ouratea* sp. (Ochnaceae)	Cerro Picacho [G]	TH 560*	
Microthyrium macrosporum (Sacc.) Höhn.	*Buxus sempervierens* (Buxaceae)	Botanical Garden Frankfurt	TH 608*	
***Platypeltella irregularis* M.L. Farr**	*Greigia sylvicola* (Bromeliaceae)	Cerro Picacho [G]	ppMP 406, ppMP 567, **TH558***	LSU
***Platypeltella smilacs* Petr.**	*Smilax* sp. (Smilacaceae)	Fortuna, forest [N]	**ppMP 1346***	LSU
Vizellaceae				
Vizella sp. (undet.)	*Schlegelia parviflora* (Schlegeliaceae)	Fortuna, slope [O]	**ppMP 1379***	LSU
Genus with unknown placement				
***Hemisphaeropsis magnoliae* Petr.**	*Magnolia sororum* (Magnoliaceae)	Cerro Picacho [G]	TH 505, TH 567*	
Hemisphaeropsis sp. (undet.)	Melastomataceae 3 (undet.)	Fortuna, slope [O]	ppMP 1371*	

kimtech precision wipe and observed under a Nikon SMZ645 stereomicroscope. Mature fungal colonies without hyperparasites were selected. Single ascomata from the colonies were picked with a sterile hollow needle and transferred to an Eppendorff cup with 10 µl of sterile water. Fungal material was added until the drop was full and appeared black. Glass beads (Roth) of 0.5 mm diam. were added to each Eppendorff cup and samples were cooled at −20 °C for at least 30 min in the refrigerator. The samples were homogenized in a cell disruptor for 3 min Isolation of genomic DNA in the field laboratory in Panama was done with the PEQLAB E.Z.N.A.® Fungal DNA Kit (PEQLAB Biotechnologie GmbH, Erlangen, Germany) following the manufacturer`s protocol. The samples were stored at −20 °C for several days to weeks, air-mailed via express service to the Department of Mycology at the J.W. Goethe-University in Frankfurt/Main in Germany and stored at −20 °C for several days until further analysis.

To isolate genomic DNA from leaf material, dried on silica gel in the molecular labroratory in Frankfurt, similar methods as above were used, except that leaves were not washed in water before. To facilitate the transfer of dried ascomata to the tube, the tip of a sterile hollow needle was moistened with sterile water from the 10 µl drop in the Eppendorff cup. Glass beads (Roth) of 0.5 mm diam. were added to each Eppendorff cup and the samples were homogenized in a pulverizing Retsch mill (Mixer Mill MM 301, Retsch) 2 times for each 1.5 min at 30 Hz. Extraction of genomic DNA was done in the molecular laboratory in Frankfurt with the PEQLAB E.Z.N.A.® Fungal DNA Kit (PEQLAB Biotechnologie GmbH, Erlangen, Germany) following the protocol.

2.9.3 PCR

PCR amplification of the SSU and LSU rDNA region was performed in the thermocycler with the primers listed below, peqGOLD dNTPs and peqGOLD Taq polymerase kit following the protocol (PEQLAB Biotechnologie GmbH, Erlangen, Germany).

PCR primers

The PCR Primers were synthesized by Eurofins MWG Operon, Ebersberg, Germany.

SSU	FF1: GTT AAA AAG CTC GTA GTT GAA C
	FR1: CTC TCA ATC TGT CAA TCC TTA TT
LSU	NL1: GCA TAT CAA TAA GCG GAG GAA AAG
	NL4: GGT CCG TGT TTC AAG ACG G

The PCR samples were analysed with gel electrophoresis and PCR products were purified with the PEQLAB E.Z.N.A.® Cycle-Pure Kit following the protocol.

2.9.4 DNA sequencing

DNA sequencing was done by Scientific Research and Development GmbH (SRD) in Oberursel, Germany.

2.9.5 Analysis of sequence data

SSU and LSU rDNA sequences were edited with CodonCode Aligner version 1.2.2 and demo version 2.0.6 (Codon Code Corporation). The SSU and LSU rDNA sequences are listed in Table 7.2. Related SSU and LSU rDNA sequences deposited in Genbank were determined with a BLAST search (Altschul et al. 1990) and downloaded to the Alignment Explorer of MEGA version 4.0 (Tamura et al. 2007). An overview of the sequences used for phylogenetic analysis is given in Table 2.3. Separate alignments of both SSU and LSU sequences were produced using the integrated ClustalW algorithm (default parameters: pairwise and multiple alignment with GOP 15 and GEP 6.66, DNA weight matrix IUB, transition weight 0.5, use negative matrix off and delay divergent cutoff 30 %) of MEGA 4.0. Alignments were not improved manually. A combined data set of SSU and LSU rDNA sequences was created in the Alignment Explorer of MEGA 4.0 and neighbour joining analysis (NJ, Saitou and Nei 1987) was conducted in MEGA 4.0 (complete deletion option). The tree is drawn to scale, with branch lengths in the same units as those of the evolutionary distances used to infer the phylogenetic tree. The evolutionary distances were computed using the Maximum Composite Likelihood method (Tamura et al. 2004) and are in the units of the number of base substitutions per site. Bootstrap analysis (Felsenstein 1985) was performed with 2000 replications. The optimal tree was rooted in the Tree Explorer of MEGA 4.0 and the tree was exported to Photoshop CS2 for additional labeling and layout improvement.

Table 2.3: GenBank accession numbers of LSU and SSU rDNA sequences from species used in the phylogenetic analysis. Species are listed in alphabetical order. Ascomycete systematics is adopted from Lumbsch and Huhndorf`s *Outline of Ascomycota 2007*. SSU and LSU rDNA sequences of *Phyllachora graminis* and *Coccodiella miconiae* from Panama were kindly provided by T. Trampe.

Class/subclass	Order, family	Species	Voucher specimen	GenBank accession no.		Reference
				SSU	LSU	
Arthoniomycetes	Arthoniales, Roccellaceae	*Dendrographa leucophaea* (Tuck.) Darb.		AY548803	AY548810	GenBank[a]
		Lecanactis abietina (Ach.) Körb.		AY548805	AY548812	GenBank[a]
		Roccella fuciformis (L.) DC.		AY584678	AY584654	Luzoni et al. (2004)
Dothideomycetes/ Dothideomycetidae	Capnodiales, Capnodiaceae	*Capnodium coffeae* Pat.		DQ247808	DQ247800	Schoch et al. (2006b)
		Scorias spongiosa (Schwein.) Fr.		DQ678024	DQ678075	Schoch et al. (2006a)
	Capnodiales, Mycosphaerellaceae	*Mycosphaerella fragariae* (Tul.) Lindau		EF114720	EF114696	Winton et al. (2007)
		Mycosphaerella graminicola (Fuckel) J. Schröt.		DQ678033	DQ678084	Schoch et al. (2006a)
		Mycosphaerella punctiformis (Pers.) Starbäck		DQ471017	DQ470968	Spatafora et al. (2006)
	Capnodiales, Schizothyriaceae	*Schizothyrium pomi* (Mont. & Fr.) Arx		EF134949	EF134949	Batzer et al. (2008)
	Dothideales, Dothideaceae	*Delphinella strobiligena* (Desm.) Sacc. ex E. Müll. & Arx		AY016341	AY016358	Lumbsch and Lindemuth (2001)
		Dothidea ribesia (Pers.) Fr.		AY016343	AY016360	Lumbsch and Lindemuth (2001)
		Sydowia polyspora (Bref. & Tavel) E. Müll.		AY544718	DQ678058	GenBank[a]
Dothideomycetes/ Pleosporomycetidae	Pleosporales, Pleosporaceae	*Cochliobolus heterostrophus* (Drechsler) Drechsler		AY544727	AY544645	GenBank[a]
		Pleospora herbarum (Pers.) Rabenh.		DQ247812	AF382386	Schoch et al. (2006b)/Jeewon et al. (2002)
		Pyrenophora tritici-repentis (Died.) Drechsler		PTU42486	DQ384097	Berbee (1996)/Kruys et al. (2006)
	Pleosporales, Sporormiaceae	*Preussia terricola* Cain		AY544726	AY544686	GenBank[a]
		Sporormia lignicola W. Philipps & Plowr.		EU263612	DQ384098	GenBank[a]/Kruys et al. (2006)
		Westerdykella cylindrica (Malloch & Cain) Arx		AY016355	AY004343	Lumbsch and Lindemuth (2001)/Lumbsch et al. (2000)
		Westerdykella dispersa (Clum) Cejp & Milko		WDU42488	DQ384099	Berbee 1996/Kruys et al. (2006)

	Pleosporales, Venturiaceae	*Apiosporina morbosa* (Schwein.) Arx		EF114718	EF114694	Winton et al. (2007)
		Fusicladium convolvularum Ondřej		AY251124	EU035428	Braun et al. (2003)/Crous et al. (2007b)
		Fusicladium effusum G. Winter		AY251126	EU035429	Braun et al. (2003)/Crous et al. (2007b)
		Venturia inaequalis (Cooke) G. Winter		EF114738	EU035460	Winton et al. (2007)/Crous et al. (2007b)
		Venturia pirina Aderh.		EF114740	EU035469	Winton et al. (2007)/Crous et al. (2007b)
Dothideomycetes/ incertae sedis	Botryosphaeriales, Botryosphaeriaceae	*Botryosphaeria dothidea* (Moug.) Ces. & De Not.		AF271128	AY928048	GenBank[a]/Alves et al. (2005)
		Botryosphaeria ribis Grossenb. & Duggar		DQ678000	DQ678053	Schoch et al. (2006a)
		Botryosphaeria stevensii Shoemaker		DQ678012	DQ678064	Schoch et al. (2006a)
		Guignardia bidwellii (Ellis) Viala & Ravaz		DQ678034	DQ678085	Schoch et al. (2006a)
	incertae sedis, Asterinaceae	*Asterina cestricola* (R.W. Ryan) Hosag. & T.K. Abraham	TH 591			
		Asterina fuchsiae Syd.	TH 590			
		Asterina phenacis Syd.	TH 589			
		Asterina weinmanniae Syd.	TH 592			
		Asterina zanthoxyli W. Yamam.	TH 561			
		Mahanteshamyces sp. on *Schlegelia parviflora*	TH 588			
	incertae sedis, Tubeufiaceae	*Helicomyces roseus* Link		DQ678032	DQ678083	Schoch et al. (2006a)
		Thaxteriella helicoma (W. Phillips & Plowr.) J.L. Crane, Shearer & M.E. Barr		AF201455	AY787939	Interbitzin et al. (2001), Kodsueb et al. (2006)
		Tubeufia cerea (Berk. & M.A. Curtis) Höhn.		AY856930	AY856907	Tsui and Berbee (2006), Tsui et al. (2006)
Sordariamycetes/ Hypocreomycetidae	Hypocreales, Hypocreaceae	*Hypocrea lutea* (Tode) Petch		AF543768	AF543791	Currie et al. (2003)
Sordariomycetes/ Xylariomycetidae	Xylariales, Xylariaceae	*Xylaria hypoxylon* (L.) Grev.		AY544692	AY544648	GenBank[a]
Sordariomycetes/ incertae sedis	Phyllachorales, Phyllachoraceae	*Coccodiella miconiae* (Duby) I. Hino & Katum.	ppMP 1342			
		Phyllachora graminis (Pers.) Fuckel	RoKi 3084			

[a] unpublished according to GenBank

2.10 Drawings/Illustrations

Original ink drawings were made with Rothring Isograph precision ink pens with drawing nibs with widths of 0.5 mm, 0.35 mm, 0.25 mm and 0.18 mm on tracing paper (92 g/m²) and were scanned with an Epson Perfection 2480 PHOTO scanner as black and white line art with a resolution of 600 dpi and image adjustments with a treshold of 40-50. Scannings were processed with Epson Scan 2.50E and saved in BITMAP format. Digitalized illustrations and digital photos were labeled and arranged in plates with Adobe Photoshop CS2 and saved in PSD and JPEG format. The completed figures were imported into the document (Microsoft Word 2003) and provided with a legend.

2.11 Abbreviations and symbols

Abbreviations of herbaria according to Holmgren et al. (1990):

BO	Herbarium Bogoriense, Bibinong, Indonesia
BPI	US National Fungus Collections, Beltsville, USA
FR	Forschungsinstitut Senckenberg, Frankfurt, Germany
HBG	Biozentrum Klein-Flottbek, Hamburg, Germany
IMI	CABI, Bioscience UK Centre, Engham, England, UK
LPS	Universidad National de la Plata, La Plata, Buenos Aires, Argentina
M	Botanische Staatssammlung München, Germany
PAD	Università degli Studi di Padova, Padova, Italy
PMA	National Herbarium of the University of Panama, Panama
PREM	Plant Protection Research Institute, Pretoria, South Africa
S	Swedish Museum of Natural History, Stockholm, Sweden

Abbreviations of private herbaria:

BoKo	Boris Koch
MP	Meike Piepenbring
ppMP	plant parasitic Microfungi from Panama
RMP	Ralph Mangelsdorff Panama
RoKi	Roland Kirschner
TH	Tina A. Hofmann
TT	Tanja Trampe

Abbreviations of ppMP collection sites:

A	Los Algarrobos, path to Majagua river
B	Los Algarrobos, border of Majagua river
C	Road to Piedra de Candela, forest
D	Road to Piedra de Candela, road side
E	Boquete, forest
F	Boquete, Alto Lino, road side
G	Parque International La Amistad (PILA), path to Cerro Pichacho
H	La Barqueta, pacific coast
I	Chorcha, forest near path to plateau
J	Canal Changuinola, marsh forest
K	Bonyik near Teribe river, forest
L	Finca Celestine, El Valle, forest
M	Parque National Volcán Barú (PNVB), road side
N	Fortuna, forest
O	Fortuna, Quijada de Diablo

General abbreviations:

alt.	altitude	GOP	gap opening penalty
approx.	approximately	GEP	gap opening penalty
a.s.l.	above sea level	h	hours
bp	base pairs	I +/−	iodine positive/negative
ca.	*circa*: about	incl.	including
cm	centimeter	ined.	inedited
coll.	collector/s	leg.	legit
det.	determined	m	meter
diam.	diameter	min	minutes
DNA	desoxyribonucleic acid	mm	millimeter
et al.	*et alii*/*et aliorum*: and	n.n.	not named
	others/and of others	n.v.	*non visus*: not seen
etc.	*et cetera*	Mt.	mount
fide	*fide*: according to	PCR	polymerase chain reaction
Fig.	figure	pH	pH-value
ft.	feet	p.p.	*pro parte*: in part

ppMP	plant parasitic Microfungi from Panama
sp.	*species*: species
s.l.	*sensu lato*: in a broad sense
s.n.	*sine numero*: without a number
s.str.	*sensu stricto*: in a narrow sense
syn. nov.	*synonymus novum*: new synonym
°C	degree Celsius
µm	micrometre

Symbols:

=	taxonomic synonym, heterotypic synonym
≡	nomenclatural synonym homotypic synonym
!	examined

3 Results

3.1 Collections

A total of 380 specimens of plant parasitic thyriothecioid ascomycetes from seven families (259 specimens Asterinaceae, 36 specimens Microthyriaceae, 26 specimens Parmulariaceae, 19 specimens Englerulaceae, 12 specimens Micropeltiaceae, five specimens Aulographaceae, vier specimens Vizellaceae) and one form group (19 specimens 'Pycnothyriales') were collected by the author or other contributors during various field trips to Western Panama between 2000 and 2008 (180 specimens by participants of the ppMP project, 174 specimens by the author, 12 specimens by M. Piepenbring, eight specimens by T. Trampe, five specimens by R. Mangelsdorff and one specimen by B. Koch). The 380 specimens comprise approx. 160 different species of plant parasitic thyriothecioid ascomycetes (92 spp. Asterinaceae, 20 spp. Microthyriaceae, 14 spp. Parmulariaceae, 12 spp. Englerulaceae, 12 spp. 'Pycnothyriales', five spp. Aulographaceae, three spp. Micropeltidaceae, two spp. Vizellaceae) growing superficially on approx. 146 different host plant species (88 of the host plants could not be identified to species level) in 137 genera (44 host plants could not be identified to genus level) belonging to 61 different host plant families (five families represented pteridophyta; 51 families angiosperms with five monocots, seven magnoliids, 39 eudicots; and five hosts could not be identified to family level). Saprotrophic, commensalistic and hyperparasitic thyriothecioid ascomycetes collected in Panama are not included in this survey.

For this contribution, 42 species of plant parasitic thyriothecioid ascomycetes were selected belonging to 13 genera (including anamorphic genera) in two families (Asterinaceae and Microthyriaceae) and one form group ('Pycnothyriales'). They are described, illustrated and discussed in detail. 35 species in five different genera represent teleomorphic Asterinaceae (additionally two anamorphic genera occuring together with the respective teleomorph), two species in two genera are exclusively anamorphic Asterinaceae, four species in three genera are plant parasitic Microthyriaceae and one species and genus of an anamorphic pycnothyrial fungus is of uncertain placement. An overview to the species presented in this study is given in Table 3.1. The 42 fungal species parasitize on 47 different host plant species (eight not identified to species level) belonging to 39 genera (two not identified to genus level) in 28 different plant families (three families belonging to magnoliids, two monocots, 23 eudicots). The 42 species of thyriothecioid ascomycetes are represented by a total of 174 specimens which were collected by different contributors in Panama (86 specimens by the autor, 74 specimens as part of the ppMP project, five specimens by M. Piepenbring, five specimens by T. Trampe, three specimens by R. Mangelsdorff and one specimen by B. Koch). Additionally, 205 fungal specimens were consulted from different herbaria (163 specimens from BPI, 25 specimens from S, ten specimens from IMI, three specimens from LPS, two specimens from HBG, one specimen from BO, one specimen from PREM, compare Table 3.2). A total of 379 specimens of plant parasitic Asterinaceae, Microthyriaceae and ‘Pycnothyriales’ were investigated during this study.

In Western Panama, *Asterina* was by far the most species-rich genus with 29 different species that parasitized 32 different host plant species belonging to 22 host plant families (magnoliids and core eudicots, Table 3.1). Six *Asterina* spp. contained an anamorphic stage, for five species the anamorph represented a species of *Asterostomella* and for one species a species of *Mahanteshamyces*. Three different species of *Asterina* were found on Solanaceae, two *Asterina* spp. were found respectively on Acanthaceae, Dilleniaceae, Euphorbiaceae and Flacourtiaceae s.str., and the rest of the host families was only parasitized by one *Asterina* species (Annonaceae, Campanulaceae, Cannabaceae, Cleomaceae, Clusiaceae, Cunoniaceae, Fabaceae s.l., Gesneriaceae, Loranthaceae, Malvaceae, Myristicaceae, Onagraceae, Rubiaceae, Rutaceae, Schlegeliaceae, Styracaceae, Urticaceae). All *Asterina* spp. were new records for Panama and for numerous species new host plant species could be determined (Table 3.1, Chapter 3.2). Two new *Asterina* species were discovered during this study, namely *Asterina schlegeliae* T.A. Hofmann and *Asterina gaiadendricola* T.A. Hofmann (Table 3.1, Chapter 3.2). Eight further species of *Asterina* could not be identified to species

Table 3.1: List of species of plant parasitic thyriothecioid ascomycetes presented in this study. Fungal species indicated with ◘ are new records for Panama, host plants indicated with ♣ are new host plant records for the respective fungal species. Species indicated with ♦ are new to science. Unidentified species are numbered consecutively and are arranged in alphabetical order according to their host plant families.

Family, genus, species	Host plant
Asterinaceae	
Asterina cestricola (R.W. Ryan) Hosag. & T.K. Abraham ◘	*Cestrum rugulosum* Francey ♣ (Solanaceae)
Asterina ciferriana Petr. ◘	*Caesalpinia boduc* L. (Roxb.) ♣ and *Senna* ♣ sp. (Fabaceae s.l.)
Asterina consobrina Syd. ◘	*Solanum aphyodendron* S. Knapp ♣ (Solanaceae)
Asterina corallopoda Syd. ◘	*Solanum trizygum* Bitter ♣ (Solanaceae)
Asterina davillae J.A. Stev. ◘ with *Asterostomella* anamorph	*Curatella americana* L. ♣ (Dilleniaceae)
Asterina diplocarpa Cooke ◘	*Sida acuta Burm.* f. and *S. rhombifolia* L. (Malvaceae)
Asterina diplopoda Syd. ◘	*Solanum acerifolium* Dunal (Solanaceae)
Asterina ekmanii Petr. & Cif. ◘	*Gonzalagunia rudis* (Standl.) Standl. ♣ (Rubiaceae)
Asterina fuchsiae Syd. ◘	*Fuchsia paniculata* Lindl. ♣ (Onagraceae)
Asterina gaiadendricola T.A. Hofmann ♦ with *Asterostomella* anamorph	*Gaiadendron punctatum* (Ruiz & Pav.) G. Don (Loranthaceae)
Asterina manihotis Syd. ◘	*Manihot esculenta* Crantz (Euphorbiaceae)
Asterina phenacis Syd. ◘	*Phenax mexicanus* Wedd. ♣ (Urticaceae)
Asterina radiofissilis (Sacc.) Theiss. ◘ with *Asterostomella* anamorph	*Acalypha arvensis* Poepp. ♣ (Euphorbiaceae)
Asterina schlegeliae T.A. Hofmann ♦ with *Mahanteshamyces* anamorph	*Schlegelia parviflora* (Oerst.) Monach. (Schlegeliaceae)
Asterina siphocampyli Syd. ◘	*Burmeistera vulgaris* E. Wimm. ♣ and *Burmeistera* ♣ sp. (Campanulaceae)
Asterina sponiae Racib. ◘	*Trema micrantha* L. (Blume) (Cannabaceae) and unknown Tiliaceae
Asterina stipitipodia M.L. Farr & anamorph *Asterostomella stipitipodia* M.L. Farr ◘	*Davilla kunthii* A. St.-Hil. ♣ (Dilleniaceae)
Asterina styracina Syd. ◘	*Styrax argenteus* C. Presl ♣ (Styracaceae)
Asterina tonduzii (Speg.) Syd. & anamorph *Asterostomella tonduzii* Syd. ◘	*Xylosma* sp. (Salicaceae s.l.)
Asterina weinmanniae Syd. ◘	*Weinmannia pinnata* L. ♣ (Cunoniaceae)
Asterina zanthoxyli W. Yamam. ◘	*Zanthoxylum scheryi* Lundell ♣ (Rutaceae)
Asterina sp. 1	*Hansteinia reflexiflora* Leonard (Acanthaceae)
Asterina sp. 2	*Hansteinia ventricosa* (Donn. Sm.) D.N. Gibson (Acanthaceae)
Asterina sp. 3	*Desmopsis bibracteata* (B.L. Rob.) Saff. (Annonaceae)
Asterina sp. 4	*Cleome* sp. (Cleomaceae)
Asterina sp. 5	*Clusia* sp. (Clusiaceae)
Asterina sp. 6	*Alloplectus ichthyoderma* Hanst. (Gesneriaceae)
Asterina sp. 7	*Compsoneura sprucei* (A. DC.) Warb. (Myristicaceae)
Asterina sp. 8	*Casearia commersoniana* Cambess. (Salicaceae s.l.)
Asterolibertia licaniicola Hansf. ◘	*Licania arborea* Seem. ♣ (Chrysobalanaceae)

Family, genus, species	Host plant
Asterolibertia nodulosa (Speg.) Hansf. ◘	*Oxandra venezuelana* R.E. Fr. ♣ (Annonaceae)
Asterolibertia sp.	cf. Annonaceae
Cirsosia splendida Bat. & H. Maia ◘ & anamorph *Homalopeltis chrysobalani* (Henn.) Bat. & Valle◘	*Chrysobalanus icaco* L. and *Hirtella triandra* Sw. ♣ (Chrysobalanaceae)
Halbanina sp.	*Chrysobalanus icaco* L. (Chrysobalanaceae)
Prillieuxina winteriana (Pazschke) G. Arnaud ◘ & anamorph *Leprieurina winteriana* G. Arnaud	*Annona montana* Macfad. (Annonaceae)
anamorphic Asterinaceae	
Asterostomella dilleniicola M.L. Farr ◘	*Davilla kunthii* A. St.-Hil. ♣ (Dilleniaceae)
Mahanteshamyces sp.	*Schlegelia parviflora* (Oerst.) Monach. (Schlegeliaceae)
Microthyriaceae	
Maublancia uleana (Pazschke) Arx ◘	*Myrcia splendens* (Sw.) DC. (Myrtaceae)
Platypeltella irregularis M.L. Farr ◘	*Greigia sylvicola* Standl. ♣ (Bromeliaceae)
Platypeltella smilacis Petr. ◘	*Smilax* sp. (Smilacaceae)
Xenostomella tovarensis Syd. ◘	*Monnina xalapensis* Kunth ♣ (Polygalaceae)
with uncertain placement ('Pycnothyriales')	
Hemisphaeropsis magnoliae Petr. ◘	*Magnolia sororum* Seibert ♣ (Magnoliaceae)

level and probably represent new species. To avoid invalid publication of the new species, they are indicated with *Asterina* sp. 1-8 (Table 3.1).

In Western Panama, the genus *Asterolibertia* was represented by three different species on three host plant species belonging to two host plant families (one host plant could not be identified, Table 3.1). *A. licaniicola* and *A. nodulosa* were new records for Panama and were collected on two new host plant species (Table 3.1, Chapter 3.2). One *Asterolibertia* species, indicated as *Asterolibertia* sp., could not be identified to species level.

Other asterinaceous genera found in Western Panama were represented by only one species, namely the genera *Cirsosia* with *Cirsosia splendida* and its anamorph *Homalopeltis chrysobalani*, and *Prillieuxina* with *Prillieuxina winteriana* and its anamorph *Leprieurina winteriana*. A species of *Halbanina* that could not be identified to species level is probably new to science. *C. splendida* with its anamorph *H. chrysobalani* and *P. winteriana* with its anamorph *L. winteriana* were new records for Panama and were collected on a new host plant species (Chapter 3.2). For *C. splendida*, two new host plant species were identified, whereas only on of the host plant species was new for *H. chrysobalani*.

Two anamorphic Asterinaceae were collected in Western Panama, *Asterostomella dilleniicola* and *Mahanteshamyces* sp. which are known to be connected to species of *Asterina*. However, both species were devoid of a teleomorphic *Asterina* stage. *Mahanteshamyces* could not be identified to species level and probably represents a new species. *A. dilleniicola* was collected on a new host plant species (Chapter 3.2).

Plant parasitic Microthyriaceae were less species-rich in Western Panama. They are represented here by 4 species in 3 different genera growing on four different host plant species belonging to 4 different host plant families (two monocots, two core eudicots). The genus *Platypeltella* was represented by two different species *P. irregularis* and *P. smilacis* on host belonging to two families of monocots (Bromeliaceae, Smilacaceae). *P. irregularis* was collected on a new host plant species (Chapter 3.2). The microthyriaceous genera *Maublancia* and *Xenostomella* were represented by one species respectively, *M. uleana* and *X. tovarensis*, which were both new records for Panama. *X. tovarensis* was collecetd on a new host plant species (Chapter 3.2).

Table 3.2: Examined herbarium specimens.

Current name	Herbarium specimens
Asterina acalyphae	BPI 689213
Asterina artabotrydis	IMI 18944 type, BPI 689247, BPI 689248, BPI 689249, BPI 689250
Asterina cestricola	labeled as *Asterina diplocarpa* var. *cestricola*: BPI 689658 lectotype (hic designatus), BPI 689656 isotype, BPI 689657 isotype, BPI 689659, BPI 689660
Asterina ciferriana	BPI 845201
Asterina consobrina	BPI 689458 syntype
Asterina corallopoda	BPI 689463 ex-type
Asterina coriacella	LPS 1370 type
Asterina costaricensis	BPI 689492
Asterina davillae	BPI 689515 type
Asterina delicata	IMI 35787 type
Asterina diaphana	S F12348 type
Asterina diplocarpa	BPI 689653 lectotype (hic designatus), BPI 689627, BPI 689628, BPI 689629, BPI 689630, BPI 689631, BPI 689632, BPI 689633, BPI 689634, BPI 689635, BPI 689636, BPI 689637, BPI 689638, BPI 689639, BPI 689640, BPI 689641, BPI 689645, BPI 689646, BPI 689647, BPI 689648, BPI 689649, BPI 689654, BPI 689655, labeled as *Asterina sidicola*: BPI 690425, labeled as *Asterina similis*: BPI 690437 type
Asterina diplopoda	BPI 689662 type
Asterina dilleniae	BPI 689618 type, BPI 689619
Asterina dispar	LPS 1669 type
Asterina disseminata	IMI 18949 type
Asterina ekmanii	S F49028 lectotype (hic designatus)
Asterina eupomatiae	S F12519 type
Asterina flacourtiae	BPI 689782 type, BPI 689781

Current name	Herbarium specimens
Asterina fuchsiae	HBG 1609 syntype?
Asterina homalii	IMI 19124 type
Asterina homaliicola	IMI 44500 type
Asterina horsfieldiae	BO 14446 type
Asterina incilis	IMI 18940 type
Asterina jahnii	S F7963 type, S F7965, BPI 689943
Asterina manihotis	BPI 690036
Asterina microchita	BPI 690084
Asterina orthosticha	BPI 690156
Asterina phenacis	BPI 690485 syntype?
Asterina phlogacanthi	labeled as *Asterina* sp.: IMI 215562
Asterina portoricensis	BPI 690311 type, BPI 690312 ex-type
Asterina punctiformis var. *fimbriata*	labeled as *A. fimbriata*: BPI 689778 type, BPI 689779, BPI 689780
Asterina pycnanthii	BPI 690339 syntype
Asterina ramosii	BPI 690361 type, BPI 690362, BPI 690363
Asterina saginata	BPI 690393 syntypes, BPI 690394 syntypes, BPI 690395 syntypes, labeled as *Asterina melanomera*: S F12393 type, labeled as *Asterina* sp: BPI 689192
Asterina scruposa	BPI 690409, BPI 690410, BPI 690411, IMI 1156
Asterina scruposa var. *longipoda*	BPI 690413 ex-type, labeled as *Asterina scruposa*: BPI 690415
Asterina sidicola	BPI 690420 syntype, BPI 690423 syntype, BPI 690421 paratype, BPI 690422 paratype
Asterina spectabilis	S F12497 type
Asterina sponiae	BPI 690504, BPI 690508, BPI 690512
Asterina stipitipodia	BPI 690522A,B isotype
Asterina styracina	BPI 690526 lectotype (hic designatus), BPI 690527 isotype, BPI 690525, labeled as *Asterina myocoproides*: S F114233
Asterina tenuis	BPI 690570
Asterina tertia var. *africana*	BPI 690571, BPI 690572, BPI 690573, BPI 690574, BPI 69075, BPI 690576, BPI 689178
Asterina thunbergiicola	BPI 690583 ex-type
Asterina tonduzii	S F83412 type (type of *Asterostomella tonduzii*), BPI 690586 paratype?, BPI 690587
Asterina tropicalis	LPS 1355 type
Asterina uvariae	BPI 690627 type, BPI 690628 ex-type
Asterina uvariicola	BPI 690629 ex-type
Asterina weinmanniae	BPI 690664
Asterina zanthoxyli	BPI 690669
Asterolibertia inaequalis	BPI 690998 labeled as *Asterina inaequalis*: BPI 689922 type,
Asterolibertia licaniicola	labeled as *Asterina inaequalis*: PREM 4086 type
Asterolibertia minor nom. nov. et stat. nov.	labeled as *Seynesia minor*: S F12536 type
Asterolibertia nodulifera comb. nov.	labeled as *Asterina nodulifera*: BPI 690120 lectotype (hic designatus), BPI 690121 isotype
Asterolibertia nodulosa	labeled as *Asterina nodulosa*: BPI 690122 labeled as *Asterolibertia malpighii*: BPI 671071

Current name	Herbarium specimens
Asterostomella dilleniicola	BPI 391479A isotype, BPI 391478A paratype
Asterostomella grewiae	labeled as *Asterina grewiae*: BPI 689845 type, IMI 18986a
Halbanina sp.	labeled as *Asterinella uleana*: BPI 690964
Halbanina byroniae	labeled as *Asterinella humiriae*: BPI 690892 syntype, BPI690893 syntype, BPI 690897 syntype, BPI 690895, BPI 690896, labeled as *Asterina* sp.: BPI 689159
Halbanina irregularis	labeled as *Asterina irregularis*: S F9157 type
Hemisphaeropsis magnoliae	S F48137
Homalopeltis chrysobalani	labeled as *Leptothyrella chrysobalani*: BPI 391611 syntype, BPI 391605, BPI 391607, BPI 391608, BPI 391609, BPI 391610, BPI 391612, labeled as *Asterina inaequalis* var. *nodulos*a: BPI 689911, BPI 689917, labeled as *Leprieurina radiata*: BPI 391581 type, labeled as *Asterina schroeteri*: BPI 690401, BPI 690403, BPI 690404, BPI 690405, BPI 391606
Maublancia uleana	labeled as *Asterina myrciae*: BPI 690099 syntype, BPI 690100 syntype, BPI 690101, BPI 690102, BPI 690103, BPI 690104, labeled as *Caudellopeltis eugeniae*: BPI 691050, labeled as *Seynesia megas*: S F49099 syntype, S F49100 syntype, S F49107 syntype, S F12378 syntype, labeled as *Seynesia megas* var. *macrospora*: S F49163 type
Platypeltella irregularis	BPI 691029 holotype
Platypeltella smilacis	labeled as *Asterolibertia myocoproides*: BPI 1108576, S F114235
Prillieuxina winteriana	BPI 690983, BPI 690984, labeled as *Asterina annonicola*: BPI 689239 syntype, S F12335 syntype, labeled as *Asterina* sp.: BPI 689156, labeled as *Aulographum juruanum*: S F12253 syntype, labeled as *Leprieurina megalospora*: BPI 391573, labeled as *Leprieurina winteriana*: BPI 1113216, BPI 391574, BPI 391575, BPI 391576, BPI 391577, BPI 391578A, BPI 391579, BPI 391582A, B, BPI 391583, BPI 391584, BPI 391585
Schiffnerula trematis	BPI 566109 type, BPI 566108 paratype
Trichasterina styracis	labeled as *Asterina multiplex*: BPI 690095, BPI 690096, BPI 690097 labeled as *Asterina silvatica*: BPI 690428, BPI 690429, BPI 690432
Xenostomella meridiensis	BPI 653089 type, BPI 653090
Xenostomella monninae	labeled as *Plochmothea monninae*: S F8312 type, S F8313 paratype, S F5813 paratype, S F61518 paratype
Xenostomella tovarensis	BPI 653091, S F6482
no *Asterina* inside	labeled as *Asterina advenula*: BPI 689209 syntype, BPI 689208 syntype, BPI 1111982 syntype
no *Asterina* inside	HBG 1683 syntype of *Asterina uleana*
no *Asterina* inside	IMI 43558c type of *Asterina disseminata* var. *cleistopholidis*

3.2 New species, records and illustrations

3.2.1 New species

New species of *Asterina*: Two new species of *Asterina* were discovered during this study. The species were published together with new records of *Asterina* spp. from Panama in Hofmann and Piepenbring (2008). The two new species are:

Asterina gaiadendricola T.A. Hofmann with its *Asterostomella* anamorph on
Gaiadendron punctatum (Ruiz & Pav.) G. Don (Loranthaceae)
Asterina schlegeliae T.A. Hofmann with its *Mahanteshamyces* anamorph on *Schleglia*
parviflora (Oerst.) Monach. (Schlegeliaceae)

Several additional species of *Asterina* could not be identified to species level and represent probably new species. To avoid invalid publication, the species are numbered consecutively and are arranged in alphabetical order according to host plant family:

Asterina sp. 1 on *Hansteinia reflexiflora* Leonard (Acanthaceae)
Asterina sp. 2 on *Hansteinia ventricosa* (Donn. Sm.) D.N. Gibson (Acanthaceae)
Asterina sp. 3 on *Desmopsis bibracteata* (B.L. Rob.) Saff. (Annonaceae)
Asterina sp. 4 on *Cleome* sp. (Cleomacaee)
Asterina sp. 5 on *Clusia* sp. (Clusiaceae)
Asterina sp. 6 on *Alloplectus ichtyoderma* Hanst. (Gesneriaceae)
Asterina sp. 7 on *Compsoneura sprucei* (A. DC.) Warb. (Myristicaceae)
Asterina sp. 8 on *Casearia commersoniana* Cambess. (Salicaceae s.l.)

New species of *Halbanina*: One species of *Halbanina* discovered during this study, could not be identified to species level. It probably represents a new species:

Halbanina sp. on *Chrysobalanus icaco* L. (Chrysobalanaceae)

3.2.2 New records for Panama, Central America and the American Continent

All presented species of thyriothecioid ascomycetes identified to species level are new records for Panama, 21 of the species are new records for Central America and 2 species are new records for the American Continent. The new records of *Asterina ciferriana*, *A. consobrina, A. fuchsiae, A. manihotis* and *A. phenacis* were published in Hofmann and Piepenbring (2008).

Panama: 29 species are new records for the country Panama and are listed below:

Asterina cestricola (R.W. Ryan) Hosag. & T.K. Abraham

Asterina ciferriana Petr.

Asterina consobrina Syd.

Asterina corallopoda Syd.

Asterina davillae J.A. Stev. with *Asterostomella* anamorph

Asterina diplocarpa Cooke

Asterina diplopoda Syd.

Asterina ekmanii Petr. & Cif.

Asterina fuchsiae Syd.

Asterina manihotis Syd.

Asterina phenacis Syd.

Asterina radiofissilis (Sacc.) Theiss. with its *Asterostomella* anamorph

Asterina siphocampyli Syd.

Asterina sponiae Racib.

Asterina stipitipodia M.L. Farr with anamorph its *Asterostomella stipitipodia* M.L. Farr

Asterina styracina Syd.

Asterina tonduzii (Speg.) Syd. with its anamorph *Asterostomella tonduzii* Syd.

Asterina weinmanniae Syd.

Asterina zanthoxyli W. Yamam.

Asterolibertia licaniicola Hansf.

Asterolibertia nodulosa (Speg.) Hansf.

Asterostomella dilleniicola M.L. Farr

Cirsosia splendida Bat. & H. Maia with its anamorph *Homalopeltis chrysobalani* (Henn.) Bat. & Valle

Prillieuxina winteriana (Pazschke) G. Arnaud with its anamorph *Leprieurina winteriana* G. Arnaud

Maublancia uleana (Pazschke) Arx

Platypeltella irregularis M.L. Farr

Platypeltella smilacis Petr.

Xenostomella tovarensis Syd.

Hemisphaeropsis magnoliae Petr.

Central America: 21 species are new records for Central America and are lisetd below.
Asterina cestricola (R.W. Ryan) Hosag. & T.K. Abraham
Asterina ciferriana Petr.
Asterina consobrina Syd.
Asterina corallopoda Syd.
Asterina davillae J.A. Stev. with its *Asterostomella* anamorph
Asterina ekmanii Petr. & Cif.
Asterina fuchsiae Syd.
Asterina manihotis Syd.
Asterina radiofissilis (Sacc.) Theiss. With its *Asterostomella* anamorph
Asterina siphocampyli Syd.
Asterina sponiae Racib.
Asterina stipitipodia M.L. Farr with its anamorph *Asterostomella stipitipodia* M.L. Farr
Asterina weinmanniae Syd.
Asterina zanthoxyli W. Yamam.
Asterolibertia licaniicola Hansf.
Asterostomella dilleniicola M.L. Farr
Cirsosia splendida Bat. & H. Maia with its anamorph *Homalopeltis chrysobalani* (Henn.) Bat. & Valle
Maublancia uleana (Pazschke) Arx
Platypeltella irregularis M.L. Farr
Xenostomella tovarensis Syd.
Hemisphaeropsis magnoliae Petr.

American Continent: 2 species are new records for the American Continent:
Asterina radiofissilis (Sacc.) Theiss. with *Asterostomella* anamorph
Asterina zanthoxyli W. Yamam.

3.2.3 New records of host plants

A total of 23 plant species represent new records of host plants for the respective thyriothecioid ascomycete. The new host plant records of *Asterina ciferriana*, *A. consobrina*, *A. fuchsiae*, *A. manihotis* and *A. phenacis* were already published in Hofmann and Piepenbring (2008). The new records are:

Asterina cestricola (R.W. Ryan) Hosag. & T.K. Abraham on *Cestrum rugulosum* Francey (Solanaceae)

Asterina ciferriana Petr. on *Caesalpinia bonduc* (L.) Roxb. and *Senna* sp. (Fabaceae)

Asterina consobrina Syd. on *Solanum aphyodendron* S. Knapp (Solanaceae)

Asterina corallopoda Syd. on *Solanum trizygum* Bitter (Solanaceae)

Asterina davillae J.A. Stev. with its *Asterostomella*-anamorph on *Curatella americana* L. (Dilleniaceae)

Asterina ekmanii Petr. & Cif. on *Gonzalagunia rudis* (Standl.) Standl. (Rubiaceae)

Asterina fuchsiae Syd. on *Fuchsia paniculata* Lindl. (Onagraceae)

Asterina phenacis Syd. on *Phenax mexicanus* Wedd. (Urticaceae)

Asterina radiofissilis (Sacc.) Theiss. with its *Asterostomella* anamorph on *Acalypha arvensis* Poepp. (Euphorbiaceae)

Asterina siphocampyli Syd. on *Burmeistera vulgaris* E. Wimm. (Campanulaceae)

Asterina stipitipodia M.L. Farr with its anamorph *Asterostomella stipitipodia* M.L. Farr on *Davilla kunthii* A. St.-Hil. (Dilleniaceae)

Asterina styracina Syd. on *Styrax argenteus* C. Presl. (Styracaceae)

Asterina weinmanniae Syd. on *Weinmannia pinnata* L. (Cunoniaceae)

Asterina zanthoxyli W. Yamam. on *Zanthoxylum scheryi* Lundell (Rutaceae)

Asterolibertia licaniicola Hansf. on *Licania arborea* Seem. (Chrysobalanaceae)

Asterolibertia nodulosa (Speg.) Hansf. on *Oxandra venezuelana* R.E. Fr. (Annonaceae)

Asterostomella dilleniicola M.L. Farr on *Davilla kunthii* A. St.-Hil. (Dilleniaceae)

Cirsosia splendida Bat. & H. Maia with its anamorph *Homalopeltis chrysobalani* (Henn.) Bat. & Valle on *Chrysobalanus icaco* L. and *Hirtella triandra* Sw. (Chrysobalanaceae)

Prillieuxina winteriana (Patzschke) G. Arnaud with its anamorph *Leprieurina winteriana* G. Arnaud on *Annona montana* Macfad. (Annonaceae)

Platypeltella irregularis M.L. Farr on *Greigia sylvatica* Standl. (Bromeliaceae)

Xenostomella tovarensis Syd. on *Monnina xalapensis* Kunth (Polygalaceae)

Hemisphaeropsis magnoliae Petr. on *Magnolia sororum* Seibert. (Magnoliaceae)

3.2.4 New teleomorph-anamorph connections

A new anamorph-teleomorph connection was found for *Cirsosia splendida* H. Maia (Asterinaceae) during this study. The anamorph was identified as *Homalopeltis chrysobalani* (Henn.) Bat. & Valle. The basionym of *Homalopeltis chrysobalani*, *Leptothyrella chrysobalani* Henn. was described apart from teleomorph more than 50 years earlier (Hennings 1908). *H. chrysobalani* occurs with or without its respective teleomorph on *Chrysobalanus icaco* (Chrysobalanaceae) at the pacific coast in Chiriquí. Additionally, the teleomorph grows always together with the anamorph on *Hirtella triandra* (Chrysobalanaceae) in a lowland gallery forest in Chiriquí. This is the first record of an anamorphic stage for a species of the genus *Cirsosia*.

3.2.5 First-time illustrations

16 of the species of thyriothecioid ascomycetes presented in this study are illustrated for the first time:

Asterina cestricola (R.W. Ryan) Hosag. & T.K. Abraham
Asterina ciferriana Petr.
Asterina consobrina Syd.
Asterina corallopoda Syd.
Asterina davillae J.A. Stev. with its *Asterostomella* anamorph
Asterina diplopoda Syd.
Asterina ekmanii Petr. & Cif.
Asterina fuchsiae Syd.
Asterina manihotis Syd.
Asterina phenacis Syd.
Asterina siphocampyli Syd.
Asterina styracina Syd.
Asterina tonduzii (Speg.) Syd. with its anamorph *Asterostomella tonduzii* Syd.
Asterina weinmanniae Syd.
Asterolibertia licaniicola Hansf.
Hemisphaeropsis magnoliae Petr.

3.3 Taxonomy, morphology and discussion of species

In the following section, selected plant parasitic thyriothecioid ascomycetes from Panama are presented and discussed in detail. For each species, the data concerning known host species and distribution are taken from the database of the U.S. National Fungus Collection (BPI, nt.ars-grin.gov/fungaldatabases) from the examined voucher material and from the literature cited in the text. Underligned host species were collected in Panama during this study.

The presented species belong to the following families of thyriothecioid ascomycetes: Asterinaceae (including anamorphic Asterinaceae) and Microthyriaceae and one form group 'Pycnothyriales'.

Key to families of plant parasitic thyriothecioid ascomycetes fom Western Panama:

1 thyriothecia open with central star-shaped, irregular fissures or with longitudinal slits, asci globose to broadly clavate, vertical within ascoma .... Asterinaceae

1* thyriothecia open with central pores, asci elongated, inclined towards a sterile center within ascoma .... Microthyriaceae

3.3.1 ASTERINACEAE Hansf. (1946)

Type genus: *Asterina* Lév.

Leaf parasites. *Surface mycelium* present, septate, brown, branched, with lateral or intercalary appressoria forming haustoria, or mycelium without appressoria but forming hypostromata within the host or penetrate host stomata. *Thyriothecia* superficial, dimidiate, circular or elongated, brown, develop below or lateral from the surface mycelium, open with central star-shaped fissures or linear slits, or central slimy dehiscence. *Scutellum* radiate, composed of rows of syncronal and dichotomously branching cells forming a continuous cell-plate, one cell layer thick, scutellum cells isodiametric or cylindrical, straight or meandrical. *Asci* globose to ovate, shortly stalked, bitunicate, with rostrate dehiscence, 4–8–spored, not synchronous in development, vertical within ascoma, interascal tissue present or absent, filamentous, often disintegrates early, septate. *Ascospores* mostly 2–celled, rarely 3– or 4–celled, first hyaline, brown at maturity.

Anamorphs present or not, if present scattered between telomorph and develop on the same surface mycelium, or develop isolated without respective teleomorph, conidia formed within superficial pycnothyria (e.g. genera *Asterostomella* Speg., *Homalopeltis* Bat. & Valle, *Leprieurina* G. Arnaud, *Mahanteshamyces* Hosag.) or develop on conidiogenous cells that arise from the surface mycelium (e.g. genera *Clasterosporium* Schwein., *Mitteriella* Syd., *Sarcinella* Sacc.). *Pycnothyria* dimidate, circular, brown, develop below or lateral from the surface mycelium, scutellum similar to scutellum of teleomorph, open with central star-shaped fissures, central pores or central slimy dehiscence. *Conidiogenous cells* within pycnothyria monoblastic, on conidiophores monoblastic or polyblastic. *Conidia* 1– to multicellular, of variable shape, from globose to ellipsoidal, clavate to pyriform or cylindrical, with truncate hilum, brown at maturity.

Notes: Fries (1849) introduced this group of thyriothecioid ascomycetes as the subfamily "Asterinei" within the family "Perisporiacei". However, the first valid publication on family level was provided by Hansford (1946) almost a hundered years later (Eriksson 1981). The Asterinaceae according to Hansford (1946), are extremely specialized "ecto-parasites" on living leaves forming haustoria within single epidermal cells of a specific host plant (Hansford 1946). Hansford segregates other leaf parasites with different penetration strategies into the Microthyriaceae. This limited concept of Asterinaceae is not accepted by Müller and Arx (1962, 1975). The authors believe, that not infection strategy but ascoma morphology, especially the development of the asci within the ascomata, are more reliable criteria for segregating bitunicate ascomycetes. Arx and Müller (1975) characterize the Asterinaceae as leaf parasites with spherical asci developing parallel and vertical within a dimidiate ascoma. The ascomata are formed from a brown surface mycelium and open at maturity with star-shaped or irregular fissures. The genera of Asterinaceae *sensu* Arx and Müller (1975) show various modes of infection of their host plants, like haustoria within single epidermal cells, intra- and subcuticular hyphae or stromata, hyphal penetration of stomata, intra- and intercellular hyphae or hypostromata within epidermal and subepidermal cells.

According to Arx and Müller (1975), the Asterinaceae are morphologically closely related to Englerulaceae, Parmulariaceae and Parodiellaceae. Species of Parmulariaceae have ascomata with similar scutellum structures as in species of Asterinaceae and asci devloping vertical within the ascoma, but they differ due to the absence of a surface mycelium. Species of Parodiellaceae and Englerulaceae posses well developed surface mycelia with appressoria but differ due to their spherical ascomata and the nonradiate ascoma walls (Eriksson 1981). Eriksson (1981) state, that the Englerulaceae are probably closely related to Asterinaceae because the ascus walls of species of both families show a blue reaction after staining with Lugol's solution. The globose ascomata of Englerulaceae develop above the surface mycelium, whereas the flat ascomata of Asterinaceae develop between the surface mcelium and the cuticule (Eriksson 1981). Intermediate species exist in the Asterinaceae and Englerulaceae, e.g. species of *Asterina* and *Rhytidenglerula*, as well as species of *Clypeolella* and *Schiffnerula* are morphologically similar (Arx and Müller 1975). The Asterinaceae are not closely related to Microthyriaceae, but are often confused with plant parasitic members of Microthyriaceae like *Maublancia* or *Asterinella* (Arx and Müller 1975). The Microthyriaceae are discussed separately in Chapter 3.3.2.

Accoding to Kirk et al. (2008), the Asterinaceae include 46 genera and about 652 species (Kirk et al. 2008). However, Kirk's predictions are probably wrong, because the type genus *Asterina* alone contains more than 700 validly described species (Table 7.3). Therefore, the family is in great need of revision. Members of Asterinaceae are restricted to tropical and subtropical regions worldwide (Barr and Huhndorf 2001, Kirk et al. 2001) and are thought to be host specific. The Asterinaceae are treated as a family with uncertain position in the class Dothideomycetes (Kirk et al. 2001, Lumbsch and Huhndorf 2007a) because phylogenetic studies including members of the family are still missing today.

Key to genera of Asterinaceae (including anamorphs) collected in Western Panama:

1 mycelial appressoria absent 2
  2 hypostromata present, intracellular 3
    3 teleomorph, ascospores 2−celled, ellipsoidal.............................. *Prilliexina*
    3* anamorph, conidia 2−celled, pyriform .... *Leprieurina*
  2* hypostromata absent, surface mycelium forms plugs in stomata ...... *Halbanina*
1* mycelial appressoria present 4
  4 mycelial appressoria lateral 5
    5 teleomorph solitary or together with anamorph .... *Asterina*
    5* anamorph solitary 6
      6 conidia ellipsoidal, clavate or pyriform .... *Asterostomella*

6* conidia triangular, flattened .... *Mahanteshamyces*

4* mycelial appressoria intercalary 7

7 sporomata elongated .... *Cirsosia*

7* sporomata circular 8

8 anamorphic, pycnothyria open with central pores, conidia 2‒celled, cylindrical .... *Homalopeltis*

8* teleomorphic, thyriothecia with central star-shaped fissures, ascospores 2‒ celled, ellipsoidal .... *Asterolibertia*

Asterina **Lév.**

Ann. Sci. Nat., Bot., sér. 3, 3: 59 (1845)

= *Dimerosporium* Fuckel, Jb. nassau. Ver. Naturk. 23-24 (Symb. Mycol.): 89 (1870). Type: *D. abjectum* (Lib.) Fuckel.

= *Asterella* Sacc., Syll. Fung. 1: 42 (subgen.), 9: 393 (1891). Type: *A. megalospor*a Berk & M. A.Curtis

= *Myxasterina* Höhn., Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. 1, 118: 870 (1909). Type: *M. strychni* Höhn.

= *Englerulaster* Höhn., Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt 1, 119: 454 (1910). Type: *E. orbicularis* (Berk. & M.A. Curtis) Höhn.

= *Parasterina* Theiss. & Syd., Ann. Mycol. 15: 246 (1917). Type: *P. melastomatis* (Lév.) Theiss. & Syd.

= *Opeasterina* Speg., Bol. Acad. Nac. Wien. Córdoba 23: 498 (1919). Type: *O. aspidii* (Henn.) Theiss.

= *Calothyriolum* Speg., Bol. Acad. Nac. Cien. Córdoba 23: 499 (1919). Type: *C. caaguazuense* (Speg.) Speg.

= *Englera* F. Stevens, in Stevens and Ryan, Illinois Biol. Monogr. (Urbana) 17(2): 45 (1939). Type: *E. atrides* (Syd. & P. Syd.) F. Stevens.

[synonymy according to Müller and Arx (1962), Sivanesan (1984)]

Type species: *Asterina melastomatis* Lév.

Anamorphs: *Asterostomella* Speg., *Clasterosporium* Schwein. and *Mahanteshamyces* Hosag. & C.K. Biju [as ‘*Mahateshamyces*’].

Colonies superficial on living leaves, black. *Surface mycelium* septate, branched, brown, hyphae sometimes penetrate host stomata. *Appressoria* lateral, lobed or entire, stalked or unstalked, with a penetration pore. *Haustoria* arbuscular, intracellular in epidermal host cells, sometimes inconspicuous. *Thyriothecia* superficial, dimidate, circular, dark, develop below or lateral from surface mycelium, open with central star-shaped fissures or by irregular dehiscence. *Scutellum* radiate, composed of rows of syncronal and dichotomously branching cells forming a continuous plate of cells, one cell layer thick, cells isodiametrical or cylindrical, straight or slightly meandrical. *Asci* globose to ovate, shortly stalked, bitunicate, with rostrate dehiscence, 4–8–spored, hyaline, vertical within ascoma, interascal tissue present or absent, filamentous, disintegrates early. *Ascospores* 2–celled, ellipsoidal, brown when mature.

Anamorph present or absent, sometimes dominates teleomorph or without teleomorph. *Pycnothyria* superficial, circular, dimidate, dark, develop below or lateral from surface mycelium, open with central star-shaped or irregular fissures. *Scutellum* similar to the one of the teleomorph. *Conidiogenous cells* monoblastic, formed inside the pycnothyrial cavity by single cells of the inner part of the scutellum layer. *Conidia* 1–celled, broadly clavate, pyriform or ellipsoidal if *Asterostomella*-like, triangular if *Mahanteshamyces*-like, both with truncate hilum, brown when mature, sometimes with a central hyaline band or hyaline germ pores.

Notes: *Asterina* was described by Léveillé (1845) with the type species *A. melastomatis* on Melastomataceae. Unfortunately, Léveillés original material of the type species of was lost (Theissen 1912a) and the original description was very scanty and too fragmentary to properly define the genus (Toro 1933). In the early 20th century, many herbaria accumulated heterogenous specimens labeled as *A. melastomatis* and Theissen suggested the neotypification of the type species based on material colleted by Montagne *1133* (Montg. Crypt. Guray 528). However, the identity of both the Montagnean specimen and Léveillés specimen was never verified (Theissen 1912a, 1913). Therefore, Theissen recommended *A. azarae* Lév. as new type species (Theissen 1912a), to avoid taxonomical and nomenclatural difficulties with the type of the species-rich genus *Asterina*. *A. azarae* was provided with an accurate description by Léveillé and the original specimen was available in the herbarium in Paris. Nevertheless, Theissens suggestions were not adopted and *A. melastomatis* remained the type species of the genus *Asterina*.

Until 1910, an exhausting number of species of *Asterina* was described by early mycologists like M.J. Berkeley and coworkers, M.C. Cooke, J.B. Ellis and coworkers, P.C. Hennings, N. Patouillard, H. Rehm, C. Spegazzini, G. Winter and others. The genus concept became heterogeneous due to an accumulation of species either with dimidiate or globose ascomata. That occurred, because until 1899 the Asterinaceae were included in the Perisporiaceae a family of foliicolous fungi with globose ascomata. Therefore, the genus was in great need for revision at the beginning of the 20th century. Theissen (1913a) first monographed the genus *Asterina* based on type material of the hitherto described 343 species, from which he excluded 261 species as synonyms or species belonging to other genera. The remainig 82 species together with new species and new combinations revealed a total of 108 species of *Asterina* (Theissen 1913a). Between 1911 and 1939 more than 130 new *Asterina* spp. were described by P. and S. Sydow from the tropics worldwide. Unfortunately, most of the species were not illustrated by the authors nor provided with detailed explanations for species-erection. Doidge (1942) revised and illustrated a total of 61 South African species of *Asterina* (under Microthyriaceae) from which 20 species were new to science. Until 1960, mainly F. Petrak, G.C. Hansford and S. Hughes contributed to the knowledge of African and Southeast Asian species of *Asterina*, whereas W. Yamamoto described numerous species from Taiwan. Only few new taxa were described between 1960 and 2000 namely by A.K. Kar and Coworkers from India and by R.K. Mibey from Kenya. Since 2000, B. Song and Coworkers described about 30 new species from China and V.B. Hosagoudar and Coworkers reported more than 80 new taxa from India.

In the early 20th century, some authors tried to distinguish morphological lineages observed for species of *Asterina*. Therfore, the genus was split up in different genera or sections due to the presence (*Parasterina*) or absence of paraphyses, the slimy disintegration of the scutellum at maturity of the ascoma (*Englera*, *Englerulaster*, *Myxasterina*), the presence (*Clypeolaster*) or absence (*Dimerosporium*) of a basal membrane in the ascoma or the missing pigmentation of the ascospores (*Asterella*) (Theissen and Sydow 1917, Arnaud 1918, Doidge 1942). Later, most of these genera were considered as artificial and became synonyms of *Asterina* (Stevens and Ryan 1939, Müller and Arx 1962).

Hosagoudar et al. (2004) introduced the new monotypic genus *Ishwaramyces* Hosag. with the types species *Ishwaramyces flacourtiae* Hosag., Kamar. & T. Sabu on *Flacourtia montana* J. Graham (Salicaceae, formerly Flacourtiaceae) from India. *I.*

flacourtiae was illustrated in detail by Hosagoudar et al. (2004) and corresponds in all aspects with *Asterina spectabilis* Syd., described by Sydow (1922) on *Flacourtia inermis* from the Philippines. Type material of *A. spectabilis* from S was examined, but the material of *I. flacourtiae* could not be obtained until the end of this study. *Ishwaramyces* probably has to be placed in synonymy with *Asterina*.

Today, the genus *Asterina* is the largest genus within the family Asterinaceae and *Asterina* spp. are distributed in tropical and subtropical regions worldwide. *A. veronicae* (Lib.) Cooke and *A. solidaginis* Cooke are the only *Asterina* spp. occuring in temperate regions of Europe. According to Hosagoudar and Abraham (2000), *Asterina* includes 578 species that parasitize on 106 host plant families. However, a search of literature published until 2008 revealed a total of 709 validly described *Asterina* spp. growing on host plant species from 120 different host plant families (see Chapter 7.5). *Asterina* spp. are obligate plant parasites, thought to be host specific at least on the level of host plant family (Hofmann and Piepenbring 2008).

The genus *Lembosia* is closely related to *Asterina* and differs only by its elongated, L–, Y– of X–shaped ascomata which open with lateral slits (Hofmann and Piepenbring 2008).

Key to species of *Asterina* collected in Western Panama:

- 1 appressoria with basal stalk cell 2
  - 2 appressoria with entire margins 3
    - 3 appressoria exclusively associated with host stomata 4
      - 4 ascospores smooth, conidia without hyaline bands .. *A. gaiadendricola*
      - 4* ascospores verrucose, conidia with hyaline bands .... *A. stipitipodia*
    - 3* appressoria not exclusively on host stomata .... *A. siphocampyli*
  - 2* appressoria with lobed margins 5
    - 5 anamorph present, conidia with a hyaline band .... *A. radiofissilis*
    - 5* anamorph absent 6
      - 6 ascospore ornamentation large, capitate 7
        - 7 app mostly with one stalk cell, often opposite .... *A. corallopoda*
        - 7* app with variable number of stalk cells, not opposite . *A. diplopoda*
      - 6* ascospore ornamentation small, warty 8
        - 8 stalked appressoria inclined towards hyphal growth direction, ascospores first germinate with unstalked appressoria .... *A. phenacis*

8* stalked appressoria not inclined towards growth direction, ascospores germinate first with stalked appressoria 9

9 appressorial cells elongated, always reflexed .... *A.* sp. 6

9* appressorial cells not elongated and reflexed .... *A. manihotis*

1* appressoria without basal stalk cell 10

10 appressoria entire or with slightly sinuate to lobulate margins 11

11 ascospores smooth 12

12 both tips of ascospores curved to one side, ascospores germinate with stalked entire appressoria .... *A. ciferriana*

12* tips of ascospores not curved to one side, ascospores germinate with unstalked slightly sinuate appressoria 13

13 numerous ascomata per colony, ascomata margins fringed, ascospores germinate first on upper or lower cell .... *A.* sp. 8

13* few ascomata per colony, ascomatal margins unfringed, ascospores germinate first laterally from upper cell 14

14 appressoria almost entire or slightly sinuate, haustoria inconspicuous .... *A. ekmanii*

14* appressoria lobulate, arbuscular haustoria large, up to 40 µm in diam. .... *A.* sp. 5

11* ascospores verrucose 15

15 ascospores with large spines, 2 (rarely 3) asci per ascoma .... *A.* sp. 7

15* ascospores warty or echinulate, not largely spinose, more than 3 asci per ascoma 16

16 appressoria globose, with broad or narrow base 17

17 ascomata rising up at maturity and become globose, scutellum cells dehisce in mucus, appressoria with narrow base and sinuate margins, ascospores 23−27 µm long ....*A. sponiae*

17* ascomata and scutellum different, appressoria broadly sessile with entire margins, ascospores 30−35 µm long....... *A. styracina*

16* appressoria cylindrical to irregularly crooked 18

18 mature thyriothecia up to 180 µm diam. 19

19 anamorph present, conidia with germpores .... *A. tonduzii*

19* anamorph absent 20

20 appressoria with entire margins, straight or curved, not

crooked, 12−16×5−6 µm .... *A.* sp. 3
20* appressoria irregularly crooked, with sinuate margins, 6−9×5−7 µm .... *A. consobrina*
18* mature thyriothecia up to 270 µm diam. 21
21 appressoria ampulliform, ascospore ornamentation dense, conspicuous .... *A. zanthoxyli*
21* appressoria not exclusively amupliiform, more irregularly and crooked, ascospore ornamentation loosely scattered, inconspicuous .... *A. weinmanniae*
10* each appressorium distinctly multi-lobate 22
22 ascospores smooth 23
23 appressorial base elongated, curved, ascospores 17−19×8−11 µm, germinate first with a stalked appressorium .... *A.* sp. 2
23* appressorial base not elongated, ascospores 14−17×7−8 µm, germinate first with an unstalked appressorium .... *A. fuchsiae*
22* ascospores verrucose 24
24 anamorph present 25
25 ascospores 15−17×7−8 µm, conidia clavate to pyriform, not angular or flat, each with a central hyaline band .... *A. davillae*
25* ascospores 20−21×10−11 µm, conidia angular, flat, each with a central hyaline germ pore .... *A. schlegliae*
24* anamorph absent 26
26 appressoria 11−14 µm broad, ascospores germinate first with stalked appressoria .... *A.* sp.1
26* appressoria less than 11 µm broad, ascospores germinate first with unstalked appressoria 27
27 ascospores up to 21 µm long .... *A. cestricola*
27* ascospores less than 19 µm long 28
28 appressoria 6−7×7−9 µm .... *A. diplocarpa*
28* appressoria 7−10×8−10 µm .... *A.* sp. 4

Asterina cestricola **(R.W. Ryan) Hosag. & T.K. Abraham, J. Econ. Taxon. Bot. 24(3): 583 (2000).** **Figs. 3.1, 3.2**

Type on *Cestrum* sp. (Solanaceae). Puerto Rico, Cayey, Ejome Alto [misspelled, = Jájome Alto], 17 Jul. 1915, *F.L. Stevens 8397* (lectotype, designated here, BPI 689658!); same locality and date, [on label: substrate undetermined, but includes same plant as lectotype], *F.L. Stevens 8384* (isotype, BPI 689656!); Arbonito, on *Cestrum* sp., 16 Jul. 1915, *F.L. Stevens 8463* (isotype, BPI 689657!).

≡ *Asterina diplocarpa* var. *cestricola* R.W. Ryan, Mycologia 16(4): 187 (1924).

Colonies epiphyllous, circular, single, rarely confluent, inconspicuous, (0.5)1–4 mm diam. (*n*=10), black. *Surface hyphae* strongly undulating often zigzag-like, branching alternate or opposite, rarely unilateral, pale brown to brown, hyphal tips paler than older hyphae, septate, hyphal cells, cylindrical, (10)16–28(32)×3–4(4.5) µm, cell wall up to 0.5 µm thick, smooth. *Appressoria* numerous, digitate, multilobate, 3 or more large lobes and various smaller lobes, straight or hooked, not sessile, at base narrow, without a stalk cell, alternate or unilateral, (6)7–10(13)×(7)8–11(12) µm (*n*=50), brown, penetration peg inconspicuous, in apical part of appressorial cell in the center of one of the larger lobes. *Haustoria* inconspicuous. *Thyriothecia* superficial, develop below surface mycelium, circular, dimidiate, single, sometimes confluent, fringed at margins, (90)108–144(160) µm diam. (*n*=50), brown to dark brown, at margins paler, open with central starshaped fissures, with distinct basal ‘plate’ formed of melanized remains of lower cell walls of scutellum cells. *Scutellum* radiate, composed of dichotomously branched filaments, scutellum cells isodiametric to cylindrical, straight in center, slightly undulating at margin of ascoma, (3)4–6(8)×(1.5)2–4(5) µm, at margins of ascoma up to 15 µm long, brown. *Asci* up to 15 per ascoma, globose to irregularly ovate, with ocular chambers, bitunicate, I–, (23)25–29(30) µm diam. (*n*=34), 4–8–spored, hyaline, develop on ascogenous hyphae with proliferating croziers, interascal tissue absent. *Ascospores* 2–celled, ellipsoidal, ends broadly rounded, constricted at septum, lower cell sometimes tapered, (18)19–21(23) µm long (*n*=50), upper cell 9–10(11) µm wide, lower cell 8–9(10) µm wide, brown, cell wall 0.5 µm thick, slightly verrucose, germinate first at the distal part of each cell with a stalked or unstalked lobed appressorium. *Anamorph* absent.

Illustrations. *A. cestricola* is illustrated here for the first time.

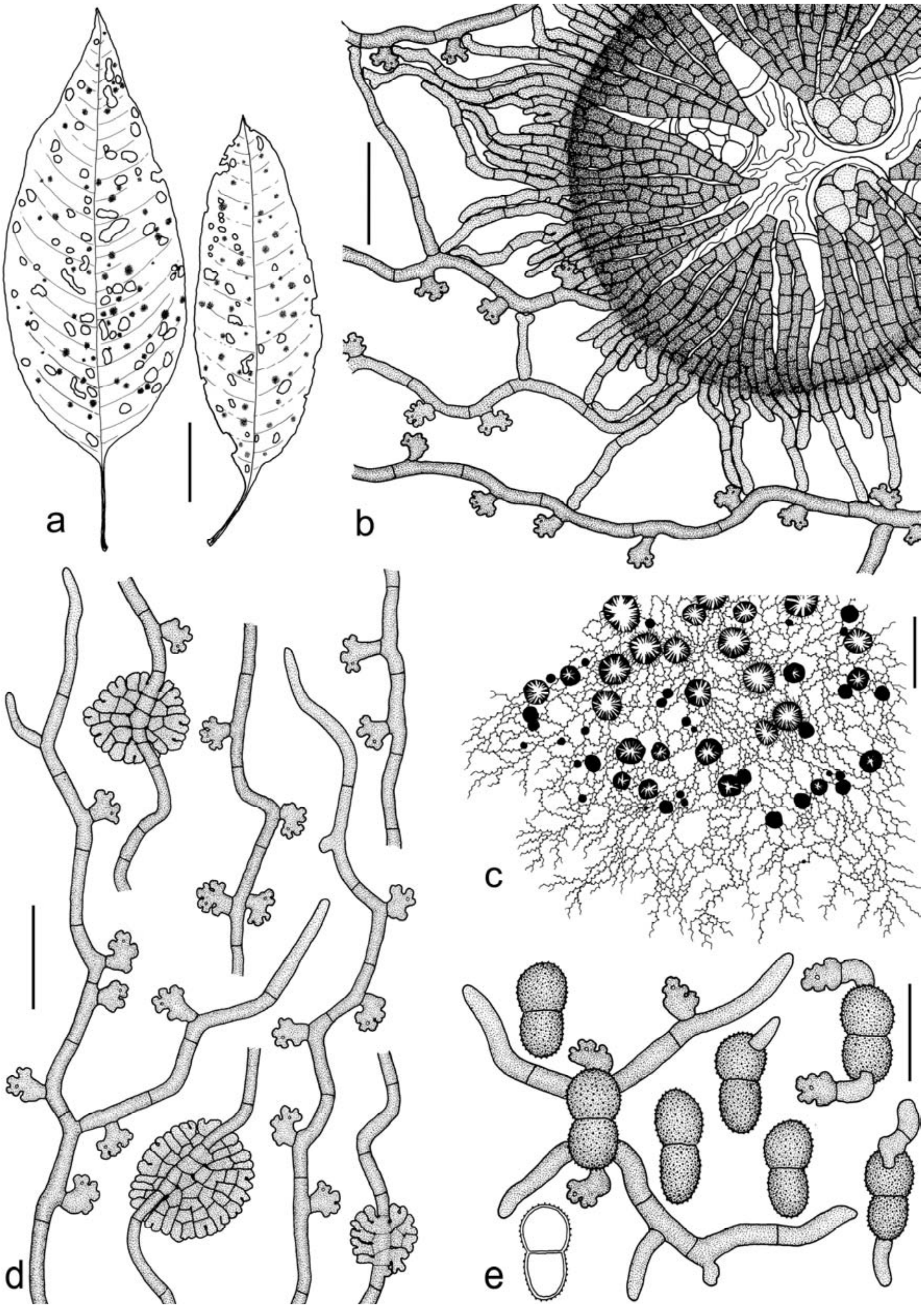

Figure 3.1: ***Asterina cestricola*** **on** ***Cestrum rugulosum*** **(TH 591) a:** Adaxial side of infected leaves. Scale bar = 3 cm. **b:** Open thyriothecium with mature and immature asci. Scale bar = 30 µm. **c:** Part of the colony with thyriothecia and surface mycelium. Scale bar = 300 µm. **d:** Surface mycelium with lobed appressoria and ascoma initials. Scale bar = 25 µm. **e:** Mature ascospores, some of them germinating. Scale bar = 20 µm.

Hosts. Solanaceae: *Cestrum macrophyllum* Vent., *Cestrum rugulosum* Francey, *Cestrum* sp. and undetermined Solanaceae. *C. rugulosum* is a new host species of *A. cestricola*.

Known distribution. Neotropical: Caribbean (Puerto Rico) and Central America (Panama). *A. cestricola* is a new record for Central America and Panama. It occurs in Western Panama in humid mountain rain forests of higher altitudes at approx. 2400 m a.s.l.

Specimens examined: PANAMA. Chiriquí Province: Parque National Volcán Barú (PNVB), path to Los Quetzales trail, ca. 2400 m a.s.l., epiphyllous on *Cestrum rugulosum* (det. T.A. Hofmann), with various hyperparasites, 20 Oct. 2007, *T.A. Hofmann 591* (FR; PMA). — Boquete, Alto Chiquero, private property of M.A. Amorùso, near ANAM entrance in direction to Los Quetzales trail, ca. 1750 m a.s.l., epiphyllous on Solanaceae, 24 Mar. 2006, *T.A. Hofmann, M. Piepenbring & T. Trampe ppMP 490* (M-0141073; PMA); same locality, amphigenous on Solanaceae (det. M. Piepenbring), 15 Jan. 2007, *R. Mangelsdorff, T.A. Hofmann & T. Trampe ppMP 1227* (M-0141074; PMA). **PUERTO RICO. Cayey:** lectotype and isotypes see above. — Locality unknown, on *Cestrum macrophyllum*, 1915, *F.L. Stevens s.n.* (BPI 689659, 689660, labeled as Asterina *diplocarpa* var. *cestricola*).

Additional specimens examined: *Asterina coriacella* Speg. BRAZIL. São Paulo: Apiahy, epiphyllous on *Cestrum* sp., May 1888, *J. Puiggari 2836* (type, LPS 1370).

Notes. *A. diplocarpa* and its varieties are known to parasitize Malvaceae, but *A. diplocarpa* var. *cestricola* was described by Ryan (1924) from *Cestrum* sp. (Solanaceae). Therefore, the epitheton of *A. diplocarpa* var. *cestricola* was changed to *A. cestricola* by Hosagoudar and Abraham (2000), however, without any further explanation or revision of the type material.

A. cestricola is one of the various species of *Asterina* with one-celled appressoria described from Solanaceae. However, only two species of *Asterina* are known to parasitize species of *Cestrum*, *A. cestricola* (R.W. Ryan) Hosag. & T.K. Abraham from Puerto Rico and *A. coriacella* Speg. from Brazil. The type of *A. coriacella* is almost identical with *A. cestricola*, however, the germination modus of mature ascospores is different. The verrucose ascospores of *A. coriacella* germinate first always with stalked appressoria, whereas spores of *A. cestricola* germinate first with stalked or unstalked appressoria (Fig. 3.1e). The ascospores of *A. coriacella* are slightly larger (1-2 µm) than those of *A. cestricola*, but sizes of ascomata, asci and appressoria are almost similar in both species.

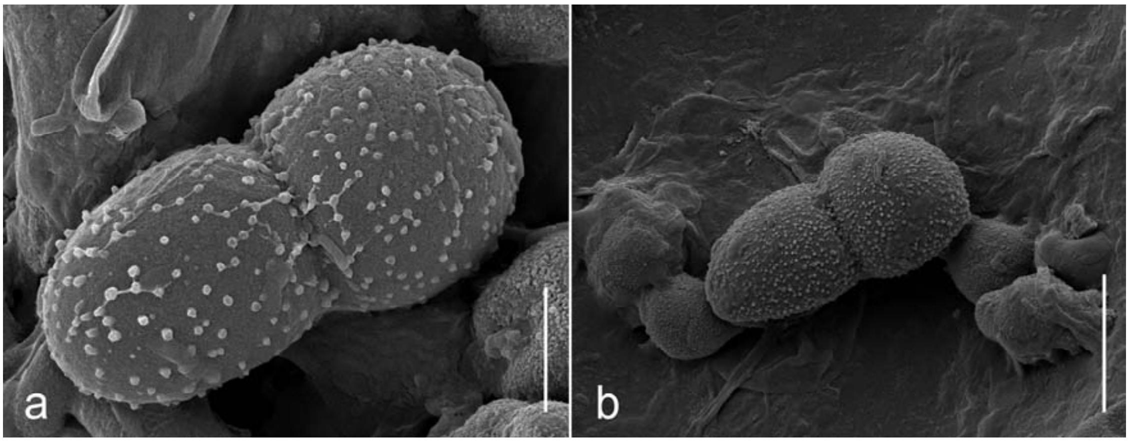

Figure 3.2: SEM photographs of *Asterina cestricola* on *Cestrum rugulosum*. a: Mature, verrucose ascospore (TH 490). Scale bar = 5 µm. **b:** Germinating ascospore (TH 591). Scale bar = 10 µm.

Asterina ciferriana Petr., in Petrak and Ciferri, Ann. Mycol. 30: 155 (1932).

Figs. 3.3, 3.4, 3.5

Type on *Caesalpinia crista* L. (Fabaceae – Caesalpinioideae). Dominican Republic, Samaná, Playa de Rincón, 20 May 1930, *E.L. Ekman 3603* (type, S F7780 n.v.).

Colonies epiphyllous, rarely hyphophyllous, concentrated at midrib, circular, single, later confluent, conspicuous and dense, 0.5–4 mm diam. (*n*=10), black. *Surface hyphae* undulating, branching opposite, alternate or unilateral, dark brown, hyphal tips paler than older hyphae, septate, hyphal cells cylindrical, (10)20–29(35)×5–6(7) µm (*n*=40), cell wall up to 1 µm thick, smooth. *Appressoria* numerous, globose to broadly ovate, entire, ends rounded, sessile, without stalk cell, unilateral or alternate, not opposite, (7)9–11(13)×(7.5)8–10(11) µm (*n*=70), brown, mostly slightly darker than surface mycelium, penetration pore very small, in distal part of appressorium. *Haustoria* inconspicuous. *Thyriothecia* superficial, develop below surface mycelium, irregularly circular, dimidiate, at maturity more globose than dimidiate, crowded and confluent, sometimes arranged in concentric rings, fringed at margins, (120)157–214(250) µm diam (*n*=62), dark brown to black, open with central fissures, which early become slimy and rupture irregularly at center, at maturity widely open to expose asci. *Scutellum* radiate, composed of dichotomously branched filaments, scutellum cells isodiametric to cylindrical, straight in center, undulating at margin of ascoma, (4.5)6–11(14)×(3.5)4–5(7.5) µm (*n*=40), brown, at tips paler. *Asci* numerous, globose to ovate, with distinct ocular chambers, bitunicate, I–, (33)35–40(45) µm diam., 8–spored, hyaline, asco-

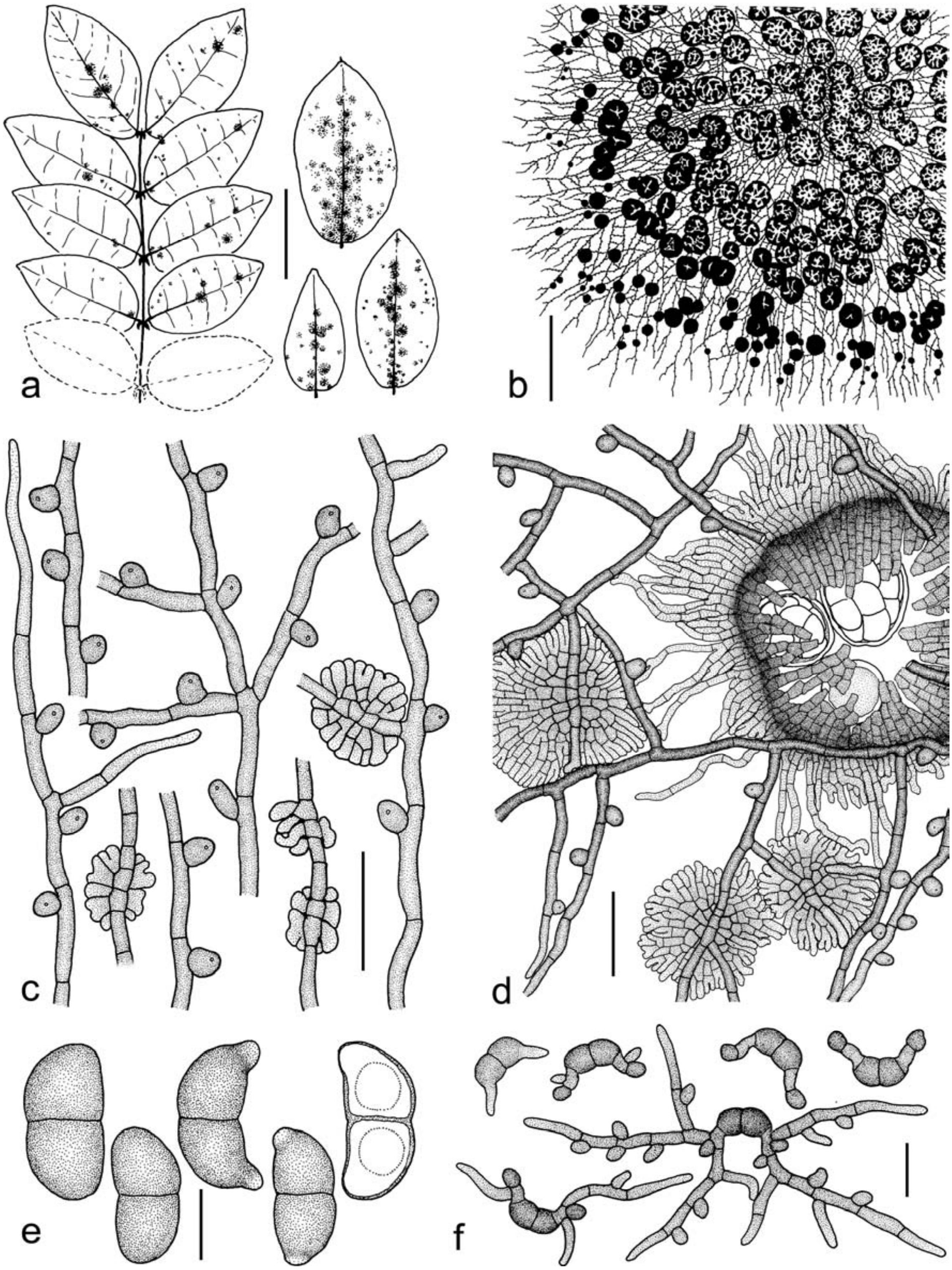

Figure 3.3: ***Asterina ciferriana*** **on** ***Caesalpinia bonduc*** **(ppMP 416). a:** Infected leaflets. Scale bar = 2 cm. **b:** Part of the colony with confluent thyriothecia and surface mycelium. Scale bar = 500 µm. **c:** Surface mycelium with ovate appressoria and ascoma initials. Scale bar = 30 µm. **d:** Open ascoma, young ascomata and surface mycelium. Scale bar = 30 µm. **e:** Mature ascospores, two of them start germinating. Scale bar = 15 µm. **f:** Germinating ascospores. Scale bar = 30 µm.

genous hyphae inconspicuous, disintegrate early, interascal tissue not observed, probably evanescent. *Ascospores* numerous, 2–celled, ellipsoidal and mostly slightly curved to one side, ends rounded or slightly acuminate, slightly constricted at septum, (29)30–32(33)×(12.5)14–16(17) µm (*n*=70), brown when mature, cell wall up to 1 µm thick, smooth, germinate first at the distal part of each cell with a stalked and globose appressorium, germtube is separated from the ascospore by formation of a septum in the upper third of each cell of the ascospore. *Anamorph* absent.

Illustrations. In Hofmann and Piepenbring (2008) and this contribution. SEM photographs of ascomata, surface mycelium and a germinating ascospore are presented here for the first time (Fig. 3.5).

Hosts. Fabaceae – Caesalpinioideae: *Caesalpinia crista* L., *C. bonduc* (L.) Roxb., *Cassia crista* Jacq. and *Senna* sp. *C. bonduc* is a new host species (Hofmann and Piepenbring 2008) and *Senna* is a new host genus for *A. ciferriana*.

Known distribution. Neotropical: Caribbean (Dominican Republic) and Central America (Panama). *A. ciferriana* is a new record for Central America and Panama (Hofmann and Piepenbring 2008). It occurs in Western Panama on the pacific coast from 0 to about 5 m a.s.l.

Specimens examined. **DOMINICAN REPUBLIC. Samaná:** coastal plain, Playa de Rincón, coastal forest, epiphyllous on *Caesalpinia crista*, 25 May 1930, *E.L. Ekmann 326* (BPI 845201). **PANAMA. Chiriquí Province:** La Barqueta, pacific coast, ca. 5 m a.s.l., epiphyllous on *Caesalpinia bonduc* (det. T.A. Hofmann), 18 Oct. 2005, *T.A. Hofmann, R. Mangelsdorff & M. Piepenbring ppMP 416* (M-0140966, PMA); same locality and host species, 13 Apr. 2006, *T.A. Hofmann, M. Piepenbring & T. Trampe ppMP 573* (M-0140995, PMA); same locality and host species, 11 Jul. 2006, *T.A. Hofmann, R. Mangelsdorff & T. Trampe ppMP 1154* (M-0140996, PMA); same locality and host species, 22 Jan. 2007, *T.A. Hofmann, R. Mangelsdorff & T. Trampe ppMP 1259* (M-0140997, PMA). — Los Algarrobos, private land of M. Piepenbring, ca. 140 m a.s.l., epiphyllous on *Senna* sp. (det. M. Piepenbring), 5 Sep. 2007, *T.A. Hofmann & M. Piepenbring 514* (M-0141002, PMA). — Los Algarrobos, path to Majagua river, ca. 140 m a.s.l., epiphyllous on *Senna* sp. (det. T. Hofmann), 21. Mar. 2006, *T.A. Hofmann 406* (M-0141079, PMA).

Notes. The asci of *A. ciferriana* are embedded in slimy mucilage within the ascoma and have distinct ocular chambers (Fig. 3.4). Ascogenous hyphae or the hamathecium are difficult to observe in detail, as the structures dissolve early in the mucilage. The ascomata become slimy at maturity and the central part of the scutellum dissolves irregularly. Therefore, Petrak and Ciferri (1932) describe the fungus as a '*Myxasterina*'-form. Species of the genus *Clypeolella* (Asterinaceae) produce similar dehiscing thyriothecia (Arx and Müller 1975), but form conspicuous mycelial conidia, that are absent in species of *Asterina*.

The specimens of *A. ciferriana* on *Senna* sp (TH 514, TH 406) differ slightly from the specimens on *Caesalpinia bonduc*. On *Senna* sp., the colonies of the fungus are larger, not concentric but more irregular in outline, become densely confluent in later stages and cover large parts of the leaf surface. The ascomata are scattered within the colony, measure (130)136–172(180) µm diam. (*n*=10) and thereby are slightly smaller than those on *C. bonduc*. However, the size of the ascospores and appressoria and the structure of the surface mycelium of the fungus are similar in both specimens from *Senna* sp. and *C. bonduc*.

According to Hosagoudar and Abraham (2000), eight species of *Asterina* are known from Fabaceae s.l. (two of the species under Caesalpiniaceae and six species under Fabaceae). The two species on Caesalpiniaceae are *A. ciferriana* Petr. from San Domingo and *A. contigua* Syd. from Sierra Leone (Hosagoudar and Abraham 2000). Hosagoudar and Abraham did not list *A. afzeliae* Mibey and *A. paramacolobii* Mibey from Kenya (Mibey and Hawksworth 1997) and *A. saracae* Hosag. T.K. Abraham & J.L. Crane from India (Hosagoudar et al. 1998a). However, *A. ciferriana* is the only species of *Asterina* from the Neotropis parasitizing a caesalpinioid host. The species is described from the host genus *Caesalpinia* (Petrak and Ciferri 1932) and occurs additionally on the host genera *Cassia* and *Senna*.

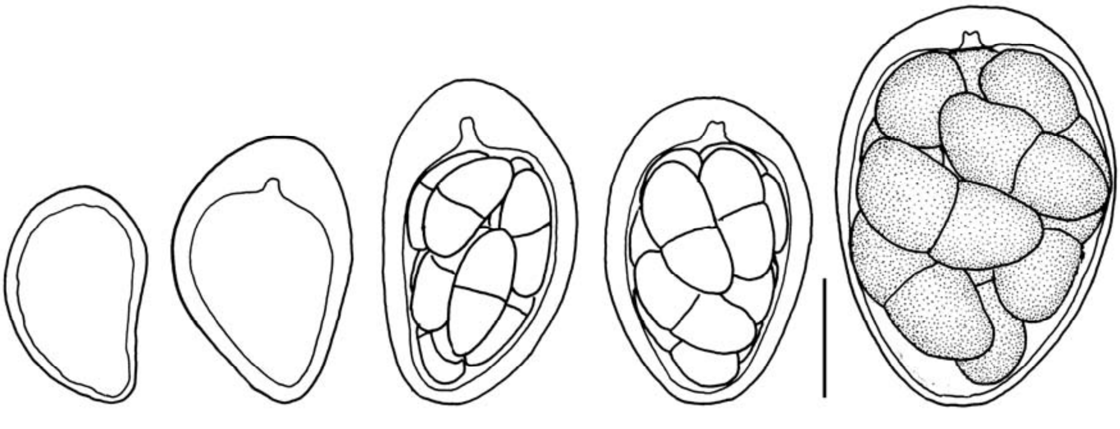

Figure 3.4: Young asci of *Asterina ciferriana* (ppMP 1259). Each ascus has a distinct ocular chamber in the apical region. The basal parts of the asci, ascogenous hyphae or the hamathecium disintegrates early and could not be observed in detail. Scale bar = 20 µm.

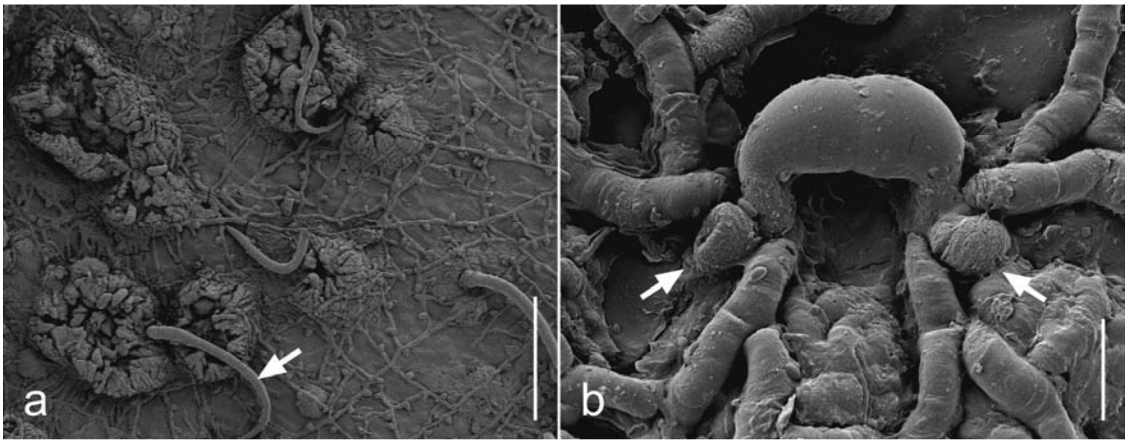

Figure 3.5: SEM photographs of *Asterina ciferriana* on *Caesalpinia bonduc* (ppMP 416). a: Mature open thyriothecia and surface mycelium with appressoria. Arrow indicates a hair on the surface of the plant. Scale bar = 150 µm. **b:** Mature, germinated ascospore and surface mycelium. Arrows indicate position of first appressoria. Scale bar = 15 µm.

Asterina consobrina Syd., Ann. Mycol. 25(1/2): 49 (1927). Figs. 3.6, 3.7

Type on *Solanum* sp. [on label: cf. *laurifolium*] (Solanaceae). Costa Rica, Alajuela Province, San Pedro de San Ramon, 2 Feb. 1925, *H. Sydow 56b* (syntype, BPI 689458!, S F7791 n.v.).

Colonies amphigenous, but predominantly hypophyllous, inconspicuous and poorly defined, early confluent, 0.1–5 mm diam. (*n*=10), brown to greyish, becoming more conspicuous and darker, later covering large parts of the lower leaf surface. *Surface hyphae* undulating, often zigzag-like, branching unilateral or alternate, never opposite, brown, hyphal tips paler, septate, hyphal cells cylindrical, (8)15–24(28)×3–5(7) µm (*n*=40), cell wall up to 1 µm thick, smooth. *Appressoria* numerous, above epidermal cells or guard cells of stomata, 1–celled, irregularly ellipsoidal to ampulliform, straight or hooked, sometimes curved in growth direction, entire or sinuate, sometimes with one deep lobe in the middle, sessile, without stalk cell, unilateral or alternate, (5)6–9(–11)×(4)5–7(9) µm (*n*=50), brown, penetration pore in distal part of appressorium, 0.5–1 µm diam. *Haustoria* inconspicuous. *Thyriothecia* superficial, develop below surface mycelium, circular, dimidiate, single, with entire margins, (80)90–117(150) µm diam. (*n*=50), brown to dark brown, open with central star-shaped fissures, at maturity wide open to expose mature and immature asci. *Scutellum* radiate, composed of dichoto-mously branched filaments, scutellum cells isodametric to cylindrical, straight in center, 4–7(10)×(2.5)3–4(5.5) µm (*n*=40), brown to dark brown, at tips paler. *Asci* few, globose, with distinct ocular chambers, bitunicate, ascus wall I+, (28)29–34(35) µm diam. (*n*=25), 8–spored, hyaline, develop on ascogenous hyphae with proliferating croziers, interascal tissue present, indistinct, evanescent. *Ascospores* 2–celled, ellipsoidal, ends broadly rounded, deeply constricted at septum, (20)21–23(25) µm long (*n*=50), upper cell (10.5)11–13 µm wide, lower cell (9)10–11(12) µm wide, brown when mature, cell wall up to 1 µm thick, verrucose, germinate first at the distal part of each cell to form surface mycelium with lateral appressoria. *Anamorph* absent.

Illustrations. In Hofmann and Piepenbring (2008) and this contribution.

Hosts. Solanaceae: *Solanum* cf. *laurifolium* Mill. and *S. aphyodendron* S. Knapp. *S. aphyodendron* is a new host species of *A. consobrina* (Hofmann and Piepenbring 2008).

Known Distribution. Neotropical: Central America (Costa Rica, Panama). *A. consobrina* is a new record for Panama (Hofmann and Piepenbring 2008). It occurs in Western Panama in humid mountain rain forests at 1500 to about 2000 m a.s.l.

Specimens examined. **COSTA RICA. Alajuela Province:** syntype, see above. **PANAMA. Chiriquí Province:** Boquete, Bajo Mono, ca. 1500 m a.s.l., mostly hypophyllous on *Solanum aphyodendron* (det. T.A. Hofmann), 3 Mar. 2006, associated with epiphyllous growing species of Meliolales, *T.A. Hofmann 447* (BPI 878176, PMA). — Parque Internacional La Amistad (PILA), Jurutungo, ca. 2,000 m a.s.l., amphigenous on *Solanum aphyodendron* (det. T.A. Hofmann), 6 Mar. 2006, *T.A. Hofmann 452* (BPI 878177, PMA).

Additional specimens examined. ***Asterina portoricensis*** **R.W. Ryan.: PUERTO RICO. Quebradillas:** on *Solanum* sp., 22 Nov. 1913, *F.L Stevens 5127* (type, BPI 690311; ex-type, BPI 690312).

Notes. The verrucose ornamentation of the ascospores of *A. consobrina* was not recognized by Sydow (1927). The thyriothecia of the type specimen from Costa Rica are larger and measure (100)102–136(150) µm diam., the ornamented ascospores are slightly larger and measure 22–24×12–13 µm.

A. consobrina is one of the numerous *Asterina* spp. on Solanaceae with one-celled, simple appressoria. Eight species of *Asterina* with one-celled appressoria are known to parazitise the host genus *Solanum*. Six of these species have simple appressoria with entire or slightly lobulate margins: *A. aquilariae* Ouyang & B. Song

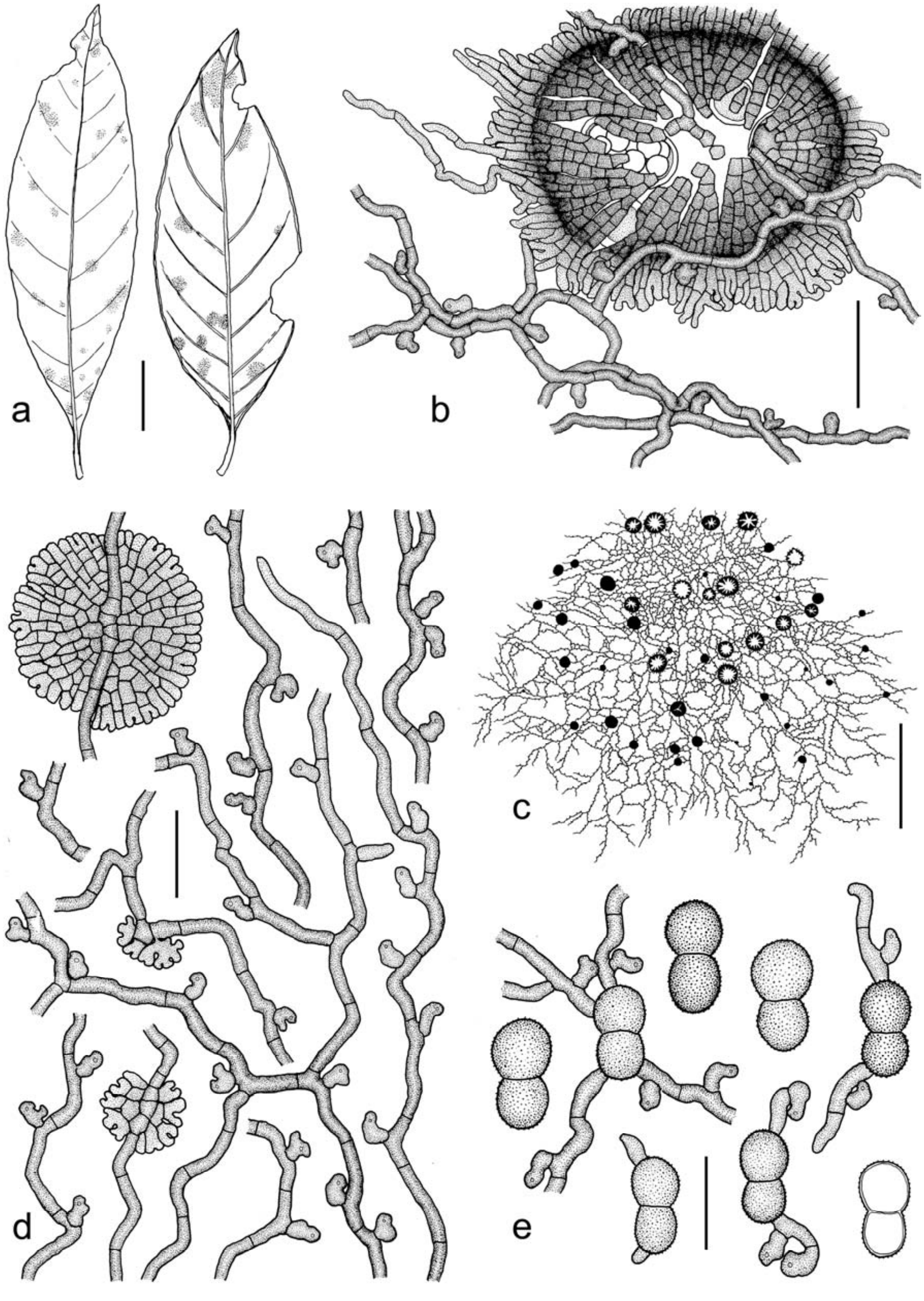

Figure 3.6: ***Asterina consobrina*** **on** ***Solanum aphyodendron*** **(TH 447). a:** Infected leaves. Scale bar = 2 cm. **b:** Open thyriothecium with immature asci. Scale bar = 30 µm. **c:** Part of the colony with ascoma and surface mycelium. Scale bar = 500 µm. **d:** Surface mycelium with appressoria and sporoma initials. Scale bar = 20 µm. **e:** Mature, slightly verrucose ascospores, some of them germinating. Scale bar = 20 µm.

from China (Ouyang et al. 1995), *A. consobrina* Syd. from Costa Rica (Sydow 1927), *A. balakrishnani* Hosag. from India (Hosagoudar et al. 1996), *A. grisea* Petr. from Ecuador (Petrak 1950), *A. portoricensis* R.W. Ryan from Puerto Rico (Ryan 1924) and *A. solanacearum* Orejuela from Colombia (Orejuela 1944). The neotropical species *A. consobrina, A. grisea, A. portoricensis* and *A. solanacearum* differ only slightly from each other. The ascospores of *A. grisea* are smallest and measure 14–17.5×6.5–8 µm (Petrak 1950), *A. solanacearum* has the largest ascospores with 28×14–15.5 µm (Orejuela 1944). Ryan measured the ascospores of *A. portoricensis* with 17–19×9 µm (Ryan 1924). However, examination of type material reveal that the ascospores are 19–22 µm long (*n*=10) (upper cell 11–12(13) µm wide, lower cell 9.5–11(12) µm wide) and almost the same size as the ascospores of *A. consobrina*. Nevertheless, *A. portoricensis* differs from *A. consobrina*, because the appressoria are almost entire or amulliform, but not lobulate, they are longer and measure (8)9–11(13)×5–7 µm (*n*=10) and the ornamentation of the ascospores is stronger.

Dennis (1970) provided a key to *Asterina* spp. on Solanaceae from Venezuela with eight species, four of them with one-celled appressoria. However, the key is incomplete and restricted to venezuelan species and *A. consobrina* is not included.

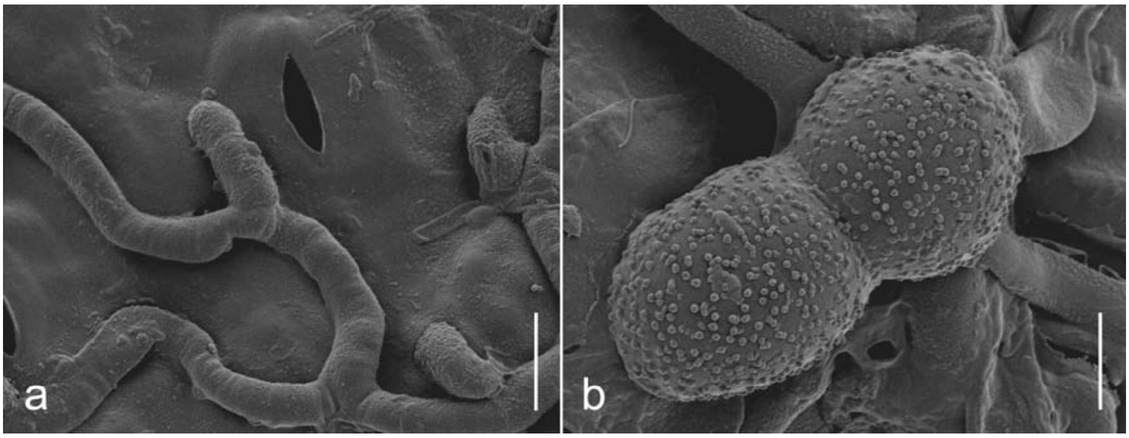

Figure 3.7: SEM photographs of *Asterina consobrina* on *Solanum aphyodendron* (TH 447). a: Surface mycelium with lateral appressorium. Scale bar = 10 µm. **b:** Mature ascospore. Scale bar = 5 µm.

***Asterina corallopoda* Syd., Ann. Mycol. 37(4/5): 384 (1939). Figs. 3.8, 3.9**

Type on *Solanum trachycyphum* Bitter (Solanaceae). Ecuador, Pastaza Province, Puyo, 15 Feb. 1938, *H. Sydow 853, 853a* (type n.v.).

Colonies epiphyllous, irregularly circular, single, later sometimes confluent, 0.5–

5 mm diam. (*n*=10), black. *Surface hyphae* irregularly undulating to zigzag-like, mostly above lateral walls of epidermal cells, later cover leaf surface like a net, branching unilateral or alternate, pale brown to brown, hyphal tips paler, septate, hyphal cells cylindrical, (5)15–30(40)×(2.5)3–4 µm, cell wall up to 1 µm thick, smooth. *Appressoria* numerous, unilateral ot alternate, with conspicuous stalk cell(s), stalk cells variable, 1– or 2–celled, very rarely 3–celled, cylindrical, undulating towards or backwards of hyphal growth direction, stalk sometimes missing, if missing lateral appressorial cell slightly stalked on hyphal cell without additional septation, stalk cell(s) (4)5–(31)35 (*n*=6) µm long, pale brown to brown like surface mycelium, stalk cell can germinate laterally to form new stalk cell(s) with a terminal appressorial cell, appressorial cell conspicuous, terminal, multilobate, with various large and smaller lobes, irregularly circular to elongated, sometimes irregularly Y–shaped, mostly 1–celled, very rarely 2–celled, if 2–celled each cell with one penetration pore, (6)9–14(16)×6–12(15) µm, dark brown, conspicuously darker than surface hyphae, penetration pore 1.5–2 µm diam. *Haustoria* inconspicuous. *Thyriothecia* superficial, develop below surface mycelium, circular, dimidiate, crowded and becoming confluent, fringed at margins, (100)124–164(180) µm diam, dark brown to blackish, at margins paler, open with star-shaped central fissures, with indistinct basal ‘plate’ formed of melanized remains of lower cell walls of scutellum cells. *Scutellum* radiate, composed of dichotomously branched filaments, scutellum cells isodiametric to cylindrical, straight in center, undulating at margin of ascoma, (3)4–7(9)×(2)3–4(5.5) µm, at margins up to 20 µm long, dark brown to blackish. *Asci* numerous, globose to ovate, with distinct ocular chambers, bitunicate, ascus wall slightly I+, (24)25–28(30) µm diam., 8–spored, hyaline, develop on ascogenous hyphae with proliferating croziers, interascal tissue absent. *Ascospores* numerous, 2–celled, ellipsoidal, ends rounded, straight, sometimes slightly bent, constricted at septum, slightly tapering at one end, (18)19–21(22) µm long, upper cell (9)10–11 µm wide, lower cell 8–10 µm, cells disintegrate rarely, brown to dark brown, cell wall up to 1 µm thick, verrucose, germinate first at the distal part of each cell with a stalked and lobed appressorium. *Anamorph* absent.

Illustrations. *A. corallopoda* is illustrated here for the first time.

Hosts. Solanaceae: *Solanum* sp., *S. trachycyphum* Bitter and *S. trizygum* Bitter. *S. trizygum* is a new host species of *A. corallopoda*.

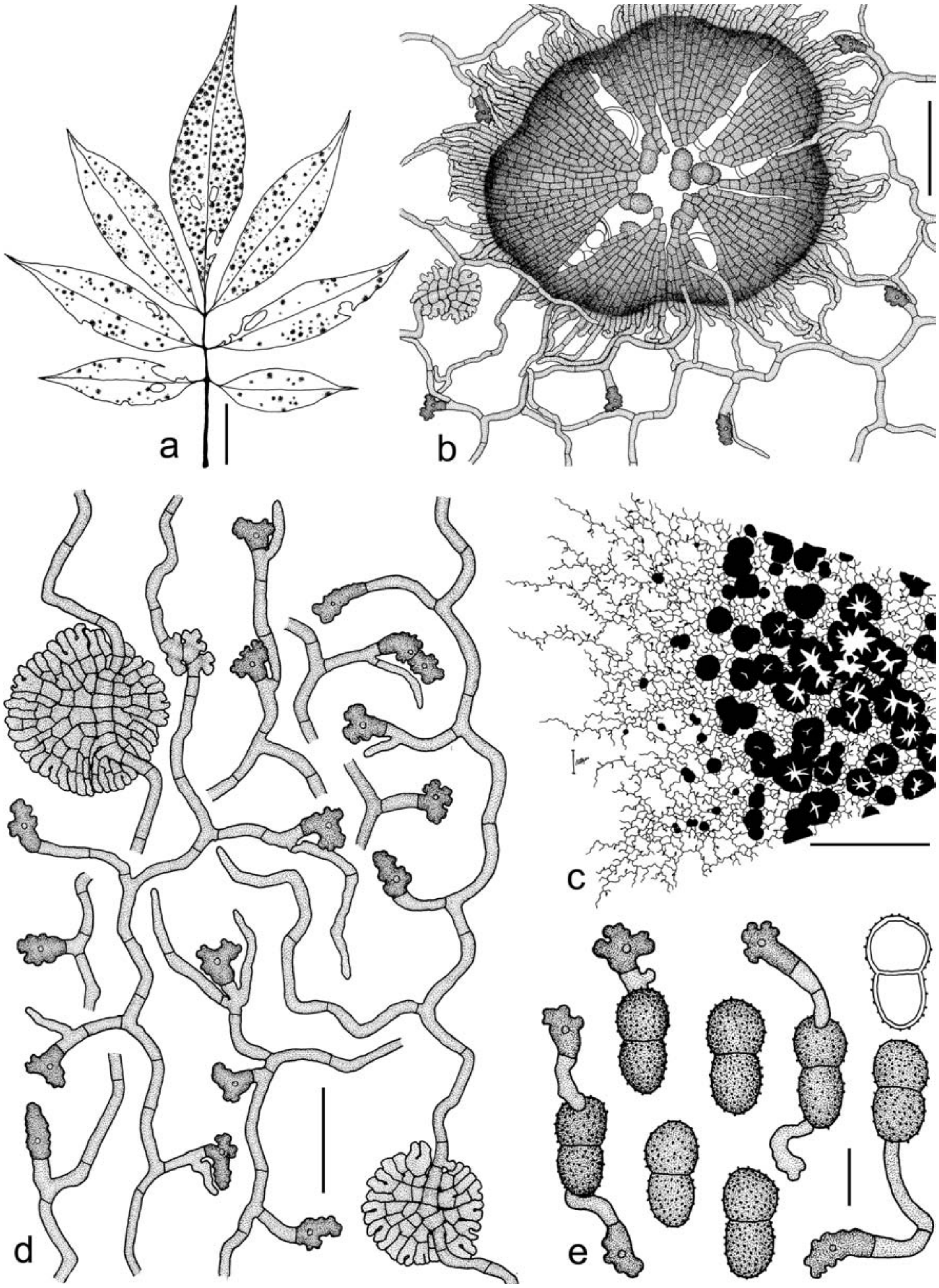

Figure 3.8: ***Asterina corallopoda*** **on** ***Solanum trizygum*** **(ppMP 1230). a:** Adaxial side of infected leaf. Scale bar = 2 cm. **b:** Open thyriothecium with released, mature ascospores and immature asci. Scale bar = 40 µm. **c:** Part of the colony with confluent thyriothecia and surface mycelium. Scale bar = 500 µm. **d:** Surface mycelium with stalked appressoria and ascoma initials. Scale bar = 25 µm. **e:** Mature, verrucose ascospores, some of them germinating. Scale bar = 10 µm.

Known distribution. Neotropical: Central America (Panama) and South America (Ecuador, Venezuela, Brazil). *A. corallopoda* is a new record for Central America and Panama. It occurs in Panama in humid mountain rainforests of higher elevations at approx. 1700 to about 2000 m a.s.l.

Specimens examined: ECUADOR. Pastaza Province: Puyo, on *Solanum trachycyphum*, 15 Feb. 1938, *H. Sydow 1205* (ex-type, BPI 689463). **PANAMA. Chiriquí Province:** Boquete, Alto Chiquero, private property of M.A. Amorùso near ANAM entrance in direction to Los Quetzales trail, ca. 1750 m a.s.l., epiphyllous on *Solanum trizygum* (det. R. Mangelsdorff), associated with hyphophyllous *Cyclotheca* sp., 11 Oct. 2005, *R. Mangelsdorff, T.A. Hofmann & M. Piepenbring ppMP 46-A* (M-0141040; PMA); same locality, host plant and associated organisms, 24 Mar. 2006, *T.A. Hofmann, M. Piepenbring & T. Trampe ppMP 484-A* (M-0141041; PMA); same locality, host plant and associated organisms, 27 Jun. 2006, *T.A. Hofmann, R. Mangelsdorff & T. Trampe ppMP 1117-A* (M-0141042; PMA); same locality, host plant and associated organisms, 15 Jan. 2007, *T.A. Hofmann, R. Mangelsdorff & T. Trampe ppMP 1230-A* (M-0141043; PMA). — Parque Internacional de la Amistad (PILA), El Retoño trail, ca. 2000 m a.s.l., epiphyllous on *Solanum trizygum* (det. T.A. Hofmann), associated with hypophyllous *Cyclotheca* sp., Apr. 2006, *A. Gonzales TH 513-A* (FR; PMA).

Additionaly specimen examined: *Asterina diplopoda* Syd. COSTA RICA. Alajuela Province: Grecia, on *Solanum acerifolium*, 19 Jan. 1925, *H. Sydow 51* (type, BPI 689662).

Notes. In some herbaria, specimens of *A. corallopoda* are deposited as *Fungi exotici exsiccati 1205* (BPI, BR, S). The exsiccate number is not cited in the protologue of the species, but the material was collected by the same collector from the same plant species at the same date and locality as the type specimen. Therefore, the exsiccate specimens are probably part of the type collection and represent syntypes of *A. corallopoda*.

The stalk cells of the appressoria of *A. corallopoda* are mostly are 1–celled and cylindrical, but sometimes they elongate and become 2–celled or very rarely even 3–celled before the terminal appressorium develops. Sometimes, hyphae develop laterally from the stalk cell(s) to form a second stalked appressorium or surface mycelium. *A. corallopoda* is morphologically similar to *A. diplopoda* because both species grow epiphyllous, form stalked and lobed appressoria and verrucose ascospores and both are known from the Neotropics (Sydow 1927, 1939). However, the stalk cells of *A. diplopoda* are less variable and mostly 1–celled, the ascospores measure 16–18×7–8.5 µm and are thereby slightly smaller than those of *A. corallopoda* (Sydow 1927).

All specimens of *A. corallopoda* from Panama on the host plant *Solanum trizygum* contain another plant parasitic thyriothecioid fungus on the abaxial side of the leaves. The fungus belongs to the Microthyriaceae and was identified as *Cyclotheca* sp.

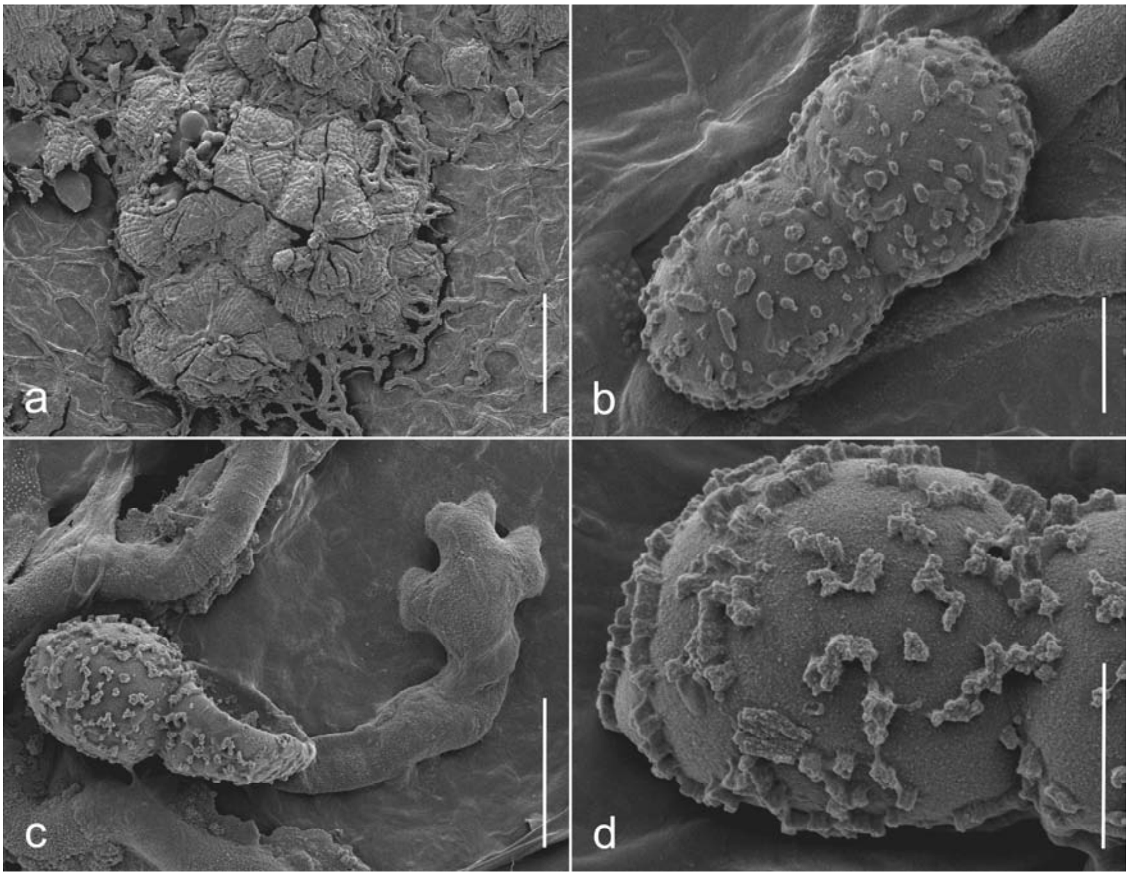

Figure 3.9: SEM photographs of *Asterina corallopoda* on *Solanum trizygum* (ppMP 1230). a: Mature, confluent thyriothecia, surface mycelium and free, mature ascospores. Scale bar = 100 µm. **b:** Mature, verrucose ascospore. Scale bar = 5 µm. **c:** Germinating ascospore, lower ascospore cell collapsed. Scale bar = 10 µm. **d:** Ornamentation pattern of mature ascospore. Scale bar = 5 µm.

***Asterina davillae* J.A. Stev., Mycologia 35: 631 (1943) Figs. 3.10, 3.11**

Type on *Davilla rugosa* A. St.-Hil. (Dilleniaceae). Brazil, Minas Gerais, Viçosa, 4 Jun. 1933, *A.S. Müller 583* (type, BPI 689515!).

Anamorph: *Asterostomella*-like, not mentioned by Stevenson, but present in the type collection of *A. davillae*.

Colonies amphigenous, irregularly circular in outline, first single and scattered, early becoming confluent, later covering large parts of the upper and lower leaf surface, conspicuous and dense, 0.5–8 mm diam. (*n*=10), dark greyish to black. *Surface hyphae* slightly undulating, branching unilateral or alternate, rarely opposite, brown, hyphal tips paler, septate, hyphal cells cylindrical, (7)11–19(22)×3–4 µm, cell wall up to 0.5 µm thick, smooth. *Appressoria* numerous, with 3–5 lobes, sessile or with a slightly stalked base, without stalk cell, unilateral or alternate, not opposite, (5)6–8(10)×(5)6–8(9) µm (*n*=100), brown, penetration pore very small and inconspicuous, in central part of the appressorium. *Haustoria* inconspicuous, arbuscular, globose to ellipsoidal to reniform, 8–11(13)×4–8(9) µm (*n*=10), hyaline, fill up to ¼ of epidermal host cell. *Thyriothecia* few, superficial, develop below surface mycelium, irregularly circular, dimidiate, at maturity more globose than dimidate, single, rarely confluent, slightly fringed at margins, (76.5)89–131(170) µm diam. (*n*=42), dark brown, open with central star-shaped fissures, at maturity widely open to expose asci, with distinct basal ‘plate’ formed of melanized remains of lower cell walls of scutellum cells. *Scutellum* radiate, composed of dichotomously branched filaments, scutellum cells isodiametric to cylindrical, straight in center, slightly undulating at margin of ascoma, (3)3.5–5(5.5)×3–4 µm (*n*=20), dark brown, at tips paler. *Asci* globose to ovate, with small ocular chambers, bitunicate, I–, 19–23(24) µm diam. (*n*=20), 8–spored, hyaline, develop on ascogenous hyphae with proliferating croziers, interascal tissue present, filamentous, septate, evanescent. *Ascospores* few, 2–celled, ellipsoidal, ends broadly rounded, lower cell sometimes slightly acuminate, straight, not or slightly constricted at septum, slightly tapering to one end, (14)15–17(18)×7–8 µm (*n*=36), brown, cell wall up to 0.5 µm thick, verrucose, germination not observed.

Anamorph present, *Asterostomella*-like. *Pycnothyria* numerous, superficial, develop below surface mycelium, circular, dimidiate, single or slightly confluent, slightly fringed, (36)49–70(90) µm diam. (*n*= 100), brown to dark brown, smaller than thyriothecia. *Scutellum* similar to the one of the thyriothecia. *Conidiogenous cells* mono-blastic, formed inside the pycnothyrial cavity by single cells of the inner part of the scutellum layer. *Conidia* numerous, 1–celled, pyriform, broadly clavate, sometimes ellipsoidal, hilum truncate, straight or bent, (13)15–18(21)×(7)8–10(11) µm (*n*=100), brown, with a central hyaline band and a pale hilum, smooth, germinate first at the region of the hyaline band with a stalked and lobed appressorium.

Illustrations. *A. davillae* is illustrated here for the first time.

Hosts. Dilleniaceae: *Davilla rugosa* Poir. and *Curatella americana* L. *Curatella* is a new host genus and *C. americana* is a new host species of *A. davillae*.

Known distribution. Neotropical: Central America (Panama) and South America (Brazil). *A. davillae* is a new record for Central America and Panama. It occurs in Western Panama in disturbed lowland forests and gallery forests at about 140 m a.s.l.

Specimens examined: BRAZIL. Minas Gerais: type, see above. **PANAMA. Chiriquí Province:** Los Algarrobos, border of Cermeño river, ca. 140 m a.s.l., amphigenous on *Curatella americana* (det. R. Mangelsdorff), 20 Feb. 2004, *R. Mangelsdorff 1247* (PMA); same locality and host plant, 1 Oct. 2005, *T.A. Hofmann, G. Kost & M. Mangelsdorff 342* (FR; PMA). — Los Algarrobos, path to Majagua river, ca. 140 m a.s.l., amphigenous on *Curatella americana* (det. M. Piepenbring), 12 Sep. 2005, *T.A. Hofmann, R. Kirschner & T. Trampe 301* (FR; PMA); same locality and host plant, 21 Mar. 2006, *T.A. Hofmann, M. Piepenbring & T. Trampe ppMP 464* (M-0141062; PMA); same loaclity and host plant, 21 Jun. 2006, *T.A. Hofmann, R. Mangelsdorff & T. Trampe ppMP 581* (M-0141063; PMA); same locality and host plant, 8 Jan. 2007, *T.A Hofmann, R. Mangelsdorff & T. Trampe ppMP 1198* (M-0141064; PMA); same locality and host plant, 8 Sep. 2007, *T.A. Hofmann 527* (PMA). — Los Algarrobos, border of Majagua river, pasture, ca. 140 m a.s.l., amphigenous on *Curatella americana* (det. T.A. Hofmann), 4 Oct. 2005, *T.A. Hofmann, R, Mangelsdorff & M. Piepenbring ppMP 305* (M-0141065; PMA); same locality and host plant, 26 Mar. 2008, *T. Trampe & A. Pfaff 623* (PMA). — Guaca, private finca of Porfirio Cruz, amphigenous on *Curatella americana* (det. R. Rincón), 6 Mar. 2000, *M. Piepenbring, M. Cruz & O. Guerra 2702* (PMA).

Additional specimens examined: *A. dilleniae* Syd. & P. Syd. PHILIPPINES. Western Visayas Region: Palawan Province, Taytay, on *Dillenia* sp., Apr 1913, *E.D. Merrill 8774* (type, BPI 689618). **DOMINICAN REPUBLIC. Santo Domingo Province:** La Cumbre, Cordiellera Central, ca. 500 m a.s.l., on Dilleniaceae, 3 Jul. 1928, *R. Ciferri 4912* (BPI 689619). ***A. orthosticha* Syd. VENEZUELA. Federal District:** Puerto La Cruz Valley, EL Limon, on *Doliocarpus dentatus*, 14 Jan. 1928, *H. Sydow 847* (BPI 690156). ***A. ramosii* H.S. Yates. PHILIPPINES. Eastern Visayas Region:** Samar Province, Catubig river, on *Dillenia* sp., Feb.-Mar. 1916, *M. Ramos, Bur. Sci. 24643* (type, BPI 690361, 690362, 690363). ***A. scruposa* Syd. UGANDA. Wakiso:** Entebbe road, on *Tetracera potatoria*, Nov. 1940, *C.G. Hansford s.n.* (IMI 1156); same locality, date and host plant, *C.G. Hansford 2910* (BPI 690409); same locality, date and host plant, *C.G. Hansford 2795* (BPI 690411). **Kampala District:** Kampala, Kazi, on *Tetracera potatoria*, Nov. 1942, *C.G. Hansford 3074* (BPI 690410). ***A. scruposa* var. *longipoda* S. Hughes. GHANA. Western Region:** Nzema East District, Esiama, on *Tetracera alnifolia*, 14 May. 1949, *S.J. Hughes s.n.* (ex-type, BPI 690413, 690415, labeled as *Asterina scruposa*). ***A. stipitipodia* M.L. Farr. BRAZIL. Amazonas:** Manaus, INPA grounds, on Dilleniaceae, 4 Jan 1978, *M.L. Farr AM-32* (isotype, BPI 690522). ***Asterostomella dilleniicola* M.L. Farr. BRAZIL. Amazonas:** Manaus, INPA grounds, on Dilleniaceae, 4 Jan. 1978, *M.L. Farr AM-28(3)* (isotype, BPI 391479A).

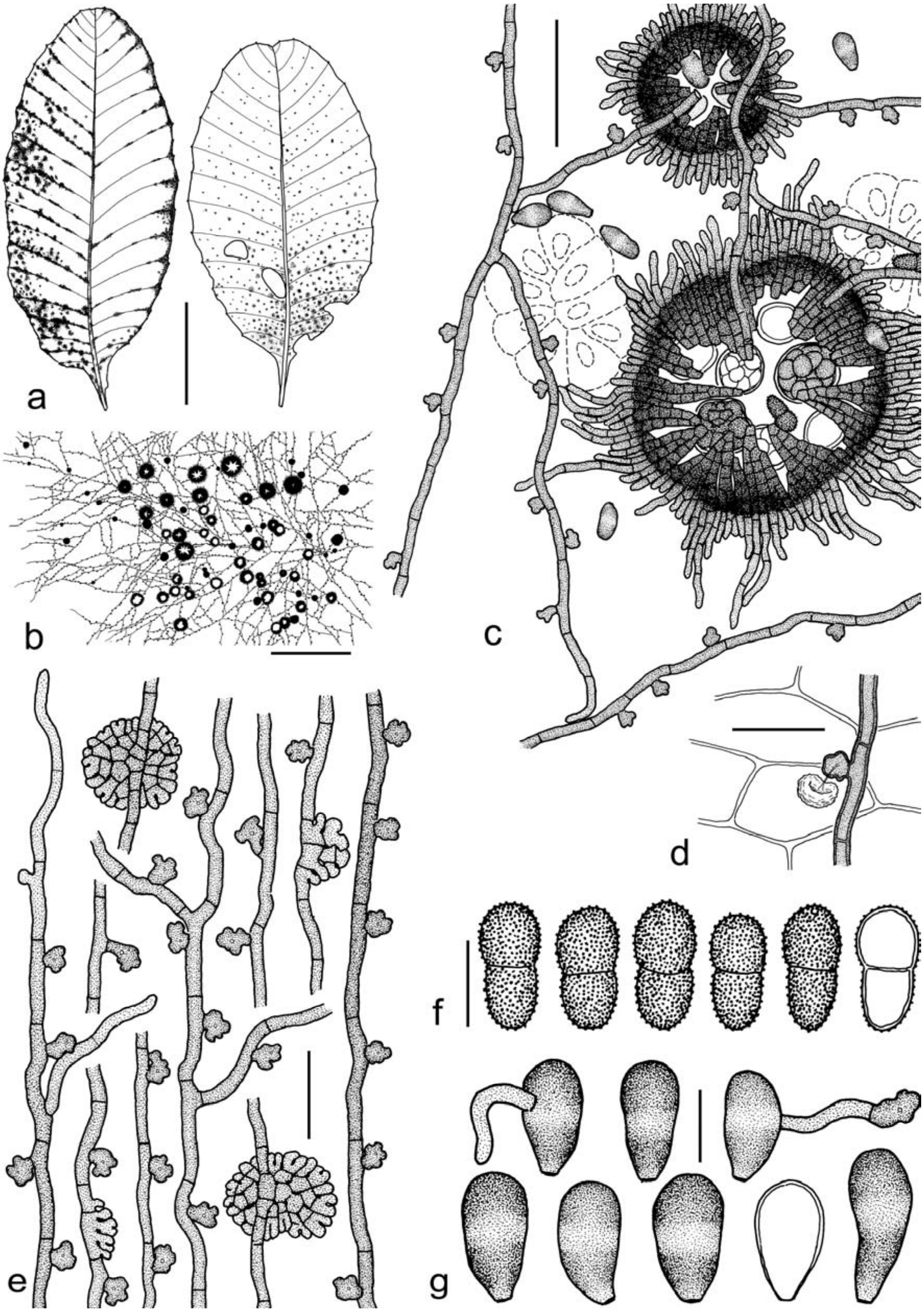

Figure 3.10: ***Asterina davillae*** **on** ***Curatella americana*.** **a:** Abaxial side (most left) and adaxial side (right) of infected leaves. Scale bar = 4 cm. **b:** Part of a colony with smaller pycnothyria and larger thyriothecia. Scale bar = 500 µm. **c:** Mature pycnothyrium (upper, smaller sporoma) with liberated conidia and thyriothecium (lower, larger sporoma) with mature and immature asci. Scale bar = 50 µm. **d:** Haustorium within epidermal host cells. Scale bar = 20 µm. **e:** Surface mycelium with lobed appressoria and sporoma initials. Scale bar = 20 µm. **f:** Mature, verrucose ascospores. Sale bar = 10 µm. **g:** Mature conidia, each with a central hyaline band, some of them germinating. Scale bar = 10 µm.

Notes. *Asterina davillae* is characterized by unstalked, slightly lobed appressoria, small verrucose ascospores and the presence of an anamorphic *Asterostomella* state with conidia with hyaline bands. The *Asterostomella* anamorph of *Asterina davillae* was not mentioned by Stevenson (1943), but is omnipresent in the type collection of *A. davillae* on *Davilla rugosa*. The type specimen of *A. davillae* is slightly different to the fungus from Panama because the appressoria are less lobate and the ascomata are generally larger in outline. However, in both specimens the sizes of appressoria, ascospores, conidia and pycnothyria are almost similar as well as the ascospore ornamentation and the shape of the hyaline banded conidia. On *Curatella americana*, the *Asterostomella* anamorph dominates the teleomorph and ascomata are difficult to observe. Teleomorph development is restricted to strongly infected leaves on which colonies often become confluent and cover large leaf parts. Under the stereomicroscope the ascomata of the teleomoph become obvious because they are larger than the pycnothyria of the anamorphic *Asterostomella* stage.

According to Hosagoudar and Abraham (2000), 10 species of *Asterina* are known from Dilleniaceae. A key to *Asterina* spp. on Dilleniaceae was proposed by Hosagoudar et al. (1997), however, this key is partly incorrect. Since 2000, one additional species of *Asterina* was described from a dilleniaceous host, *A. tetracericola* B. Song, T.H. Li & F.W. Xing on *Tetracera asiatica* from China (Song et al. 2004). Additionally, several species of *Asterostomella* are known from Dilleniaceae and are described separately or together with a teleomorphic stage. An overview to all hitherto described *Asterina* spp. and *Asterostomella* spp. from Dilleniaceae is given in Table 3.3. For *Asterina davillae*, *A. dilleniae*, *A. tetracerae* and *A. davillae* var. *major*, the associated anamorph was not described and named separately (Farr 1986, Batista and Gayão 1953, type! of *A. davillae*). *Asterostomella orthosticha* and *A. stipitipodia* were described separately, but with the same epitheton used for their respective teleomorph (Sydow 1930, Farr 1987). Apart from that, two *Asterostomella* anamorphs without a related teleomorph were described from Dilleniaceae, *A. dilleniacearum* from India and *A. dilleniicola* from Brazil. *A. dilleniicola* was collected in Panama on *Davilla kunthii* and is described, illustrated and discussed below.

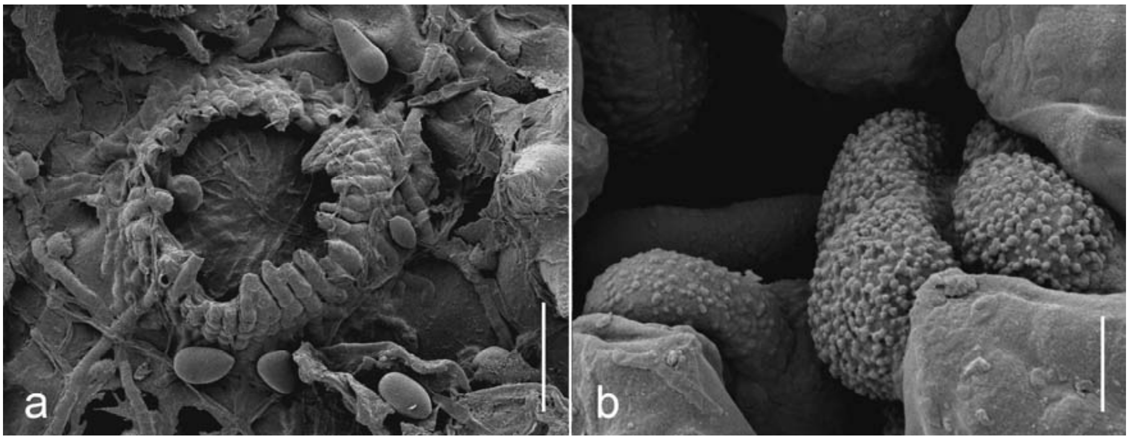

Figure 3.11: SEM photographs of *Asterina davillae* on *Curatella americana* (TH 301). a: Open pycnothyrium with liberated conidia. Scale bar = 30 µm. **b:** Mature, verrucose ascospores within open ascoma. Scale bar = 5 µm.

Table 3.3: List of *Asterina* (*A.*) spp. and *Asterostomella* (*Aella.*) spp. on Dilleniaceae according to literature. Species are listed in alphabetical order according to continents, Africa: *A. scruposa* to *A. scruposa var. longipoda*, Asia: *A. dilleniae* to *Asterostomella dilleniacearum*, South America: *A. davillae* to *Asterostomella dilleniicola*. Names of anamorphic *Asterostomella* spp. known to be associated with a telomorph were not listed additionally. Taxa indicated with asterisks are not listed in Hosagoudar and Abraham (2000). Cited host plants and localities correspond to the protolouge of the type species only. Morphological data are cited from the original publication, revised data or own observations from examined type material are indicated in brackets. Abbreviations: anam = anamorph, teleo = teleomorph, lc = lower cell, uc = upper cell.

Species	Host plant	Country	Appressoria	Sporomata	Ascospores/Conidia	Anam/ Teleo
A. scruposa Syd. 1983	*Tetracera potatoria* (first as '*alnifolia*')	Uganda	unstalked, up to 9.5 µm long, 4–5.5 or 6–8 µm wide, lobate	160–200 µm diam.	23–26×12.5–13.5 µm, verrucose	—
A. scruposa var. *longipoda* S. Hughes 1952	*Tetracera alnifolia*	Ghana	unstalked, 11–22×5–6 µm, cylindrical, entire or sublobate	[as *A. scruposa*]	[as *A. scruposa*]	—
A. dilleniae Syd. & P. Syd. 1914 (anamorph present, unnamed)	*Dillenia* sp.	Philippines	unstalked, 10–15×9–11 µm, globose to cylindrical, sinuate	140–200 µm diam.	20–25×10–12 µm, verrucose	anam present
A. ramosii H.S. Yates 1918	*Dillenia* sp.	Philippines	unstalked, 6–8×5µm, globose to cylindrical, entire to lobed	80–120 µm diam.	14–16×6–8 µm, smooth	—
A. tetracerae Syd. 1931 (anamorph present, unnamed)	*Tetracera scandens*	Philippines	unstalked, 5–8×6–8.5 µm, globose, entire or lobate	80–160 µm diam.	15–20×7–9 µm, [verrucose]	anam present
A. tetracericola B. Song, T.H. Li & F.W. Xing 2004*	*Tetracera asiatica*	China	unstalked, 5.5–10×5.5–9 µm, lobed	up to 130 µm diam.	20–23×8–10 µm, verrucose	—
Aella. dilleniacearum Hosag., T.K. Abraham & C.K. Biju 1997*	*Dillenia pentagyna*	India	unstalked, 6–8×8–9.5 µm, cylindrical, entire to sublobate	up to 72 µm diam.	14–17×9–12 µm, smooth	—
A. davillae J.A. Stev. 1943 (anamorph present, unnamed)	*Davilla rugosa*	Brazil	unstalked, 5–9×5–6 µm, ovate to slightly lobed	150–200 µm diam.	15–17×7–8 µm, [smooth?]	[anam present]
A. davillae var. *major* Bat. & A.F. Vital 1953 (anamorph present, unnamend)	*Davilla rugosa*	Brazil	unstalked, 5.5–9.5×5–6 µm, ovate to irregular, entire	122–200 µm diam.	23–26.5×13–15 µm, verrucose	anam presetn
A. laevipodia M.L. Farr 1987	undetermined	Brazil	unstalked, 7–10×4–7 µm, oblong to cylindrical, entire	160–200 µm diam.	22–24(30)×10–12 µm, verrucose	—
A. orthosticha Syd. 1930 with anamorph *Asterostomella orthosticha* Syd. 1930	*Doliocarpus dentatus*	Venezuela	unstalked, 7.5–11×6–7.5 µm, globose to short cylindrical, entire	150–200 µm diam.	30–35 µm long, uc 15–18 µm wide, lc 12–15 µm wide, verrucose	anam present
A. stipitipodia M.L. Farr 1987 with anamorph *Aella. stipitipodia* M.L. Farr 1987	undetermined	Brazil	stalked, 6–10 µm diam., globose, angular to sublobed; unstalked, 4–12×6–10 µm, ovoid to subglobose, lobed	64–110(120) µm diam.	15–18×6.5–8 µm, verrucose	anam present
Aella. dilleniicola M.L. Farr 1986*	cf. *Doliocarpus* sp.	Brazil	unstalked, 9–10×4–6 µm, globose, sublobate	55–80 µm diam.	16–23×12–14 µm, smooth	—

Asterina diplocarpa Cooke, Grevillea 10: 129 (1882). Figs. 3.12, 3.13

Type on *Sida cordifolia* L. (Malvaceae, BPI specimen was misidentified as *S. rhombifolia*). South Africa, KwaZulu-Natal, Inanda, date unknown, *M. Wood 601* (type, BPI 689653!).

= *Asterina similis* Cooke, Grevillea 10: 130 (1882). Type on *Sida rhombifolia* L. (Malvaceae). South Africa, KwaZulu-Natal, Inanda 1881, *M. Woo*d *544* (type, BPI 690437!, K n.v.).

= *Asterina sidae* Earle, Bull. N. York. Bot. Gard. 3: 310 (1904). Type on *Sida carpinifolia* L. f. (Malvaceae). Puerto Rico, Ponce, Adjuntas Road 5 miles from Ponce, 24 Dec. 1902, *A.A. Heller 6333* (type, S F9603 n.v.).

= *Asterina kwangensis* Henn., Ann. Mus. du Congo 2(2): 99 (1907). Type on Asclepiadaceae. Congo. Kwango, Boko St. Barbe, May 1905, *H. Vanderyst 128* (syntypes, B destroyed *fide* Hein 1988, S F49018 n.v.).

= *Asterina huallagensis* Henn., Hedwigia 43: 372 (1904). Type on *Croton* sp. (Euphorbiaceae). Peru, San Martín, Huallaga, Tarapoto, *E. Ule 3248* (type, B destroyed *fide* Hein 1988).

= *Seynesia balansae* var. *africana* Sacc., Hedwigia Beih. 38: 133 (1899). Type on *Sida cordifolia* L. f. (Malvaceae, misidentified by Saccardo as *Rubus rigidus*). South Africa, KwaZulu-Natal, Durban, 14 May 1897, *M. Wood 6464* (type, S F7649 n.v.).

≡ *Asterina balansae* var. *africana* (Sacc.) Theiss., Abh. zool.-bot. Ges. Wien 7(3): 88 (1913).

[synonymy according to Theissen (1913a) and Doidge (1942)]

Colonies epiphyllous, circular, single, later confluent, sometimes covering large parts of the upper leaf surface, conspicuous and dense, 0.5−3.5(4) mm diam. (*n*=10), black. *Surface hyphae* undulating to zigzag-like, branching unilateral or alternate, sometimes opposite, brown, hyphal tips paler, septate, hyphal cells cylindrical, (15)18−23(25)× (3.5)4−4.5 µm, cell wall up to 1 µm thick, smooth. *Appressoria* numerous, with 2−4(5) deep lobes, lobes asymmetrical, unilateral or alternate, sessile, without stalk cell, (4.5)6−7(9)×7−9(11) µm (*n*=120), brown, penetration pore inconspicuous, in the distal part between 2 or 3 lobes of the appressorium, 0.5−1 µm diam. *Haustoria* irregularly ellipsoidal to reniform, 8−12×4−8 µm (*n*=10), hyaline. *Thyriothecia* superficial, develop below surface mycelium, irregularly circular in outline, dimidate, sometimes confluent, margins not very fringed, (80)94−128(158) µm diam. (*n*=109), brown to dark brown or black, open with central star-shaped fissures, with indistinct basal ‘plate’ formed of melanized remains of lower cell walls of scutellum cells. *Scutellum* radiate, composed of dichotomously branched filaments, scutellum cells isodiametric to cylindrical, straight in center, not fringed at margin of ascoma, (3)4.5−7(9)×(2.5)3−5(5.5) µm, brown to dark brown or blackish, at tips paler.

Asci globose, with distinct ocular chambers, bitunicate, I−, (20)21−25(28) µm diam. (*n*=93), 8–spored, hyaline, develop on ascogenous hyphae with proliferating croziers, interascal tissue absent. *Ascospores* numerous, 2–celled, ellipsoidal, ends broadly rounded, slightly constricted at septum, sometimes tapering to one end, (14)16−17(19) µm long (*n*=113), upper cell (7)8−9 µm wide, lower cell (6)7−8(8.5) µm wide, brown when mature, cell wall up to 1 µm thick, densely verrucose, germinate first at the distal part of each cell with a lobed appressorium. *Anamorph* absent.

Illustrations. In Theissen (1913a), Doidge (1942), Farr (1969) and this contribution. The morphology of the haustoria (Fig. 3.12c) and the ornamentation of the ascospores are illustrated here for the first time (Fig. 3.13).

Hosts. Clusiaceae: *Clusia gundlachii* A. Stahl. (host probably misidentified). **Malvaceae-Malvoideae:** *Abutilon* sp., *Sida acuta* Burm. f., *S. carpinifolia* L. f., *S. cordifolia* L., *S. glomerata* Cav., *S. humilis* Cav., *S. rhombifolia* L., *Sida* sp., *S. stipulata* Cav. and *S. urens* L. **Malvaceae-Byttnerioideae:** *Corchorus hirtus* L.

Known distribution. Pantropical: Africa (South Africa, Sierra Leone), Caribbean (Dominica, Dominican Republic, Grenada, Puerto Rico, Trinidad and Tobago, Virgin Islands), Central America (Costa Rica, Honduras, Panama), South America (Brazil, Colombia, Venezuela) and Southeast Asia (Myanmar). *A. diplocarpa* is a new record for Panama. A. diplocarpa is common in Western Panama and occurs mostly on pastures and rural vegetation near roadsides from 5 to about 1500 m a.s.l.

Specimens examined. BRAZIL. Rio Grande do Sul: Sao Leopoldo, epiphyllous on *Sida carpinifolia* (det. T.A. Hofmann), 1913, *Reck 2133* (BPI 689628). **COSTA RICA. Cartago:** Turrialba, epiphyllous on *Sida* sp., 25 Nov. 1949, *A.S. Muller 1920* (BPI 689631). **DOMINICA. St. Joseph:** Mannetts Gutter, Clark Hall, epiphyllous on *Sida* sp., 16 Mar. 1966, *M.L. Farr 2906* (BPI 689632). **Saint Andrew:** Southwest of Pagua Bay, ca. 200 ft. a.s.l., epiphyllous on *Sida* sp., 26 Mar. 1966, *M.L. Farr 3005a* (BPI 689627). **HONDURAS. Atlántida:** Tela, at sea level, epiphyllous on *Sida rhombifolia* (det. T.A. Hofmann), 14 Dec. 1927-15 Mar. 1928, *P.C. Standley 54703* (BPI 689633). — Lancetilla Valley, near Tela, 20-600 m a.s.l., epiphyllous on *Sida rhombifolia* (det. T.A. Hofmann), 6 Dec. 1927-20 Mar. 1928, *P.C. Standley 54066* (BPI 689634). **PANAMA. Chiriquí Province:** Los Algarrobos, border of Cermeño river, pastures, ca. 150 m a.s.l., epiphyllous on *Sida rhombifolia* (det. T.A. Hofmann), 1 Oct. 2005, *T.A. Hofmann 343* (FR, PMA). — Los Algarrobos, path to el Salto cascade, ca. 140 m a.s.l., epiphyllous on *Sida rhombifolia* (det. T.A. Hofmann), 7 Jan. 2006, *T.A. Hofmann 495* (FR, PMA). — Los

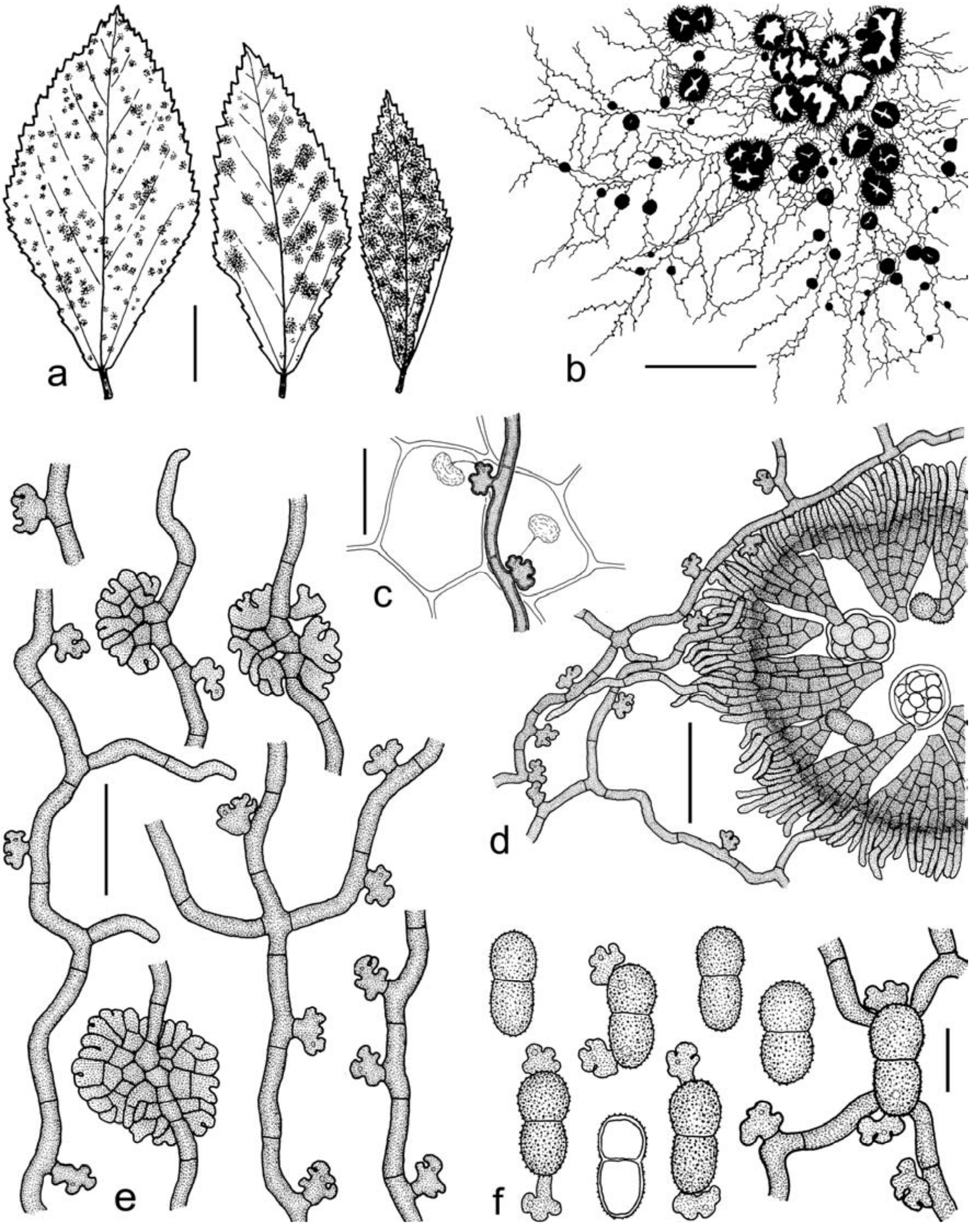

Figure 3.12: ***Asterina diplocarpa*** **on** ***Sida rhombifolia*** **(TH 343). a:** Infected leaves. Scale bar = 1 cm. **b:** Part of the colony with thyriothecia and surface mycelium. Scale bar = 300 µm. **c:** Haustoria within epidermal host cells. Scale bar = 20 µm. **d:** Part of an open thyriothecium with released, mature ascospores and mature and immature asci. Scale bar = 30 µm. **e:** Surface mycelium with lobed appressoria and sporoma initials. Scale bar = 20 µm. **e:** Mature, slightly verrucose ascospores, some of them germinating. Scale bar = 10 µm.

Algarrobos, path to Majagua river, ca. 140 m a.s.l., epiphyllous on *Sida rhombifolia* (det. T.A. Hofmann), 4 Oct. 2005, *T.A. Hofmann, R. Mangelsdorff & M. Piepenbring ppMP 314* (M-0141003, PMA); same locality and host species, 8 Jan. 2007, *T.A. Hofmann, R. Mangelsdorff & T. Trampe ppMP 1199* (M-0141004, PMA). — Los Algarrobos, border of Majagua river, pastures, ca. 140 m a.s.l., epiphyllous on

Sida rhombifolia (det. T.A. Hofmann), 23 Oct. 2007, *T.A. Hofmann 598* (FR, PMA). — La Barqueta, pacific coast, ca. 5 m a.s.l., epiphyllous on *Sida rhombifolia* (det. T.A. Hofmann), 22 Jan. 2007, *T.A. Hofmann, R. Mangelsdorff & T. Trampe ppMP 1261* (M-0141008, PMA). — Chorcha, road to plateau, ca. 269 m a.s.l., epiphyllous on *Sida acuta* (det. T.A. Hofmann), 20 Oct. 2005, *T.A. Hofmann 398* (FR, PMA); same locality, epiphyllous on *Sida rhombifolia* (det. T.A. Hofmann), 20 Oct. 2005, *T.A. Hofmann 399* (PMA); same locality and host species, 13 Sep. 2007, *T.A. Hofmann 536* (PMA). — Road to Piedra de Candela, road margin, ca. 1400 m a.s.l., epiphyllous on *Sida rhombifolia* (det T.A. Hofmann), 8 Oct. 2005, *T.A. Hofmann, R. Mangelsdorff & M. Piepenbring ppMP 363* (M-0141005, PMA); same locality and host species, 29 Mar. 2006, *T.A. Hofmann, M. Piepenbring & T. Trampe ppMP 529* (M 0141006, PMA); same locality and host species, 22 Apr. 2006, *T.A. Hofmann 435* (FR, PMA); same locality and host species, 18 Jan. 2007, *T.A. Hofmann, R. Mangelsdorff & T. Trampe ppMP 1249* (M-0141007, PMA). **PUERTO RICO. Maricao:** epiphyllous on *Sida carpinifolia*, 20 Jul. 1915, *F.L. Stevens 8869* (BPI 690425, as *Asterina sidicola*). **SIERRA LEONE. Eastern Province:** Konu, Sefadu, epiphyllous on *Sida cordifolia*, 7 Dec. 1938, *F.C. Deighton 19000a* (BPI 689648). **SOUTH AFRICA. KwaZulu-Natal**: lectotype, see above; lectotype of *A. similis*, see above. — Umkomaas, epiphyllous on *Sida cordifolia*, 25 Apr. 19??, *A.M. Bottomley 11894* (BPI 689646, 689647, 689649). **TRINIDAD AND TOBAGO. Trinidad:** Matchepoorie, epiphyllous on *Sida* sp., 11 Mar. 1921, *F.J. Seaver 3130* (BPI 689629). **UGANDA. Wakiso:** Entebbe road, epiphyllous on *Sida cordifolia*, Mar. 1944, *C.G. Hansford 3454* (BPI 689645); same locality and host plant, Aug. 1944, *C.G. Hansford 3531* (BPI 689654). **VENEZUELA. Caracas:** Los Naranjos pr. Puerto La Cruz, epiphyllous on *Sida rhombifolia* (det. T.A. Hofmann), 7 Jan. 1928, *H. Sydow 845* (BPI 689638). **Distrito Federal:** El Valle, epiphyllous on *Sida urens*, 15 Dec. 1930, *R.A. Toro 74* (BPI 689655). **Miranda:** Petare Hills, Sta.-Lucía road, 1200-1250 m a.s.l., epiphyllous on *Sida urens* (det. T.A. Hofmann), 8 Jul. 1932, *C.E. Chardon & R.A. Toro 451* (BPI 689635). — Petare-Guarenas road, 380-500 m a.s.l., epiphyllous on *Sida rhombifolia* (det. T.A. Hofmann), 11 Jul. 1932, *C.E. Chardon & R.A. Toro 511* (BPI 689641). — Los Teques, Knoop`s Park, 1150-1200 m a.s.l., epiphyllous on *Sida urens* (det. T.A. Hofmann), 13 Jul. 1932, *C.E. Chardon & Guiscafré 575* (BPI 689636); same locality, epiphyllous on *Sida rhombifolia* (det. T.A. Hofmann), 13 Jul. 1932, *C.E. Chardon & Guiscafré 556* (BPI 689639, 689640). — Hills S. of Turmerito, to La Cortada, 1100-1300 m a.s.l., epiphyllous on *Sida urens* (det. T.A. Hofmann), 9 Jul. 1932, *C.E. Chardon & R.A. Toro 476* (BPI 689637). **Sucre:** Carupano-El Pilar Road, 9 km north of El Rincon, epiphyllous on *Sida* sp., 6 Jul. 1972, *K.P. Dumont, R.F. Cain, G.J. Samuels & G. Morillo 4059* (BPI 689630).

Additional specimens examined. *Asterina sidicola* R.W. Ryan: PUERTO RICO. Cayey: Jajome Alto, epiphyllous on Malvaceae, 3 Dec. 1913, *F.L. Stevens 5693* (syntype, BPI 690420); same locality, on *Sida* sp., 3 Dec. 1913, *F.L. Stevens 5693* (syntype, BPI 690423). **San Germán:** Rosario Alto, on *Sida* sp., 1915, *F.L. Stevens 4809* (paratypes, BPI 690421, BPI 690422).

Notes. *A. diplocarpa* was described by Cooke (1882) from South Africa. The host plant of the type specimen deposited in BPI (BPI 689653) was misidentified as *Sida rhombifolia*, the correct name of the host is *S. cordifolia* (Cooke 1882). In the short

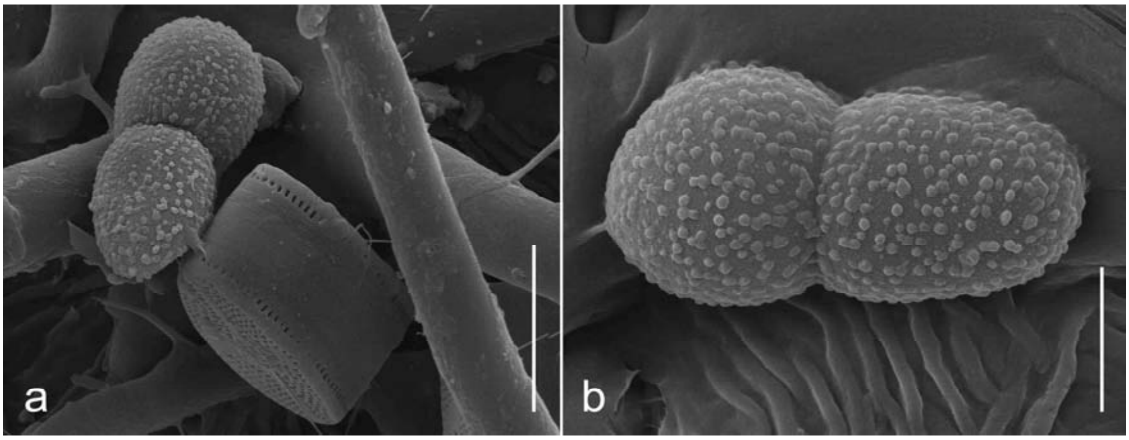

Figure 3.13: SEM photographs of *Asterina diplocarpa* on *Sida rhombifolia* (TH 343). a-b: Mature ornamented ascospores. **a:** Ascospore associated with a diatom. Scale bar = 10 µm. **b:** Scale bar = 5 µm.

description of *A. diplocarpa* no anamorphic state was mentioned, but the type material contains pycnothyria and conidia. Theissen (1913a) and Doidge (1942) reported pycnidia and pycnospores from the type material and Doidge (1942) also illustrated them. Later, Farr (1969) described the anamorphic state as a new species *Asterostomella diplocarpa* M.L. Farr. All examined specimens of *A. diplocarpa* on *Sida rhombifolia* and *S. acuta* from Panama, however, did not contain any anamorphic *Asterostomella*-state.

According to Hosagoudar and Abraham (2000), 13 species of *Asterina* are known from Malvaceae (five species under Malvaceae, three species under Sterculiaceae and five species under Tiliaceae). Four of these species are known to parasitize species of *Sida*, *A. diplocarpa* Cooke from Africa (Cooke 1882), *A. kusukusuensis* W. Yamam. from Taiwan (Yamamoto 1957), *A. pavoniae* Werderm. from Africa (the host plant of *A. pavoniae* was misidentified as *Pavonia* sp., the correct name is *Sida hislopii* according to Doidge 1942) and *A. sidicola* R.W. Ryan from Puerto Rico (Ryan 1924). In the original descriptions of the four species, the sizes of ascomata, ascospores and appressoria are very similar. *A. kusukusuensis* differs by smaller ascomata and slightly smaller and smooth ascospores (Yamamoto 1957), *A. pavoniae* has smaller ascomata and smooth ascospores (Doidge 1942). *A. sidicola* is the only species from the Neotropics on *Sida* and contains slightly smaller ascospores (Ryan 1924), but seems to be most similar to *A. diplocarpa*. Examination of type material of *A. sidicola* revealed, that the fungus indeed is different to *A. diplocarpa*. Ryan (1924) measured *A. sidicola* as followed: ascomata 123−156 µm diam., ascospores 12−14×5 µm and verrucose, appressoria 7 µm and lobed, anamorph not present. However, the measurements of Ryan (1924) seem to be wrong, I measured the ascomata with

(120)124−164(180) µm diam., ascospores (18)21−24(25)×(10)12−13.5(14) µm and appressoria (6)7−9(10)×(7)8−11 µm (each with *n*=20). In contrast to *A. diplocarpa*, the ascospores of *A. sidicola* are conspicuously larger. They are deeply constricted at the septum, have a prominent ornamentation (up to 1 µm high) and are darkly pigmented when fully mature.

Asterina diplopoda **Syd., Ann. Mycol. 25(1/2): 56 (1927). Figs. 3.14, 3.15**

Type on *Solanum acerifolium* Dunal (Solanaceae). Costa Rica, Alajuela Province, Grecia, 19 Jan. 1925, *H. Sydow 51* (type, BPI 689662!, S F7867 n.v.).

Colonies epiphyllous, irregularly circular, single to confluent, conspicuous and dense, 0.25–4 mm diam (*n*=10), black. *Surface hyphae* undulating, not straight, branching alternate or unilateral, rarely opposite, brown, hyphal tips paler, septate, hyphal cells cylindrical, (10)15.5–30(35)×(3.5)4–5 µm, cell wall 0.5 µm thick, smooth. *Appressoria* numerous, opposite or almost opposite, unilateral or alternate, with conspicuous stalk cell, total length (12)14–23(28) µm, brown, stalk cell 1-celled, very rarely 3-celled, cylindrical, irregularly curved or undulating towards or backwards the hyphal growth direction, (4.5)5–12(16)×(3.5)4(5) µm, appressorial cell lobed, more rarely entire, mostly with 2–5 apical lobes, lower part not lobed, mostly hooked, more rarely straight, (7)9–11(12)×(6)7–9(11) µm, darker than stalk cell, penetration pore in distal part, ca. 0.5–1 µm in diam. *Haustoria* inconspicuous. *Thyriothecia* superficial, develop below surface mycelium, irregularly circular in outline, dimidate, often confluent, not deeply fringed at margin of ascoma, (90)108–156(180) µm diam., dark brown to blackish, open with central star-shaped fissures. *Scutellum* radiate, composed of dichotomously branched filaments, scutellum cells isodiametric to cylindrical, straight in center, slightly undulating at margin of ascoma, in total 4–8(12)×(2.5)3–5(6) µm, brown to dark brown, at tips paler, wall up to 0.5 µm thick. *Asci* globose to ovate, with small ocular chambers, bitunicate, ascus walls I+, (26)27–30(33) µm diam., 8–spored, hyaline, ascogenous hyphae indistinct, slimy, disintegrate early, interascal tissue absent. *Ascospores* numerous, 2–celled, ellipsoidal, ends broadly rounded, constricted at septum, total (18)19–21 µm long, upper cell (9)10–11 µm wide, lower cell 8–9(10) µm wide, first hyaline, brown when fully mature, cell wall up to 0.5 µm thick, baculate to capitate ornamentation, up to 1 µm high, germinate first at the distal part of each cell with a stalked and lobed appressorium. *Anamorph* absent.

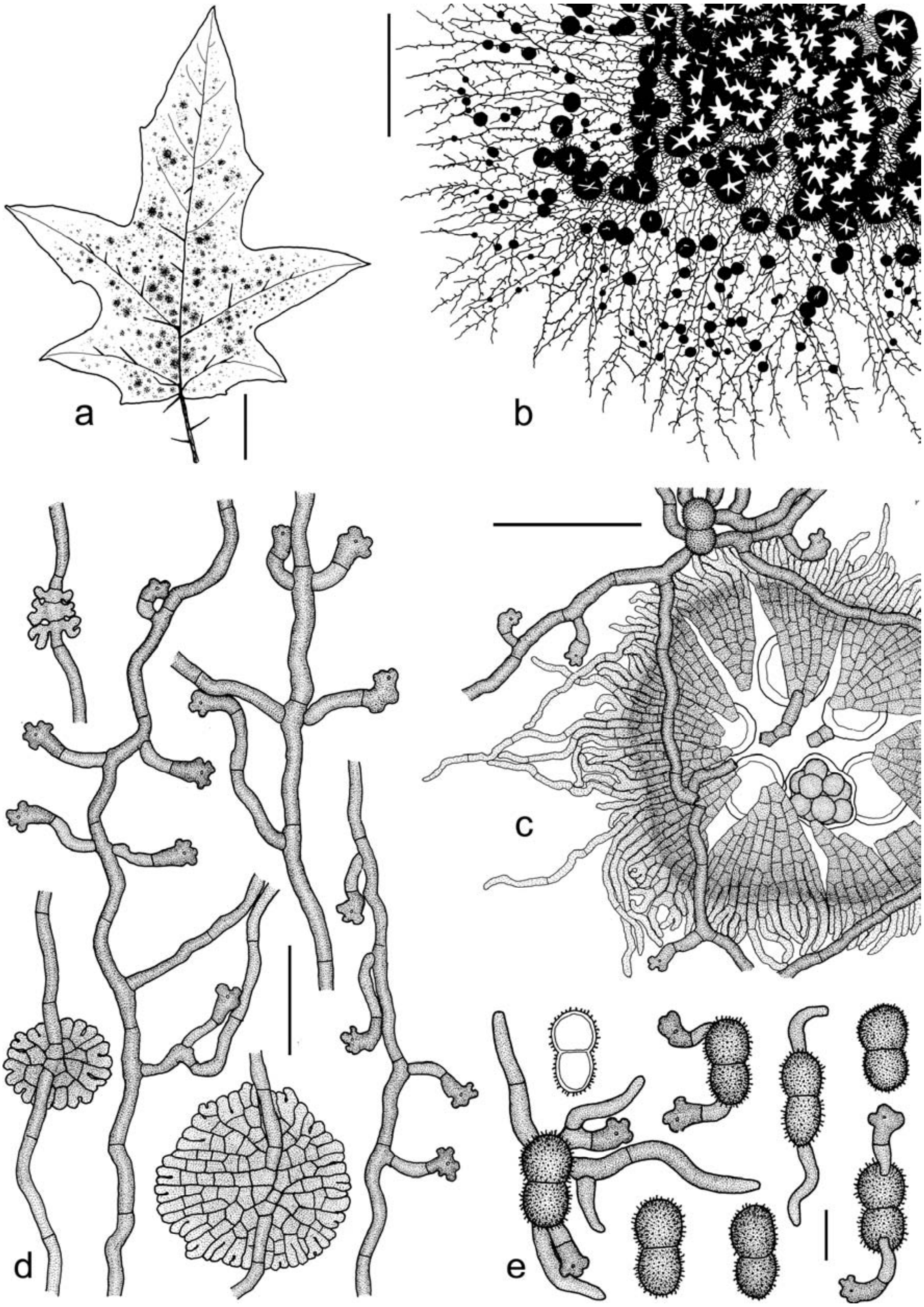

Figure 3.14: ***Asterina diplopoda*** **on** ***Solanum acerifolium*** **(TH 461). a:** Adaxial side of infected leaf. Scale bar = 2 cm. **b:** Part of the colony with confluent thyriothecia and surface mycelium. Scale bar = 400 µm. **c:** Open thyriothecium with mature and immature asci. Scale bar = 50 µm. **d:** Surface mycelium with stalked appressoria and sporoma initials. Scale bar = 25 µm. **e:** Mature, baculate ascospores, some of them germinating. Scale bar = 10 µm.

Illustrations. *A. diplopoda* is illustrated here for the first time.

Hosts. Solanaceae: Solanum acerifolium Dunal, *S. callicarpaefolium* Kunth & Bouché, *Solanum* sp., and *S. stramoniifolium* Jacq.

Known distribution. Neotropical: Caribbean (Trinidad and Tobago), Central America (Costa Rica, Panama) and South America (Colombia, Venezuela). *A. diplopoda* is a new record for Panama. It occurs in Western Panama in humid moutain rainforests of higher elevations at about 2000 m a.s.l.

Specimens examined: COSTA RICA. Alajuela Province: type, see above. **PANAMA. Chiriquí Province:** Parque National Volcán Barú (PNVB), Los Quetzales trail, ca. 2100 m a.s.l., epiphyllous on *Solanum acerifolium* (det. T.A. Hofmann), 5 Jun. 2006, *T.A. Hofmann 461* (FR; M-0141086; PMA).

Additional specimens examined. ***Asterina corallopoda*** **Syd.: ECUADOR. Pastaza Province:** Puyo, on *Solanum trachycyphum* Bitter, 15 Feb. 1938, *H. Sydow 1205* (BPI 689463, ex-type).

Notes. *A. diplopoda* is morphologically similar to *A. corallopoda* and was discussed in detail before (see notes of *A. corallopoda*).

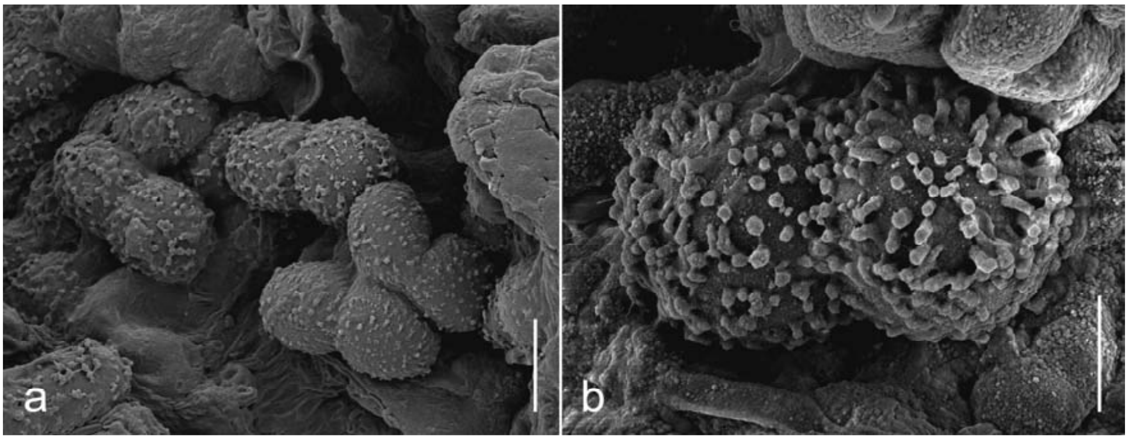

Figure 3.15: SEM photographs of *Asterina diplopoda* on *Solanum acerifolium* (TH 461). a-b: Mature, ascospores with baculate ornamentation. **a:** Scale bar = 10 µm. **b:** Scale bar = 5 µm.

Asterina ekmanii Petr. & Cif., Ann. Mycol. 30(3/4): 158 (1932). Fig. 3.16

Type on *Gonzalagunia spicata* (Rubiaceae). Dominican Republic, Santiago Province, Cordillera Septentrional, Loma Serrazo, 750 m a.s.l., 20 Feb. 1930, *E.L. Ekman 3211* (lectotype, designated here), S F49028!).

Colonies epiphyllous, inconspicuous and poorly defined, single, later confluent, sometimes covering large parts on the adaxial side of the leaf, 0.5–3 mm diam. (n=10), black. *Surface hyphae* undulating, zigzag-like, branching unilateral or alternate, brown, hyphal tips paler, septate, hyphal cells cylindrical, (10)15–27(35)×(2.5)3–4(4.5) µm (*n*=40), cell wall up to 1 µm thick, smooth. *Appressoria* few, ellipsoidal to ovate, entire or slightly sinuate, rarely with 1 or 2 small lobes, sessile, unilateral or alternate, never opposite, without stalk cell, (4)5–6(7)×(7)8–10(11) µm (*n*=40), brown, penetration pore in central part of appressorium, paler than appressorium, up to 1 µm diam. *Haustoria* inconspicuous. *Thyriothecia* superficial, develop below surface hyphae, irregularly circular in outline, dimidate, single, but often becoming confluent, not very fringed at margin of ascoma, (60)88–146(180) µm diam. (*n*=40), dark brown to blackish, margin paler, open with central star-shaped or irregular fissures. *Scutellum* radiate, composed of dichotomously branched filaments, scutellum cells isodiametric to cylindrical, straight or slightly sinuate in center, meandrical and elongated at margin of ascoma, (4.5)6–13(20)×(2)3–4(5) µm (*n*=40), brown to dark brown. *Asci* few, disintegrate early, globose to ovate, with distinct ocular chambers, bitunicate, ascus walls slightly I+, (20)24–30(32) µm diam. (*n*=21), hyaline, ascogenous hyphae indistinct, evanescent, interascal tissue present, filamentous, septate, disintegrates early. *Ascospores* few, 2–celled, ellipsoidal, sometimes slightly curved, ends acuminate, slightly constricted at septum, tapering to one or both ends, (16)18–21(22)×7(8) µm (*n*=33), brown when mature, cell wall up to 1 µm thick, smooth, germinate first laterally at the upper cell with a slightly lobed appressorium.

Illustrations. *A. ekmanii* is illustrated here for the first time.

Hosts. Rubiaceae: *Gonzalagunia rudis* (Standl.) Standl. and *G. spicata* (Lam.) M. Gómez. *G. rudis* is a new host species of *A. ekmanii*.

Known distribution. Neotropical: Caribbean (Dominican Republic) and Central America (Panama). *A. ekmanii* is a new record for Central America and Panama. Occurs in Western Panama in disturbed areas of humid lowland rainforests on the Caribbean side of the central Cordillera from about 50 to 600 m a.s.l.

Specimens examined: **DOMINICAN REPUBLIC. Santiago Province:** lectotype, see above. **PANAMA. Bocas del Toro Province:** El Valle, Finca Celestine, Road side, ca. 600 m a.s.l. epiphyllous on *Gonzalagunia rudis* (det. T.A. Hofman), 28 Sep. 2005, *T.A. Hofmann et al. 326* (M-0141087; PMA). — Teribe river, forest near plantation above Bonjik, ca. 55 m a.s.l., epiphyllous on *Gonzalagunia rudis* (det. T.A. Hofmann), 24 Oct. 2005, *T.A. Hofmann 403* (M-0141088; PMA); same locality and host species, 2 Oct. 2007, *T.A. Hofmann 570* (FR; PMA).

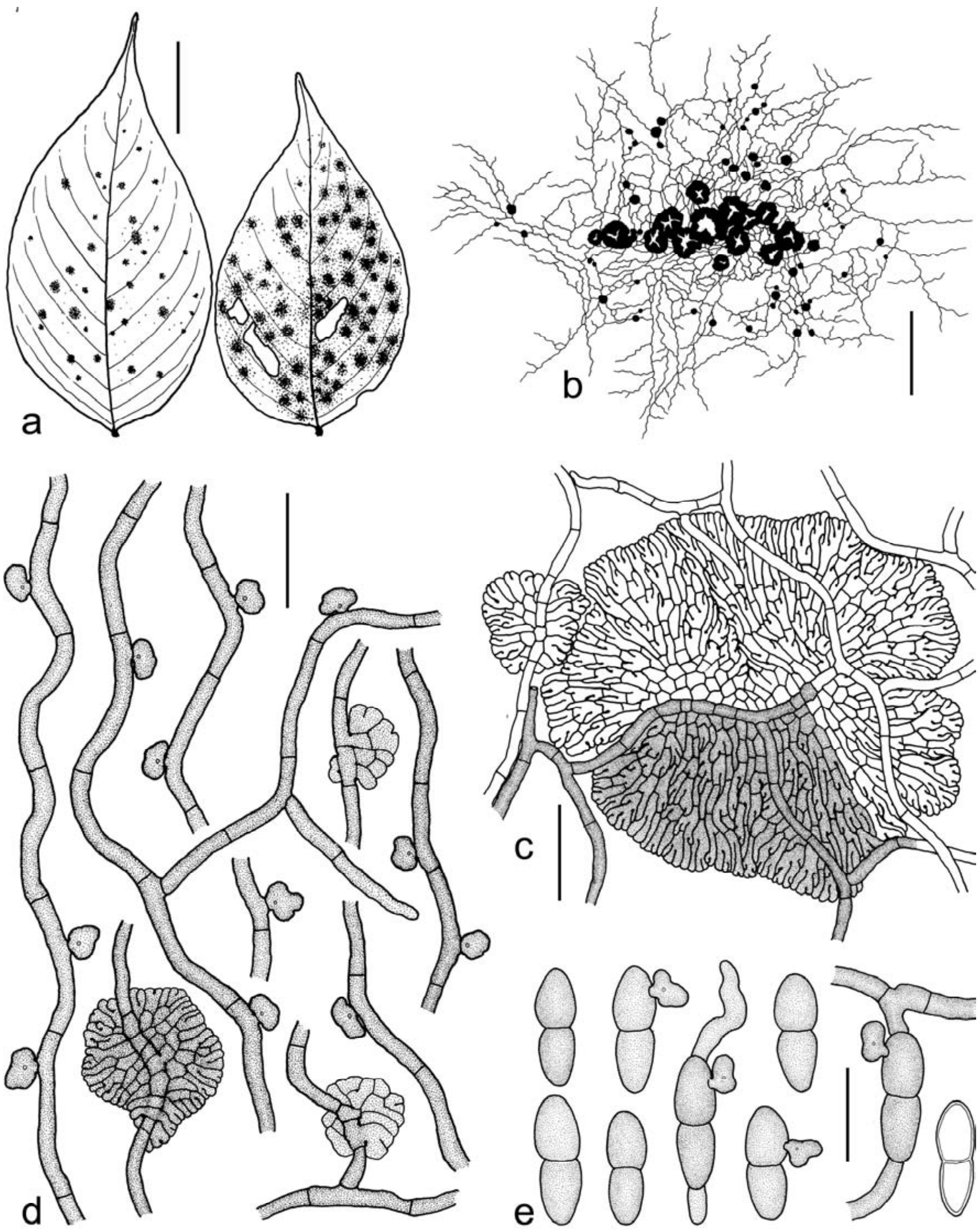

Figure 3.16: ***Asterina ekmanii*** **on** ***Gonzalagunia rudis*** **(TH 326). a:** Infected leaves. Scale bar = 2 cm. **b:** Entire colony with confluent thyriothecia and surface mycelium. Scale bar = 500 µm. **c:** Young thyriothecium with undulating scutellum cells, pigmentation only partly shown. Scale bar = 30 µm. **d:** Surface mycelium with appressoria and sporoma initials. Scale bar = 25 µm. **e:** Mature ascospores, some of them germinating. Scale bar = 15 µm.

Notes. Typical for *A. ekmanii* are the simple, globose to ellipsoidal and sessile appressoria and the narrow ascospores with acuminate ends.

According to Hosagoudar and Abraham (2000), 22 species of *Asterina* are described from Rubiaceae. Nevertheless, only *A. ekmanii* is known to parasitize species of *Gonzalagunia*. A complete revision of all species of *Asterina* on Rubiaceae is still missing and *A. ekmanii* probably is a synonym of an earlier described taxon.

Asterina fuchsiae **Syd., Ann. Mycol. 37: 385 (1939). Fig. 3.17**

Type on *Fuchsia scabriuscula* Benth. (Onagraceae). Ecuador, Tungurahua Province, Hacienda San Antonio, 18 Dec. 1937, *H. Sydow 574* (type n.v.)

Colonies epiphyllous, inconspicuous and poorly defined, single, 0.5–3 mm diam. (*n*=10), dark brown. *Surface hyphae* undulating, branching opposite, alternate or unilateral, brown, hyphal tips paler, septate, hyphal cells cylindrical, (11)1626(30)×(3)4.5–5.5 µm, cell wall up to 1 µm thick, smooth. *Appressoria* variable in shape, with 3–4(5) deep lobes, lobes asymmetrical, unilateral or alternate, sessile, without stalk cell, 7–11(19)×9–12(13) µm (*n*=40), brown, penetration pore inconspicuous. *Haustoria* not seen. *Thyriothecia* superficial, develop terminally on lateral hyphae, irregularly circular, dimidiate, single or confluent, with fringed margins, (80)87–114(140) µm diam. (*n*=40), brown, open with central star-shaped fissures. *Scutellum* radiate, composed of dichotomously branched filaments, scutellum cells isodiametric to cylindrical, straight in center, undulating at margin of ascoma, (3)5–9(11)×3–6(7) µm, brown, at tips paler. *Asci globose*, bitunicate, with ocular chambers, I–, (20)22–26(28) µm diam., 8–spored, hyaline, develop on ascogenous hypahe with proliferating croziers, interascal tissue absent. *Ascospores* few, 2–celled, ellipsoidal, ends rounded, lower cell tapering to one end, slightly constricted at septum, 14–17(18)×7–8 µm (*n*=20), brown when mature, cell wall up to 1 µm thick, smooth, germinate first at the distal part or laterally at each cell with a lobed appressorium or surface mycelium. *Anamorph* absent.

Illustrations. In Hofmann and Piepenbring (2008) and this contribution.

Hosts. Onagraceae: *Fuchsia scabriuscula* Benth. and *F. paniculata* Lindl. *F. paniculata* is a new host species of *A. fuchsiae* (Hofmann and Piepenbring 2008).

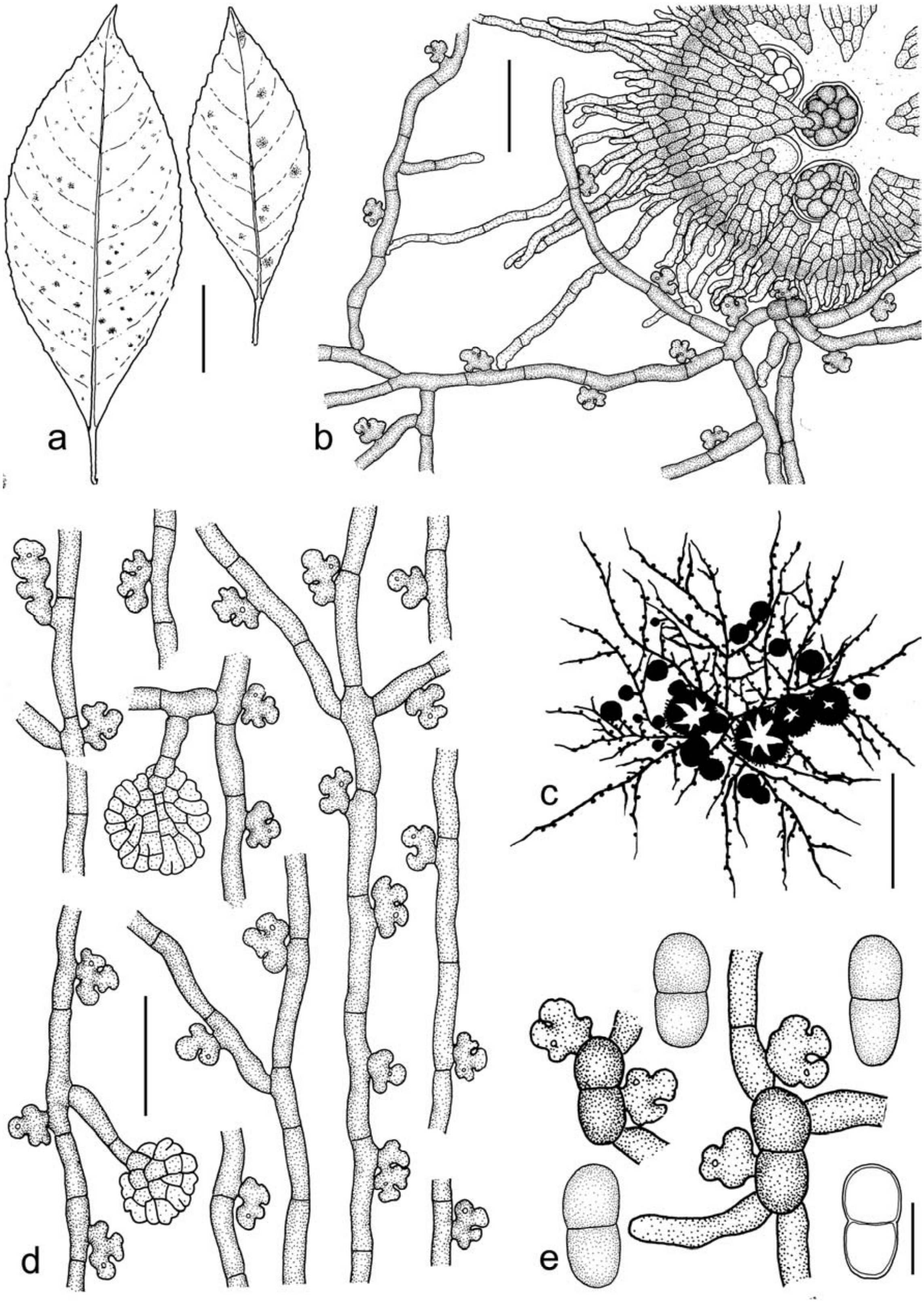

Figure 3.17: *Asterina fuchsiae* on *Fuchsia paniculata* (TH 312). a: Adaxial side of infected leaves. Scale bar = 2 cm. **b:** Mature thyriothecium with asci and surface mycelium. Scale bar = 25 µm. **c:** Entire colony with thyriothecia and surface mycelium. Scale bar = 250 µm. **d:** Surface mycelium with lobed appressoria and ascoma initials. Scale bar = 20 µm. **e:** Mature ascospores, some of them germinating. Scale bar = 10 µm.

Known distribution. Neotropical: Central America (Panama) and South America (Ecuador). *A. fuchsiae* is a new record for Central America and Panama (Hofmann and Piepenbring 2008). It occurs in Western Panama in humid mountain rainforests of higher elevations at approx. 2500 m a.s.l.

Specimens examined: **ECUADOR. Tungurahua Province:** Hacienda San Antonio, on *Fuchsia scabriuscula*, 18 Dec. 1937, *H. Sydow 1206* (HBG 1609 syntype?). **PANAMA. Chiriquí Province:** Parque National Volcán Barú (PNVB), Los Quetzales trail, ca. 2500 m a.s.l., epiphyllous on *Fuchsia paniculata* (det. T.A. Hofmann), with three different hyperparasites, 15 Sep. 2005, *T.A. Hofmann et al. 312* (M-0140967, PMA); same locality and host species, 5 Jun. 2006, *T.A. Hofmann 457* (M-0140968, PMA). — Parque National Volcán Barú (PNVB), path to Los Quetzales trail, ca. 2300 m a.s.l., epiphyllous on *Fuchsia paniculata* (det. T.A. Hofmann), 20 Oct. 2007, *T.A. Hofmann 590* (M-0140969, PMA).

Notes. In some herbaria, specimens of *A. fuchsiae* are deposited as *Fungi exotici exsiccati 1206* (HBG, BR, S). The exsiccate number *1206* is not cited in the protologue of the species, but the exsiccate specimens were collected by the same collector from the same plant species at the same date and locality as the type specimen. Therefore, the exsiccate specimens are probably part of the type collection and represent syntypes of *A. fuchsiae*. The examined specimen from Ecuador contains less variable appressoria, however, the sizes of the ascomata, asci and ascospores are very similar to the specimens from Panama.

According to Hosagoudar and Abraham (2000), *A. fuchsiae* is the only species of *Asterina* described from Onagraceae.

Asterina gaiadendricola **T.A. Hofmann, in Hofmann and Piepenbring, Mycol. Prog. 7: 88 (2008).** **Figs. 3.18, 3.19**

Type hypophyllous on *Gaiadendron punctatum* (Ruiz & Pav.) G. Don (Loranthaceae, det. D. Cáceres). Panama, Chiriquí Province, Parque Internacional de la Amistad (PILA), path to La Cascada, ca. 2450 m a.s.l., associated with unknown species of Parmulariaceae, 22 Apr. 2006, *T.A. Hofmann 440-A* (holotype, M-0140963!; isotype, PMA!).

Anamorph: *Asterostomella*-like, not treated as distinct species by the author.

Colonies hypophyllous, irregularly circular, single, in later stages confluent, 1–7 mm diam. (*n*=10), black. *Surface hyphae* irregularly undulating, branching unilateral or alternate, netlike, not rigid or straight, brown, apically paler, septate, hyphal cells cylindrical, (8.5)15–30(35)×3–4(5) µm, cell wall 1 µm thick, smooth. *Appressoria* numerous, only above stomatal guard cells, stalked, ellipsoidal to spathulate, tips rounded to acuminate, sometimes stalked with one appressorial cell or bifurcate with two appressorial cells, (7.5)9–12(13)×6–7(9) µm (n=40), brown, appressoria slightly darker than mycelial hyphae. *Haustoria* inconspicuous, within guard cells. *Thyriothecia* superficial, develop below surface mycelium, circular, dimidiate, single or slightly confluent, fringed at margins, (180)201–273(330) µm diam. (n=34), brown, open with irregular to star-shaped central fissures. *Scutellum* radiate, composed of dichotomously branched filaments, scutellum cells isodiametric to cylindrical, straight in center, undulating at margin of ascoma, (3)5–7(9)×(2)3–5(6) µm, brown, at tips paler. *Asci* in most cases immature, few mature asci, globose to ovate, with distinct ocular chambers, bitunicate, I–, (35)40–46(47) µm diam. (*n*=13), 8–spored, hyaline, develop on ascogenous hyphae with proliferating croziers, interascal tissue present, filamentous, septate. *Ascospores* few, 2–celled, ellipsoidal, ends rounded, constricted at septum, slightly tapering at one end, (25)28–31(34) µm long (*n*=24), upper cell (13)14–15(16) µm wide, lower cell 11–13(14) µm wide, brown, cell wall up to 1 µm thick, smooth, germinating ascospores not observed.

Anamorph present, *Asterostomella*-like. *Pycnothyria* numerous, superficial, developing below surface mycelium, circular, dimidiate, single or slightly confluent, not as fringed as ascomata, (90)97–123(140) µm diam. (*n*=40), brown to dark brown, smaller than thyriothecia. *Scutellum* similar to scutellum of thyriothecia. *Conidiogenous cells* monoblastic, formed inside the pycnothyrial cavity by single cells of the inner part of the scutellum layer. *Conidia* numerous, 1–celled, broadly clavate, more rarely ellipsoidal, (17)21–26(29)×(11)14–18(19) µm (*n*=40), brown, without hyaline band, with pale and truncate hilum, smooth, germinating conidia not observed.

Illustrations. In Hofmann and Piepenbring (2008) and this contribution.

Hosts. Loranthaceae: *Gaiadendron punctatum* (Ruiz & Pav.) G. Don.

Known distribution. Endemic to Panama, only known from the type locality. *A. gaiadendricola* occurs in Panama in humid mountain rainforests of higher elevations at about 2500 m a.s.l (Hofmann and Piepenbring 2008).

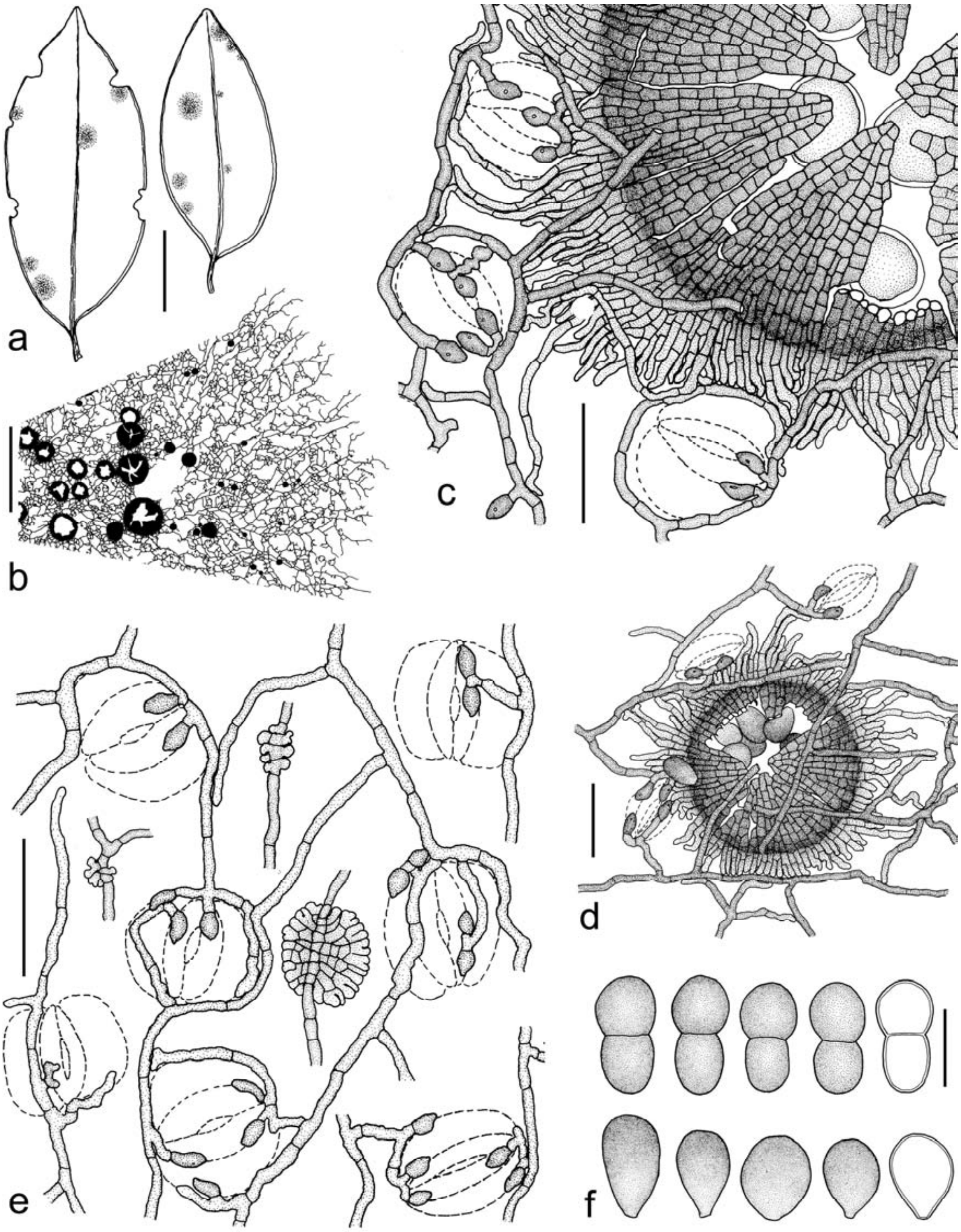

Figure 3.18: ***Asterina gaiadendricola*** **on** ***Gaiadendron punctatum*** **(holotype).** Guard cells of stomata are indicated with dottet lines. **a:** Abaxial side of infected leaves. Scale bar = 2 cm. **b:** Part of colony with thyriothecia and surface mycelium. Scale bar = 600 µm. **c:** Part of an open young thyriothecium with immature asci. Scale bar = 40 µm. **d:** Open pycnothyrium with mature conidia and surface mycelium. Scale bar = 40 µm. **e:** Surface mycelium with appressoria on stomata and sporoma initials. Scale bar = 50 µm. **f:** Mature ascospores (upper line) and conidia (lower line). Scale bar = 20 µm.

Specimens examined: PANAMA. Chiriquí Province: Type see above; same locality and host species, associated with a hyphomycetous hyperparasite and with an unidentified species of Parmulariaceae, 22 Sep. 2005, *M. Piepenbring et al. 3585-A* (paratypes, BPI 878814, PMA); same locality and host species, 4 Apr. 2008, *T. Trampe & A. Pfaff 662-A* (FR, PMA).

Notes. Nine species of *Asterina* are described on Loranthaceae but no species is known from the host genus *Gaiadendron* (Hofmann and Piepenbring 2008). A key to species of *Asterina* on Loranthaceae is presented by Hofmann and Piepenbring (2008). The hypophyllous growth and the unique morphology of appressoria as well as their exclusive occurrence on stomatal guard cells makes the fungus on *Gaiadendron punctatum* different from all *Asterina* spp. on Loranthaceae (Hofmann and Piepenbring 2008).

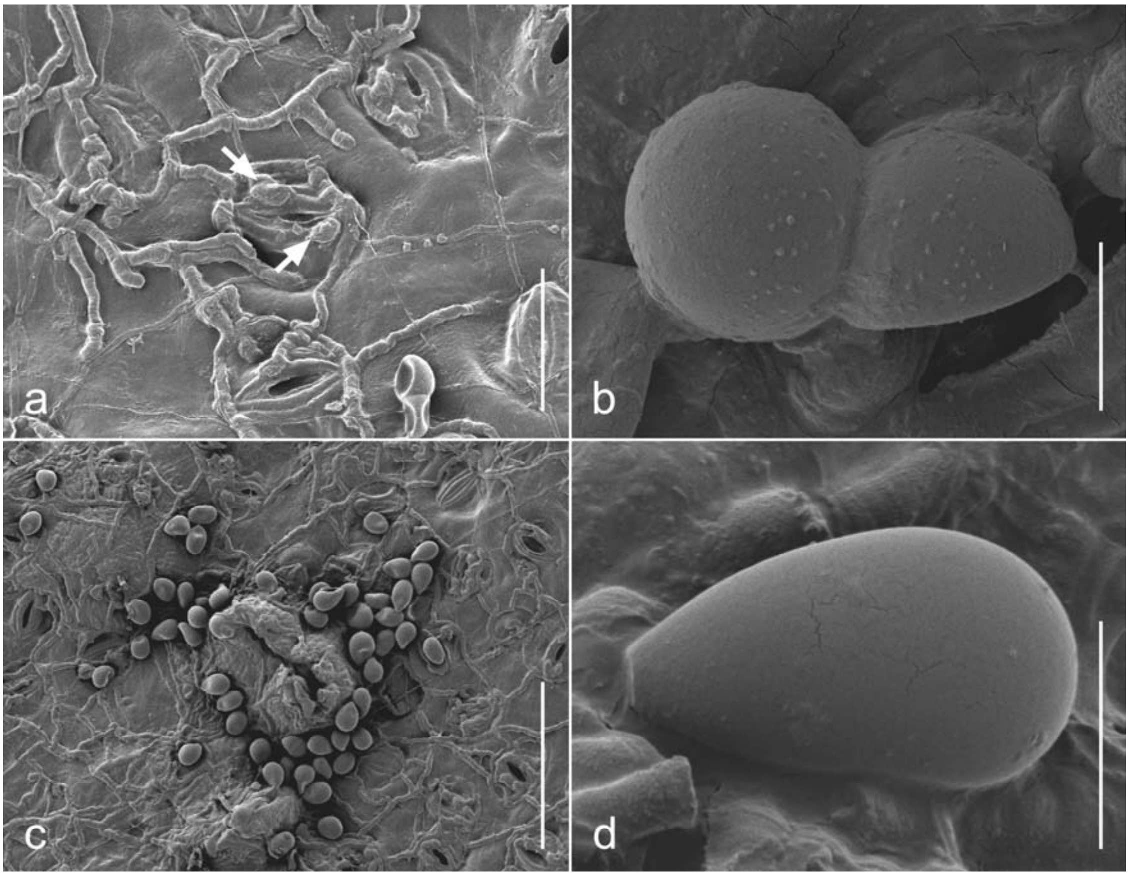

Figure 3.19: SEM photographs of *Asterina gaiadendricola* on *Gaiadendron punctatum* (holotype). a: Surface mycelium with appressoria (arrows) on stomatal guard cells. Scale bar = 50 µm. **b:** Mature ascospore. Scale bar = 10 µm. **c:** Sporomata with free, mature conidia. Scale bar = 100 µm. **d:** Mature conidium. Scale bar = 10 µm.

Asterina manihotis **Syd., Ann. Mycol. 37: 233 (1939).   Figs. 3.20, 3.21, 3.22**

Type on *Manihot glaziovii* Müll. Arg. (Euphorbiaceae). Sierra Leone, Mabang, 27 Nov. 1936, *F.C. Deighton 1264* (type, n. v.).

Colonies epiphyllous, inconspicuous and not well defined, irregular in outline, single, later becoming confluent and than covering large parts of the leaf surface, 0.5–3 mm diam. (*n*=10), dark brown. *Surface hyphae* slightly undulating, branching opposite, alternate or unilateral, brown, septate, hyphal cells cylindrical, (13)18–32(38)×4–5 µm, cell wall up to 1 µm thick, smooth. *Appressoria* numerous, straight to slightly curved, entire, with stalk cell, total length (10)11–16(22) µm, brown, stalk cell short cylindrical, in right angles or curved towards hyphal growth direction, unilateral or alternate, 2–6(13)×3–4(5) µm, appressorial cell irregularly ellipsoidal, straight to curved, sinuate to slightly 1–3 times lobed, rarely entire, (7)8–10(11)×(5)6–9(10) µm, penetration pore inconspicuos. *Haustoria* inconspicuous. *Thyriothecia* superficial, develop below surface mycelium, circular, dimidiate, single or slightly confluent, margins fringed, (60)80–110(130) µm diam., brown, open with central star-shaped fissures, early wide open to expose mature and immature asci. *Scutellum* radiate, composed of dichotomously branched filaments, scutellum cells isodiametric to cylindrical, straight in center, undulating at margins of ascoma, (3)4–8(11)×(2)3–4(5) µm, brown, at tips paler. *Asci* globose, with distinct ocular chambers, bitunicate, I–, (25)27–32(35) µm diam., 8–spored, hyaline, ascogenous hyphae indistinct, interascal tissue not observed. *Ascospores* numerous, 2–celled, ellipsoidal, ends broadly rounded, constricted at septum, 17–20 µm long, upper cell (8)9–10 µm wide, lower cell (7)8–9(9.5) µm wide, brown when mature, cell wall up to 1 µm thick, verrucose, ascospores germinate first at the distal part of each cell with a stalked and lobed appressorium. *Anamorph* absent.

Illustrations. In Hofmann and Piepenbring (2008) and this contribution. The surface composition of the mycelium and young ascomata initials of *A. manihotis* in SEM analysis are illustrated here for the first time.

Hosts. Euphorbiaceae: *Manihot esculenta* Crantz, *Manihot glaziovii* Müll. Arg., *Manihot* sp. and *M. utilissima* Pohl.

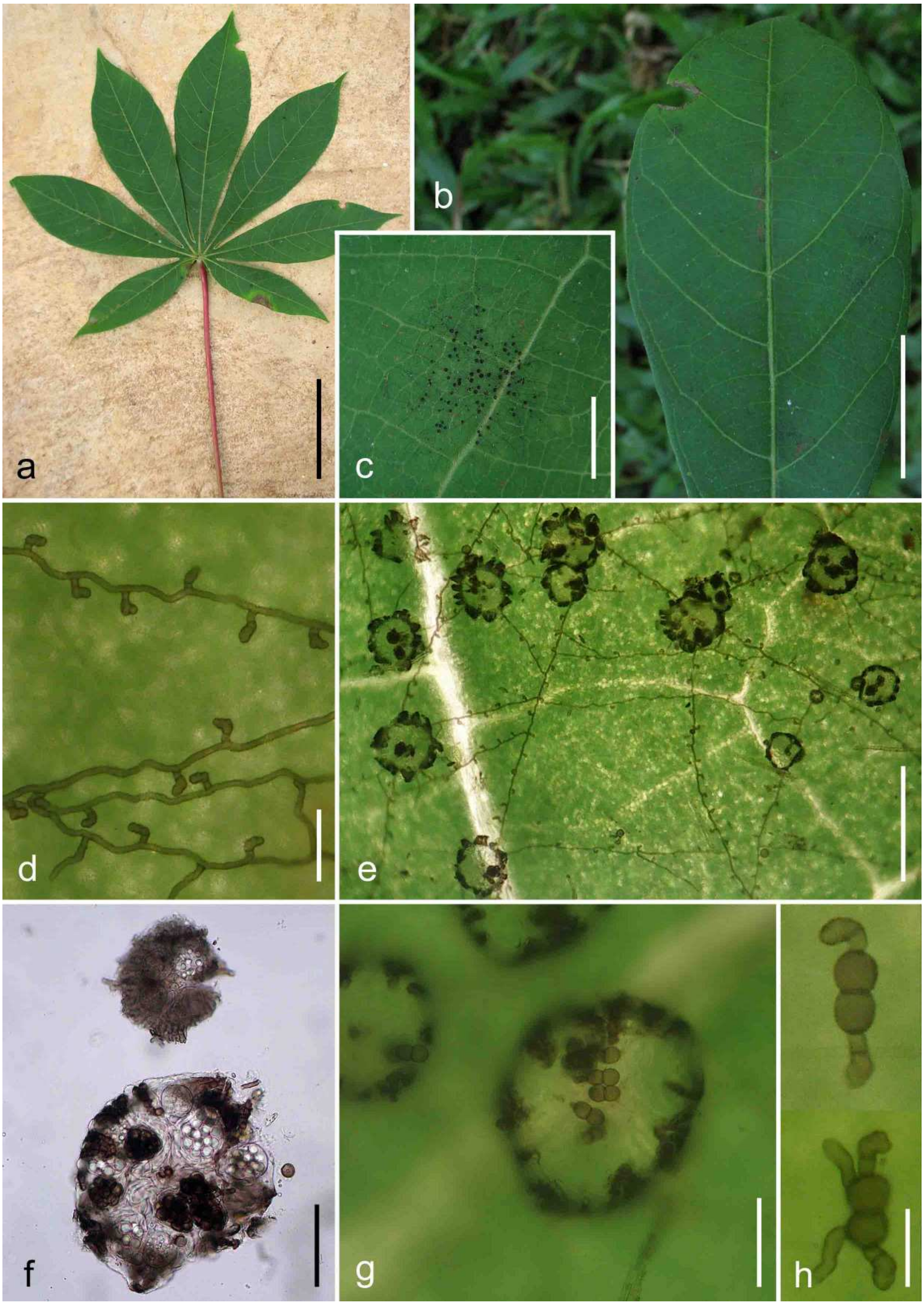

Figure 3.20: *Asterina manihotis* on *Manihot esculenta* (TH 534). a: Leaf of host plant. Scale bar = 5 cm. **b:** Infected leaflet with several inconspicuous colonies. Scale bar = 1.5 cm. **c:** Single colony. Scale bar = 1 mm. **d:** Surface mycelium with stalked appressoria. Scale bar = 50 µm. **e:** Mature, widely open thyriothecia and surface mycelium. Scale bar = 200 µm. **f:** Young ascoma initial and open ascoma with mature and immature asci. Scale bar = 50 µm. **g:** Open ascomata with liberated, mature ascospores. Scale bar = 50 µm. **h:** Germinating ascospores. Scale bar = 20 µm.

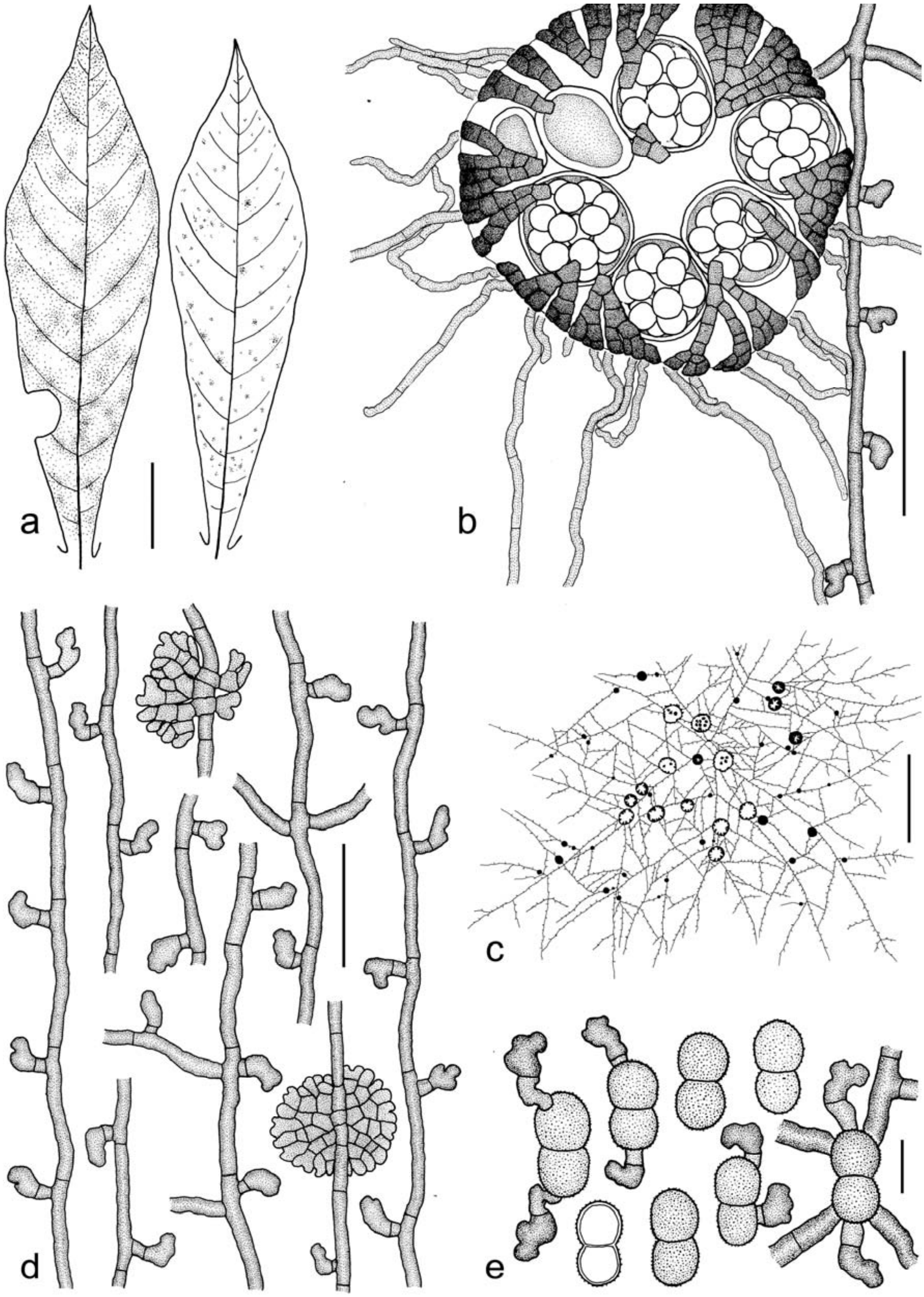

Figure 3.21: ***Asterina manihotis*** **on** ***Manihot esculenta*** **(TH 494). a:** Adaxial side of infected leaves. Scale bar = 2 cm. **b:** Widely open thyriothecium with immature asci. Scale bar = 45 µm. **c:** Part of the colony with widely, open thyriothecia and surface mycelium. Scale bar = 500 µm. **d:** Surface mycelium with stalked appressorium and ascoma initials. Scale bar = 30 µm. **e:** Mature, slightly verrucose ascospores, some of them germinating. Scale bar = 10 µm.

Known distribution. Pantropical: Africa (Ghana, Ivory Coast, Sierra Leone), Caribbean (Barbados), Central America (Panama) and Southeast Asia (Malaysia). *A. manihotis* is a new record for Central America and Panama (Hofmann and Piepenbring 2008). *A. manihotis* occurs in Western Panama in open lowland vegetation and is widespread, due to the cultivation of its host.

Specimens examined. SIERRA LEONE. Mojamba District: Njiala (Kori), on *Manihot esculenta* Crantz (Euphorbiaceae), 23 Feb. 1953, *F.C. Deighton* (BPI 690036). **PANAMA. Chiriquí Province:** Los Algarrobos, private garden, ca. 140 m a.s.l., epiphyllous on *Manihot esculenta* (det. T.A. Hofmann), associated with Meliolales, 3 Jan. 2007, *T.A. Hofmann 494* (M-0140970, PMA); same locality and host species, 12 Sep. 2007, *T.A. Hofmann 534* (M-0140971, PMA); same locality and host species, 1 Nov. 2007, *T.A. Hofmann 607* (FR; PMA).

Notes. The ascomata of *A. manihotis* open widely to expose mature and immature asci.

According to Hosagoudar and Abraham (2000), 31 species of *Asterina* are known from Euphorbiaceae. Nevertheless, *A. manihotis* is the only species of *Asterina* known to parasitize species of *Manihot*.

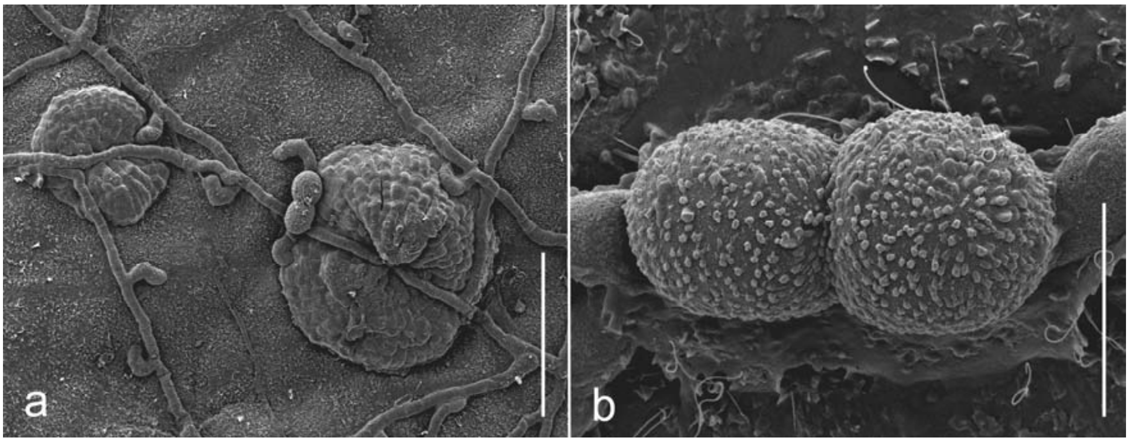

Figure 3.22: SEM photographs of *Asterina manihotis* on *Manihot esculenta* (TH 494). a: Surface mycelium with lateral appressoria, sporoma initials and a germinating ascospore. Scale bar = 50 µm. **b:** Mature, verrucose ascospore. Scale bar = 10 µm.

Asterina phenacis Syd., Ann. Mycol. 25 (1/2): 66 (1927). Figs. 3.23, 3.24

Type on *Phenax hirtus* Wedd. (Urticaceae). Cost Rica, Alajuela Province, Grecia, 14 Jan. 1925, *H. Sydow 72* (type, n.v.).

Colonies epiphyllous, irregularly circular, single, later sometimes confluent, 0.5–3 mm diam. (n=10), black. *Surface hyphae* straight to slightly undulating, branching opposite, alternate or unilateral, brown, hyphal tips paler, septate, hyphal cells cylindrical, (10)17–31(35)×(3.5)4–5(6) µm, cell wall up to 1 µm thick, smooth. *Appressoria* numerous, with stalk cell, unilateral or alternate, total length (9)11–17(23) µm (*n*=110), brown, stalk cell short cylindrical, strongly curved towards growth direction, (2.5)3–7(11)×3–5(9) µm, appressorial cell ellipsoidal to slightly digitate, sinuate with 1–3 lobes, curved towards hyphal growth direction, sometimes slightly darker than the mycelium, (6)7–10(14.5)×(5)7–9(11) µm, penetration pore visible, smaller than 1 µm diam. *Haustoria* reniform, arbuscular, (7)11–17(20)×6–11(17) µm (n=60), hyaline, filling ca. 1/4 of the host cell. *Thyriothecia* superficial, develop below surface mycelium, irregularly circular in outline, dimidiate, mostly crowded and confluent, margins deeply fringed, (90)106–141(160) µm diam. (*n*=110), brown to dark brown, open with central star-shaped fissures, open widely to expose mature asci. *Scutellum* radiate, composed of dichotomously branched filaments, scutellum cells isodiametric to cylindrical, straight in center, undulating at margin of ascoma, (3)5–10(15)×(2)3–5(6) µm (*n*= 60), brown to dark brown, at tips paler. *Asci* globose to ovate, with small ocular chambers, bitunicate, I–, (25)28–32(35) µm diam. (*n*=42), 8–spored, hyaline, ascogenous hyphae indistinct, interascal tissue not observed. *Ascospores* numerous, 2–celled, ellipsoidal, ends rounded, constricted at septum, (13)18–20(22) µm long (*n*=110), upper cell (9)10–11 µm wide, lower cell (8)9–10 µm wide, brown when mature, cell wall 0.5–1 µm thick, densely verrucose, ascospores germinate first at the distal part of each cell with a lobed appressorium. *Anamorph* absent.

Illustrations. In Hofmann and Piepenbring (2008) and this contribution.

Hosts. Urticaceae: *Phenax hirtus* (Sw.) Wedd., <u>*Phenax mexicanus*</u> Wedd. and an <u>unknown Urticaceae</u>. *P. mexicanus* is a new host species for *A. phenacis* (Hofmann and Piepenbring 2008).

Known distribution. Neotropical: in Central America (Costa Rica, Panama) and South America (Colombia). *A. phenacis* is a new record for Panama (Hofmann and Piepenbring 2008). It occurs in Western Panama in humid mountain rain forests of higher elevations from 1500 to about 2500 m a.s.l.

Specimens examined: **COSTA RICA. Alajuela Province:** Grecia, on *Phenax hirtus*, 14 Jan. 1925, *H. Sydow 684* (syntype?, BPI 690485). **PANAMA. Chiriquí Province:** Boquete, Bajo Mono, ca. 1500 m a.s.l., epiphyllous on *Phenax mexicanus* (det. T.A. Hofmann), 14 Sep. 2005, *T.A. Hofmann et al. 305* (M-

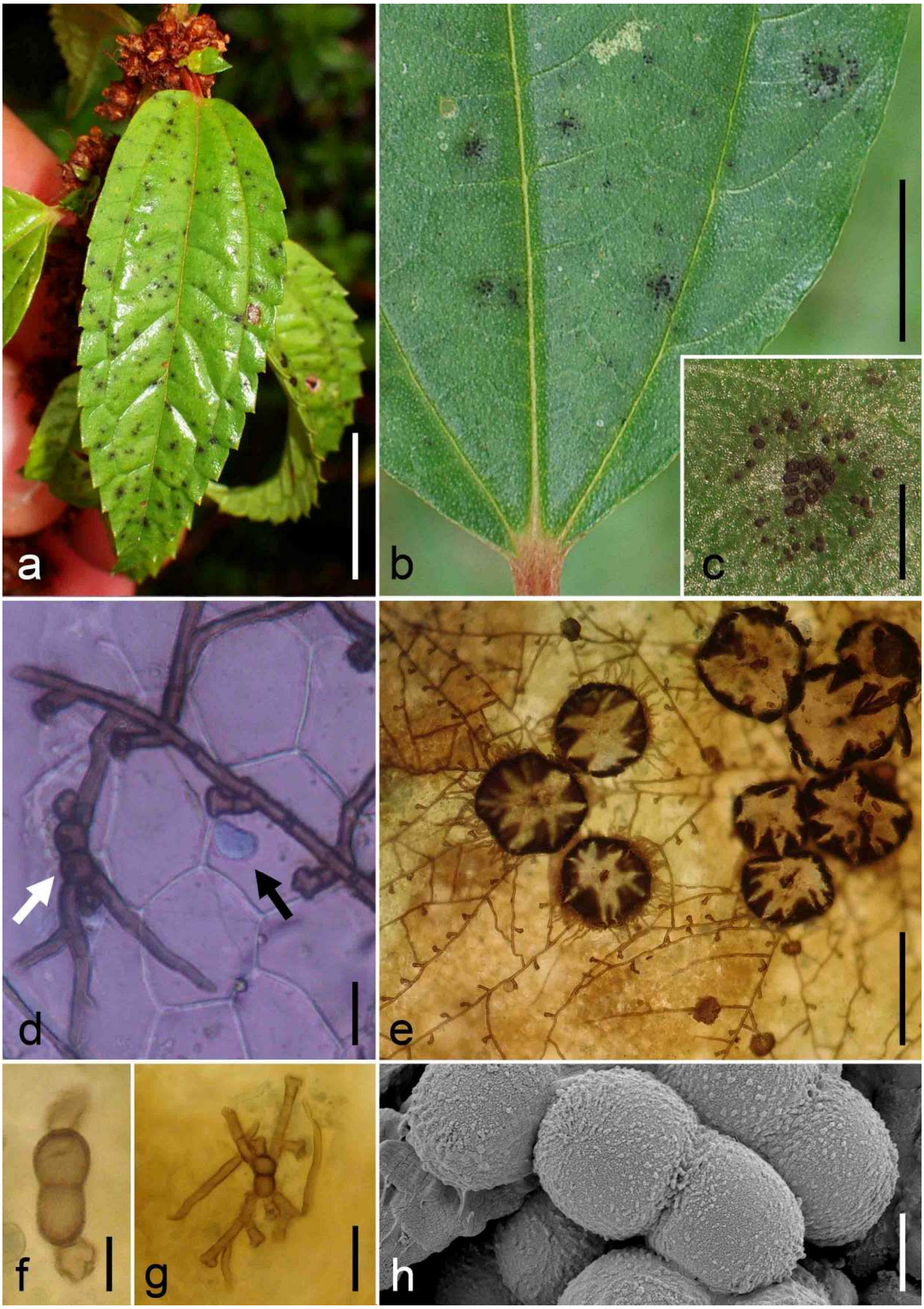

Figure 3.23: ***Asterina phenacis* on *Phenax mexicanus*. a:** Habit on adaxial side of living leaves (TH 455). Scale bar = 1.5 cm. **b:** Infected leaf with several, black colonies (TH 589). Scale bar = 0.5 cm. **c:** Single colony (TH 589). Scale bar = 1 mm. **d:** Germinating ascospore (white arrow) and surface mycelium with stalked appressoria and haustoria within epidermal cell (black arrow) (TH 443). Scale bar = 20 µm. **e:** Mature, open thyriothecia and surface mycelium (TH 589). Scale bar = 100 µm. **f:** Mature, germinating ascospore (TH 589). Scale bar = 10 µm. **g:** Germinating ascospore with surface mycelium and lateral appressoria (TH 589). Scale bar = 30 µm. **h:** SEM photograph of mature, slightly verrucose ascospores (TH 443). Scale bar = 5 µm.

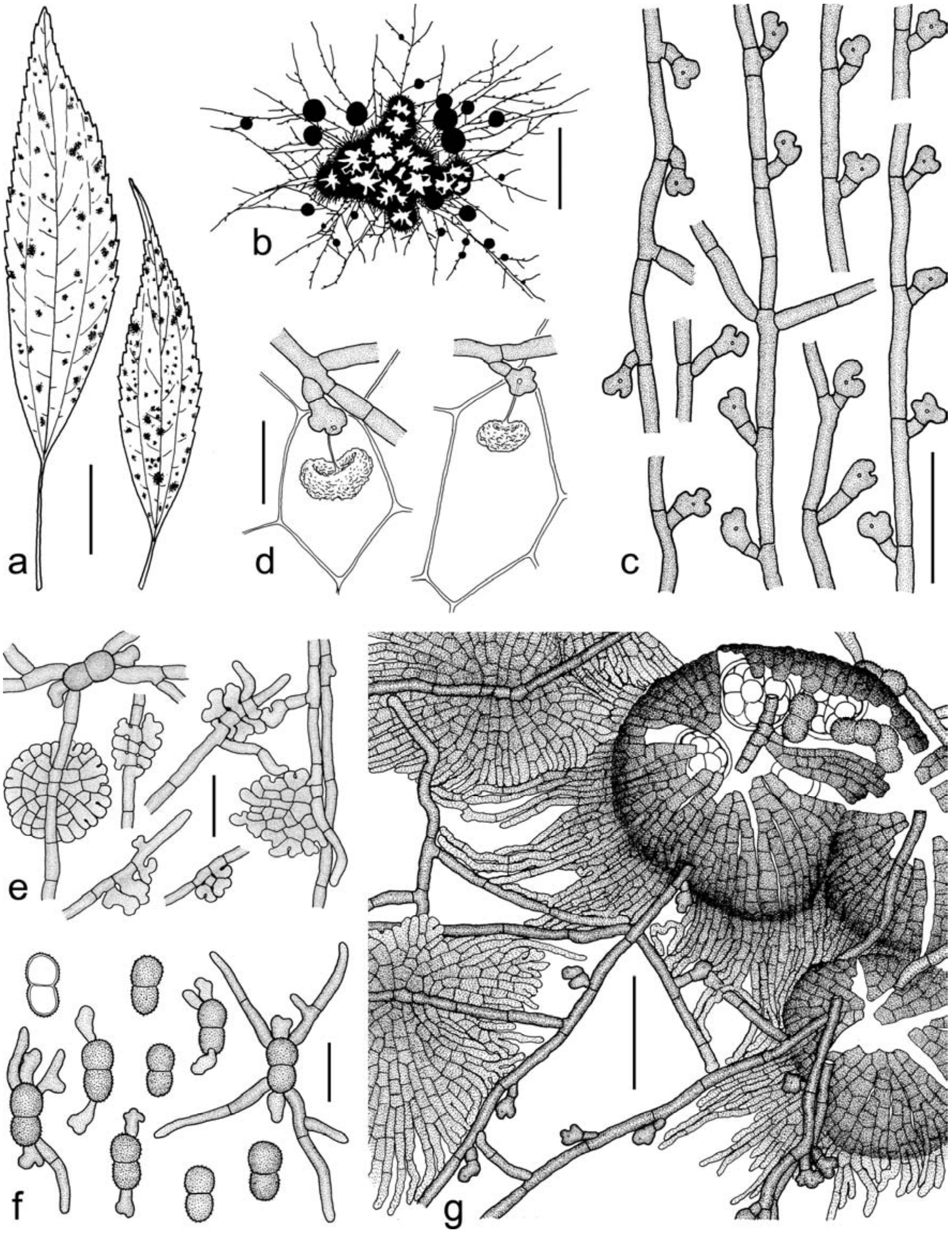

Figure 3.24: ***Asterina phenacis*** **on** ***Phenax mexicanus*** **(TH 443). a:** Adaxial side of infected leaves. Scale bar = 2 cm. **b:** Entire colony with confluent thyriothecia and surface mycelium. Scale bar. = 300 µm. **c:** Surface mycelium with stalked appressoria. Scale bar = 50 µm. **d:** Haustoria within epidermal host cells. Scale bar = 20 µm. **e:** Surface mycelium with ascoma initials and one germinating ascospore. Scale bar = 20 µm. **f:** Mature, slightly verrucose ascospores, some of them germinating. Scale bar = 20. **g:** Mature ascoma within immature neighbouring ascomata. Scale bar = 50 µm.

0140974, PMA); same locality and host species, 3 Mar 2006, *T.A. Hofmann 446* (BPI 878178, PMA); same locality and host species, 3 Mar. 2006, *T.A. Hofmann 450* (FR; PMA); same locality and host species, 29 Mar. 2008, *T. Trampe & A. Pfaff 640* (FR, PMA). — Boquete, path to Pata de Macho, ca. 1700 m a.s.l., epiphyllous on *Phenax mexicanus* (det. T.A. Hofmann), 29 Apr. 2006, *T.A. Hofmann et al.*

443 (BPI 878179, PMA). — Parque Nacional Volcán Barú, Los Quetzales trail, ca. 2500 m a.s.l., epiphyllous on *Phenax mexicanus* (dwarf from at high elevations, det. T.A. Hofmann), 15 Feb. 2003, *M. Piepenbring & R. Kirschner 3140* (M-0140973, PMA), same locality and host species, 5 Jun. 2006, *T.A. Hofmann 455* (BPI 878180, PMA). — Parque Nacional Volcán Barú, path to los Quetzales trail, ca. 2300 m a.s.l., epiphyllous on *Phenax mexicanus* (det. T.A. Hofmann), 20 Oct. 2007, *T.A. Hofmann 589* (M-0140975, PMA). — Road to Piedra de Candela, road margin, ca. 1400 m a.s.l., epiphyllous on unknown Urticaceae (det. T.A. Hofmann), 8 Oct. 2005, *T.A. Hofmann, R. Mangelsdorff & M. Piepenbring ppMP 357* (M-0141009, PMA); same locality, on unknown Urticaceae, 8 Oct. 2005, *T.A. Hofmann, R. Mangelsdorff & M. Piepenbring ppMP 361* (M-0141010, PMA).

Notes. In some herbaria, specimens of *A. phenacis* are deposited as *Fungi exotici exsiccati 684* (BPI, BR, S). The exsiccate specimens are not cited in the protologue of the species, but they were collected by the same collector from the same host plant species at the same locality and date as the type specimen. Therefore, the exsiccate specimens are probably part of the type collection and represent syntypes of *A. phenacis*. The examined BPI specimen of *A. phenacis* from Costa Rica includes a fungus with smaller ascomata that measure (90)95–115(120) µm diam. The material is hyperparasitized and contains apparently a second species of *Asterina* with one celled and lobed appressoria.

According to Hosagoudar and Abraham (2000), 13 species of *Asterina* are known from Urticaceae. Nevertheless, *A. phenacis* is the only species of *Asterina* known to parasitize species of *Phenax*.

Asterina radiofissilis **(Sacc.) Theiss., Ann. Mycol. 10(1): 22 (1912a).**

Figs. 3.25, 3.26

Type on unknown plant. Africa, Saõ Thomé, Sep 1885, *A. Moller s.n.* (type n.v.).

≡ *Dimerium radiofissile* Sacc. [as '*radio-fissile*'], Bol. Soc. Brot. 21: 212 (1904).

= *Asterina natalensis* Doidge, Trans. Roy. Soc. South Africa 8(4): 248, 275 (1920). Type on *Mikania* sp. [=*Ctenomeria capensis* Harv. ex Sond. (Euphorbiaceae) *fide* Doidge 1942]. South Africa, KwaZulu-Natal Province, Winkle Spruit, 28 May 1915, *E.M. Doidge 9001* (type n.v.).

[synonymy according to Doidge (1942)]

Anamorph: *Asterostomella*-like, not treated as distinct species by the author.

Colonies amphigenous, irregularly circular, single, later confluent, sometimes covering large parts of the adaxial side of the leaf, 0.5–2.5 µm diam. (*n*=10), black.

Surface hyphae irregularly undulating, branching unilateral or alternate, brown, hyphal tips paler, septate, hyphal cells cylindrical, (9)16–26(33)×(3.5)4(4.5) µm, cell wall up to 0.5 µm thick, smooth. *Appressoria* numerous, with stalk cell, unilateral or alternate, total length (8)10–14(17) µm (*n*=70), brown, stalk cell short cylindrical, curved towards or backwards hyphal growth direction, (2)3–5(9)×(3.5)4(5) µm (*n*=70), appressorial cell with 2-4 deep lobes, straight or curved, (5)6–9(12)×(8)9–11(16) µm (*n*=70), peneration pore not visible. *Haustoria* inconspicuous. *Thyriothecia* superficial, develop below surface hyphae, circular in outline, dimidate, single or confluent, margins fringed, (90)99–126(150) µm diam. (*n*=60), brown to dark brown, open with central star-shaped fissures. *Scutellum* radiate, composed of dichotomously branched filaments, scutellum cells isodiametrical to cylindrical, straight in center, undulating at margins of ascoma, 4–7(9)×(3)4–5 µm, brown to dark brown, at tips paler. *Asci* globose, with ocular chambers, bitunicate, I–, (15)16–19(21) µm diam. (*n*=40), 8–spored, hyaline, develop on indistinct ascogenous hyphae, interascal tissue not observed. *Ascospores* 2–celled, ellipsoidal, sometimes slightly curved to one side, ends broadly rounded, slightly constricted at septum, lower cell sometimes tapering, (13)14–15(16) µm long (*n*=64), upper cell (6.5)7–8 µm wide, lower cell (5.5)6(6.5) µm wide, brown, cell wall up to 0.5 µm thick, verrucose, germinate first at the distal part of one cell with a lobed appressorium.

Anamorph present, *Asterostomella*-like. *Pycnothyria* numerous, superficial, developing below surface hyphae, circular, dimidiate, single or confluent, fringed at margins, (50)61–75(90) µm diam. (*n*=70), brown to dark brown, smaller than thyriothecia. *Scutellum* radiate, similar to scutellum of the thyriothecia. *Conidiogenous cells* mono-blastic, formed inside the pycnothyrial cavity by single cells of the inner part of the scutellum layer. *Conidia* numerous, 1–celled, broadly clavate, pyriform or ellipsoidal, sometimes curved to one side, (12)14–17(19)×(7)9–10(11) µm (*n*=70), brown, with central hyaline band, smooth, larger than ascospores, germinate first at the region of the hyaline band with a stalked and lobed appressorium.

Illustrations. In Theissen (1913a), Doidge (1942) and this contribution. The ornamentation of the ascospores and the morphology of the conidia are illustrated here for the first time (Fig. 3.26).

Hosts. Euphorbiaceae-Acalyphoideae: <u>*Acalypha arvensis*</u> Poepp., *A. capensis* (L. f.) Prain, *A. decumbens* Thunb., *A. nemorum* F. Muell. ex Müll. Arg., *Ctenomeria capensis*

Harv. ex Sond., *Dalechampia capensis* Sond. and *Erythrococca berberidea* Prain. *A. arvensis* is a new host species of *A. radiofissilis*.

Known distribution. Pantropical: Africa (South Africa), Central America (Panama) and Oceania (Australia). *A. radiofissilis* is a new record for the American Continent, Central America and Panama. It occurs in Western Panama in disturbed rural vegetation from 1200 to about 1400 m a.s.l.

Specimens examined: **PANAMA. Chiriquí Province:** Boquete, Alto Lino, ca. 1270 m a.s.l., epiphyllous on *Acalypha arvensis* (det. T.A.Hofmann), 24 Mar. 2006, *T.A. Hofmann, M. Piepenbring & T. Trampe ppMP 494* (M-0141014, PMA); same locality and host species, 12 Jan. 2007, *T.A. Hofmann, R. Mangelsdorff & T. Trampe ppMP 1216* (M-0141015, PMA). — Road to Piedra de Candela, road margin, ca. 1400 m a.s.l., epiphyllous on *Acalypha arvensis* (det. T.A. Hofmann), 8 Oct. 2005, *T.A. Hofmann, R. Mangelsdorff & M. Piepenbring ppMP 354* (M-0141011, PMA); same locality and host species, 21 Jul. 2006, *T.A. Hofmann, R. Mangelsdorff & T. Trampe ppMP 1189* (M-0141012, PMA); same locality and host species, 18 Jan. 2007, *T.A. Hofmann, R. Mangelsdorff & T. Trampe ppMP 1247* (M-0141013, PMA).

Additional specimens examined. ***Asterina acalyphae*** **Syd.:** **COSTA RICA. Alajuela Province:** Grecia, epiphyllous on *Acalypha macrostegia* var. *hirsutissima*, 19 Jan. 1925, *H. Sydow 676* (BPI 689213). ***Asterina tenuis*** **G. Winter:** **UGANDA. Masaka District:** Masaka Road, epiphyllous on *Acalypha* sp., Jun. 1937, *G.C. Hansford U1999* (BPI 690570).

Notes. The type material and host plants of *A. radiofissilis* were discussed in detail by Doidge (1942). According to Theissen (1912a), *A. radiofissilis* is probably closely related to *A. tenuis* G. Winter, *A. kwangensis* Henn. (= *A. diplocarpa* Cooke) und *A. vagans Speg.*, but explicit differences were not specified by the author. The sizes of appressoria, ascomata, asci and ascospores from the original description of *A. tenuis* (Winter 1886), were very similar to those of *A. radiofissilis*. However, Theissen (1913a) listed *A. tenuis* under his category of doubtful species because the type material was missing and numerous probably heterogeneous specimens labeled as *A. tenuis* were distributed in many herbaria. *A. diplocarpa* from Africa and *A. vagans* from Brazil differ in some morphological aspects from *A. radiofissilis*. *A. diplocarpa* has a surface mycelium with unstalked appressoria and parasitizes Malvaceae (Cooke 1882, Doidge 1942). *A. vagans* has stalked, multilobate appressoria, larger ascospores with 24×11.25 µm and parasitizes Solanaceae (Arnaud 1918, as *Dimerosporium vagans* (Speg.) G. Arnaud).

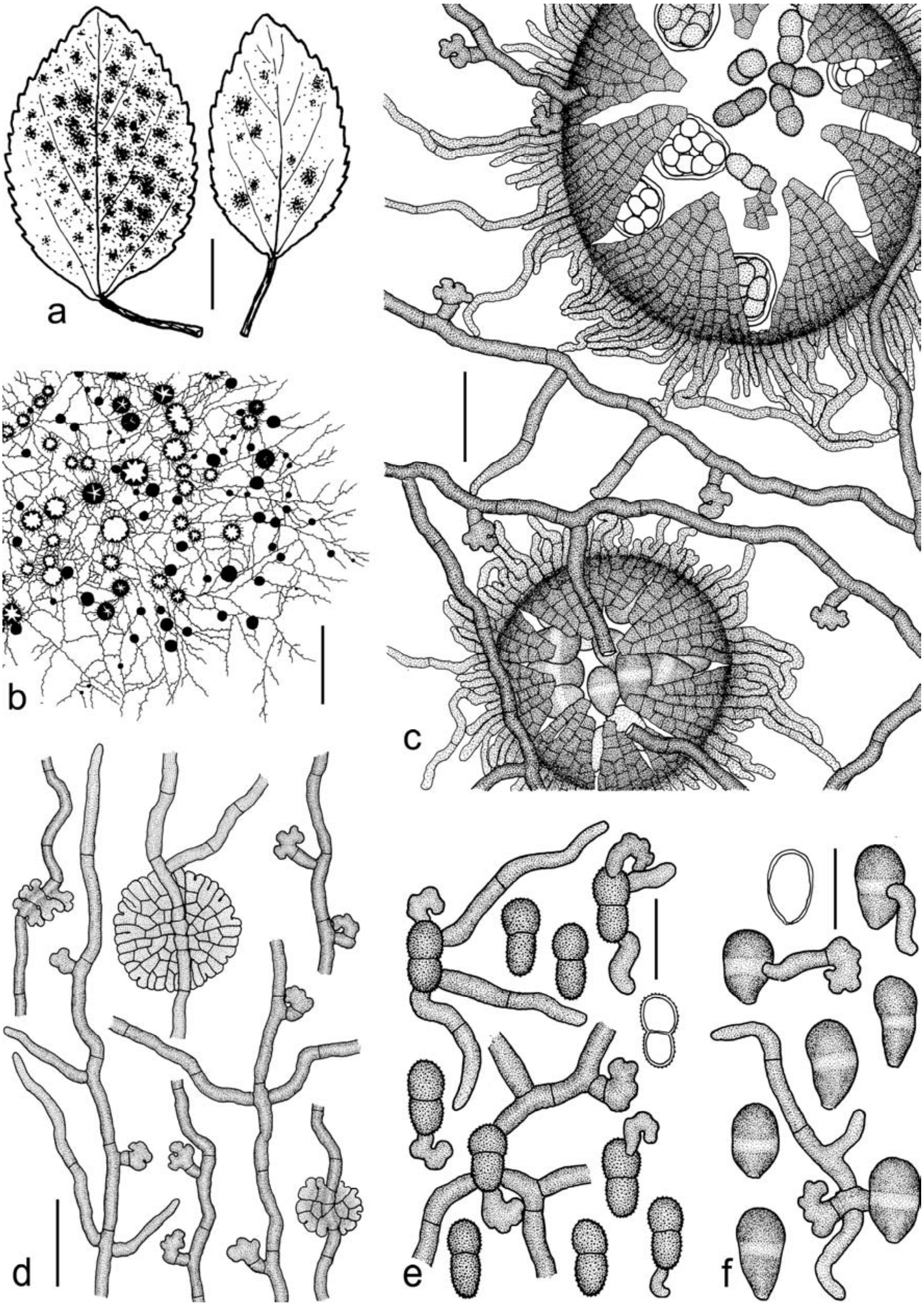

Figure 3.25: ***Asterina radiofissilis*** **on** ***Acalypha arvensis*****.** **a:** Adaxial side of infected leaves (ppMP 1247). Scale bar = 1 cm. **b:** Part of a colony with sporomata and surface mycelium (ppMP 449). Scale bar = 400 µm. **c:** Part of an open thyriothecium (upper sporoma) with mature and immature asci and free ascospores and an open pycnothyrium (lower sporoma) with conidia (ppMP 494). Scale bar = 25 µm. **d:** Surface mycelium with stalked appressoria and ascoma initials (ppMP 1216). Scale bar = 25 µm. **e:** Mature, verrucose ascospores, some of them germinating (ppMP 1216). Scale bar = 15 µm. **f:** Mature conidia, some of them germinating (ppMP 1216). Scale bar = 15 µm.

According to Hosagoudar and Abraham (2000), 31 species of *Asterina* are known from Euphorbiaceae. Only *A. acalyphae* Syd. from Costa Rica occurs on the host genus *Acalypha* (Sydow 1925). The examined material of *A. acalyphae* from Costa Rica differs from the fungus on *Acalypha arvensis* collected in Panama. *A. acalyphae* has larger ascomata with (110)129–195(250) µm diam. (*n*=10), larger ascospores that are 19–22(23) µm long (*n*=10) [upper cell (10)11–12(12.5) µm wide, lower cell 9–11(12) µm wide] with a more prominent ornamentation, larger pycnothyria (60)71–90 µm diam. (*n*=10) and larger conidia 16–19(20)×(8)10–11 µm (*n*=70). The ascospores of *A. acalyphae* germinate first at the distal part of each cell with a stalked appressorium.

Species of *Asterina* reported from *Acalypha*, but not originally described from this host genus, are *A. radiofissilis* (Sacc.) Theiss and *A. tenuis* G. Winter from Africa (compare BPI database). *A. tenuis* is morphologically similar to *A. radiofissilis*, but type material of *A. tenuis* could not be obtained until the end of this study. *A. radiofissilis* and *A. tenuis* are probably identical. However, in contrast to *A. tenius*, *A. radiofissilis* contains a related anamorph (Doidge 1942). Therefore, and because *A. tenuis* is treated as doubtful species by Theissen (1913a), the fungus on *Acalypha arvensis* from Panama with its related *Asterostomella*-anamorph is namend *A. radiofissilis*.

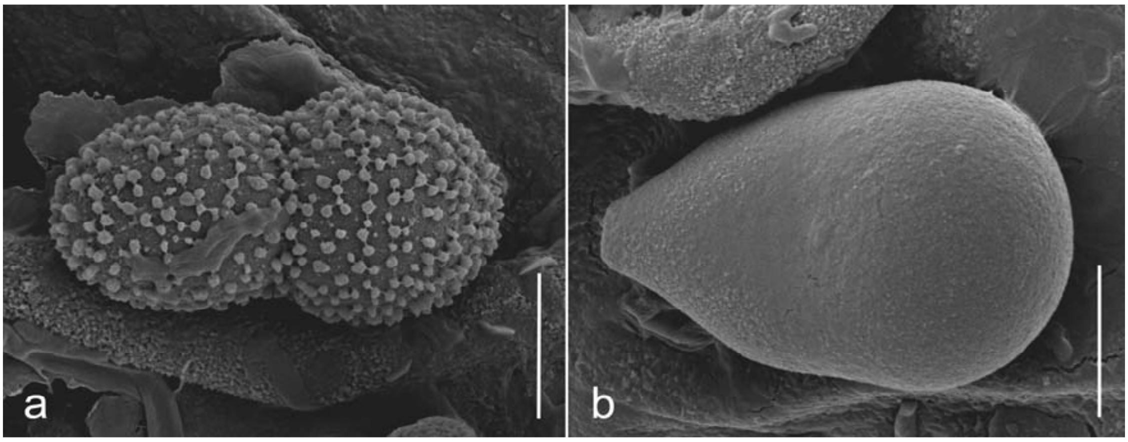

Figure 3.26: SEM photographs of *Asterina radiofissilis* on *Acalypha arvensis* (TH 494). a: Mature, verrucose ascospore. Scale bar = 5 µm. **b:** Mature conidium. Scale bar = 5 µm.

Asterina schlegeliae **T.A. Hofmann, in Hofmann and Piepenbring, Mycol. Prog. 7: 90 (2008). Figs. 3.27, 3.28, 3.29**

Type epiphyllous on *Schlegelia parviflora* (Oerst.) Monach. (Schlegeliaceae, det. R. Mangelsdorff). Panama, Chiriquí Province, Fortuna, Quijada del Diablo, ridge on continental divide, ca. 1280 m a.s.l., with hyphomycetous hyperparasite and associated with other fly-speck fungi, 15 Oct. 2005, *T.A. Hofmann & R. Mangelsdorff 388* (holotype, M-0140964!; isotype, PMA!).

Anamorph: *Mahanteshamyces*-like, not treated as distinct species by the author.

Colonies epiphyllous, rarely hypophyllous, circular to irregularly rounded, often confluent, inconspicuous, without well defined margins, like a thin film, 4–15 mm diam. (*n*=10), greyish. *Surface hyphae* straight to slightly undulating but rigid, branching mostly opposite, more rarely unilateral or alternate, brown, tips paler, septate, hyphal cells cylindrical, (16)25–37(41)×(3.5)4–5 µm, cell wall 0.5–1 µm thick, smooth. *Appressoria* numerous, symmetrical or irregular, digitate, with 3–4(5) lobes, sessile, without stalk cell, alternate or unilateral, (6)7–8(10)×(8)9–11 µm (*n*=50), wider than long, brown. *Haustoria* within epidermal cells, arbuscular, (30)32–45×(20)23–33(35) µm (*n*=10), hyaline, filling at least 1/4, mostly 1/2 or 3/4 of the host cell. *Thyriothecia* superficial, develop below surface mycelium, circular, dimidiate, single or rarely confluent, fringed at margins, (130)150–190(220) µm diam. (*n*=50), brown, paler than conidiomata, open with star-shaped central fissures. *Scutellum* radiate, composed of dichotomously branched filaments, scutellum cells isodiametric to cylindrical, straight in center, undulating at margin, (8)9–10.5(11)×(6)7–8(10) µm, brown, at tips paler. *Asci* 6–12 per ascoma, globose to ovate, with indistinct ocular chambers, bitunicate, I–, 33–39(40) µm diam. (*n*=6), 8–spored, hyaline, develop on ascogenous hyphae with proliferating croziers, interascal tissue absent. *Ascospores* few, 2–celled, ellipsoidal, ends rounded, constricted at septum, slightly tapering to one end, (19)20–21(22.5) µm long (*n*=25), upper cell 10–11(11.5) µm wide, lower cell (8)9–10 µm wide, brown, cell wall up to 1 µm thick, slightly verrucose, germinate first at the distal part of each cell to form surface mycelium with lateral appressoria.

Anamorph present, *Mahanteshamyces*-like. *Pycnothyria* numerous, superficial, developing below surface mycelium, circular, dimidiate, single or confluent, not as fringed as ascomata, (70)71–116(160) µm diam. (*n*=50), dark brown to blackish, smaller than thyriothecia. *Scutellum* radiate, scutellum cells isodiametric to cylindrical, straight in center, undulating at margin, (2.5)3–5(6)×2–5(6) µm, brown, at tips paler,

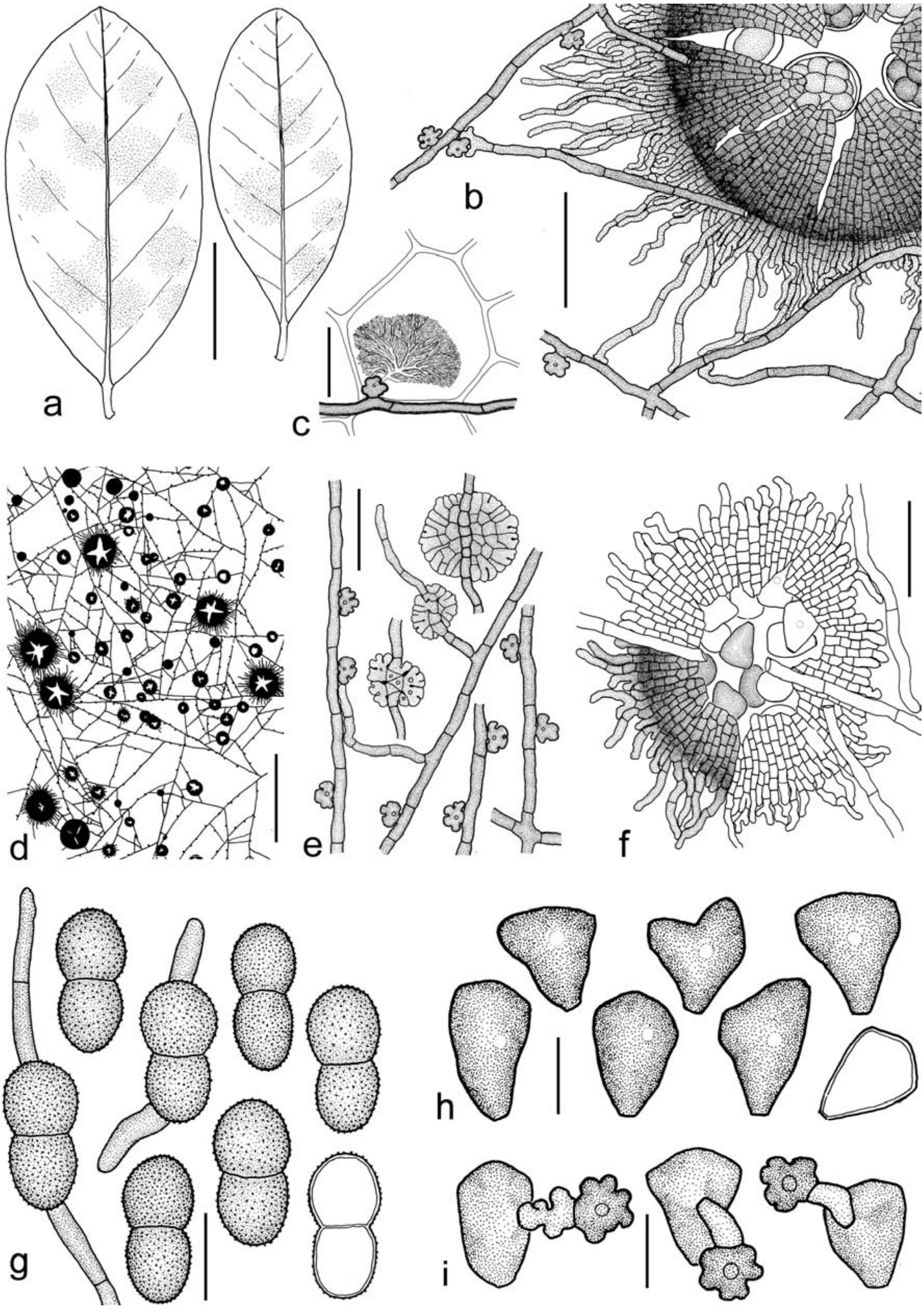

Figure 3.27: ***Asterina schlegeliae*** **on** ***Schlegelia parviflora*** **(holotype). a:** Adaxial side of infected leaves. Scale bar = 3 cm. **b:** Open thyriothecium with mature and immature asci and free ascospores. Scale bar = 90 µm. **c:** Arbuscular haustorium in epidermal host cell. Scale bar = 25 µm. **d:** Part of a colony with sporomata and surface mycelium. Scale bar = 500 µm. **e:** Surface mycelium with lateral appressoria and sporoma initials. Scale bar = 30 µm. **f:** Open pycnothyrium with conidia and surface mycelium, pigmentation only partly shown. Scale bar = 30 µm. **g:** Mature, verrucose ascospores, some of them germinating. Scale bar = 15 µm. **h:** Mature conidia, each with a central germpore. Scale bar = 10 µm. **i:** Germinating conidia. Scale bar = 10 µm.

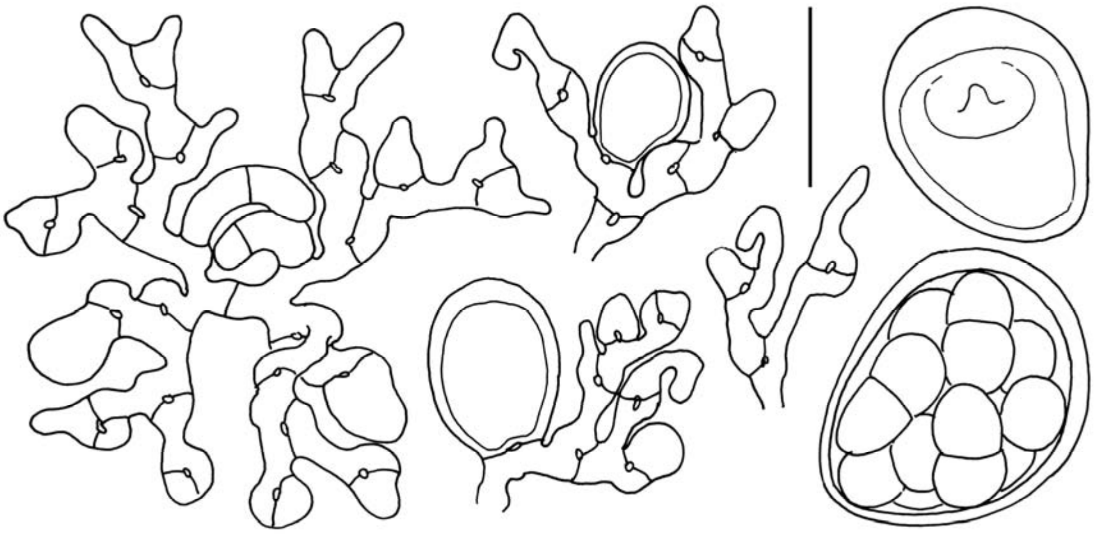

Figure 3.28: Ascogenous hyphae and young asci of *A. schlegeliae* (holotype). Asci develop on ascogenous hyphae with proliferating croziers. Scale bar = 20 µm.

smaller than those from the ascomata. *Conidiogenous cells* monoblastic, formed inside the pycnothyrial cavity by single cells of the inner part of the scutellum layer. *Conidia* numerous, 1–celled, triangular to irregularly angular, broadly clavate and rarely ellipsoidal, more or less flattened, (13)15–18(20)×(9)11–14(15) µm (*n*=50), brown, each conidium with a central subhyaline pore, smooth, germinate first through the central hyaline pore with a stalked and lobed appressorium.

Illustrations. In Hofmann and Piepenbring (2008) and this contribution. Arbuscular haustoria and developing asci of *A. schlegeliae* are illustrated here for the first time (Fig. 3.27c, Fig. 2.38).

Hosts. Schlegeliaceae: *Schlegelia parviflora* (Oerst.) Monach.

Known distribution. Endemic to Panama, known only from the type locality. *A. schlegeliae* occurs in Western Panama in cloudy and humid mountain rainforests on the continental divide at about 1280 m a.s.l. (Hofmann and Piepenbring 2008).

Specimens examined: **PANAMA. Chiriquí Province:** holotype see above; same locality, host species and associated organisms, 1 Aug. 2006, *R. Mangelsdorff 454-A* (paratypes, BPI 878815, PMA); same locality and host species, 23 Feb. 2007, *T.A. Hofmann, R. Mangelsdorff & T. Trampe 512-A* (paratype, PMA); same locality and host species, 13 Oct. 2007, *T.A. Hofmann 587* (paratypes, M-040965, PMA).

Notes. *A. schlegeliae* differs from all described *Asterina* spp. by its *Mahanteshamyces* anamorph with conspicuous triangular conidia. The genus *Mahanteshamyces* Hosag. was originally described without a related teleomorphic stage (Hosagoudar 2004). A connection to a teleomorphic *Asterina*-stage was reported for the first time by Hofmann and Piepenbring (2008). A remarkable feature of *A. schlegeliae* is the formation of large arbuscular haustoria within the epidermal cells of the host (Fig. 3.27c). The epiphyllous *A. schlegeliae* with its *Mahanteshamyces* anamorph is associated with another *Mahanteshamyces* anamorph on the abaxial side of the leaves. This fungus differs morphologically from *A. schlegeliae* and its anamorph and is discussed on page 216.

A. schlegeliae is the only species of *Asterina* that occurrs on a member of the plant family Schlegeliaceae (Hofmann and Piepenbring 2008). The Schlegeliaceae are closely related to either Bignoniaceae or Scrophulariaceae (Burger and Barringer 2000), they are distributed from Mexico to tropical South America and are restricted to the neotropical region. A key to species of *Asterina* on the plant families Bignoniaceae, Scrophulariaceae and Schlegeliaceae was elaborated in Hofmann and Piepenbring (2008).

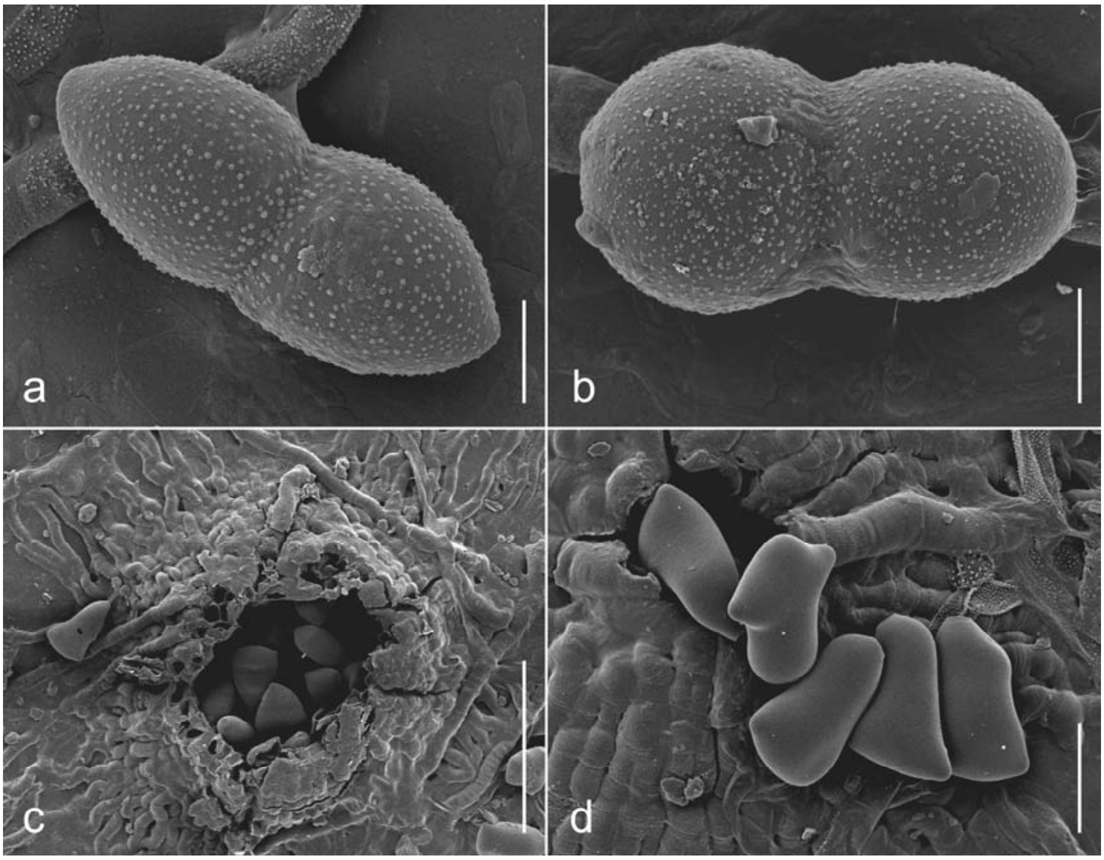

Figure 3.29: SEM photographs of *Asterina schlegeliae* on *Schlegelia parviflora*. a-b: Mature, verrucose ascospores (holotype, TH 388). Scale bars = 5 µm. **c:** Pycnidium with conidia (paratype, RMP 454-A). Scale bar = 50 µm. **d:** Mature, angular conidia (paratype, RMP 454-A). Scale bar = 10 µm.

Asterina siphocampyli **Syd., Ann. Mycol. 37: 387 (1939).**

Figs. 3.30, 3.31, 3.32

Type on *Siphocampylus campanulatus* (Cav.) A. DC. (Campanulaceae). Ecuador, Tungurahua Province, Hacienda San Antonio pr. Baños, 24 Dec. 1937, *H. Sydow 600* (type, n.v.).

Colonies epiphyllous, irregularly circular or irregular star-shaped, single or confluent, conspicuous and dense, in younger stages often poorly defined, 0.5–4 mm diam. (*n*=10), black. *Surface hyphae* strongly undulating and zigzag-like, branching alternate or unilateral, brown to dark brown, hyphal tips paler, septate, hyphal cells cylindrical, (11)17–31(35)×(4)5–6 µm, cell wall up to 1 µm thick, smooth. *Appressoria* numerous, alternate or unilateral, with stalk cell, total length (12)13–19(22.5) µm, brown to dark brown, stalk cell shortly cylindrical, straight or slightly bent to one side, (2)3–5(8)×(5)6–7(7.5) µm, appressorial cylindrical, end broadly rounded, entire, rarely slightly sinuate, straight or bent, (9)10–14(16)×(6)7–8 µm, penetration pore small, in central or distal part of the appressorium. *Haustoria* inconspicuous. *Thyriothecia* superficial, develop below surface mycelium, circular, dimidiate, single or confluent, with fringed margins, (114)162–222(248) µm diam. (*n*=15), dark brown to blackish, open with central star-shaped fissures, at maturity widely open to expose mature and immature asci. *Scutellum* radiate, composed of dichotomously branched filaments, scutellum cells isodiametrical to cylindrical, straight in center, undulating at margins of ascoma, (5)6–11(15)×(2)3–5(5,5) µm, dark brown, paler at margins of ascoma. *Asci* globose, with distinct ocular chambers, bitunicate, I–, (24)28–36(39) µm diam., 8–spored, hyaline, develop on ascogenous hyphae with proliferating croziers, interascal tissue absent. *Ascospores* 2–celled, ellipsoidal, straight or slightly bent, ends broadly rounded, lower cell mostly tapered, constricted at septum, (21)25–28 µm long, upper cell (10)11–13(16) µm wide, lower cell (8)9–11(12) µm wide, brown, cell wall up to 1 µm thick, verrucose, germinate frist at the distal part of each or just one cell with a stalked and entire appressorium. *Anamorph* absent.

Illustrations. *A. siphocampyli* is illustrated here for the first time.

Hosts. Campanulaceae: *Siphocampylus campanulatus* (Cav.) A. DC, *Burmeistera* sp. and *Burmeistera vulgaris* E. Wimm. *Burmeistera* is a new host genus and *B. vulgaris* is a new host species of *A. siphocampyli*.

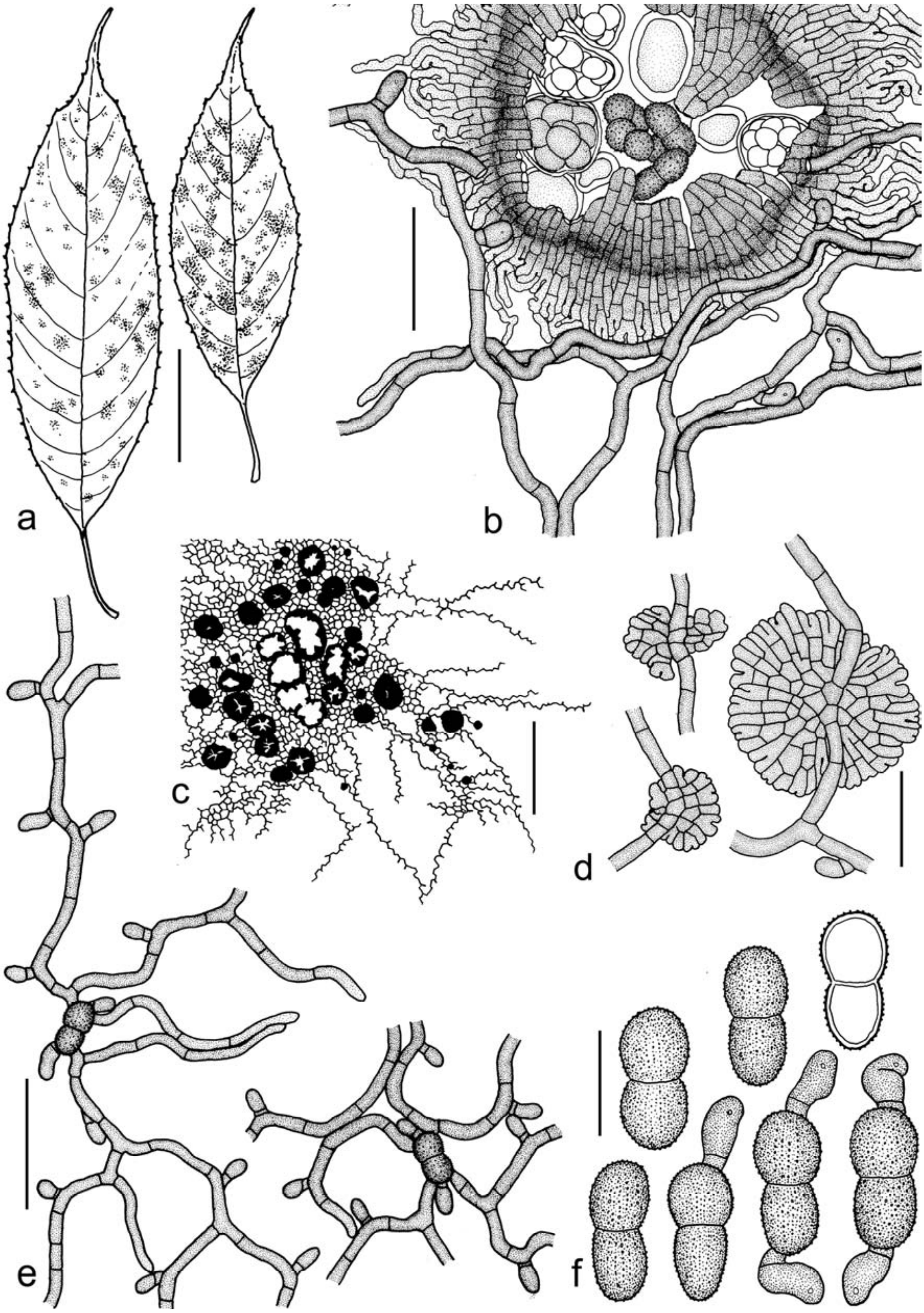

Figure 3.30: ***Asterina siphocampyli*** **on** ***Burmeistera vulgaris*** **(MP 3202). a:** Adaxial side of infected leaves. Scale bar = 2 cm. **b:** Surface mycelium with appressoria part of a mature thyriothecium with mature and immature asci and liberated ascospores. Scale bar = 40 µm. **c:** Part of a colony with confluent thyriothecia and undulating surface mycelium. Scale bar = 500 µm. **d:** Ascoma initials. Scale bar = 30 µm. **e:** Germinated ascospores and appressoriate surface mycelium. Scale bar = 60 µm. **f:** Mature ascospores, some of them germinating. Scale bar = 20 µm.

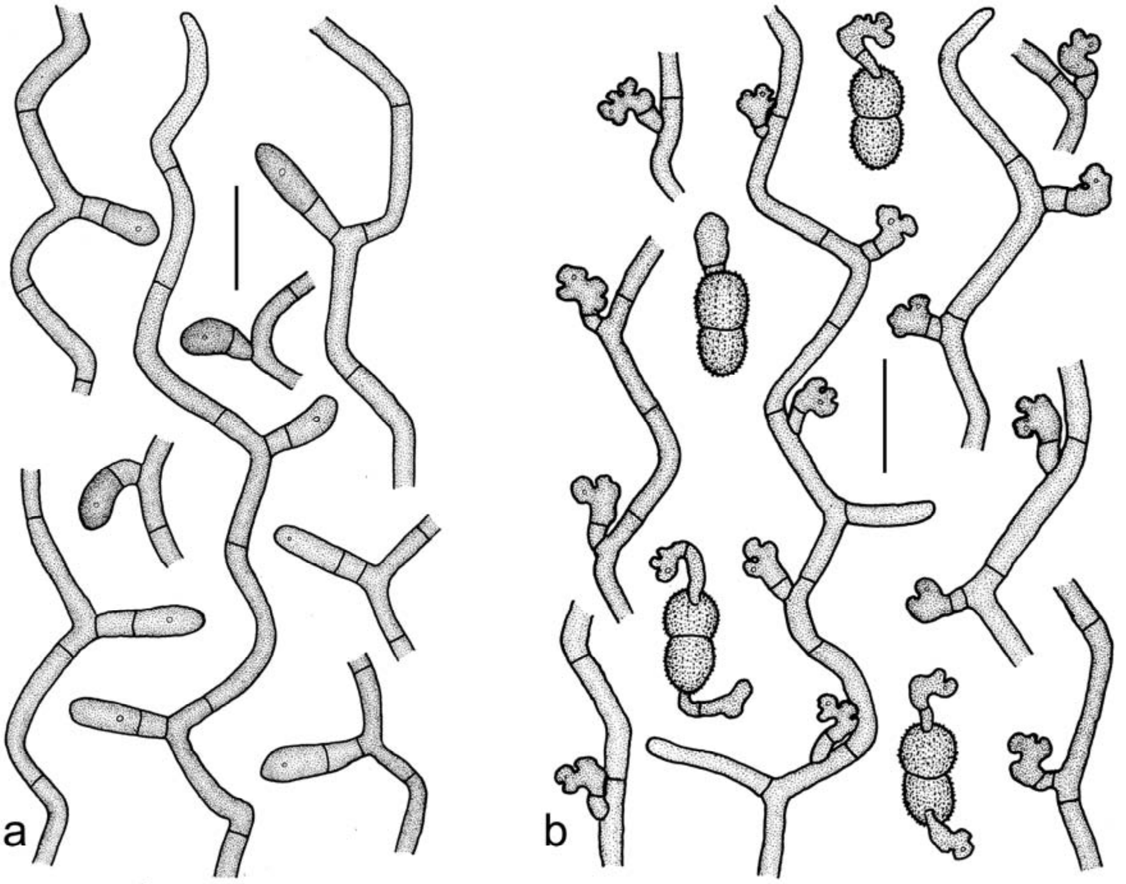

Figure 3.31: Appressorial variability of the specimen ppMP 1324 on *Burmeistera* sp. a: Surface mycelium with stalked, entire appressoria. Scale bar = 25 cm. **b:** Surface mycelium with stalked, lobate appressoria and germinating ascospores. Scale bar = 25 µm.

Known distribution. Neotropical: Central America (Panama) and South America (Ecuador). *A. siphocampyli* is a new record for Central America and Panama. The species occurs in Panama in humid mountain rainforests of higher altitudes from 1200 to about 2500 m a.s.l.

Specimens examined: PANAMA. Chiriquí Province: Parque International La Amistad (PILA), La Cascada trail, ca. 2200-2500 m a.s.l., epiphyllous on *Burmeistera vulgaris* (det. R. Mangelsdorff and T.A. Hofmann), with at least 2 different perithecioid hyperparasites, 4 Mar. 2003, *M. Piepenbring, R. Kirschner et al. 3202* (FR; PMA). — Fortuna, ca. 5 km before Lake Fortuna, mountain rain forest, 1240 m a.s.l., epiphyllous on *Burmeistera* sp. (det. T.A. Hofmann), with a hyphomycetous hyperparasite and probably a second species of *Asterina*, 19 Feb. 2007, *T.A. Hofmann, R. Mangelsdorff & T. Trampe ppMP 1324* (M-0141060, PMA); same locality, host species and associated organisms, 22 Sep. 2007, *T.A.Hofmann & M. Piepenbring ppMP 1347* (M-0141061; PMA).

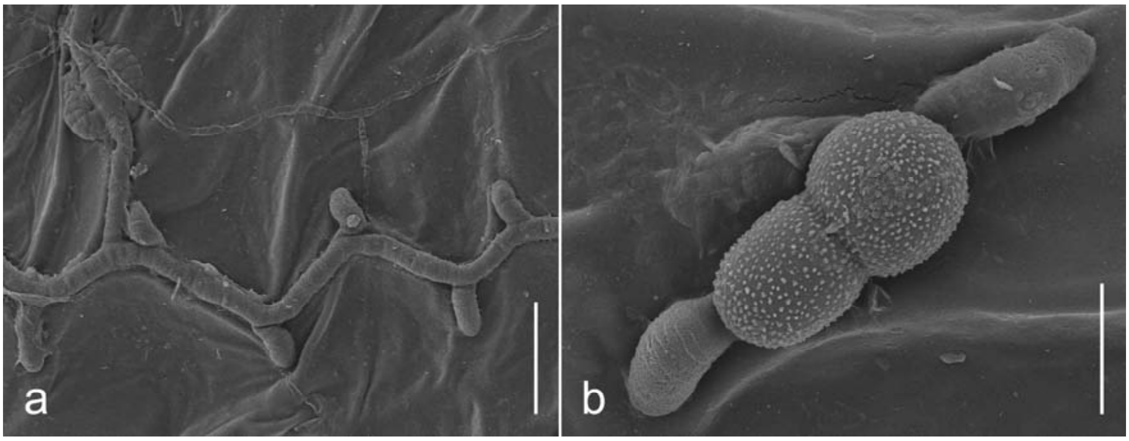

Figure 3.32: SEM photographs of *Asterina siphocampyli* on *Burmeistera vulgaris* (MP 3202). a: Surface mycelium with appressoria and an ascoma initial (upper left). Scale bars = 25 µm. **b:** Germinating ascospore. Scale bar = 10 µm.

Notes. According to Hosagoudar and Abraham (2000), seven species of *Asterina* were known from Campanulaceae. Hosagoudar et al. (2004a) described another *Asterina* on Campanulaceae from India, *A. lobeliacearum* Hosag. & C.K. Biju. From these eight species, three contain stalked appressoria, *A. centropogonis* R.E.D. Baker & W.T. Dale from Trinidad (Baker and Dale 1951), *A. lobeliae* F. Stevens & R.W. Ryan from Hawaii (Stevens and Ryan 1925) and *A. siphocampyli* Syd. from Ecuador (Sydow 1939). *A. centropogonis* was described from *Centropogon cornutus* and has lobed appressorial head cells and verrucose ascospores that measure 19–25×9–14 µm (Baker and Dale 1951, Inacio and Cannon 2003 IMI decription no. 1573). *A. lobeliae* from *Lobelia* sp. has lobed appressorial head cells and small ascospores with 12–14×3–5 µm (Stevens and Ryan 1925). *A. siphocampyli* has 2–celled appressoria with variable head cells with mostly entire margins but sometimes they become sinuate or lobed with 2–3 lobes (Sydow 1939).

Specimen *MP 3202* of *Burmeistera vulgaris* from Panama contains mycelia with exclusively entire appressoria (Fig. 3.30e) but the specimens *ppMP 1324* and *ppMP 1347* on *Burmeistera* sp. show mycelia with two different morphological types of appressoria (Fig. 3.31). The first has elongated, entire appressoria up to 27 µm long with larger stalk and head cells than observed for *MP 3202* (Fig. 3.31a). And the second type has lobed appressorial head cells that are up to 12 µm broad (Fig. 3.31b). Additionally, both specimens from *Burmeistera* sp. have smaller ascospores with 21–23(24)×(10)11–12 µm (*n*=16). Due to the variability of the appressoria mentioned by Sydow (1939) the fungi on *Burmeistera vulgaris* and *Burmeistera* sp. are treated as a single species *A. siphocampyli*. Nevertheless, the morphological similarity between *A.*

centropogonis from Trinidad and the variety with lobed appressoria found on *Burmeistera* sp. should be considered. The material of *A. siphocampyli* on *Burmeistera* sp. seem to be intermixed with a second species of *Asterina*, probably *A. centropogonis*.

The specimens of *A. siphocampyli* from Panama are parasitized by various ascomycetous and hyphomycetous hyperparasites.

Asterina sponiae **Racib., Parasit. Alg. Pilze Java´s (Jakarta) 3: 34 (1900).**

Figs. 3.33, 3.34

Type on *Sponia virgata* Planch. (Ulmaceae s.str.). Indonesia, Java, Mt. Salak, date and collector unknown (type, n.v.).

Colonies epiphyllous, irregularly circular, single, later confluent and sometimes cover large leaf parts, conspicuous and dense, 0.5–4 mm diam., black. *Surface hyphae* slightly undulating, branching opposite, unilateral or alternate, brown, hyphal tips paler, septate, hyphal cells cylindrical, (12)21–33(35)×4–5(6) µm, cell wall 0.5–1 µm thick, smooth. *Appressoria* numerous, globose to ellipsoidal, entire or margins sinuate to slightly lobed, sessile to slightly stalked, stalk cell mostly missing, very rarely with cylindrical stalk cell, unilateral or alternate, very rarely opposite, (4)6–9(10)×(7)8–10(11) µm (*n*=60), brown, penetration pore in central part of appressorium, 1–2 µm diam. *Haustoria* inconspicuous. *Thyriothecia* superficial, developing below surface mycelium, circular, dimidiate, at maturity more globose than dimidiate, mostly crowded and confluent, fringed at margins, (70)84–128(160) µm diam. (*n*=60), brown to dark brown, open with central fissures, which early become slimy and rupture irregularly at center, at maturity widely open to expose mature and immature asci. *Scutellum* radiate, composed of dichotomously branched filaments, scutellum cells isodiametric to cylindrical, straight in center, slightly undulating at margin of ascoma, 3–6(10)×3–5(7) µm, brown, at tips paler. *Asci* globose to ovate, with distinct ocular chambers, bitunicate, ascus walls I+, (25)31–39(40) µm diam. (*n*=40), 4–8–spored, hyaline, develop on ascogenous hyphae with proliferating croziers, mature asci few, interascal tissue present, becomes slimy. *Ascospores* numerous, 2–celled, ellipsoidal, ends rounded, constricted at septum, cells similar or lower cell slightly tapered, (20)23–27(28) µm long (*n*=60), upper cell (11)12–13(14) µm wide, lower cell (10)11–13(14) µm wide, brown when mature, cell wall up to 1 µm thick, slightly verrucose, germinate first at the distal part of each cell to form surface mycelium with lateral appressoria, germinate rapidly outside or even within the mature ascus. *Anamorph* absent.

Illustrations. In Arnaud (1918) as *Dimerosporium triumfettae* and in this contribution. The ornamentation of the ascospores is illustrated here for the first time (Fig. 3.34).

Hosts. Malvaceae-Grewioideae: *Triumfetta* sp. **Malvaceae-Tilioideae**: unknown genus. **Cannabaceae:** *Sponia virgata* Planch., *Trema amboinensis* (Willd.) Blume, *T. aspera* (Brongn.) Blume, *T. cannabina* Lour., *T. guineensis* (Schum. & Thonn.) Ficalho, *T. micrantha* (L.) Blume, *T. mollis* Blume, *T. orientalis* (L.) Blume and *Trema* sp.

Known distribution. Pantropical: Africa (Ghana), Caribbean (Dominican Republic), Central America (Panama), East Asia (China, Japan, Taiwan), North America (USA-Florida), Oceania (Australia), South America (Venezuela) and Southeast Asia (Indonesia, Malaysia, Philippines). *A. sponiae* is a new record for Central America and Panama. The species occurs in Western Panama in disturbed vegetation of lowland secondary forests up to forests of higher elevations at about 1500 m a.s.l.

Specimens examined: PANAMA. Chiriquí Province: Boquete, Bajo Mono, ca. 1500 m a.s.l., epiphyllous on *Trema micrantha* (det. D. Cáceres), 14 Sep. 2005, associated with hypophyllous *Capnodiastrum guaraniticum* Speg., *T.A. Hofmann & J. Guerrero 308-A* (FR, PMA); same locality, host species and associated organisms, 3 Mar. 2006, *T.A. Hofmann 445-A* (M-0141089; PMA).). — locality unknown, probably Los Algarrobos, path to Majagua river, epiphyllous on *Trema micrantha* (det. T.A. Hofmann), 13 Sep. 2005, *C. Inacio TH 613* (PMA). — Boquete, Alto Chiquero, on Tiliaceae, ca. 1750 m, 6 Oct. 2005, *T. Hofmann 361-A* (PMA). **PHILIPPINES. Pampanga Province, Central Luzon:** Mt. Ararat, epiphyllous on *Trema orientalis*, 31 Oct. 1925, *M.S. Clemens* (BPI 690512). **USA. Florida:** Royal Palm State Park, Dade Co., epiphyllous on *Trema mollis*, 5 Mar. 1944, *A.S. Rhoads* (BPI 690508). **VENEZUELA. Federal District:** Puerto La Cruz Valley, EL Limon, epiphyllus on *Trema micrantha*, 12 Jan. 1928, *H. Sydow 216* (BPI 690504).

Additional specimens examined: *Schiffnerula trematis* Syd. [as '*tremae*'] [=*Rhytidenglerula trematis* (Syd.) Arx]. VENEZUELA. Federal District: Puerto La Cruz Valley, EL Limon, hypophyllous on *Triumfetta* sp., 3 Jan. 1928, *H. Sydow* (type, BPI 566109); same locality and host species, 9 Jan. 1928, *H. Sydow* (paratype, BPI 566108).

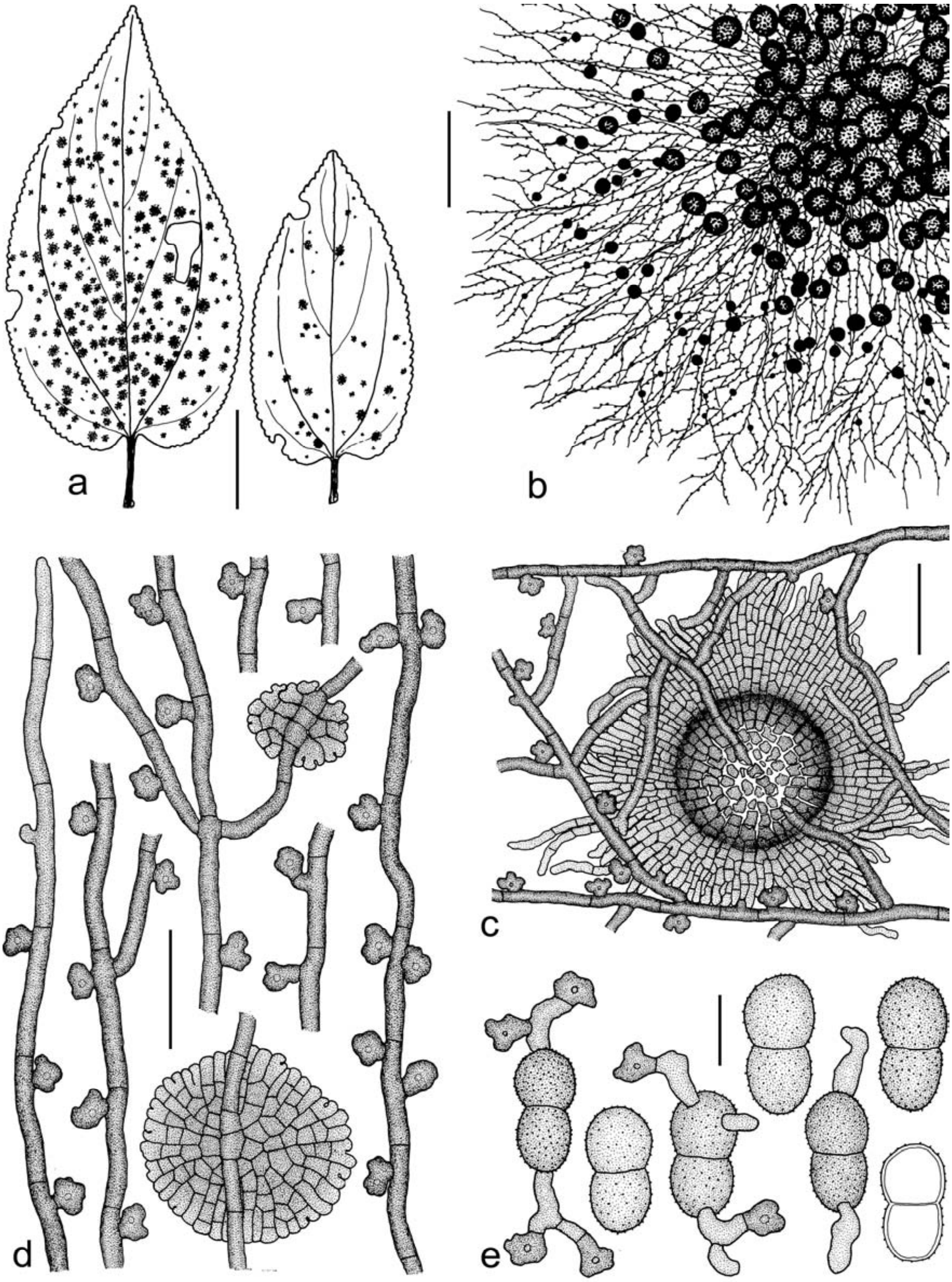

Figure 3.33: *Asterina sponiae* on *Trema micrantha* (TH 455-A). a: Adaxial side of infected leaves. Scale bar = 2 cm. **b:** Part of the colony with confluent thyriothecia and surface mycelium. Scale bar. = 300 µm. **c:** Young thyriothecium with surface mycelium. Scale bar = 30 µm. **d:** Surface mycelium with appressoria and ascoma initials. Scale bar = 30 µm. **e:** Mature, slightly verrucose ascospores, some of them germinating. Scale bar = 15 µm.

Notes. The ascoma of *A. sponiae* become globose during maturity and the central part of the scutellum dissolves and disintegrates irregularly. In the original description of

Raciborsky (1900), the ascospore wall is described as smooth. By careful light microscopical investigation and scanning electron microscopy the verrucose ornamentation of the ascospores is evident (Fig. 3.34). *A. sponiae* is a common species in the tropics worldwide (Petrak 1954).

According to Hosagoudar and Abraham (2000), three species of *Asterina* are described from Cannabaceae (under Ulmaceae), *A. celtidicola* Henn. from Brazil, *A. dallasica* Petr. from Borneo, Indonesia and *A. sponiae* Racib. from Java, Indonesia. Both *A. celtidicola* and *A. dallasica* have smaller ascospores than *A. sponiae*. They measure 15–20×8–9 µm for *A. celtidicola* (Hennings 1905) and 17–24×8–11 µm for *A. dallasica* (Petrak 1954). It is possible that *A. dallasica* and *A. celtidicola* are identical because sizes of ascomata and appressoria and the ascospore ornamentation are similar in the descriptions. Nevertheless, type material of *A. dallasica* and *A. celtidicola* could not be analysed until the end of this study.

The examined material of *Trema micrantha* from Panama contains various foliicolous ascomycetes from different groups. One example on the lower leaf surface is an imperfect fungus identified as *Capnodiastrum guaraniticum* Speg. *C. guaraniticum* forms a surface mycelium with lateral appressoria and brown, pyriform conidia similar to *Asterostomella* spp. which are anamorphic states of *Asterina*. In contrast to *Asterostomella*, species of *Capnodiastrum* form globose pycnidia and are thought to be anamorphic states of Englerulaceae. Members of Englerulaceae differ from members of Asterinaceae in ascoma morphology. Ascomata of species of Englerulaceae are not dimidiate, but globose and the ascoma wall is composed of cells which disintegrate very early during ascoma maturity. The few, bitunicate asci are embedded in a slimy, transparent to pale brown substance, formed when cells of the ascoma wall dissolve. Species of Englerulaceae and *Asterina* share the same ecological niche and are morphologically similar due to the superficial growth, surface mycelia with lateral appressoria, slightly iodine positive asci and 2–celled, brown ascospores. According to Müller and Arx (1962), one member of Englerulaceae is known from *Trema* spp.: *Rhytidenglerula trematis* (Syd.) Arx. Examination of type material of *R. trematis* revealed that the fungus indeed is different from *A. sponiae*. *R. trematis* forms globose ascomata composed of early dissolving cells. The ascomata become transparent at maturity and the few mature and immature asci are easily visible without squeezing the fruitingbodies.

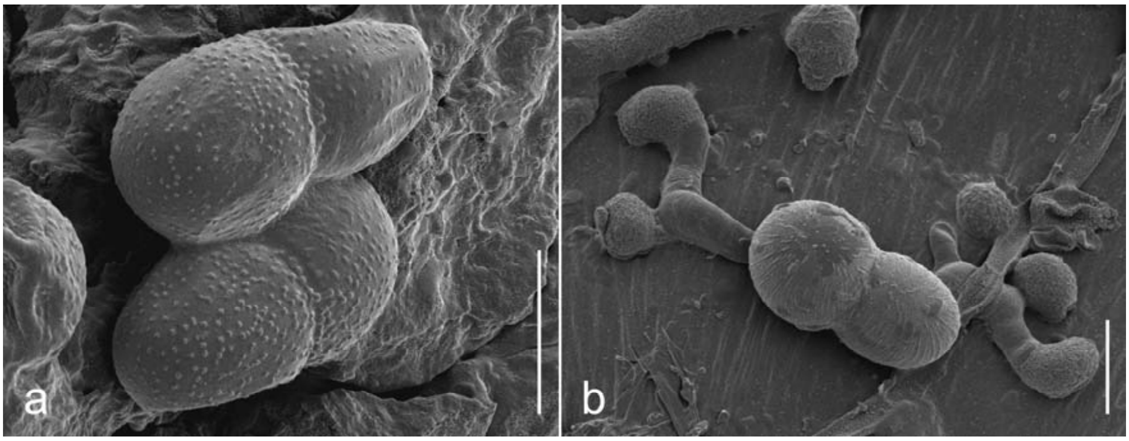

Figure 3.34: SEM photographs of *Asterina sponiae* on *Trema micrantha* (TH 455-A). a: Two, mature, verrucose ascospores. Scale bar = 10 µm. b: Germinating ascospore. Scale bar = 10 µm.

Asterina stipitipodia M.L. Farr, Mycologia 79(1): 108 (1987). Figs. 3.35, 3.36

Type on unknown plant (?dilleniaceous). Brazil, Amazonas, Manaus, INPA grounds, across from Botany complex, 4 Jan. 1978, *M.L. Farr AM-32* (holotype, NY n.v.; isotype, BPI 690522 A!,B!).

Anamorph: *Asterostomella stipitipodia* M.L. Farr, Mycologia 79(1): 109 (1987).

Type hypophyllous on Dilleniaceae. Brazil, Amazonas, Terr. Roraima, along Manaus-Boa Vista Road, 240 km from junction with Manaus-Itacoatiara Road., 8 Dec. 1977, *Dumont et al. BR-691* (holotype, NY n.v.; isotype, BPI n.v.).

Colonies hypophyllous, irregularly circular, margins of colony not well defined, single, early becoming confluent, concentrated at leaf margins, sometimes covering large parts of the lower leaf surface, inconspicuous and poorly defined, 1–15 mm diam. (*n*=10), blackish. *Surface hyphae* undulating, branching opposite, unilateral or alternate, brown, at tips paler, septate, hyphae cells cylindrical, (15)22–39(46)×(3.5)4(4.5) µm, cell wall up to 0.5 µm thick, smooth. *Appressoria* exclusively above stomata of host, terminal on one or more cylindrical stalk cells of variable length, more rarely with stalked base or sessile, stalk cells elongated, undulating, paler than surface hyphae, appressorial head cell globose to ovate or clavate or spathulate, entire or slightly lobulate, 6–9(10)×(5.5)6–8(9) µm, brown, slightly darker than stalk cells. *Haustoria* inconspicuous, no penetration of stomatal cavity or neighbouring host cells observed. *Thyriothecia* superficial, develop below surface mycelium, circular, dimidiate, single, with fringed margins, (80)86–116(150) µm diam., brown to dark brown, open widely with central star-shaped fissures. *Scutellum* radiate, composed of dichotomously branched filaments, scutellum cells isodiametric to cylindrical, straight in center, slightly undulating at margin of ascoma, (3)4–6×3–5(7) µm, brown to dark brown, at margins of ascomata paler. *Asci* globose to ovate, with distinct ocular chambers, bitunicate, I–, (18)20–24(27) µm diam., 8–spored, hyaline, develop on ascogenous hyphae with proliferating croziers, interascal tissue not observed. *Ascospores* 2–celled, ellipsoidal, ends rounded, slightly constricted at septum, tapering to one end, (14)15–16(17) µm long, upper cell 6–7(8) µm wide, lower cell 5–6(6.5) µm wide, pale brown, cell wall up to 0.5 µm thick, verrucose, germinate first at upper or lower cell with surface mycelium with a terminal appressorium

Anamorph present, *Asterostomella stipitipodia* M.L. Farr. Pycnothyria numerous, superficial, develop below surface mycelium, circular, dimidiate, single fringed at margins, 40–54(60) µm diam., brown to dark brown, open with central star-shaped fissures or by irregular break down of central scutellum cells, scattered between thyriothecia, first dominating them. *Scutellum* similar to the one of the thyriothecia. *Conidiogenous cells* monoblastic formed inside the pycnothyrial cavity by single cells of the inner part of the scutellum layer. *Conidia* numerous, 1–celled, broadly clavate to pyriform, (17)18–22(24)×(9)10–12(13) µm, brown, with a central hyaline band, smooth, germinate first at the region of the central hyaline band with surface mycelium with a terminal appressorium.

Illustrations (teleomorph and anamorph). In Farr (1987) and this contribution.

Hosts (teleomorph and anamorph). Dilleniaceae: *Davilla kunthii* A. St.-Hil. and on unknown plant (Dilleniaceae?). *Davilla* is a new host genus and *D. kunthii* is a new host species of *A. stipitipodia* and its anamorph *Asterostomella stipitipodia*

Known distribution (teleomorph and anamorph). Neotropical: Central America (Panama) and South America (Brazil). *A. stipitipodia* and its anamorph *Asterostomella stipitipodia* are new records for Central America and Panama. It occurs in Western Panama in disturbed lowland forests and gallery forests near riversides at 140 m a.s.l.

Specimens examined (teleomorph and anamorph): BRAZIL. Amazonas: isotype of *Asterina stipitipodia*, see above. **PANAMA. Chiriquí Province:** Los Algarrobos, path to Majagua river, ca. 140 m a.s.l., hypophyllous on *Davilla kunthii* (det. T.A. Hofmann), associated with epiphyllous

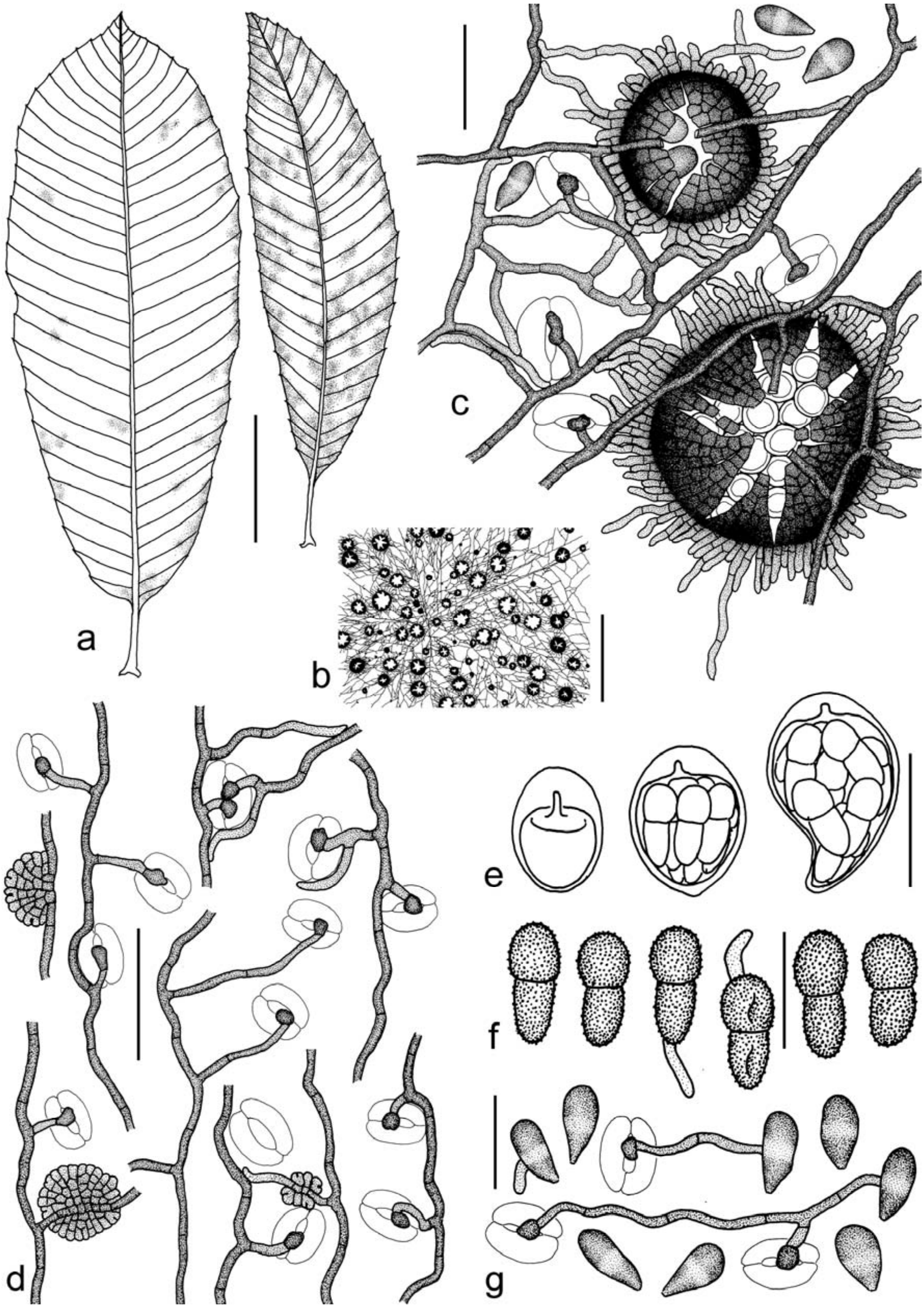

Figure 3.35: ***Asterina stipitipodia*** **with** ***Asterostomella stipitipodia*** **anamorph on** ***Davilla kunthii*****. a:** Adaxial side of infected leaves (TH 526). Scale bar = 4 cm. **b:** Part of the colony with thyriothecia, pycnothyria and surface mycelium (ppMP 738). Scale bar. = 500 µm. **c:** Pycnothyrium with mature conidia (upper sporoma) and young thyriothecium with immature asci and surface mycelium (TH 526). Scale bar = 35 µm. **d:** Surface mycelium with appressoria on host stomata and ascoma initials (ppMP 1201). Scale bar = 50 µm. **e:** Asci in different developmental stages with distinct ocular chambers (TH 526). Scale bar = 20 µm. **f:** Mature, slightly verrucose ascospores, some of them germinating (TH 526). Scale bar = 15 µm. **g:** Mature conidia with central hyaline bands, some of them germinating (TH 596-B). Scale bar = 25 µm.

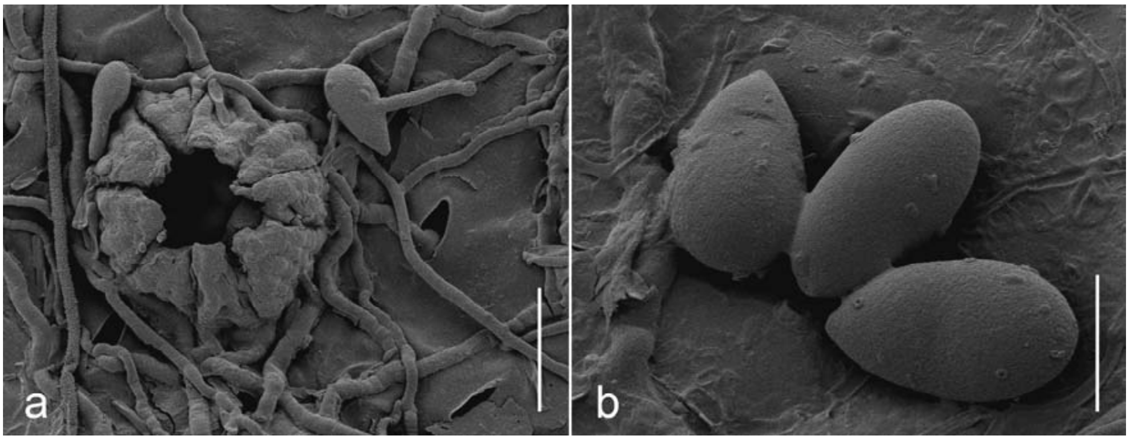

Figure 3.36: SEM photographs of *Asterostomella stipitipodia* on *Davilla kunthii* (TH 596-B). a: Pycnothyrium with liberated conidia. Scale bar = 23 µm. **b:** Mature conidia. Scale bar = 10 µm.

Asterostomella dilleniicola, 17 Apr. 2006, *T.A. Hofmann 424-B* (FR; PMA); same locality, host plant species and associated organisms, 21 Mar. 2006, *T.A. Hofmann, M. Piepenbring & T. Trampe ppMP 470-B* (M-0141016; PMA); same locality, host plant species and associated organisms, 21 Jun. 2006, *T.A. Hofmann, R. Mangelsdorff & T. Trampe ppMP 583-B* (M-0141017; PMA); same locality, host plant species and associated organisms, 8 Sep. 2007, *T.A. Hofmann 526* (PMA); same locality, host plant species and associated organisms, 8 Jan. 2007, *T.A. Hofmann, R. Mangelsdorff & T. Trampe ppMP 1201* (M-0141018; PMA). — Los Algarrobos, border of Majagua river, ca. 140 m a.s.l., hypophyllous on *Davilla kunthii* (det. T.A. Hofmann), associated with epiphyllous *Asterostomella dilleniicola*, 22 Mar. 2006, *M. Piepenbring, T.A. Hofmann & T. Trampe ppMP 738-B* (M-0141019; PMA). — Los Algarrobos, path to Lajas river and El Salto cascade, ca. 140 m a.s.l., hypophyllous on *Davilla kunthii* (det. T.A. Hofmann), associated with epiphyllous *Asterostomella dilleniicola*, 7 Jan. 2007, *T.A. Hofmann 496-B* (FR; PMA).

Notes. *Asterina stipitipodia* and its anamorph are characterized by appressoria occuring exclusively above the stomata of the host plant. Therefore, the fungus is restricted to the abaxial side of living leaves. The terminal globose appressoria enter the stomata but a deeper penetration or the formation of haustoria in neighbouring host cells was not observed. The stalk cells of the appressoria are variable in length and cell number, depending on the respective distance between the surface mycelium from which the stalk cells emerge and the infected host stomata. On *Davilla kunthii* the *Asterostomella*-anamorph dominates the teleomorph at first but in older and larger colonies thyriothecia of the teleomorph are frequently present.

In a survey on foliicolous fungi from Brazil, Farr (1987) introduced *Asterina stipitipodia* with its respective anamorph *Asterostomella stipitipodia* from an unknown dilleniaceous host. The anamorph was discussed earlier by Farr (1986) because it is associated with a second *Asterostomella*-species on the adaxial side of leaves of the same host plant from Brazil. The second, morphologically different species is *Asterostomella dilleniicola* M.L. Farr (Farr 1986) and was collected in Panama together with *A. stipitipodia* on a Dilleniaceae (*Davilla kunthii*). *Asterostomella dilleniicola* is not connected to a teleomorph and is illustrated and discussed in detail on page 196. An overview to all hitherto described *Asterina* spp. and *Asterostomella* spp. from Dilleniacaee is given on Table 3.3 (see discussion of *Asterina davillae*).

Asterina styracina Syd., Ann. Mycol. 25(1/2): 72 (1927). Figs. 3.37, 3.38

Type on *Styrax polyneurus* Perkins (Styracaceae). Costa Rica, Alajuela Province, Mt. Poas, near Grecia, 15 Jan. 1925, *H. Sydow 156* (lectotype, designated here), BPI 690526!; isotypes, BPI 690527!, S F12504 n.v.).

Colonies epiphyllous, irregularly circular, single, rarely confluent, conspicuous and dense, 0.5–5 mm diam. (*n*=10), dark brown to blackish. *Surface hyphae* straight, rigid, branching mostly opposite, sometimes lateral or alternate, dark brown, hyphal tips paler, septate, hyphal cells shortly cylindrical, (7.5)11–24(27)×4–5(6) µm, cell wall up to 1 µm thick, smooth. *Appressoria* numerous, globose, simple, entire, ends rounded, broadly sessile, without stalk cell, unilateral or alternate, rarely almost opposite, (5)6–8(9)×(5)6–7 µm, brown, penetration pore small, up to 1 µm diam., in distal or central part of appressorium. *Haustoria* irregularly ellipsoidal, reniform or globose, (5)6–9(10)×4–7(8) µm (*n*=10), hyaline. *Thyriothecia* superficial, develop below surface mycelium, irregularly circular, dimidiate, mostly single, sometimes confluent, fringed at margins, (180)215–272(300) µm diam, brown to dark brown, open with star-shaped or irregular central fissures, at maturity widely open to expose asci. *Scutellum* radiate, composed of dichotomously branched filaments, scutellum cells isodiamteric to cylindrical, straight in center, undulating at margin of ascoma, (4.5)6–13(18)×(2)3–5(7) µm, brown to dark brown, at tips paler. *Asci* few, globose to ovate, without ocular chambers, bitunicate, I–, (55)59–71(75) µm diam. (*n*=10), 8–spored, hyaline, endotunica sometimes up to 15 µm thick, disintegrate rapidly during maturity, develop on ascogenous hyphae with proliferating croziers, interascal tissue present, evanescent. *Ascospores* few, 2–celled, ellipsoidal, not curved, ends rounded, not tapered, slightly constricted at septum, (29)30–35(36) µm long (*n*=14), upper cell 17–20(22) µm wide, lower cell 15–18(20) µm wide, dark brown to blackish when mature, cell wall up to 1 µm thick, verrucose, germinate first at the distal part of each cell to form surface mycelium with lateral appressoria. *Anamorph* absent.

Illustrations. *A. styracina* is illustrated here for the first time.

Hosts. Polygalaceae: *Diclidanthera laurifolia* Mart. (host probably misidentified). **Styracaceae:** *Styrax argenteus* C. Presl and *S. polyneurus* Perkins. *S. argenteus* is a new host species for *A. styracina*.

Known distribution. Neotropical: Central America (Costa Rica, Panama) and South America (Brazil). *A. styracina* is a new record for Panama and occurs in Western Panama in humid mountain rainforests of higher elevations from 2000 to 2500 m a.s.l.

Specimens examined: BRAZIL. Minas Gerais: Viçosa, epiphyllous on *Diclidanthera laurifolia*, *A.S. Müller 555* (BPI 690525, host probably misidentified). **São Paulo State:** Santos, on Melastomataceae (probably Styracaceae, det. T.A. Hofmann), 1884, *Cl.B. Balansa s.n.* (S F114233, labeled as *Asterina myocoproides*). **COSTA RICA. Alajuela Province:** lectotype, isotype, see above. **PANAMA. Chiriquí Province:** Parque International La Amistad (PILA), Cerro Picacho, ca. 2300 m a.s.l., epiphyllous on *Stryax argenteus* (det. T.A. Hofmann and J.A. Polanco), with various hyperparasites and associated with members of Meliolales, Vizellaceae, Parmulariaceae, Englerulaceae and an unknown bitunicate ascomycete, 19 Apr. 2006, *T.A. Hofmann 433-A* (M-0141090; PMA); same locality, host species and associated organisms, 5 Jun. 2006, *T.A. Hofmann 459-A* (FR; PMA); same locality, host species and associated organisms, 2 Jul. 2006, *T.A. Hofmann 481* (PMA).

Additional specimens examined: ***Asterina dispar*** **Speg. PARAGUAY. Cordillera Department:** Piribebuy (as ‘Peribebuy’), epiphyllous on *Styrax* sp., *B. Balansa 3979-39782* (type, LPS 1669). ***Asterina multiplex*** **Rehm [=*Trichasterina stryacis* (Theiss.) G. Arnaud]. BRAZIL. Rio Grande do Sul:** Sao Leopoldo, epiphyllous on *Styrax* sp., 1906, *S.J. Rick* (BPI 690095); same locality and date, epiphyllous on *Styrax leprosus*, *S.J. Rick 5*? (BPI 690096, 690097). ***Asterina silvatica*** **Rehm [=*Trichasterina stryacis* (Theiss.) G. Arnaud]. BRAZIL. Rio Grande do Sul:** Sao Leopoldo, epiphyllous on *Styrax acuminatus* Pohl, 1907, Rick 336 (BPI 690429); same locality and host species, Feb. 1908, *F. Theissen 77* (BPI 690428); same locality, on undetermined leaves, May 1908, *F. Theissen 52* (BPI 690432).

Notes. Typical for *A. styracina* are the numerous, simple and sessile appressoria distributed densely along the surface mycelium. The host plant *Diclidanthera laurifolia* (Polygalaceae, BPI 690525) from Brazil, was probably misidentified and seems to be a Styracaceae as well.

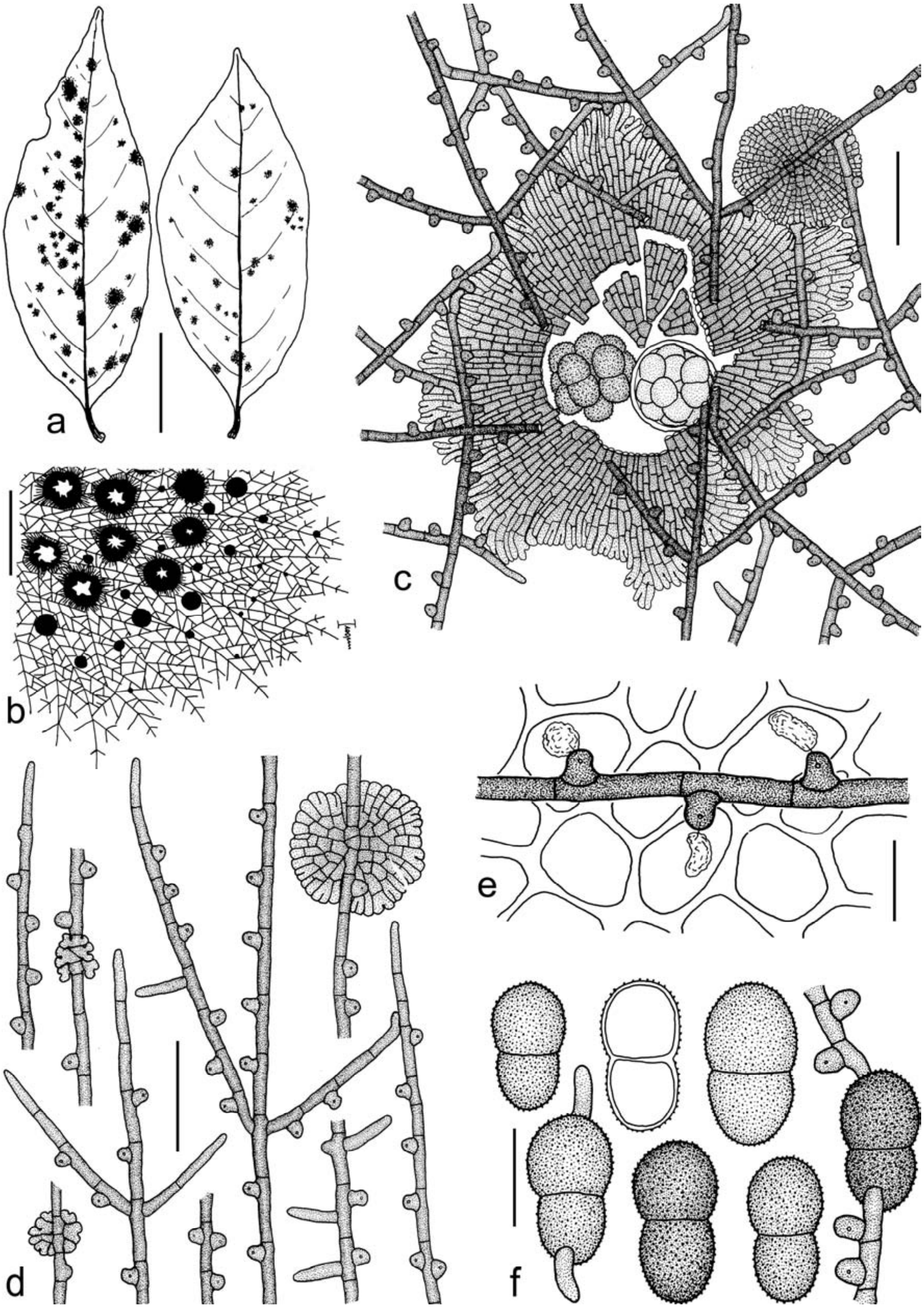

Figure 3.37: ***Asterina styracina*** **on** ***Styrax argenteus*** **(TH 433-A). a:** Adaxial side of infected leaves. Scale bar = 2 cm. **b:** Part of the colony with thyriothecia and surface mycelium. Scale bar = 500 µm. **c:** Young thyriothecium with mature and immature asci. Scale bar = 50 µm. **d:** Surface mycelium with appressoria and ascoma initials. Scale bar = 40 µm. **e:** Haustoria within epidermal host cells. Scale bar = 15 µm **f:** Mature, slightly verrucose ascospores, some of them germinating. Scale bar = 20 µm.

According to Housagoudar and Abraham (2000), four species of *Asterina* are known from Styracaceae, *A. dispar* Speg. and *A. multiplex* Rehm from Brazil, *A. hiiranensis* W. Yamam. from Taiwan and *A. styracina* Syd from Costa Rica. *A. multiplex* is a synonym of *Trichasterina styracis* (Theiss.) G. Arnaud (Müller and Arx 1962) and *A. hiiranensis* was recombined into *Asterolibertia hiiranensis* (W. Yamam.) W. Yamam. by Yamamoto (1957). Therefore, only *A. dispar* and *A. styracis* are validly published *Asterina* spp. on Styracaceae. According to the original descriptions from Speggazini (1889) and Sydow (1927), both fungi are morphologically very similar and parasitize species of *Styrax*. *A dispar* was described from Brazil, *A. styracina* from Costa Rica. The type material of *A. dispar* was examined and the species differs in few morphological aspects from *A. styracina*. *A. dispar* forms smaller ascospores by (25)27–30×(10)11–15 µm, the appressoria are slightly larger by (7)8–11(12)×6–7 µm and often contain a narrow base and are hooked. The appressoria of *A. styracina*, however, are sessile with a broad base, straight, and are never longer that 9 µm.

The leaves of *Styrax argenteus* from Panama are parasitized by various foliicolous fungi, which, in some cases, are hyperparasited by other fungi. Together with *A. styracina*, members of Meliolales, Parmulariaceae, Vizellaceae, an unknown bitunicate ascomycete and a species of *Capnodiastrum* were found on the leaves of *S. argenteus* in Panama.

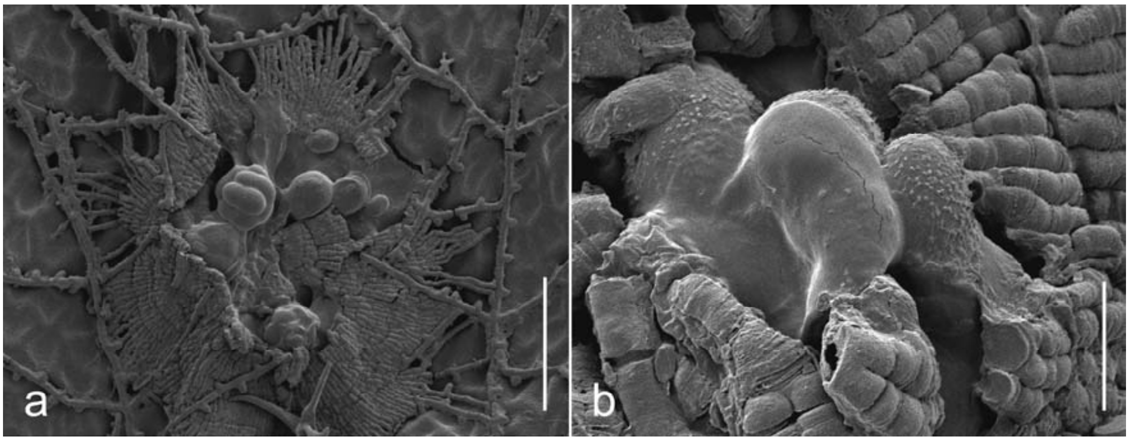

Figure 3.38: SEM photographs of *Asterina styracina* on *Styrax argenteus* (TH 459-A). a: Surface mycelia and an open thyriothecium with asci. Scale bar = 100 µm. **b:** Mature, verrucose ascospores partly embedded in mucus or remnants of collapsed asci. Scale bar = 20 µm.

Asterina tonduzii **(Speg.) Syd. [as '*tonduzi*'], Ann. Mycol. 25(1/2): 74(1927). Figs. 3.39., 3.40**

Type on *Xylosma salzmanni* (Clos) Eichler [= *Xylosma velutina* (Tul.) Triana & Planch. *fide* Sydow 1927] (Saliaceae s.l., formerly Flacourtiaceae). Costa Rica, Cartago Province, around Cartago, Nov. 1897, *A. Tonduz s.n.* (type, n.v.)

≡ *Opasterinella tonduzii* Speg. [as 'tonduzi'], Bol. Acad. Nac. Cien. Córdoba 23: 571 (1919).

[synonymy according to Sydow (1927)]

Anamorph: *Asterostomella tonduzii* Syd.[as '*tonduzi*'], Ann. Mycol. 25(1/2): 136 (1927).

Type on *Xylosma velutina* (Tul.) Triana & Planch. (Salicaceae s.l., formerly Flacourtiaceae). Costa Rica, San José Province, San José, 22 Dec. 1924, *H. Sydow 210* (type, S F83412!); La Caja, 24 Dec. 1924, *H. Sydow 100* (para?type, n.v.).

Colonies amphigenous, irregularly circular, margins of colony not well defined, if single, early becoming confluent, sometimes covering large parts of the leaf surface, conspicuous, 1–5 mm diam. (*n*=10), greyish to black. *Surface hyphae* slightly undulating, branching unilateral or alternate, sometimes opposite, brown, at tips paler, septate, hyphal cells, cylindrical, (7)14–25(30)×3–4(4.5) µm, cell wall up to 1 µm thick, smooth. *Appressoria* numerous, mostly short cylindrical to ampulliform, straight or slightly hooked, entire, sometimes slightly lobate, rarely bifurcate, sessile, without a stalk cell, alternate or unilateral, (7)9–14(17)×(3)4–5(6) µm (*n*=50), brown. *Haustoria* inconspicuous. *Thyriothecia* superficial, develop below surface mycelium, circular, dimidiate, single or confluent, with fringed margins, (120)137–165(180) µm diam. (*n*=50), brown, open with central star-shaped fissures. *Scutellum* radiate, composed of dichotomously branched filaments, scutellum cells isodiametric to cylindrical, straight in center, slightly undulating at margin of ascoma, (3)4–7(10)×(2)3–4(6) µm, brown, at margins paler. *Asci* numerous, globose to ovate, without ocular chambers, bitunicate, I–, (26)29–34(37) µm diam. (*n*=36), 8–spored, hyaline, develop on indistinct ascogenous hyphae, interascal tissue absent. *Ascospores* numerous, 2–celled, ellipsoidal, ends rounded, constricted at septum, sometimes tapering to one end, (18)19–22(23) µm long (*n*=41), upper cell 9–13(20) µm wide, lower cell (8)9–11(12) µm wide, brown, cell wall up to 1 µm thick, smooth, germinate first at the distal part of the lower cell to form a surface mycelium with lateral appressoria.

Anamorph present, = *Asterostomella tonduzii* Syd. *Pycnothyria* very numerous, superficial, developing below surface mycelium, circular, dimidiate, single or confluent, fringed at margins, single to slightly confluent, scattered between thyriothecia, (50)56–77(90) µm diam. (*n*=50), dark brown to blackish, open with central star-shaped fissures or with irregular breaking of central scutellum cells. *Scutellum* similar to the one of the thyriothecia, but dark brown to blackish. *Conidiogenous cells* monoblastic, formed inside the pycnothyrial cavity by single cells of the inner part of the scutellum layer. *Conidia* very numerous, 1–celled, globose, broadly clavate, pyriform or ellipsoidal, sometimes slightly angular, (9)14–19(21)×(5)9–12(13) µm (*n*=50), brown, smooth, with numerous hyaline germpores, arranged in a central ring or irregularly around the surface of the conidium, germinate first through germ pore with a stalked and cylindrical appressorium.

Illustrations (teleomorph and anamorph). *A. tonduzii* and its anamorph are illustrated here for the first time.

Hosts. Salicaceae s.l. (Flacourtiaceae s.str.) (teleomorph and anamorph): *Flacourtia ramontchi* L'Hér., *Xylosma* sp. and *X. velutina* (Tul.) Triana & Planch.

Known distribution (teleomorph and anamorph). Tropical: Central America (Costa Rica, Panama) and South Asia (India). *A. tonduzii* and its anamorph are new records for Panama. Teleomorph and anamorph occur in Western Panama on the Atlantic side in lowland marsh forests at about 20 m a.s.l.

Specimens examined (teleomorph and anamorph together): COSTA RICA. San José Province: type of *Asterostomella tonduzii*, see above. — La Caja, amphigenous on *Xylosma velutina*, 24 Dec. 1924, *H. Sydow 687* (paratype?, BPI 690586); same locality, same host plant and same date, *H. Sydow s.n.* (BPI 690587). **PANAMA. Bocas del Toro Province:** Changuinola, border of Canal Changuinola (dominated by *Raphia taedigera*), ca. 19 m a.s.l., amphigenous on *Xylosma* sp. (det. T.A. Hofmann), 16 Jul. 2006, *T.A. Hofmann, R. Mangelsdorff & T. Trampe ppMP 1172, 1176* (M-0141020; PMA); same locality and host plant, 14 Feb. 2007, *T.A. Hofmann, R. Mangelsdorff & T. Trampe ppMP 1302* (M-0141021; PMA); same host plant and locality, 3 Oct. 2007, *T.A. Hofmann & M. Piepenbring ppMP 1365* (M-0141022; PMA).

Additional specimens examined: see *Asterina* sp. 8 on *Casearia commersoniana* (Salicaceae).

Notes. In the type material, the pycnothyria of the anamoph *Asterostomella tonduzii* dominate the telomorph *Asterina tonduzii*. The pycnothyria are smaller and darker than

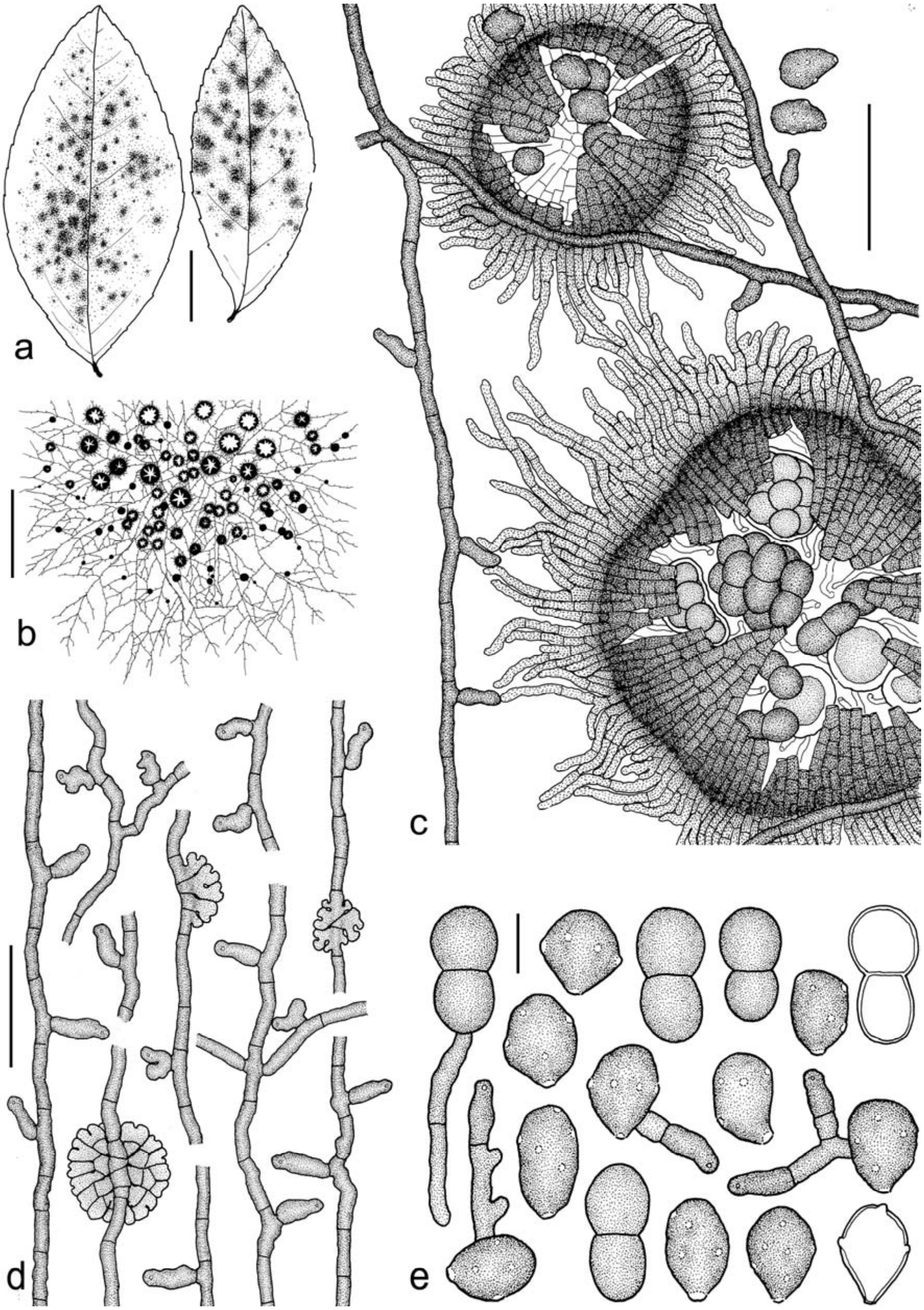

Figure 3.39: ***Asterina tonduzii*** **on** ***Xylosma*** **sp. a:** Adaxial side of infected leaves (ppMP 1172). Scale bar = 2 cm. **b:** Part of the colony with thyriothecia, pycnothyria and surface mycelium (ppMP 1172). Scale bar = 900 µm. **c:** Pycnothyrium with conidia and mature thyriothecium with asci (ppMP 1302). Scale bar = 40 µm. **d:** Surface mycelium with appressoria and sporoma initials (ppMP 1302). Scale bar = 30 µm. **e:** Mature ascospores and conidia with germ pores, some of them germinating. Scale bar = 10 µm.

the ascomata. The conidia from the type specimen are not that angular as in the specimens from Panama. However, they do contain hyaline germpores as illustrated in Fig. 3.39e. The presence of conidial germpores was not mentioned by Sydow in his detailed description (Sydow 1927). According to Hughes (2007), the anamoph *Asterostomella tonduzii* from Costa Rica is parasitized by the obligate fungicolous hyphomycete *Pirozynskiella costaricensis* (Speg.) S. Hughes. However, the mycoparasitic hyphomycete was not found on colonies of *A. tonduzii* from Panama.

Species of *Asterina* on Salicaceae s.l. (Flacourtiaceae s.str.) are compared in Table 3.4. Two of these species parasitize species of *Xylosma*, *A. tonduzii* Syd. from Costa Rica and *A. xylosmae* J.M. Mend. from the Philippines. However, *A. xylosmae* differs, because the ascomata are larger with 200–360 µm diam., the ascospores are smaller with 16–19×10–11 µm and the appressoria are stalked (Mendoza 1932).

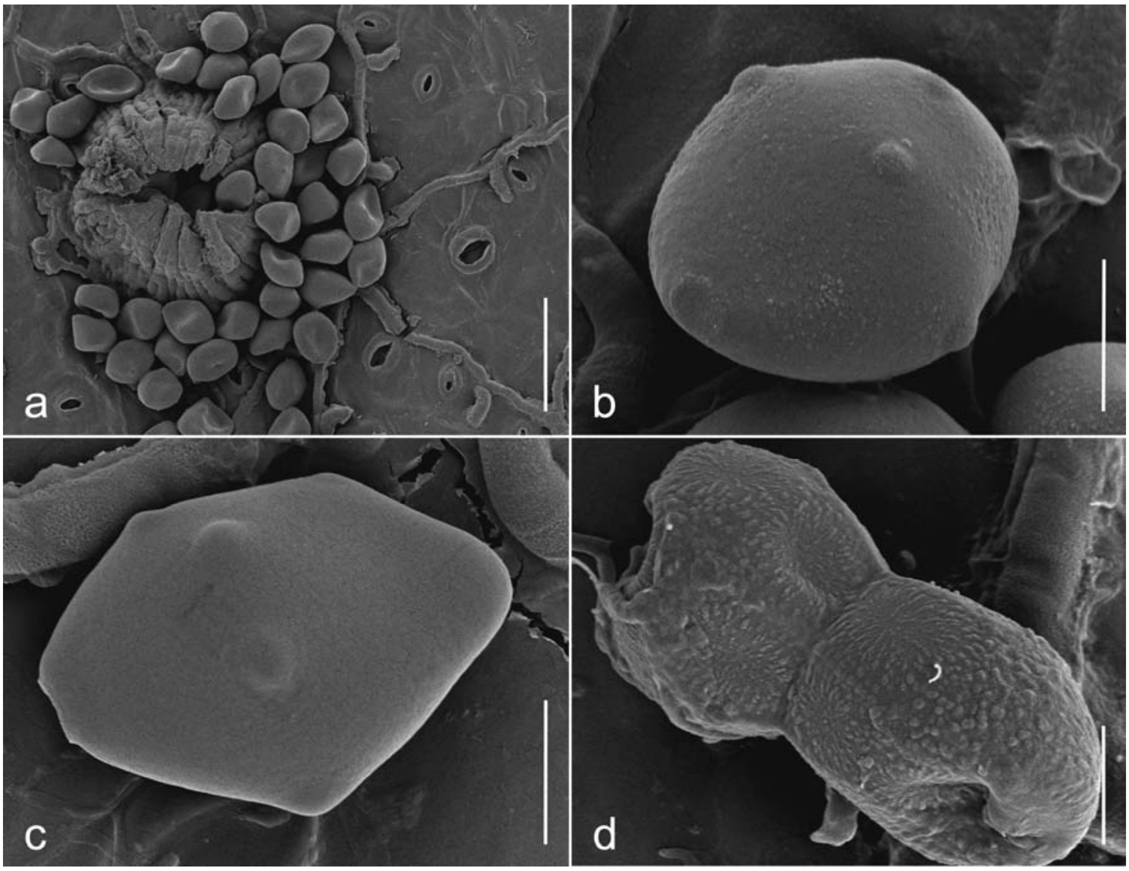

Figure 3.40: SEM photographs of *Asterina tonduzii* on *Xylosma* sp. (ppMP 1176). a: Open pycnothyrium with masses of liberated conidia. Scale bar = 30 µm. **b-c:** Mature conidia with elevated germ pores. Scale bars = 5 µm. **d:** Collapsed, old ascospore. Scale bar = 5 µm.

Asterina weinmanniae **Syd., Ann. Mycol. 37(4/5): 388 (1939). Figs. 3.41,3.42**

Type on *Weinmannia hirtella* Kunth (Cunoniaceae). Ecuador, Tungurahua Province, Hacienda San Antonio pr. Baños, 12 Jan. 1938, *H. Sydow 723* (syntype, S F12317 n.v.); 5 Dec 1938, *H. Sydow 675* (syntype, n.v.); on *W. macrophylla* Kunth (Cunoniaceae). Ecuador, Tungurahua Province, Hacienda San Antonio pr. Baños, 8 Jan. 1938, *H. Sydow 699* (syntype, n.v.).

Colonies amphigenous, irregularly circular to elliptical, single, rarely confluent, inconspicuous and poorly defined, 1–5 mm diam. (*n*=10), black. *Surface hyphae* slightly undulating, branching unilateral, alternate or opposite, brown, hyphal tips paler, septate, hyphal cells cylindrical, (12)23–35(38)×(4.5)5–6(7) µm, cell wall 0.5–1 µm thick, smooth. *Appressoria* numerous, cylindrical, sometimes ampulliform, margins entire, sinuate or slightly 1–3 times lobed, ends rounded, straight or hooked, appressorial tips sometimes touch generatorhyphae, sessile, without stalk cell, unilateral or alternate, not opposite, (8)10–14(16)×5–8(11) µm, brown, penetration pore small, in the distal part of the appressorium. *Haustoria* inconspicuous. *Thyriothecia* superficial, develop below surface mycelium, circular, dimidiate, single, fringed at margins, (150)175–227(250) µm diam., dark brown to blackish, open with star-shaped central fissures, at maturity sometimes widely open to expose mature and immature asci. *Scutellum* radiate, composed of dichotomously branched filaments, scutellum cells isodiametric to cylindrical, straight in the center, undulating at margins of ascoma, (4)5–9(10)×(2)3–6(7) µm, brown to dark brown, at tips paler. *Asci* globose to ovate, with distinct ocular chambers, bitunicate, I–, (30)33–43(50) µm diam. (*n*=17), 8–spored, hyaline, develop on ascogenous hyphae with proliferating croziers, interascal tissue present, filamentous, septate. *Ascospores* 2–celled, ellipsoidal, ends rounded, rarely slightly acuminate, sometimes slightly tapered to one end, constricted at septum, (27)28–33(37) µm long, upper cell (13)14–16(17) µm wide, (11)12–14(15) µm wide, brown when mature, sometimes dark brown, cell wall up to 1 µm thick, slightly verrucose, germinate first at the distal part of both cells to form surface mycelium with lateral apressoria. *Anamorph* absent.

Illustrations. *A. weinmanniae* is illustrated here for the first time.

Hosts. Cunoniaceae: *Weinmannia hirtella* Kunth, *W. macrophylla* Kunth and *W. pinnata* L. *W. pinnata* is a new host species for *A. weinmanniae*.

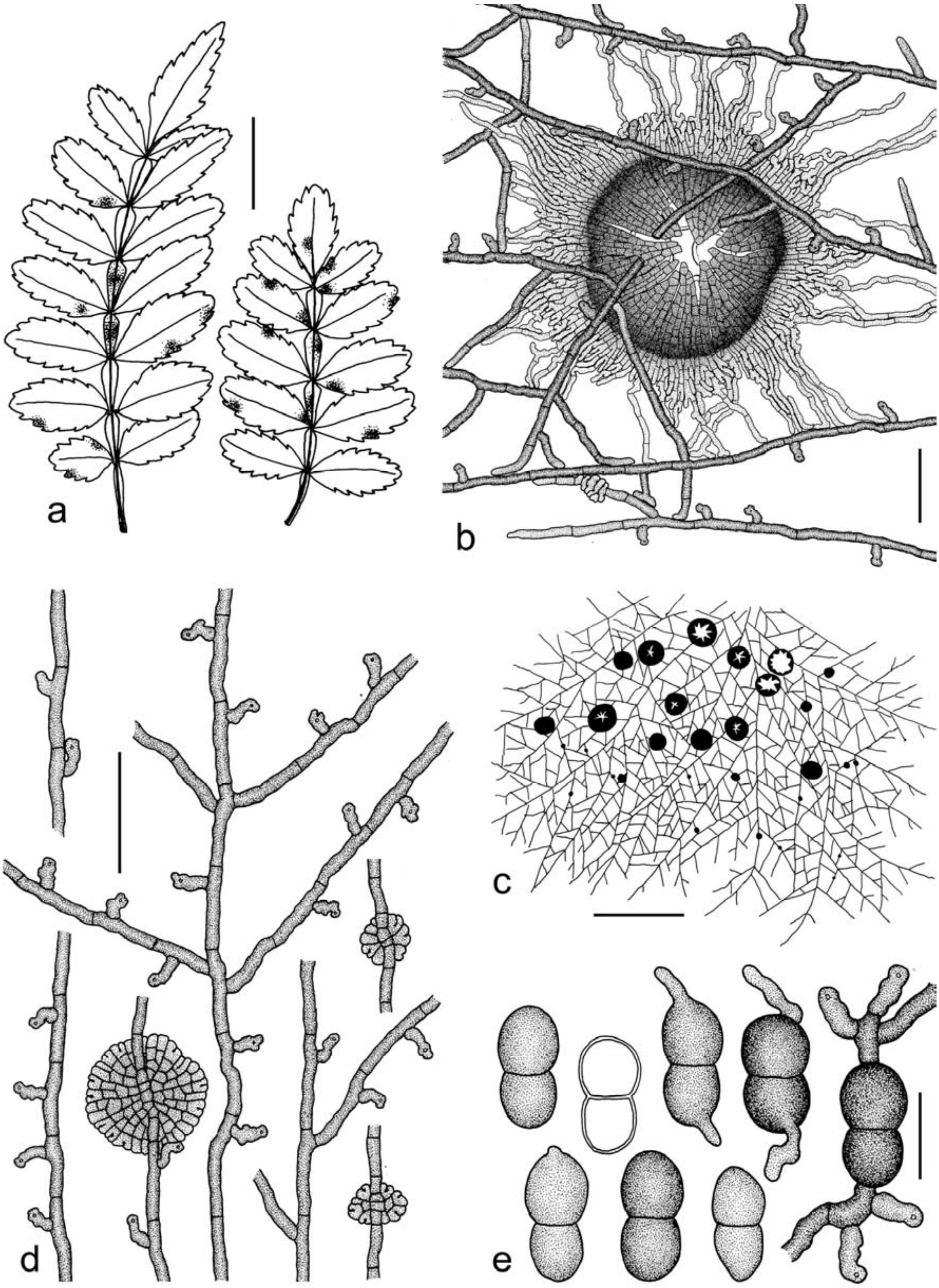

Figure 3.41: ***Asterina weinmanniae*** **on** ***Weinmannia pinnata*** **(TH 592). a:** Infected leaves. Scale bar = 2 cm. **b:** Young thyriothecium with immature asci. Scale bar = 50 µm. **c:** Part of a colony with thyriothecia and surface mycelium. Scale bar = 500 µm. **d:** Surface mycelium with appressoria and ascoma initials. Scale bar = 50 µm. **e:** Mature ascospores, some of them germinating (ornamentation of ascospores not shown). Scale bar = 20 µm.

Known distribution. Neotropical: Central America (Panama) and South America

(Ecuador). *A. weinmanniae* is a new record for Central America and Panama and occurs in Western Panama in mountain rain forests of higher elevations at about 2300 m a.s.l.

Specimens examined: **ECUADOR. Tungurahua Province:** Hacienda San Antonio pr. Baños, epiphyllous on *Weinmannia hirtella* Kunth, 5 Feb. 1938, *H. Sydow 1208* (BPI 690664). **PANAMA. Chiriquí Province:** Parque National Volcán Barú (PNVB), Los Quetzales trail, ca. 2300 m a.s.l., amphigenous on *Weinmannia pinnata* (det. T.A. Hofmann), 20 Oct. 2007, *T.A. Hofmann 592* (M-0141091; PMA).

Notes. The specimen from Ecuador (BPI 690664) differs slightly from the material from Panama. The surface mycelium is more rigid and straight, not undulating, the appressoria are mostly straight, not hooked and the margins are not lobed or sinuate. However, almost all sizes as well as the germination mode of the ascospores are similar in the specimens from Panama. Sydow (1939) described the ascospores of *A. weinmanniae* as smooth, but ultrastructural analysis with SEM proved the presence of a verrucose ornamentation of the ascospores (Fig. 3.42).

According to Hosagoudar and Abraham (2000), *A. weinmanniae* is the only species of *Asterina* occuring on Cunoniaceae.

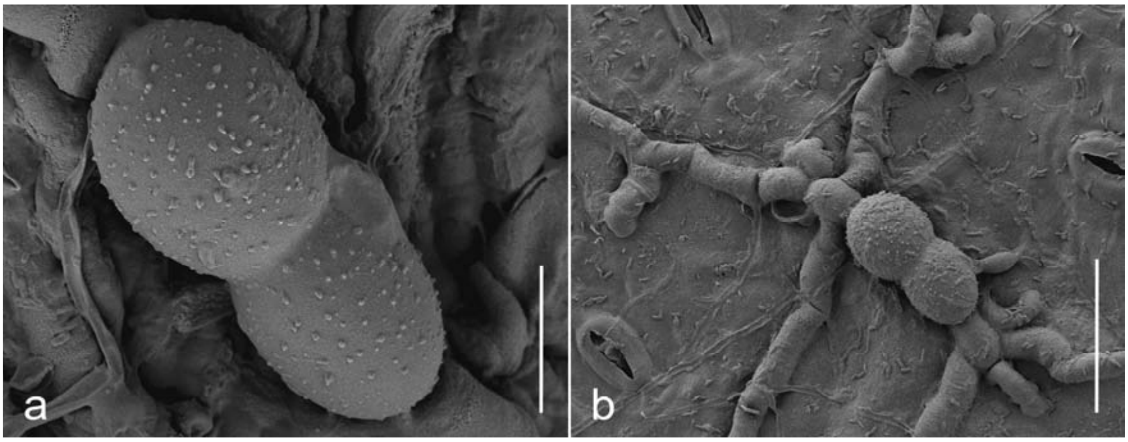

Figure 3.42: SEM photographs of *Asterina weinmanniae* on *Weinmannia pinnata* (TH 592). a: Mature verrucose ascospores. Scale bar = 10 µm. **b:** Germinating ascospore with appressoriate surface mycelium. Scale bars = 30 µm.

Asterina zanthoxyli **W. Yamam., Sci. Rep. Hyogo Univ. Agric., Agric. Biol. Ser. 3, 1: 28 (1957).** **Figs. 3.43, 3.44**

Type on *Zanthoxylum setosum* Hemsl. ex Forb. & Hemsl. (Rutaceae). Taiwan, Taityu, Rengeti, 18 Dec. 1938, *W. Yamamoto* (type, n.v.).

≡ *Parasterina zanthoxyli* W. Yamam., Sci. Rep. Hyogo Univ. Agric., Agric. Biol. Ser. 1: 47 (1953).

[synonymy according to Yamamoto (1957)]

Colonies amphigenous, irregularly circular, single, later sometimes becoming confluent, conspicuous, 2–10 µm diam. (*n*=10), black. *Surface hyphae* straight to slightly undulating, branching mostly opposite, rarely unilateral or alternate, dark brown, hyphal tips paler, septate in short intervals, hyphal cells cylindrical, (11)17–27(35)×4–5(6) µm, cell wall up to 1 µm thick, smooth, very rarely hyphal penetration of host stomata. *Appressoria* numerous, ampulliform, pyriform or cylindrical, always narrow at apex, sessile, rarely stalked, entire or slighly sinuate, but not lobed, sometimes slightly hooked, without stalk cell, unilateral, alternate or opposite, (8)10–13(15)×(4.5)5–6(7) µm (*n*=40), apex 3–4(5) µm wide, dark brown, but slightly paler than surface hyphae, at apex paler, penetration pore small, always in distal part of the appressorium. *Haustoria* inconspicuous, arbuscular, ellipsoidal or reniform, more rarely globose, (6)6.5–9(10)×4–6 µm (*n*=10), hyaline, fill up to ¼ of epidermal host cell. *Thyriothecia* superficial, develop below surface hyphae, circular, dimidiate, single or slightly confluent, fringed at margins, (180)194–235(270) µm diam. (*n*=40), at maturity dark brown to black, open with central star-shaped fissures, sometimes open widely to expose mature and immature asci. *Scutellum* radiate, composed of dichotomously branched filaments, scutellum cells isodiametric to cylindrical, straight in center, undulating or meandrical at margin of ascoma, in total (4)5–9(10)×(2)3–4.5(5) µm, at margins of ascoma up to 30 µm long, dark brown, at tips paler, develop sometimes with lateral appressoria at ascomatal margins. *Asci* globose, with distinct ocular chambers, bitunicate, I–, (30)36–51(55) µm diam. (*n*=11), 8–spored, hyaline, develop on ascogenous hyphae with proliferating croziers, mature asci few, interascal tissue present. *Ascospores* 2–celled, ellipsoidal, broadly rounded, sometimes slightly acuminate, constricted at septum, sometimes tapering to one or both ends, (26)29–33(35) µm long (*n*=40), upper cell (13)14–16(17) µm wide, lower cell (11)12–13(14) µm wide, brown to dark brown when mature, cell wall 0.5–1 µm thick, densely

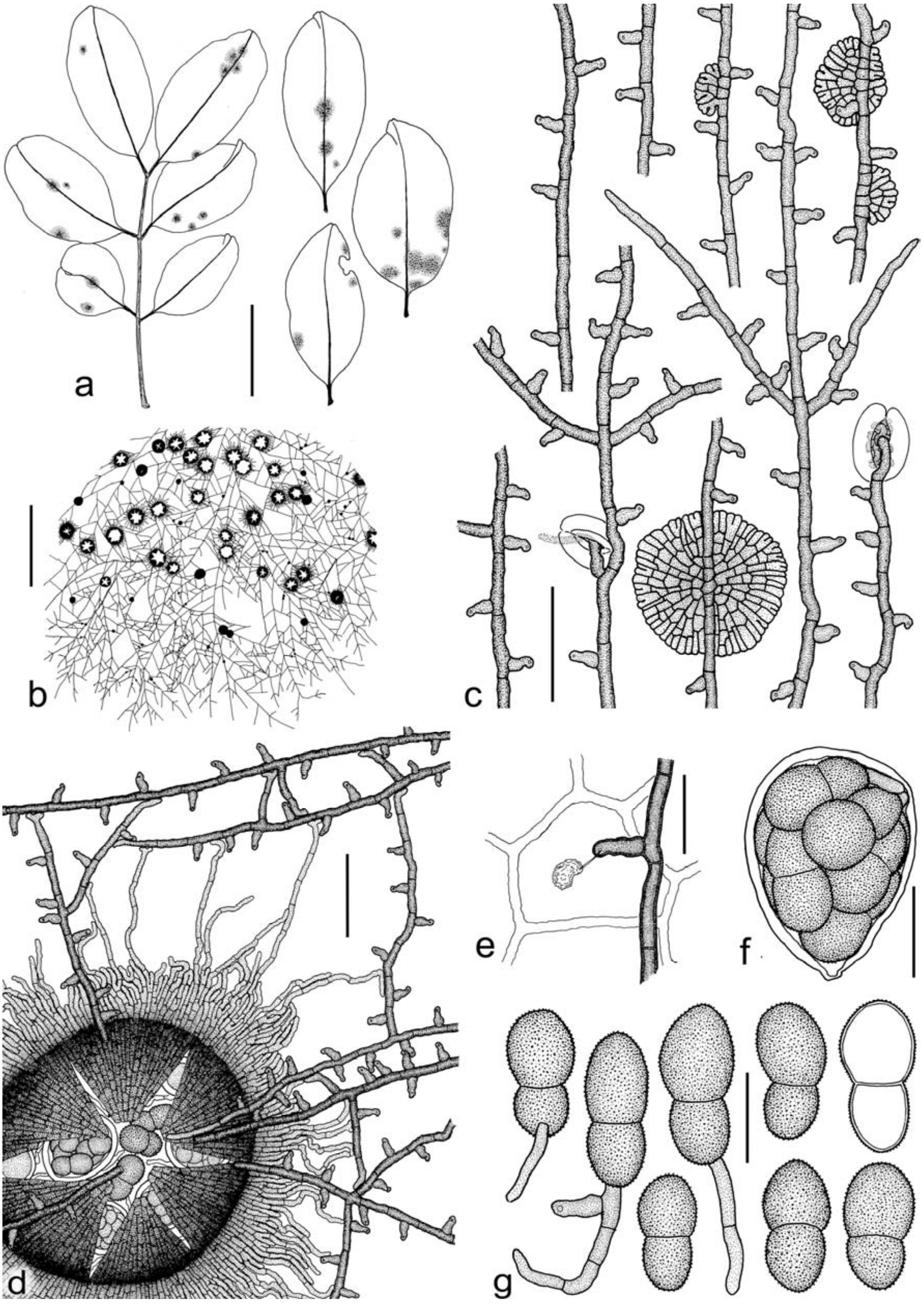

Figure 3.43: ***Asterina zanthoxyli* on *Zanthoxylum scheryi* (TH 487) a:** Infected leaves. Scale bar = 4 cm. **b:** Part of the colony with thyriothecia and surface mycelium. Scale bar = 1 mm. **c:** Surface mycelium with appressoria and ascoma initials. Scale bar = 50 µm. **d:** Open thyriothecium with mature and immature asci and liberated ascospores. Scale bar = 50 µm. **e:** Haustorium within epidermal host cell. Scale bar = 10 µm. **f:** Mature ascus with ascospores, two of them germinating. Scale bar = 10 µm. **g:** Mature ascospores, some of them germinating. Scale bar = 10 µm.

verrucose, ornamentation mostly in rows, germinate first at the distal part of the lower cell to form a surface mycelium with lateral appressoria. *Anamorph* absent.

Illustrations. In Yamamoto (1957) and this contribution. The morphology of haustoria, ascoma, asci and the ornamentation of the ascospores are illustrated here for the first time (Figs. 3.43e-f, 3.44).

Hosts. Rutaceae: *Zanthoxylum cuspidatum* Champ. ex Benth., *Z. oxyphyllum* Edgew., *Z. scheryi* Lundell, *Z. setosum* Hemsl. ex Forb. & Hemsl. and *Z. simulans* Hance. *Z. scheryi* is a new host species for *A. zanthoxyli*.

Known distribution. Tropical: Central America (Panama), East Asia (China, Taiwan) and South Asia (India). *A. zanthoxyli* is a new record for the American Continent, Central America and for Panama. The species occurs in Western Panama in humid mountain rainforests of higher elevations at approx. 2500 m a.s.l.

Specimens examined: INDIA. West Bengal: Darjeeling district, Lebong, on *Zanthoxylum oxyphyllum, M.K. Maity C-1248* (BPI 690669). **PANAMA. Chiriquí Province:** Parque International La Amistad (PILA), Cerro Picacho, ca. 2500 m a.s.l., amphigenous on *Zanthoxylum scheryi* (det. T.A. Hofmann), 13 Jul. 2006, *T.A. Hofmann 487* (FR; PMA); same locality and host species, 12 Oct. 2005, *T.A. Hofmann, R. Mangelsdorff & M. Piepenbring ppMP 410* (M-0141023; PMA); same locality and host species, 25 Sep. 2007, *T.A. Hofmann 561* (PMA).

Notes. According to Hosagoudar and Abraham (2000), 17 species of *Asterina* are known from Rutaceae. However, the host genus *Zanthoxylum* is only parasitized by *A. zanthoxyli*.

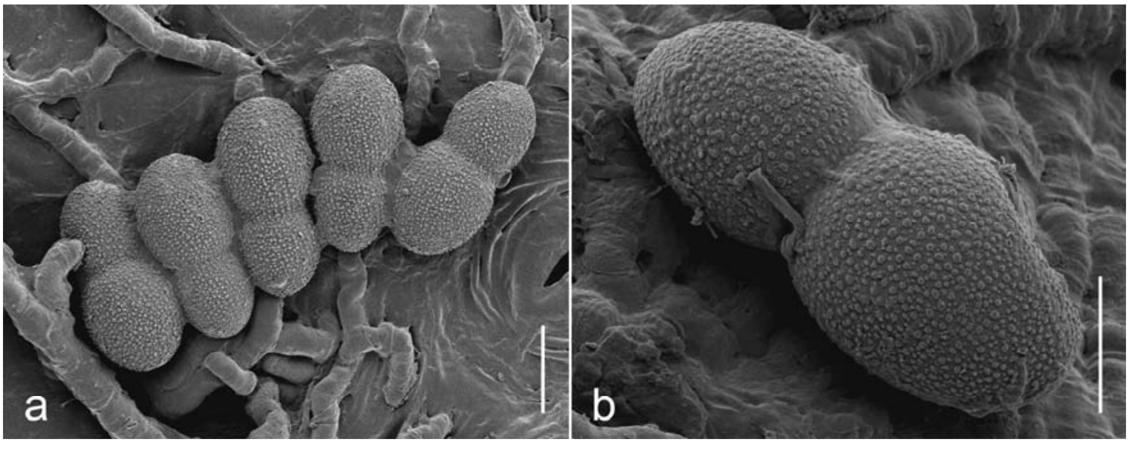

Figure 3.44: SEM photographs of *Asterina zanthoxyli* on *Zanthoxylum scheryi* (TH 487). a: Group of mature ascospores. Scale bar = 15 µm. **b:** Mature, verrucose ascospore. Scale bar = 10 µm.

Asterina **sp. 1 on *Hansteinia reflexiflora* (Acanthaceae). Figs. 3.45, 3.46**

Colonies amphigenous, inconspicuous and poorly defined, irregularly circular, single, early becoming confluent and cover large parts of the leaf surface, (1)2–5(6) mm diam. (*n*=10), greyish to black. *Surface hyphae* strongly undulating, branching alternate, unilateral or opposite, pale brown to brown, at hyphal tips paler, septate, hyphal cells cylindrical, (7)13–27(31)×3–4(4,5) µm, cell wall up to 1 µm thick, smooth. *Appressoria* few, digitate, multilobate, with 4 or more large and various small lobes, straight, not sessile, at base narrow, without a stalk cell, alternate or unilateral, (6)7–10(11)×(10)11–14(16) µm, pale brown to brown, penetration peg up to 1 µm diam., in apical part of appressorial cell, in the center of one of the larger lobes. *Haustoria* inconspicuous. *Thyriothecia* superficial, develop below surface mycelium, circular, single, sometimes confluent, fringed at margins, (120)131–159(170) µm diam., dark brown to blackish, open with central star-shaped fissures, at maturity wide open to expose mature and immature asci, with distinct basal 'plate' formed of melanized remains of lower cell walls of scutellum cells. *Scutellum* radiate, composed of dichotomously branched filaments, scutellum cells isodiametric to cylindrical, straight in center, undulating at margin of ascoma, (3)5–7(8)×(2.5)3–4(5) µm, at margins of ascoma up to 30 µm long, brown, at margins of ascoma paler. *Asci* globose, with distinct ocular chambers, bitunicate, I–, 25–30 µm diam., (*n*=15), 8–spored, hyaline, develop on ascogenous hyphae with proliferating croziers, interascal tissue present. *Ascospores* 2–celled, ellipsoidal, ends broadly rounded, sometimes slightly acuminate, constricted at septum, lower cell sometimes tapered, (18)19–20(21) µm long, upper cell 9–10(11) µm wide, lower cell (7)8–9 µm wide, brown, cell wall up to 1 µm thick, verrucose, germinate first at the distal part of the upper cell with a stalked and lobed appressorium. *Anamorph* absent.

Illustrations. In this contribution.

Hosts. Acanthaceae: <u>*Hansteinia reflexiflora*</u> Leonard

Known distribution. Neotropical: Central America (Panama). *Asterina* sp. 1 occurs in Panama in humid mountain rain forests at about 1700 m a.s.l.

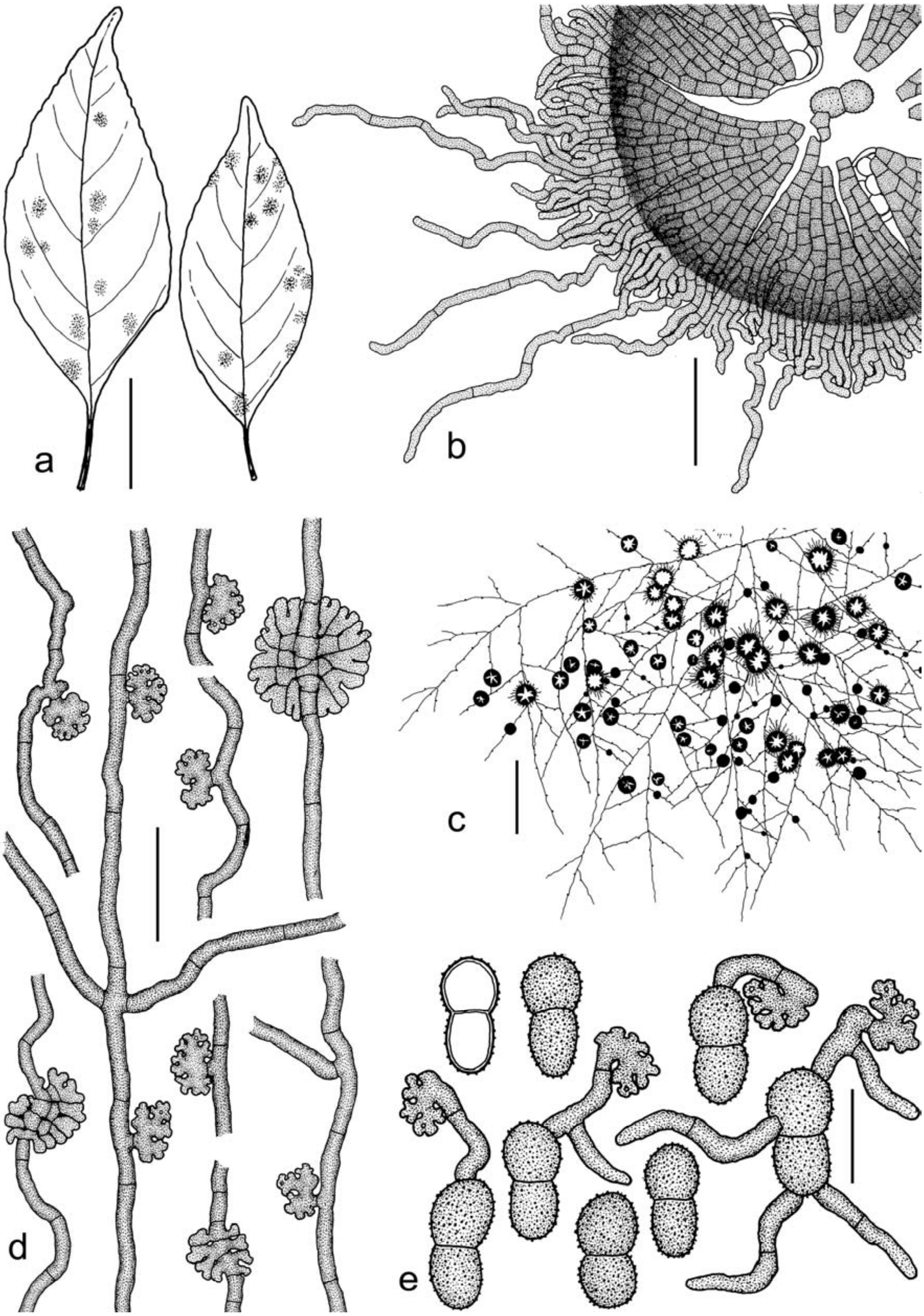

Figure 3.45: ***Asterina* sp. 1 on *Hansteinia reflexiflora* (TH 442-A) a:** Adaxial side of infected leaves. Scale bar = 2 cm. **b:** Part of an open thyriothecium with immature asci and a liberated ascospore. Scale bar = 30 µm. **c:** Part of the colony with thyriothecia and surface mycelium. Scale bar = 500 µm. **d:** Surface mycelium with lobed appressoria and ascoma initials. Scale bar = 25 µm. **e:** Mature, slightly verrucose ascospores, some of them germinating. Scale bar = 15 µm.

Specimen examined: **PANAMA. Chiriquí Province:** Boquete, path to Pata de Macho, ca. 1700 m a.s.l., epiphyllous on *Hansteinia reflexiflora* (det. D. Cáceres), associated with various hyperparasites and hypophyllous with *Cyclotheca* sp. (Microthyriaceae), 29 Apr. 2006, *T.A. Hofmann et al. 442-A* (M-0141080, PMA).

Additional specimens examined: ***A. costaricensis*** **Syd. COSTA RICA. Alajuela Province:** on *Jacobinia tinctoria*, Jan. 1925, *H. Sydow 606* (BPI 689492). ***A. incilis*** **Syd. SIERRA LEONE. Noerthern Province:** Bombali District, Makeni, on *Rungia grandis*, 14 Jan. 1934, *F.C. Deighton 562* (type, IMI 18940). ***A. phlogacanthi*** **[as '*phlogacathae*'] A.K. Kar & S.N. Ghosh. INDIA. West Bengal:** Calcutta, on *Phlogacanthus curviflorus*, 1977, *A.K. Khan* (IMI 215562, labeled as *Asterina* sp.). ***A. punctiformis*** **var.** ***fimbriata*** **(Kalchbr. & Cooke) Theiss. SOUTH AFRICA. KwaZulu-Natal:** on *Hypoestes aristata*, *M. Wood 608* (type, BPI 689778, as *A. fimbriata* Kalchbr. & Cooke). **Eastern Cape Province:** East London, on *Sclerochiton harveyanus*, 24 Nov. 1917, E.M. Doidge 10910 (BPI 689779, 689780, labeled as *A. fimbriata*). ***A. tertia*** **var.** ***africana*** **Doidge Syd. SOUTH AFRICA. Eastern Cape Province:** Ketani, on *Hypoestes verticillaris*, 6 May. 1915, *A. Pegler 2317*, 9074 (BPI 690571, 690572, 690573). **GHANA.** Akoka, between Moose? [Moore?] juntion & Apedwa, on *Justicia flava*, 19 May. 1949, *S.J. Hughes 769* (BPI 690574); Bunsu, same host pant, 7 Jun. 1949, *S.J. Hughes 1114* (BPI 69075, 690576). **PHILIPPINES. Pampanga Province, Central Luzon:** Mt. Arayat, on *Hypoestes cinerea*, 31 Oct. 1925, *M.S.* Clemens s.n. (BPI 689178). ***A. thunbergiicola*** **Hansf. SIERRA LEONE. Eastern Province:** Kenema Distrikt, Tunkia [Gorahun, as 'Giewahun'], on *Thunbergia chrysops*, 19 Dec. 1939, *F.C. Deighton 2181* (ex-type, BPI 690583).

Notes. *Asterina* sp. 1 on *Hansteinia reflexiflora* is characterized by unstalked, multi-lobate appressoria with a sessile base (Fig. 3.45d) and verrucose ascospores (Fig. 3.46). A second species of *Asterina* (*Asterina* sp. 2) on Acanthaceae was collected from a different locality in Western Panama on *Hansteinia ventricosa*. *Asterina* sp. 2 differs from *Asterina* sp. 1 because of the stalked and curved bases of the appressoria (Fig. 3.47d) and smooth ascospores (Fig. 3.48b).

According to Hosagoudar and Abrahm (2000), nine species of *Asterina* occur on Acanthaceae. However, the authors did not include *A. brasiliana* (Theiss.) Speg. from Paraguay (as *A. combreti* var. *brasiliensis* in Theissen 1913, Spegazzini 1919) and *A. thunbergiicola* Hansf. from Sierra Leone (Hansford 1944-45, compare Table 3.4). None of these 11 species occur on the host genus *Hansteinia*. Therefore, species of *Asterina* from Acanthaceae were compared morphologically with type material or typical material obtained for selected species and literature data cited from the original species descriptions (Table 3.4). *A. costaricensis* and *A. brasiliana* are species with neotropical distribution. However, they form stalked appressoria and, therefore, are different from

Asterina sp. 1 from Panama (Table 3.4). Species with paleotropical distribution and unstalked and lobed appressoria are *A. incilis* and *A. tertia* var. *africana* from Africa and *A. dendroidea*, *A. diclipterae*, *A. phlogacanthi* and *A. tertia* from Asia (Table 3.4). *A. incilis* differs from *Asterina* sp. 1 by the presence of an anamorph, narrower appressoria and smaller and smooth ascospores (Sydow 1938). *A. tertia* var. *africana* differs because of the presence of an anamorph, less lobed appressoria and ascospores that germinate with unstalked appressoria (Doidge 1920). *A. diclipterae* and *A. phlogacanthi* both have smaller and smooth ascospores (Yamamoto 1956, Kar and Ghosh 1987) and *A. tertia* has smooth ascospores (Theissen 1913a). Only *A. dendroidea* from Taiwan is morphologically similar to *Asterina* sp. 1 (Table 3.4, Yamamoto 1956). However, type material of *A. dendroidea* could not be consulted until end of the study and the species of *Asterina* on *Hansteinia reflexiflora* remains unidentified.

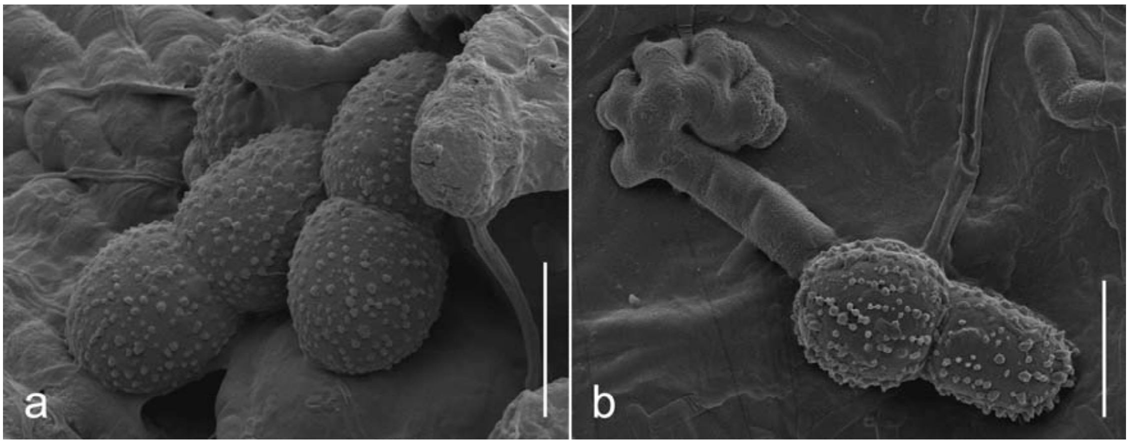

Figure 3.46: SEM photographs of *Asterina* sp. 1 on *Hansteinia reflexiflora* (TH 422-A). a: Two mature, verrucose ascospores. Scale bar = 10 µm. **b:** Germinating ascospore. Scale bar = 10 µm.

Table 3.4: List of *Asterina* spp. on Acanthaceae according to literature. Species are listed in alphabetical order according to continents, Africa: *A. incilis* to *A. thunbergiicola*, Asia: *A. betonicae* to *A. tertia*, Central America: *A. costaricensis*, South America: *A. combreti var. brasiliensis*. Taxa indicated with asterisks are not listed in Hosagoudar and Abraham (2000). Cited host plants and localities correspond to the protolouge of the type species only. Morphological data are cited from the original publication, revised data or own observations from examined type material are indicated in brackets. Abbreviations: Anam = anamorph, lc = lower cell, uc = upper cell.

Species	Host plant	Country	Appressoria	Ascomata	Ascospores	Anam
A. incilis Syd. 1938	*Rungia grandis*	Sierra Leone	unstalked, 6–10×7–9 µm, lobed	100–130 µm diam.	16–17.5 µm long, uc 7–8 µm wide, lc 6–7 µm wide, smooth	yes
A. punctiformis var. *fimbriata* (Kalchbr. & Cooke) Theiss. 1913	*Sclerochiton harveyanus*	South Africa	stalked, 8–12 µm long, head 8–10 µm wide, lobed	130–170 µm diam.	18–22×8–9 µm, smooth	—
A. tertia var. *africana* Doidge 1920	*Dicliptera clinopodia*	South Africa	unstalked, 5–10×6–12.5 µm, lobed	100–140 µm diam.	16–18×7.5–10 µm, verrucose	yes
A. thunbergiicola Hansf. 1944-45*	*Thunbergia chrysops*	Sierra Leone	stalked, 8–13 µm long, head 5–10×4–8 µm, lobed	80–110 µm diam.	12–14×6–7 µm, verrucose	—
A. betonicae Hosag. & Goos 1996	*Justicia betonica*	India	unstalked, 6–9.5×6–7 µm, ovate, entire	up to 220 µm diam.	15–18.5×9–10 µm, smooth	—
A. dendroidea W. Yamam. 1956	*Strobilanthes longespicatus*	Taiwan	unstalked, 7–10×10–14 µm, lobed	112–168 µm diam.	16–18.5×7–8 µm, verrucose	—
A. diclipterae W. Yamam. 1956	*Dicliptera chinensis*	Taiwan	unstalked, 4.5–9×7–11.5 µm, lobed	84–112 µm diam.	11–15×4.5 µm, smooth	—
A. phlogacanthi [as '*phlogacantae*] A.K. Kar & S.N. Ghosh 1986	*Phlogacanthus curviflorus*	India	unstalked, 8.4–12.22×5.35 –8.4 µm, lobed	76.4–164.26 µm diam.	16.04–17.95×7.25–8.02 µm, smooth	—
A. tertia Racib. 1913	*Adhatoda* sp. and *Crossandra* sp.	Java	unstalked, 5–8×8–13 µm, lobed	120–160 µm diam.	16–20×8–10 µm, smooth	yes
A. costaricensis Syd. 1927	*Jacobinia* sp.	Costa Rica	stalked, 10–13 µm long, head 10– 12.5 µm wide, lobed	90–150 µm diam.	15–18×7–8(9) µm, smooth	—
A. brasiliana (Theiss.) Speg. 1919*	undetermined	Paraguay	stalked, 11–15×9–14 µm, lobed	[130–170 µm diam. as *A. combreti*?]	18–22×8–10 µm, verrucose	—

Asterina sp. 2 on *Hansteinia ventricosa* (Acanthaceae). Figs. 3.47, 3.48

Colonies amphigenous, but mostly epiphyllous, very inconspicuous and poorly defined, irregularly circular, 1.5–5 µm diam. (*n*=10), greyish to black. *Surface hyphae* irregularly undulating, branching alternate, unilateral or opposite, pale brown to brown, at hyphal tips paler, septate, hyphal cells cylindrical, (5)12–30(35)×3–4 µm, cell wall up 0.5–1 µm thick, smooth. *Appressoria* few, digitate, multilobate, with 2 or more large lobes and various small lobes, straight or hooked, at base narrow, sometimes stalked, without stalk cell, alternate or unilateral, never opposite, 7–11(15)×(8)10–13(14) µm (*n*=50), pale brown to brown, penetration peg up to 1 µm diam., in apical part of appressorial cell, in the center of a small lobe. *Haustoria* inconspicuous. *Thyriothecia* superficial, develop below surface mycelium, circular, single, rarely confluent, fringed at margins, (100)111–136(150) µm diam. (*n*=50), brown to dark brown, open with central star-shaped fissures, at maturity wide open to expose mature and immature asci, with distinct basal ‘plate’ formed of melanized remains of lower cell walls of scutellum cells. *Scutellum* radiate, composed of dichotomously branched filaments, scutellum cells isodiametric to cylindrical, straight in center, undulating at margins of ascoma, (2)4–8(11)×(2)3–5(6) µm, brown to dark brown, at margins of ascoma paler. *Asci* globose, with distinct ocular chambers, bitunicate, I–, (20)23–28(30) µm diam. (*n*=50), 8–spored, hyaline, develop on ascogenous hyphae with proliferating croziers, interascal tissue absent. *Ascospores* 2–celled, ellipsoidal, ends broadly rounded, constricted at septum, lower cell slightly tapered, (15)17–19(20) µm (*n*=50) long, upper cell 8–10(11) µm wide, lower cell µm 7–8(9) µm wide, brown, cell wall up to 1 µm thick, smooth, germinate first in the distal or lateral part of the upper cell with a stalked and lobed appressorium. *Anamorph* absent.

Illustrations. In this contribution.

Hosts. Acanthaceae: <u>*Hansteinia ventricosa*</u> (Donn. Sm.) D.N. Gibson.

Known distribution. Neotropical: Central America (Panama). *Asterina* sp. 2 occurs in Western Panama in humid mountain rain forest at approx. 1750 m a.s.l.

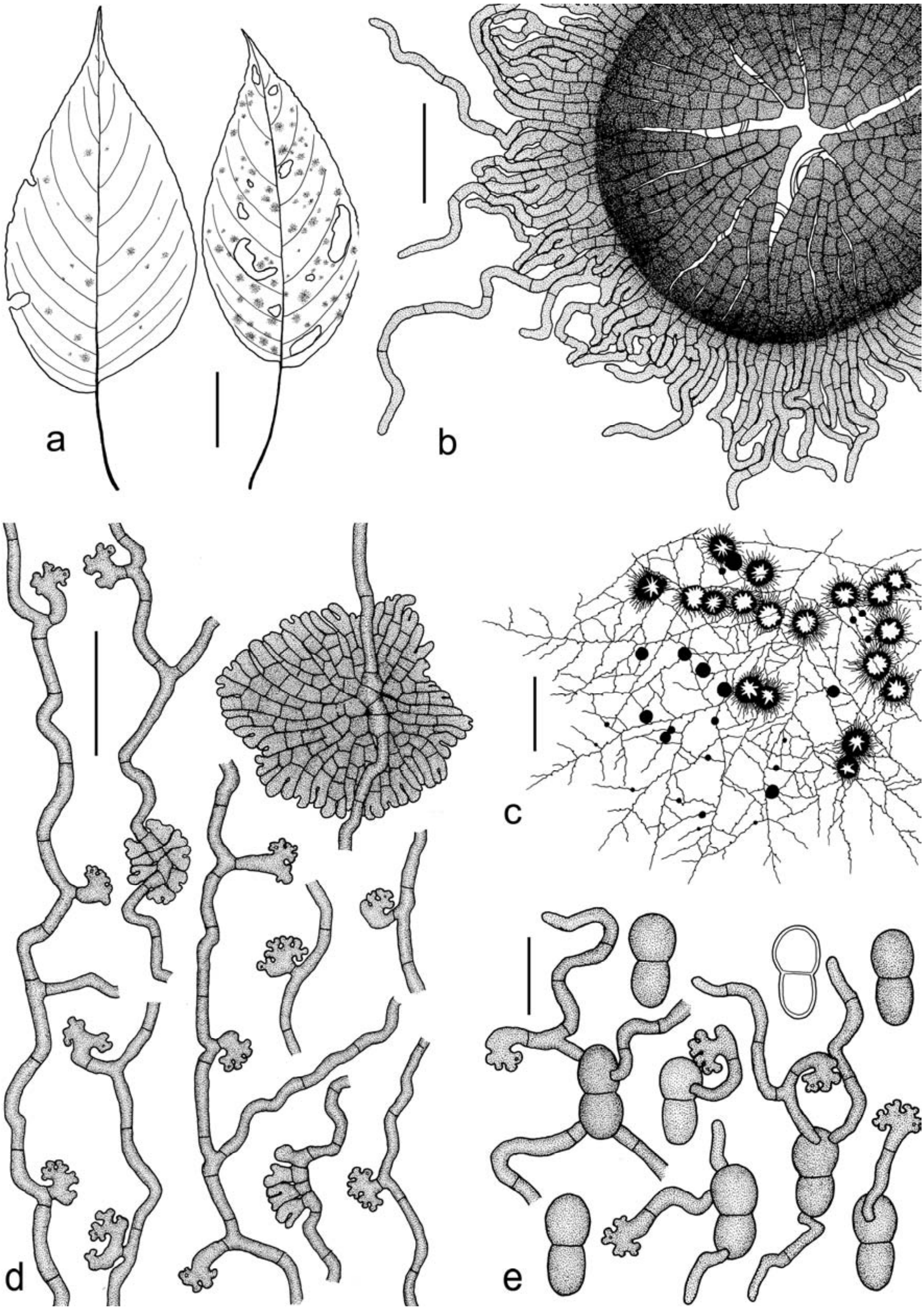

Figure 3.47: ***Asterina*** **sp. 2 on** ***Hansteinia ventricosa*** **(ppMP 1226) a:** Adaxial side of infected leaves. Scale bar = 3 cm. **b:** Part of an immature thyriothecium with immature asci. Scale bar = 25 µm. **c:** Part of the colony with thyriothecia and surface mycelium. Scale bar = 400 µm. **d:** Surface mycelium with lobed appressoria and ascoma initials. Scale bar = 30 µm. **e:** Mature, smooth ascospores, some of them germinating. Scale bar = 15 µm.

Specimens examined: **PANAMA. Chiriquí Province:** Boquete, Alto Chiquero, private property of M.A. Amorùso, near ANAM entrance in direction to Los Quetzales trail, ca. 1750 m a.s.l., amphigenous on *Hansteinia ventricosa* (det. D. Cáceres and R. Mangelsdorff), with at least two different ascomycetous hyperparasites, 24 Mar. 2006, *T.A. Hofmann, M. Piepenbring & T. Trampe ppMP 489* (M-0141066; PMA); same locality, host plant and associated organisms, 27 Jun. 2006, *T. Hofmann, R. Mangelsdorff & T. Trampe ppMP 1121* (M-0141067; PMA); same locality, host plant and associated organisms, 15 Jan. 2007, *T.A. Hofmann, R. Mangelsdorff & T. Trampe ppMP 1226* (M-0141068; PMA).

Additional specimens examined: see *Asterina* sp. 1.

Notes. *Asterina* sp. 2 is morphologically similar to *A.* sp. 1 described from *Hansteinia reflexiflora*, because both species have multilobate appressoria and the sizes of the ascomata, asci and ascospores are almost similar in both species. However, *Asterina* sp. 2 has smooth ascospores (Fig. 3.48b) and appressoria with mostly stalked, narrow and curved basal parts (Fig. 3.47d). *Asterina* sp. 2 was collected from a different locality in Western Panama and grows on a different host plant species than *Asterina* sp. 1.

Species of *Asterina* on Acanthaceae with unstalked appressoria and smooth ascospores are *A. incilis* from Africa and *A. diclipterae*, *A. phlogacanthi* and *A. tertia* from Asia (Table 3.4). *A. diclipterae* and *A. phlogacanthi* both have smaller ascomata and ascospores (Yamamoto 1956, Kar and Ghosh 1987). *A. incilis* and *A. tertia* are most similar to *Asterina* sp. 2 but differ by the presence of anamorphic stages (Sydow 1938, Theissen 1913a).

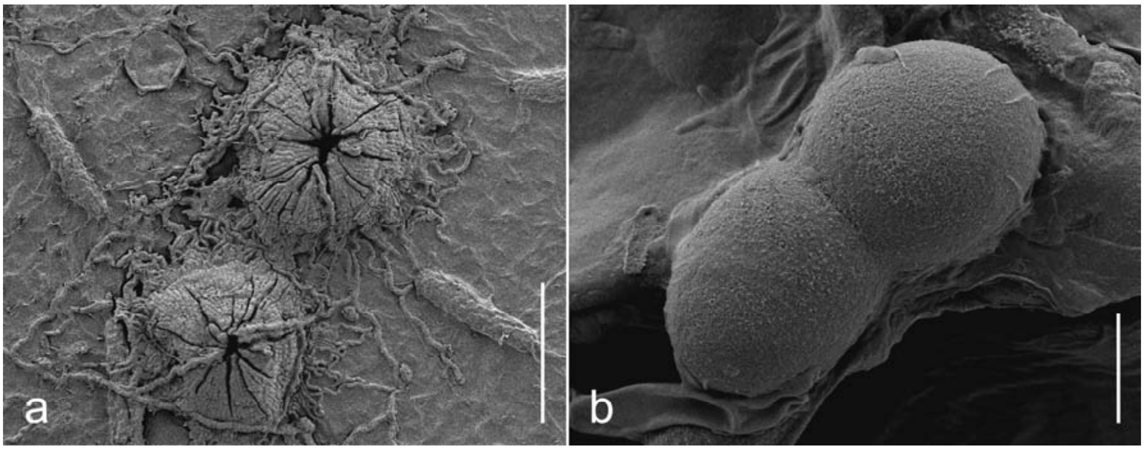

Figure 3.48: SEM photographs of *Asterina* sp. 2 on *Hansteinia ventricosa*. a: Two ascoma with star-shaped central fissures (TH 489). Scale bar = 100 µm. **b:** Mature ascospore (ppMP 1226). Scale bar = 5 µm.

***Asterina* sp. 3 on *Desmopsis bibracteata* (Annonaceae). Figs. 3.49, 3.50**

Colonies epiphyllous, rarely hypophyllous, irregularly circular, inconspicuous and poorly defined, single or confluent, sometimes covering large parts of the upper leaf surface, 1.5–10 mm diam. (*n*=10), greyish to black. *Surface hyphae* straight or slightly undulating, branching opposite, alternate or unilateral, brown, at hyphal tips paler, septate, hyphal cells cylindrical, (8)16–31(37)×(3.5)4–5 µm, cell wall up to 0.5 µm thick, smooth. *Appressoria* numerous, ellipsoidal to cylindrical or ampulliform, straight or hooked, entire, sessile, without a stalk cell, unilateral or alternate, rarely opposite, (10)12–16(20)×(4.5)5–6(8) µm (*n*=60), apex narrow, brown, penetration pore up to 1 µm diam., in distal part of appressorium. *Haustoria* ovate, ellipsoidal or reniform, more rarely globose, (8)9–11×6–8(9) µm (*n*=10), hyaline, filling up to 1/5 of the epidermal host cell. *Thyriothecia* superficial, develop below surface mycelium, circular, single, rarely slightly confluent, with fringed margins, (100)119–154(175) µm diam. (*n*=60), dark brown, open with central shar-shaped fissures. *Scutellum* radiate, composed of dichotomously branched filaments, scutellum cells isodiametric to cylindrical, straight in center, slightly undulating at margin of ascoma, 4–10(17)×(2)3–5(5.5) µm, brown to dark brown, at margins of ascomata paler. *Asci* globose, with distinct ocular chambers, bitunicate, I–, (30)33–40(45) µm diam. (*n*=47), 4–8–spored, hyaline, develop on ascogenous hyphae with proliferating croziers, interascal tissue absent. *Ascospores* 2–celled, ellipsoidal, ends broadly rounded, deeply constricted at septum, lower cell sometimes tapered, (22)25–27(28.5) µm long (*n*=60), upper cell (10.5)11–13 µm wide, lower cell (9)10–11(11.5) µm wide, cells sometimes disintegrate, brown when mature, cell wall up to 1 µm thick, verrucuose, germinate first at the distal part of one or both cells with a stalked appressorium or form surface mycelium with lateral appressoria. *Anamorph* absent.

Illustrations. In this contribution.

Hosts. Annonaceae: <u>*Desmopsis bibracteata*</u> (B.L. Rob.) Saff.

Known distribution. Neotropical: Central America (Panama). *Asterina* sp. 3 occurs in Western Panama in disturbed lowland forests and gallery forests at approx. 140 m a.s.l.

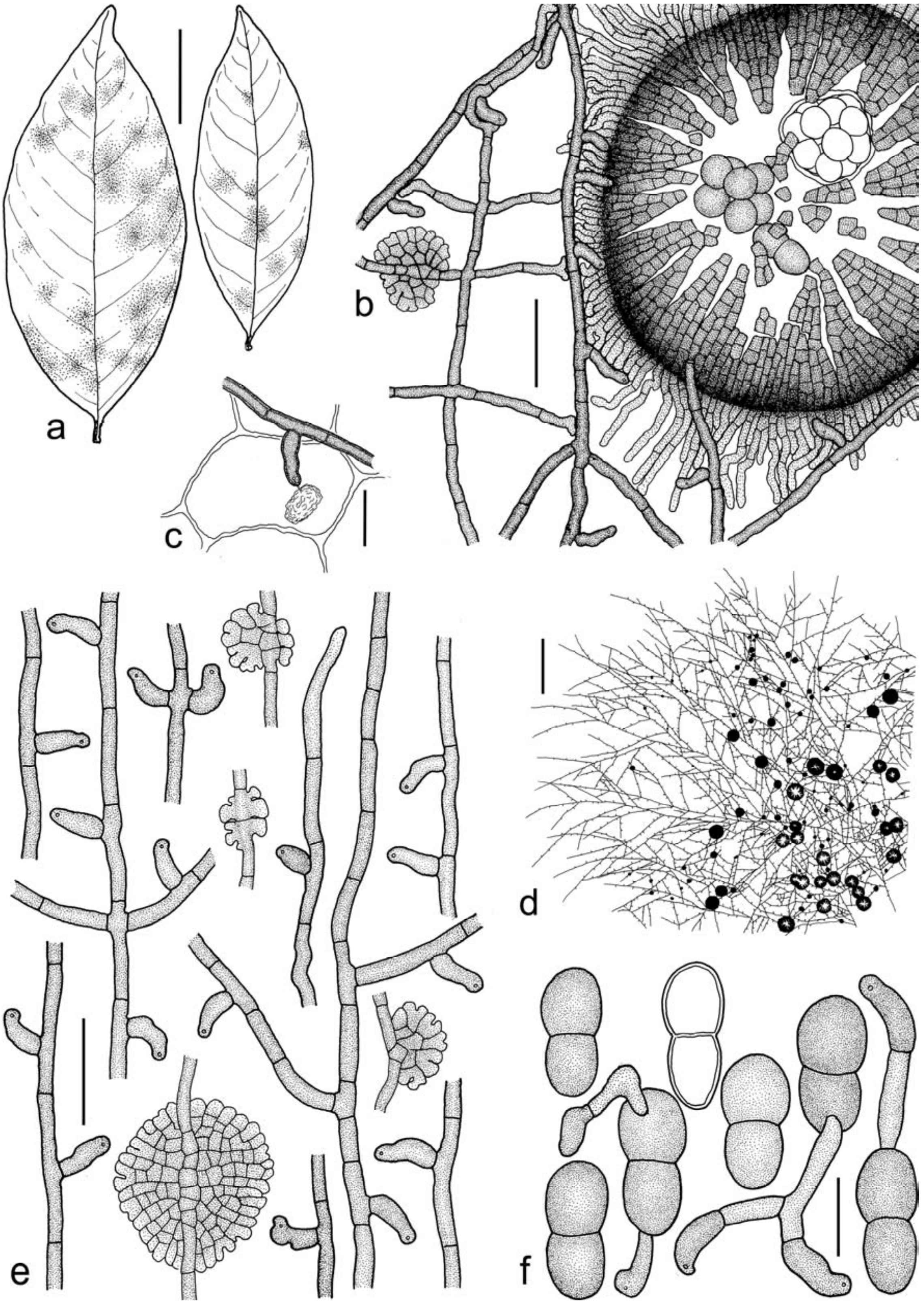

Figure 3.49: ***Asterina* sp. 3 on *Desmopsis bibracteata*. a:** Adaxial side of infected leaves (TH 499). Scale bar = 2.5 cm. **b:** Open thyriothecium with immature asci and liberated ascospores (TH 483). Scale bar = 30 µm. **c:** Haustorium within epidermal host cell (TH 468). Scale bar = 15 µm. **d:** Part of the colony with thyriothecia and surface mycelium (TH 468). Scale bar = 500 µm. **e:** Surface mycelium with appressoria and ascoma initials (TH 468). Scale bar = 25 µm. **f:** Mature ascospores, some of them germinating (ornamentation of ascospores not shown) (TH 468). Scale bar = 15 µm.

Specimens examined: PANAMA. Chiriquí Province: Los Algarrobos, border of Majagua river, ca. 140 m a.s.l., epiphyllous on *Desmopsis bibracteata* (det. T.A. Hofmann), associated with leaf parasitic algae *Cephaleuros* sp. (Trentepohliales), 11 Jun. 2006, *T.A. Hofmann 468* (FR; PMA); same locality, host plant and associated organisms, 6 Jul. 2006, *T.A. Hofmann 483* (PMA); same locality, host plant and associated organisms, 6 Oct. 2007, *T.A. Hofmann 577* (PMA); same locality, host plant and associated organisms, 21 Jun. 2006, *T.A. Hofmann, R. Mangelsdorff & T. Trampe ppMP 1101* (M-0141069; PMA). — Los Algarrobos, path to Lajas river and El Salto cascade, ca. 140 m a.s.l., epiphyllous on *Desmopsis bibracteata* (det. T.A. Hofmann), 7 Jan. 2007, *T.A. Hofmann 499* (FR; PMA).

Additional specimens examined: *A. artabotrydis* Hansf. UGANDA. Kampala District: Kampala, Kazi, on *Artabotrys nitidus*, Nov. 1940, *C.G. Hansford 2865* (BPI 689247). **Wakiso District:** Entebbe road, on *Artabotrys* sp., Dec. 1931, *C.G. Hansford s.n.* (type, IMI 18944); same locality, on *Artabotrys nitidus*, Nov. 1943, *C.G. Hansford 3281* (BPI 689248, BPI 689249); same locality and same host plant species, Mar. 1944, *C.G. Hansford 3446* (BPI 689250). ***A. disseminata* Syd. SIERRA LEONE. Southern Province:** Moyamba District, Njala, on *Uvaria afzelii*, 14 Jan. 1933, *F.C. Deighton s.n.* (type, IMI 18949). ***A. eupomatiae* (Henn.) Theiss. AUSTRALIA. South Queensland:** Eumundi, on *Eupomatia laurina*, May 1902, *Pritzel 50* (type, S F12519). ***A. jahnii* Syd. VENEZUE-LA. Federal District:** Puerto La Cruz Valley, EL Limon, on cf. *Guatteria* sp., 18 Jan. 1928, *H. Sydow 298* (type, S F 7963); same locality, date and host plant species, *H. Sydow 410* (S F7965); same locality and date, on leaves, *H. Sydow s.n.?* (BPI 689943). ***A. saginata* Syd. & P. Syd. PHILIPPINES. Calabarzon region:** Laguna Province, hills back of Paete Hills back of Paete, on *Dasymaschala clusiflora*, Apr. 1914, *C.F. Baker 3123* (S F12393 type of *Asterina melanomera*). **Central Luzon Region:** Bataan Province, on *Polyalthia* sp., Dec. 1915, *M. Ramos s.n., Bur. Sci. 24024* (syntypes, BPI 690393, 690394, 690395). **UGANDA. Wakiso District:** Entebbe road, on *Popowia mabirensis*, Jun. 1942, *C.G. Hansford 3015* (BPI 689192, labeled as *Asterina* sp.). ***A. uvariae* Hansf. UGANDA. Wakiso District:** Entebbe road, on *Uvaria bukobensis*, Nov. 1942, *C.G. Hansford 3121* (type BPI 690627, ex-type, BPI 690628). ***A. uvariicola* Hansf. UGANDA. Wakiso District:** Entebbe road, on *Uvaria welwitschii*, Nov. 1943, *C.G. Hansford 3289* (ex-type, BPI 690629).

Notes. *Asterina* sp. 3 is characterized by unstalked, cylindrical appressoria and ascospores with an inconspicuous ornamentation almost invisible with the light microscope, but distinctive with in scanning electron microscope resolution (Fig. 3.50).

Eleven species of *Asterina* are described on members of Annonaceae (Hosagoudar and Abraham 2000). Not included in Hosagoudar`s list is *A. monanthotaxis*, described from Kenya by Mibey and Hawksworth (1997). Since 2000, two more species of *Asterina* were described from Annonaceae, *A. miliusiae* from India (Hosagoudar et al. 2004b) and *A. uvariae-microcarpae* from China (Song et al. 2002). However, none of the *Asterina* spp. occur on species of *Desmopsis*. All 14 *Asterina* spp. on Annonaceae are summarized in Table 3.5.

A. jahnii is the only neotropical species of *Asterina* on Annonaceae (Sydow 1930). However, *A. jahnii* has stalked cylindrical appressoria and ascospores with a prominent ornamentation. Species with simple cylindrical and unstalked appressoria comparable to those of *Asterina* sp. 3 are: *A. disseminata*, *A. disseminata* var. *cleistopholidis*, *A. clemensiae* and *A. milusiae*. *A. disseminata* contains an anamorphic *Asterostomella*-stage, has smaller appressoria with a distinct variability in shape and forms smooth ascospores (Sydow 1939). *A. disseminata* var. *cleistopholodis* described and well illustrated by Hughes (1952) as a variety of *A. disseminata*, has smaller and smooth ascospores and contains an anamorphic *Asterostomella*-state. Examination of the type material of *A. disseminata* var. *cleistopholidis* from IMI revealed, that no fungal material is present on the included leaf. *A. clemensiae* has larger ascospores (Sydow and Petrak 1931) and *A. milusiae* has more or less opposite appressoria and slightly larger ascospores (Hosagoudar and Biju 2004). Type material of *A. clemensiae* and *A. milusiae* should be consulted first to ensure whether the fungus on *Desmopsis bibracteata* corresponds to a new species of *Asterina* or not.

Together with *Asterina* sp. 3 grows *Phycopeltis* sp. a superficial alga from the order Trentepohliales (Thomson and Wujek 1997). The hyphae of *Asterina* sp. 3 are able to grow over the thallus of the alga and even can form lateral appressoria on the thallus. The hyphae change their appearance above the thallus and become angular to zigzag-like due to the progress of the cells of the algal thallus. However, the appressoria are not able to penetrate the cells and no intracellular haustoria were observed in the algal cells.

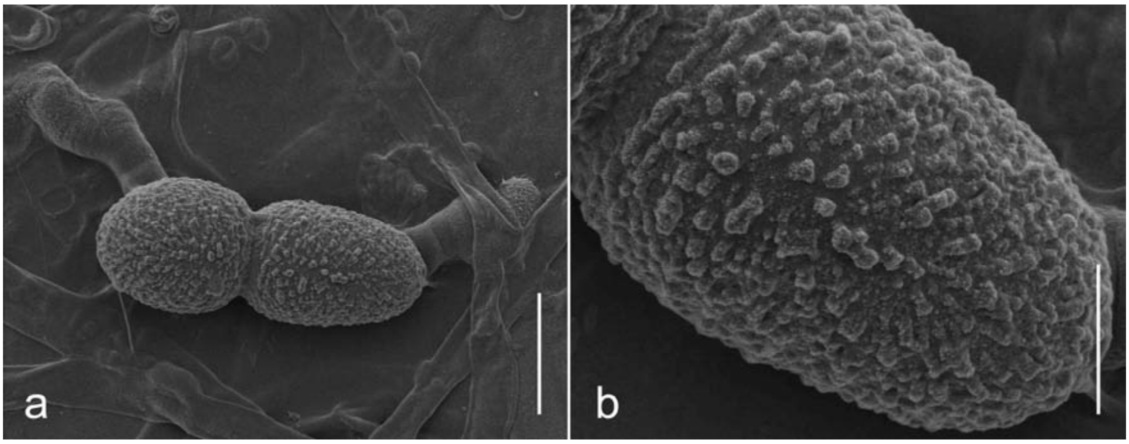

Figure 3.50: SEM photographs of *Asterina* sp. 3 on *Desmopsis bibracteata* (TH 477). a: Germinating ascospore. Scale bar = 10 µm. **b:** Ascospore ornamentation. Scale bar = 4 µm.

Table 3.5: List of *Asterina* spp. on Annonaceae according to literature. Species are listed in alphabetical order according to continents, Africa: *A. artabotrydis* to *A. uvariicola*, Asia: *A. clemeniae* to *A. uvariae-microcarpae*, Oceania: *A. eupomatiae*, South America: *A. jahnii*. Taxa indicated with asterisks are not listed in Hosagoudar and Abraham (2000). Cited host plants and localities correspond to the protolouge of the type species only. Morphological data are cited from the original publication, revised data or own observations from examined type material are indicated in brackets. Abbreviations: Anam = anamorph, lc = lower cell, uc= upper cell.

Species	Host plant	Country	Appressoria	Ascomata	Ascospores	Anam
A. artabotrydis Hansf. 1938	*Artabotrys* sp.	Uganda	stalked, 10–16×4–5 µm, cylindrical, entire	120–160 µm diam.	21–25×8–12 µm, verrucose	—
A. disseminata Syd. 1939	*Uvaria afzeli*	Sierra Leone	unstalked, 5–7×3–3.5 µm, ovate to cylindrical, entire	100–150 µm diam.	20–25×9.5–12 µm, smooth	yes
A. disseminata var. cleistopholidis S. Hughes 1952	*Cleistopholis patens*	Ghana	unstalked, 6–14×2–4 µm, cylindrical, entire	up to 140 µm	18–21×9–10 µm, smooth	yes
A. monanthotaxis [as '*monanthotaxiae*'] Mibey 1997*	*Monanthotaxis fornicata*	Kenya	unstalked, 5–9×5–9 µm, globose, entire	285–350 µm diam.	23–33×9–14 µm, spinose	—
A. uvariae Hansf. 1944-45	*Uvaria bukobensis*	Uganda	unstalked, 9–13×5–9, subglobose, entire	90–140 µm diam.	22–25×11–13 µm, verrucose	—
A. uvariicola Hansf. 1944-45	*Uvaria welwitschii*	Uganda	unstalked, 4–6×5–10 µm, lobed	80–120 µm diam.	20–23×9–12 µm, smooth	yes
A. clemensiae Petr. 1931	*Polyalthia* sp.	Philippines	unstalked, 7–12×6–8 µm, cylindrical, entire	up to 180 µm diam.	28–35 µm long, uc 15.5–17 µm wide, lc 14–15 µm wide, verrucose	—
A. melanomera Syd. & P. Syd. 1917	*Dasymachalon clusiflorus*	Philippines	unstalked, 11–14×10–11 µm, subglobose, entire	180–240 µm diam.	25–30×12–14 µm, [verrucose]	—
A. miliusiae Hosag. & C.K. Biju 2004*	*Miliusa* sp.	India	unstalked, 9–16×6–8 µm, cylindrical, entire	up to 200 µm diam.	24–32×12–16 µm, verrucose	—
A. saginata Syd. & P. Syd. 1917	*Polyalthia* sp.	Philippines	unstalked, 13–16×10–11 µm, subglobose, entire	200–300 µm diam.	27–30×12–14 µm, [verrucose]	—
A. saccopetali Tilak & U.K. Kulk. 1978	*Saccopetalum tomentosum*	India	unstalked, 7–9×5–6 µm, obovate	250–375 µm diam.	25–30×10–12 µm, smooth?	—
A. uvriae-microcarpae B. Song, T.H. Li & J. Q. Liang 2002*	*Uvaria microcarpa*	China	stalked, head 6–8×5–7.5 µm, lobed	90–140 µm	17–20×7.5–8.5 µm, smooth?	yes
A. eupomatiae (Henn.) Theiss. 1913	*Eupomatia laurinea*	Australia	stalked, [head 5–10×5.5–10 µm, lobed]	up to 170 µm diam.	12–18×5–6 µm, [verrucose-spinose]	—
A. jahnii Syd. 1930	cf. *Guatteria* sp.	Venezuela	stalked, head 9–11×5–6(7) µm, cylindrical, entire	150–200 µm diam.	24–33×12–16 µm, verrucose	—

***Asterina* sp. 4 on *Cleome* sp. (Cleomaceae).** **Figs. 3.51, 3.52, 3.53**

Colonies epiphyllous, conspicuous and dense, irregularly circular, mostly discrete, later sometimes confluent, 0.5–3 mm (*n*=10), black. *Surface hyphae* undulating to zigzag-like, branching alternate or unilateral, not opposite, brown, at hyphal tips paler, septate, hyphal cells cylindrical, (15)22–35(39)×3–4(4.5) µm, cell wall up to 0.5 µm thick, smooth. *Appressoria* numerous, digitate, multilobate, with 5–7 lobes, straight or slightly bent, at base narrow and stalked, base rarely broader and sessile, without stalk cell, alternate or unilateral, never opposite, (6)7–10(12)×(7)8–10(11) µm, brown, penetration peg up to 1 µm diam., in apical part of appressorium, in the center or a larger lobe. *Haustoria* globose, ellipsoidal or reniform, 9–11×6–8(9) µm (*n*=10), hyaline, filling only a small part of the epidermal host cell. *Thyriothecia* superficial, develop below surface mycelium, irregularly circular, single, rarely confluent, slightly or not fringed at margins, (80)107–147(170) µm diam., dark brown, open with central star-shaped fissures. *Scutellum* radiate, composed of dichotomously branched filaments, scutellum cells isodiametric to cylindrical, straight in center, slightly undulating at margins of ascoma, (3)4–7(10)×2–4(5) µm, brown to dark brown, at margins of ascoma paler. *Asci* globose, with distinct ocular chambers, bitunicate, I–, (23)24–28(30) µm diam. (*n*=11), 8–spored, hyaline, ascogenous hyphae indistinct, evanescent, interascal tissue present, evanescent. *Ascospores* 2–celled, ellipsoidal, ends broadly rounded, constricted at septum, lower cell sometimes slightly tapered, (16)17–18 µm long, upper cell (8.5)9–10 µm wide, lower cell (7)8–9 µm wide, brown, cell wall up to 1 µm thick, verrucose, germinate first in the distal or lateral part of each cell with an unstalked and lobed appressorium. *Anamorph* absent.

Illustrations. In this contribution.

Hosts. Cleomaceae: *Cleome* sp.

Known distribution. Neotropical: Central America (Panama). *Asterina* sp. 4 occurs in Western Panama in humid mountain rainforest from 1200 to about 1750 m a.s.l.

Specimens examined: **PANAMA. Chiriquí Province:** Boquete, Alto Chiquero, private property of M.A. Amorùso, near ANAM entrance in direction to Los Quetzales trail, ca. 1750 m a.s.l., epiphyllous on *Cleome* sp. (det. M. Piepenbring), 27 Jun. 2006, *T.A. Hofmann, R. Mangelsdorff & T. Trampe ppMP 1123*

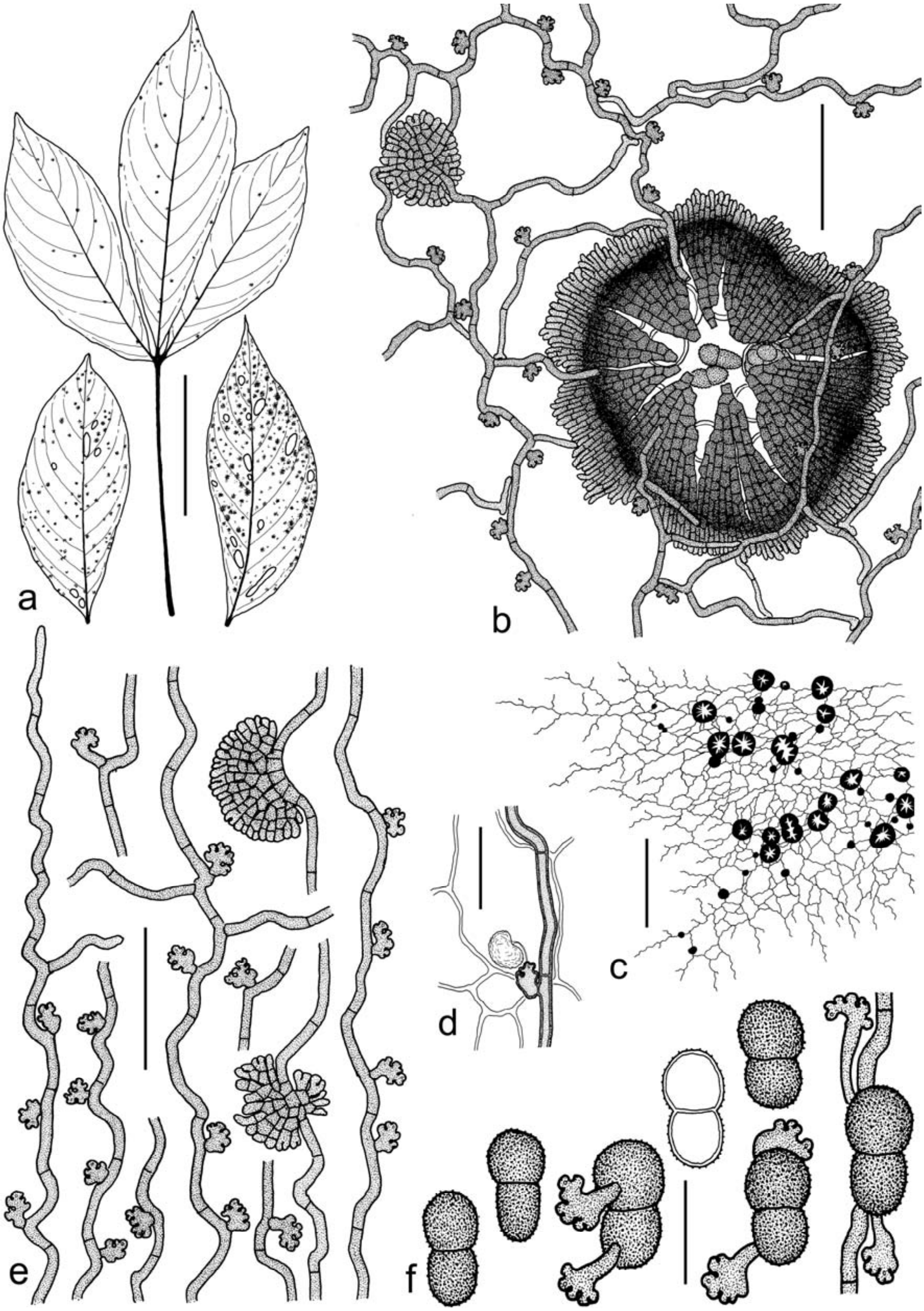

Figure 3.51: ***Asterina* sp. 4 on *Cleome* sp. a:** Abaxial side of infected leaves (ppMP 1123). Scale bar = 5 cm. **b:** Surface mycelium with lateral appressoria and an open thyriothecium with mature and immature asci and a young ascoma (TH 507). Scale bar = 50 µm. **c:** Part of a colony with thyriothecia and surface mycelium (ppMP 1123). Scale bar = 400 µm. **d:** Surface hyphae with a lateral appressorium and a haustorium within an epidermal cell. Scale bar = 20 µm. **e:** Surface mycelium with lobed appressoria and ascoma initials. Scale bar = 40 µm. **e:** Mature ascospores, some of them germinating. Scale bar = 15 µm.

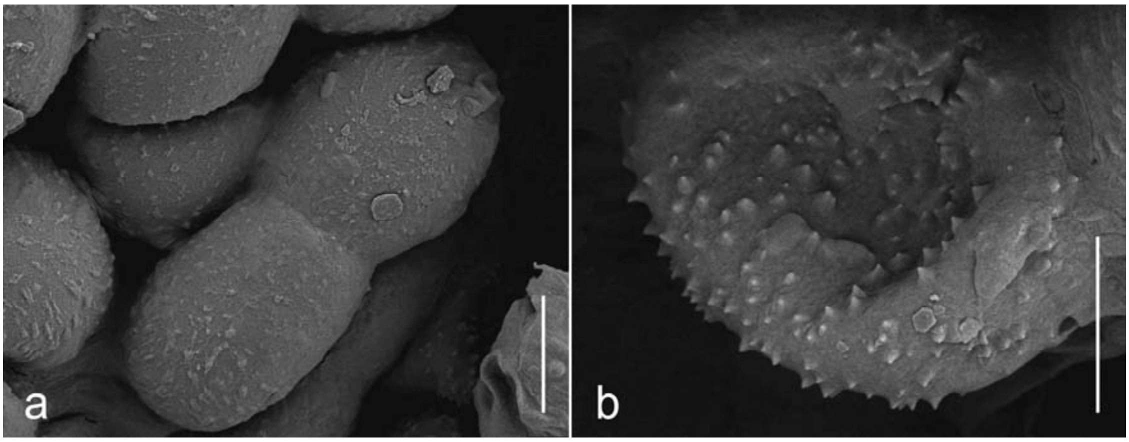

Figure 3.52: SEM photographs of *Asterina* sp. 4 on *Cleome* sp. (ppMP 1123). a: Mature ascospores. Scale bar = 5 µm. **b:** Ascospore ornamentation. Scale bar = 3 µm.

(M-0141076; PMA). — Fortuna, ca. 5 km before Lake Fortuna, mountain rain forest, 1240 m a.s.l., epiphyllous on *Cleome* sp. (det. R. Mangelsdorff), associated with thyriothecioid and perithecioid hyperparasites, 10. Feb 2007, *T.A. Hofmann 507* (PMA).

Notes. According to Hosagoudar and Abraham (2000), no species of *Asterina* is known from the host genus *Cleome* or the Cleomaceae. Cleomaceae have two sisterfamilies, Brassicaceae and Capparaceae (Hall et al. 2002). For Brassicaceae, no species of *Asterina* is known, but Capparaceae are parasitized by numerous *Asterina* spp. (Hosagoudar and Abraham 2000). However, Hosagoudar`s list is not complete and partly incorrect because *A. cambodijana* Joly from Vietnam (Joly 1965), *A. grandicarpa* Mibey and *A. thylachii* Mibey from Kenya are not included (Mibey and Hawksworth 1997). *A. radicans* Ellis from Florida, USA has to be excluded from Hosagoudar's list because it was treated as doubtful *Asterina* species by Theissen (1913a). Since 2000, two more species of *Asterina* were described on Capparaceae, *A. sawadai* B. Song and *A. stixis* B. Song , T.H. Li & Hosag. from China (Song et al. 2003, Song and Li 2004). All hitherto described *Asterina* spp. from Capparaceae are listed and compared in Table 3.6. The only neotropical species of *Asterina* on Capparaceae is *A. papillata* Syd. from Peru, but it differs from *Asterina* sp. 4 because of its stalked appressoria and the larger ascospores (Sydow 1916). Four of the species of *Asterina* on Capparaceae have unstalked appressoria, *A. grandicarpa* Mibey and *A. thylachii* Mibey from Kenya, *A. sawadai* B. Song and *A. stixis* B. Song, T.H. Li & Hosag. from China (Table 3.6). *A. grandicarpa*, *A. sawadai* and *A. stixis* have cylindrical, entire appressoria and, therefore, are different from *Asterina* sp. 4 from Panama. *A. thylachii* is similar due to the lobed appressoria, but it is reported as endemic to Kenya, has larger appressoria with 11–

14×8–11 µm, larger ascospores with 17–23×9–11 µm and contains an anamorphic *Asterostomella*-state (Mibey and Hawksworth 1997). Therefore, *Asterina* sp. 4 on *Cleome* sp. from Panama is probably new to science.

Ultrastructural analysis of *Asterina* sp. 4 revealed that the haustoria, formed in epidermal host cells, are surrounded by a broad electron dense zone that probably represents the extrahaustorial membrane between fungus and plant cell (Fig. 3.53).

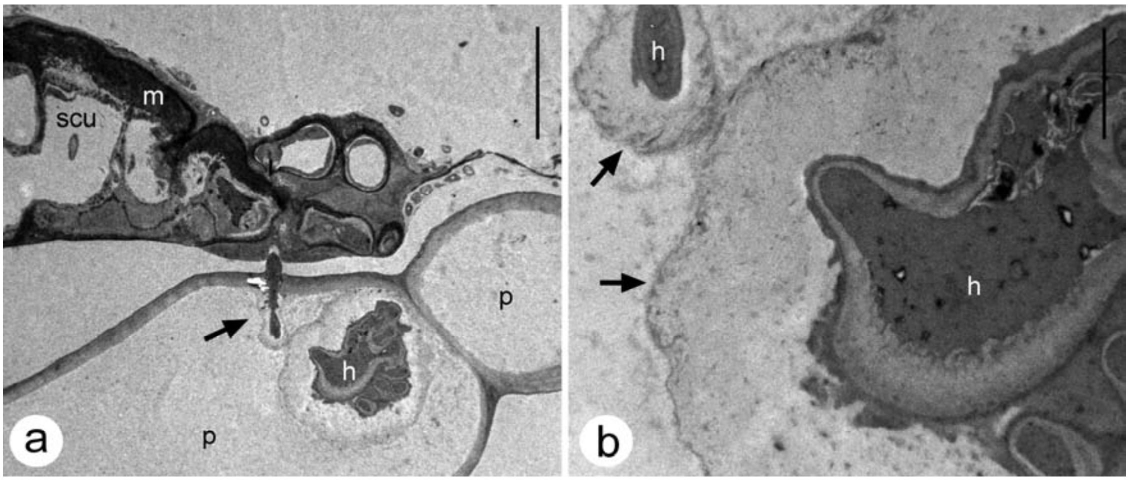

Figure 3.53: Ultrastructure of *Asterina* sp. 4 on *Cleome* sp. (TH 507). a: Part of a young detached fruitingbody with collapsed scutellum cells (scu) with melanized cell walls (m). One plant cell (p) contains a haustorium (h) with penetration peg (arrow). Scale bar = 5 µm. **b:** Part of the haustorium (h), note the broad electron dense zone (arrows) around the haustorium and the penetration hyphae. Scale bar = 1 µm.

Table 3.6: List of *Asterina* spp. on Capparaceae according to literature. Species are listed in alphabetical order according to continents, Africa: *A. capparicola* to *A. woodii*, Asia: *A. boedijana* to *A. stixis*, South America: *A. papillata*. Taxa indicated with asterisks are not listed in Hosagoudar and Abraham (2000). Cited host plants and localities correspond to the protolouge of the type species only. Morphological data are cited from the original publication, revised data or own observations from examined type material are indicated in brackets. Abbreviations: Anam = anamorph, lc = lower cell, uc= upper cell.

Species	Host plant	Country	Appressoria	Ascomata	Ascospores	Anam
A. capparicola [as '*capparidicola*'] Doidge 1942	*Capparis zeyheri*	South Africa	stalked, 10–15×5.5–7.5 µm, subglobose to cylindrical, entire	110–140 µm diam.	22–27.5 µm long, uc 11.5–13.5 µm wide, lc 10–11.5 µm wide, verrucose	yes
A. celtidicola var. *microspora* Doidge 1920	*Maerua* sp.	South Africa	stalked, head 9–13×6–10 µm, lobed	85–100 µm diam.	16–18(20)×8–9 µm, verrucose	yes
A. elegans Doidge 1942	*Capparis citrifolia*	South Africa	stalked, 12–20×4–6 µm long, cylindrical, entire	130–170 µm diam.	22–25 µm long, uc 11–12.5 µm wide, lc 9–10.5 µm wide, verrucose	yes
A. grandicarpa Mibey 1997*	undetermined	Kenya	unstalked, 9–12×5–6 µm, cylindrical, entire	180–270 µm diam.	22–31×11–14 µm, verrucose	yes
A. thylachii Mibey 1997*	*Thylachium africanum*	Kenya	unstalked, 11–14×8–11 µm, lobed	110–175 µm diam.	17–23×9–11 µm, verrucose	yes
A. woodii Doidge 1942	*Capparis guenezii*	South Africa	stalked, 10–17.5×3.5–5 µm, cylindrical to sub-clavate, entire or sinuate	120–160 µm diam.	22.5–25×10–12.5 µm, verrucose	—
A. boedijana Hansf. 1954	*Capparis acuminata*	Java	stalked, 13–22 µm long, head 8–15×4–7 µm, lobed	up to 170 µm diam.	22–25×11–12, verrucose	—
A. cambodiana Joly? 1965*	*Capparis flavicans*	Vietnam	stalked, 10–13×5–6 µm, head globose, entire	117–167 µm diam.	18–24×9–12, verrucose	yes
A. capparis [as '*capparidis*'] Syd., P. Syd. & E.J. Butler 1911	*Capparis* sp.	India	stalked, [head 5–9×4.5–6.5 µm, lobed (Sydow and Petrak 1929)]	90–120 µm diam.	16–19×8–10 µm, verrucose	yes
A. sawadai B. Song 2004*	*Capparis kikuchii*	Taiwan	unstalked, 6–9×5–6 µm, cylindrical entire	up to 230 µm diam.	29–33×11–13.5 µm, verrucose	—
A. stixis B. Song, T.H. Li & Hosag. 2003*	*Stixis suaveolens*	China	unstalked, 6.5–7.5×3.6–5 µm, cylindrical, sinuate	up to 160 µm diam.	20–27.5×7.5–14 µm, verrucose	yes
A. papillata Syd. 1916	*Capparis* sp.	Peru	stalked, 14–17×4–5.5 µm, cylindrical, entire	140–200 µm diam.	24–28×12–13 µm, verrucose	—

***Asterina* sp. 5 on *Clusia* sp. (Clusiaceae). Figs. 3.54, 3.55**

Colonies amphigenous, irregularly circular in outline, single or confluent, inconspicuous, with few ascomata per colony, 0.5–2.5 mm diam., greyish to black. *Surface hypae* in adaxial side slightly undulating, on abaxial side strongly undulating and curved, grow ring-like around stomatal guard cells, branching unilateral or alternate, brown to dark brown, hyphal tips paler, septate, hyphal cells cylindrical, (9)15–23(25)×3–4.5(5) µm, cell wall up to 0.5 µm thick, smooth. *Appressoria* 1–celled, without a stalk cell, irregularly circular, ovate or ellipsoidal, slightly lobed or with 2–3(4) deep lobes, sessile or sometimes slightly stalked, unilateral or alternate, (6)7–9.5(11)×(8)10–12(13) µm, brown to dark brown, often slightly darker than surface hyphae, penetration pore in the center of appressorium, paler than appressioral cell, pore 0.5–1 µm diam. *Haustoria* conspicuous and large, arbuscular, (20)25–37(40)×(20)22–30(35) µm (*n*=10), hyaline, each filling ¼ – ¾ or the entire epidermal host cell. *Thyriothecia* superficial, develop below surface mycelium, circular, dimidiate, single or confluent, margins not deeply fringed, (90)125–194(230) µm diam., dark brown to blackish, open with irregular central holes or star-shaped fissures, which develop when central scutellum cells break or disintegrate irregularly. *Scutellum* radiate, composed of dichotomously branched filaments, scutellum cells isodiametric to cylindrical, straight in center, at margins sometimes slightly undulating and meandrical, (4)5–11(15)×(2)3–5 µm, brown to dark brown, at tips paler. *Asci* globose to ovate, mature asci few, with distinct ocular chambers, bitunicate, ascus walls I+, (20)22–29(33) µm diam. (*n*=15), 8–spored, hyaline, ascogenous hyphae indistinct, interascal tissue present, dissolves early. *Ascospores* 2–celled, ellipsoidal, ends rounded or slightly acuminate, slightly constricted at septum, tapering to one end, 21–23(25) µm long, upper cell 9–10(11) µm wide, lower cell 8–9(10) µm wide, brown when mature, cell wall up to 0.5 µm thick, smooth, germinate first laterally at the upper cell with an entire or slightly lobed appressorium, first appressorium often darker than the ascospore. *Anamorph* absent.

Illustrations. In this contribution.

Hosts. Clusiaceae: *Clusia* sp.

Known distribution. Neotropical: Central America (Panama). *Asterina* sp. 5 occurs in Western Panama in humid rainforest on the continental divide (bushy, dwarf vegetation, exposed constantly to strong winds) at approx. 1280 m a.s.l.

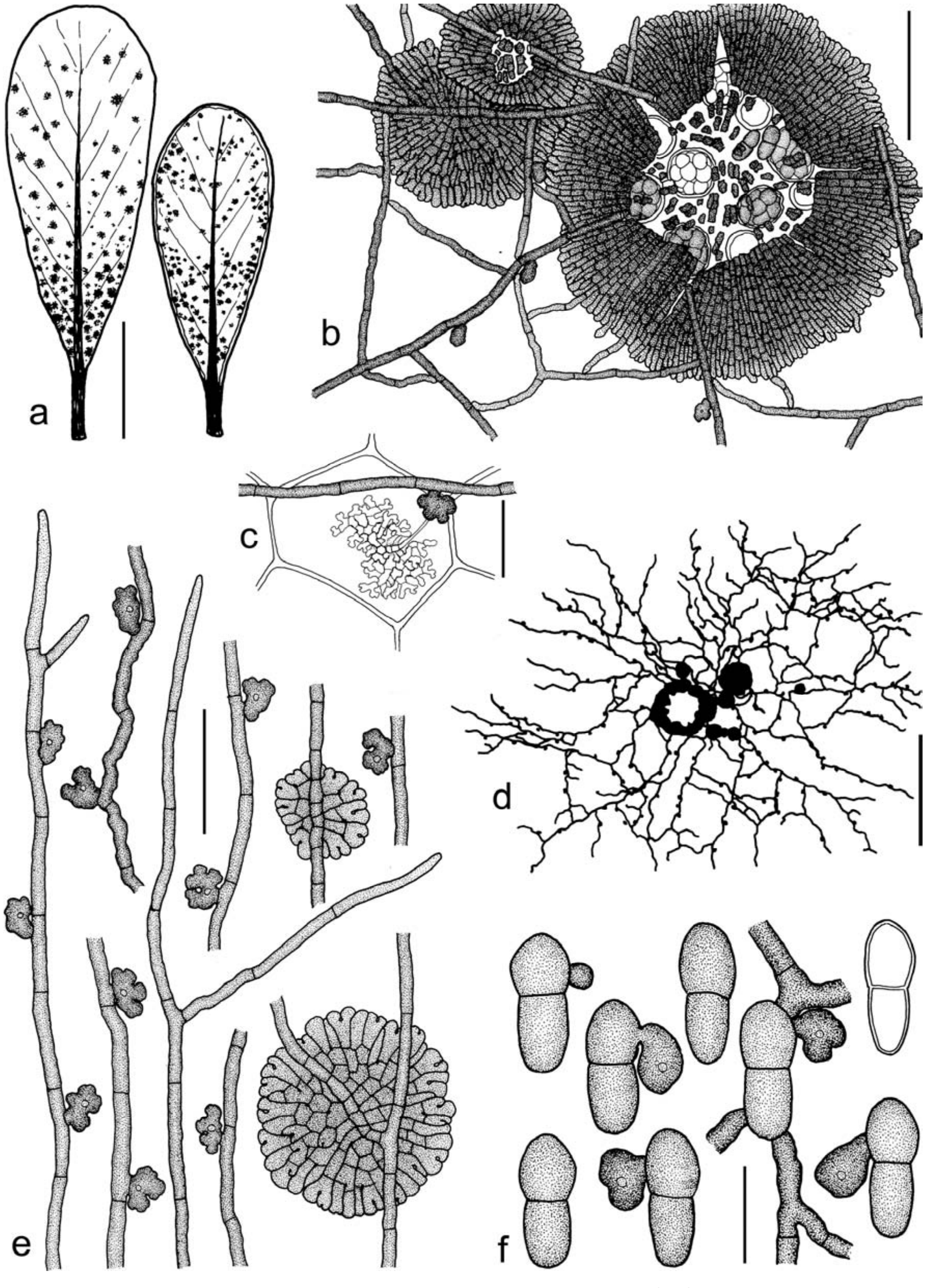

Figure 3.54: ***Asterina* sp. 5 on *Clusia* sp. (ppMP 1329) a:** Abaxial side of infected leaves. Scale bar = 2 cm. **b:** Open thyriothecium with mature and immature asci and two young ascoma. Scale bar = 60 µm. **c:** Arbuscular haustorium within epidermal host cell. Scale bar = 20 µm. **d:** Entire colony with few thyriothecia and surface mycelium. Scale bar = 300 µm. **e:** Surface mycelium with lobed appressoria and ascoma initials. Scale bar = 30 µm. **f:** Mature ascospores, some of them germinating. Scale bar = 15 µm.

Specimens examined: **PANAMA. Chiriquí Province:** Fortuna, Quijada del Diablo, ridge on continental divide, ca. 1280 m a.s.l., amphigenous on *Clusia* sp. (det. T.A. Hofmann), 15. Oct 2005, *T.A. Hofmann & R. Mangelsdorff 391* (FR; PMA); same locality and host species, 23. Feb 2007, *T.A. Hofmann, R. Mangelsdorff & T. Trampe ppMP 1329* (M-0141056; PMA); same locality and host species, 13 Oct. 2007, *T.A. Hofmann & M. Piepenbring ppMP 1376* (M-0141057; PMA).

Additional specimens examined: ***Asterina tropicalis*** **Speg. COSTA RICA. San José Province:** San José, on *Reedia dulcis*, Sep. 1897, *A. Tonduz s.n.* (type, LPS 1355).

Notes. *Asterina* sp. 5 forms small colonies with few confluent ascomata per colony. The ascomatal wall is formed by dark, rigid scutellum cells disintegrating irregularly in the ascoma center during maturity of the thyriothecium. Typical are the entire margins of mature and immature ascomata (Fig. 3.54b).

According to Hosagoudar and Abraham (2000), two species of *Asterina* occur on species of Clusiaceae, *A. garciniae* Hansf. from India and *A. garciniicola* Ouyang & B. Song from China. Both species are described from the host genus *Garcinia* (Hansford 1946, Ouyang et al. 1995). *A. tropicalis* Speg. on *Reedia dulcis* from Costa Rica (Spegazzini 1919) and *A. morellae* Hosag., C.K. Biju & T.K. Abraham on *Garcinia morella* from India (Hosagoudar et al 2001) are not included in the list of Hosagoudar and Abraham (2000). The four *Asterina* spp. are morphologically similar and differ only slightly from each other and from the material from Panama. *A. garciniae* has larger colonies up to 5 mm diam., entire hemisphaerical appressoria of 7–10×5–7 µm and ascomata with fimbriate margins (Hansford 1946). *A garciniicola* differs due to the longer, cylindrical and entire appressoria of 7–15.4×5.8–9 µm and larger, verrucose ascospores 25–30×14–18 µm (Ouyang et al. 1995). *A. morellae* has strongly echinulate ascospores and is associated with an anamorphic *Asterostomella*–state (Hosagoudar et al. 2001). *A. tropicalis* seems to be most identical to *Asterina* sp. 5 (Spegazzini 1919) and, therefore, type material of *A. tropicalis* from LPS was analyzed. Unfortunately, the fungus from the type material is poorly developed and mature ascomata and germinating ascospores could not be examined, without destroying the material completely. The surface mycelium and appressoria are almost identical to the fungus from Panama. Spegazzinis notes and pencil drawings included on the sheat show ascomata with central star-shaped fissures and fringed margins. *Asterina* sp. 5 remains as an uncertain species, because of the different central dehiscence and the strictly entire margins of its ascomata.

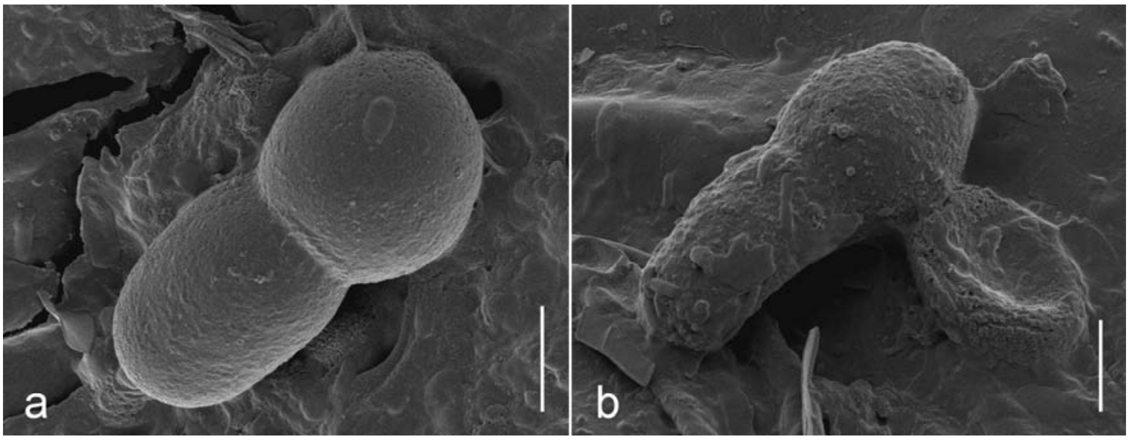

Figure 3.55: SEM photographs of *Asterina* sp. 5 on *Clusia* sp. (ppMP 1329). a: Mature ascospores. Scale bar = 5 µm. **b:** Germinating ascospore. Scale bar = 5 µm.

Asterina sp. 6 on *Alloplectus ichthyoderma* (Gesneriaceae). Figs. 3.56,3.57

Colonies hypophyllous, inconspicuous, circular, single, rarely confluent, 2–9 mm diam. (*n*=10), greyish to black. *Surface hyphae* strongly undulating, often zigzag-like, irregularly curved, branching unilateral or alternate, never opposite, brown, hyphal tips paler, septate in large intervals, hyphal cells cylindrical, (10)23–49(60)×3–4 µm, cell wall up to 0.5 µm thick, smooth. *Appressoria* numerous, unilateral or alternate, with stalk cell, total length (14)16–23(30) µm (incl. hooked parts), brown, stalk cell shortly cylindrical, straight or slightly curved, stalk very rarely missing or 2–celled, (3)4–7(10)×3–4 µm, appressorial cell hooked or deflexed, bent towards one direction, rarely two directions, sometimes becoming strongly deflexed and tip reaches its originating hyphae, irregular in outline, rarely Y-shaped or arrowhead-like, entire or lobate, or with 2–3 conspicuous deep lobes, (10)12–18(20)×4–5(6) µm, penetration pore small, in distal part of appressorium. *Haustoria* mostly reniform, more rarely ellipsoidal, (10)10.5–13×4–10(14) µm (*n*=10), hyaline, filling only a small part of the epidermal host cell. *Thyriothecia* superficial, develop below surface mycelium, circular, dimidiate, single, margins slightly fringed, (90)100–142(170) µm diam., brown to dark brown, open with central star-shaped fissures, in early stages wide open to expose mature and immature asci. *Scutellum* radiate, composed of dichotomously branched filaments, scutellum cells, isodiametrical to cylindrical, straight in center, undulating at margin of ascoma, (3)5–7(8)×(2.5)3–5(6) µm, brown to dark brown, at tips paler. *Asci* numerous, globose, with distinct ocular chambers, bitunicate, I–, (25)27–33(35) µm diam., 8–

spored, hyaline, ascogenous hyphae indistinct, interascal tissue present. *Ascospores* 2–celled, numerous, ellipsoidal, sometimes slightly curved, ends broadly rounded, deeply constricted at septum, lower cell sometimes tapered, 20–22 µm long, upper cell 10–11(12) µm wide, lower cell 9–10 µm wide, brown when mature, cell wall up to 0.5 µm thick, verrucose, germinate first at the distal part of each cell with a stalked and hooked appressorium. *Anamorph* absent.

Illustrations. In this contribution.

Hosts. Gesneriaceae: *Alloplectus ichthyoderma* Hanst. and an unknown Gesneriaceae.

Known distribution. Neotropical: Central America (Panama). *Asterina* sp. 6 occurs in Western Panama in humid mountain rainforests of higher elevations from 1750 to about 2500 m a.s.l.

Specimens examined: **PANAMA. Chiriquí Province:** Parque International La Amistad (PILA), Cerro Picacho, ca. 2500 m a.s.l., hypophyllous on *Alloplectus ichthyoderma* (det. M. Piepenbring and T.A. Hofmann), associated epiphyllous with member of Microthyriaceae, 26 Jan. 2007, *T.A. Hofmann, R. Mangelsdorf & T. Trampe ppMP 1276* (M-0141058; PMA); same locality, host species and associated organisms, 10 Apr. 2006, *M. Piepenbring, T.A. Hofmann & T. Trampe ppMP 857-B* (M-0141059; PMA). — Boquete, Alto Chiquero, private property of M.A. Amorùso, near ANAM entrance in direction to Los Quetzales trail, ca. 1750 m a.s.l., epiphyllous on Gesnericaceae (det. D. Cáceres), 24 Mar. 2006, *T.A. Hofmann, M. Piepenbring & T. Trampe ppMP 485* (M-0141075; PMA).

Notes. The fungus on specimen *ppMP 485* from Boquete differs slightly from the specimen from Cerro Picacho, as it grows epiphyllous on a different species of Gesneriaceae, the head cells of the appressoria are regularly lobate and the ascospores are slightly smaller with 16–18(19)×8–9 µm (*n*=10).

According to Hosagoudar and Abraham (2000), five species of *Asterina* occur on Gesneriaceae. *A. cyrtandrae* Hansf. from Java (Hansford 1954b), *A. dilabens* Syd. & Syd. and *A. mitrariae* Syd. from Chile (Sydow and Sydow 1904, Sydow 1932), *A. fieldiae* Hansf. from Australia (Hansford 1954a) and *A. streptocarpi* from South Africa (Doidge 1924). All five species are characterized by unstalked and lobed appressoria and none of these species is described from the host genus *Alloplectus*. Therefore, *Asterina* sp. 6 on *Alloplectus ichtyoderma* from Panama is probably new to science.

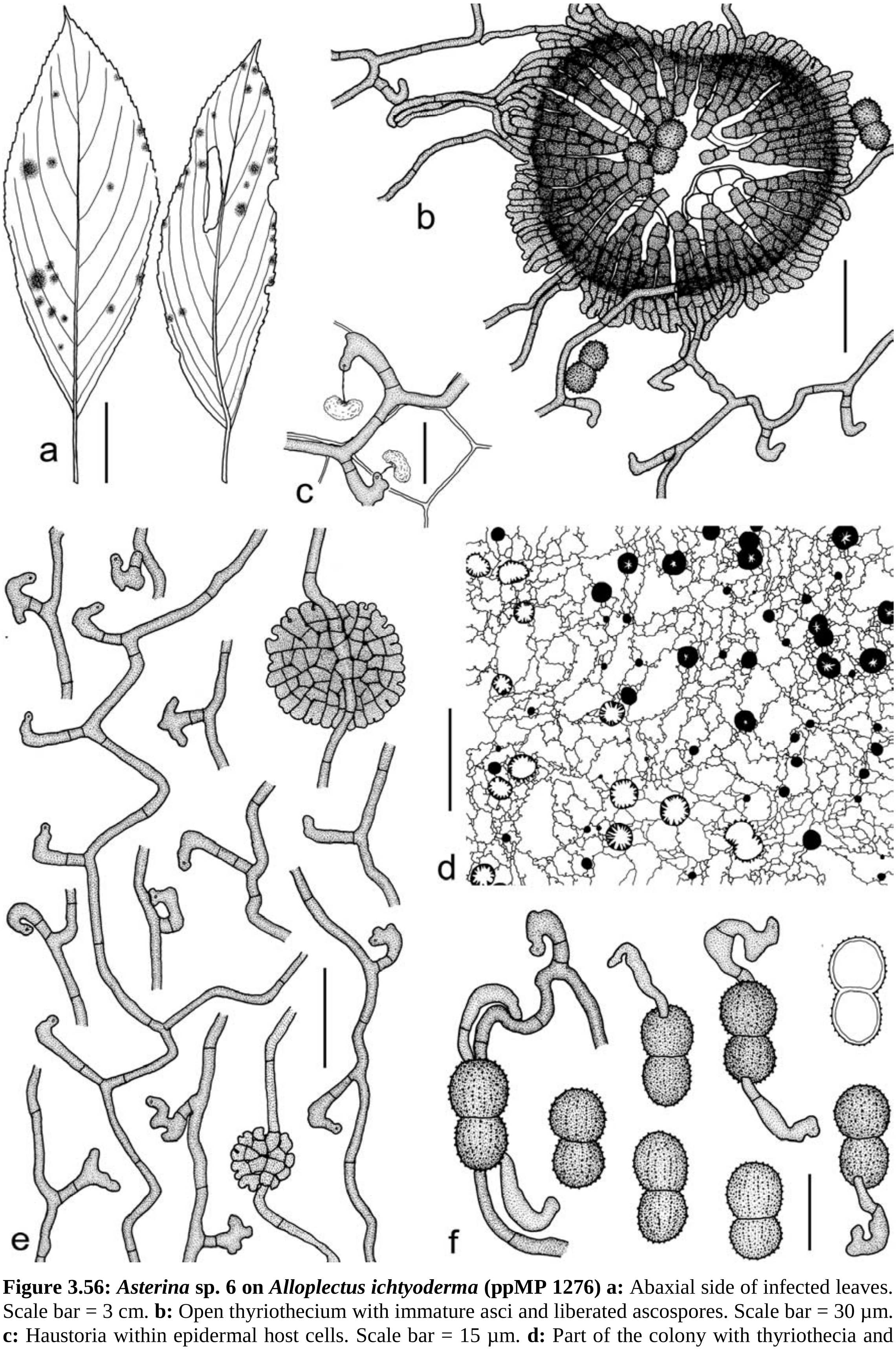

Figure 3.56: ***Asterina*** **sp. 6 on** ***Alloplectus ichtyoderma*** **(ppMP 1276) a:** Abaxial side of infected leaves. Scale bar = 3 cm. **b:** Open thyriothecium with immature asci and liberated ascospores. Scale bar = 30 µm. **c:** Haustoria within epidermal host cells. Scale bar = 15 µm. **d:** Part of the colony with thyriothecia and surface mycelium. Scale bar = 500 µm. **e:** Surface mycelium with appressoria and ascoma initials. Scale bar = 25 µm. **f:** Mature ascospores, some of them germinating. Scale bar = 15 µm.

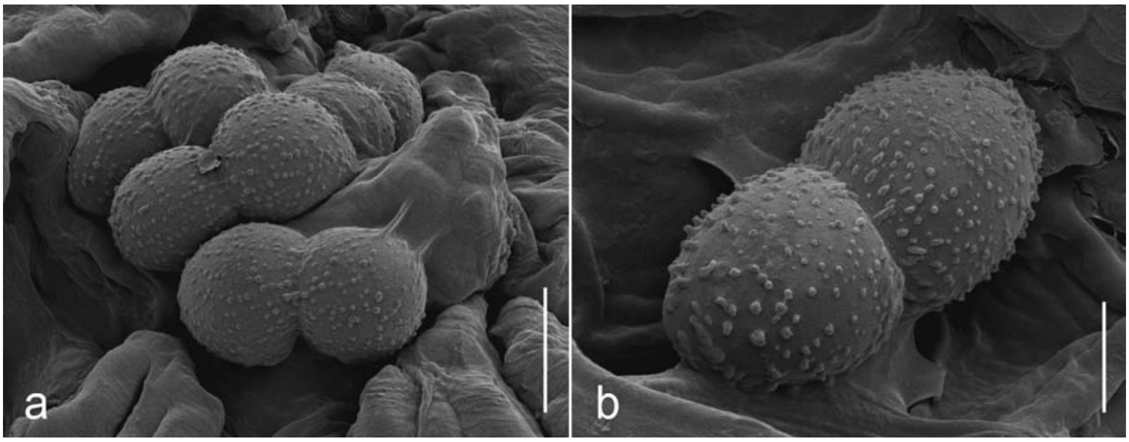

Figure 3.57: SEM photographs of *Asterina* sp. 6 on *Alloplectus ichtyoderma* (ppMP 1276). a: Group of mature ascospores. Scale bar = 10 µm. **b:** Mature, verrucose ascospore. Scale bar = 5 µm.

Asterina sp. 7 on *Compsoneura sprucei* (Myristicaceae).

Figs. 3.58, 3.59, 3.60

Colonies hypophyllous, mostly concentrated at leaf margins, irregularly circular, single, sometimes becoming confluent, conspicuous and dense, 2–20 mm diam. (*n*=10), black. *Surface hyphae* mostly straight, sometimes slightly undulating, sometimes growing densely together, branching unilateral, alternate or opposite, brown to dark brown, at tips paler, septate, hyphal cells cylindrical, (22)27–41(46)×5–6(6.5) µm, cell wall up to 1 µm thick, smooth. *Appressoria* numerous, ampulliform, narrow at apex straight, hooked or irregularly curved, entire, sessile, without stalk cell, opposite, unilateral or alternate, (7)9–13(15.5) µm long (*n*=80), at base (4)5–6(6.5) µm wide, at apex (2.5)3–4(5) µm wide, brown to dark brown, at apex slightly paler, penetration pore 0.5–1 µm diam., in the distal part of the appressorium. *Haustoria* inconspicuous. *Thyriothecia* superficial, develop below surface mycelium, circular to slightly elongated and ellipsoidal in outline, dimidiate, single or confluent, with entire margins, (165)190–234(270)×(110)137–168(190) µm (*n*=80), dark brown to blackish, contain only 2 or 3 asci per ascoma, open with irregular fissures above each mature ascus. *Scutellum* radiate, composed of dichotomously branched, filaments, scutellum cells isodiametric to cylindrical, straight at center, not undulating at margin of ascoma, (5)7–12(13)×(2.5)3–4(5.5) µm, dark brown, at margins paler. *Asci* few, only 2 or 3 asci per ascoma, globose to broadly ovate, with distinct ocular chambers, bitunicate, ascus walls slightly I+, (50)56–65(72) µm diam. (*n*=40), 8–spored, hyaline, develop opposite to each other on short ascogenous hyphae in ascocarp center, attached laterally to ascogenous hyphae, interascal tissue absent. *Ascospores* few, 2–celled, cells sometimes disintegrating, ellipsoidal, ends rounded or slightly acuminate, strongly constricted at septum, slightly tapering to one end, (32)34–40(43) µm long (*n*=76), upper cell (14)16–18(22) µm wide, lower cell (13)14–16(17) µm wide, dark brown, conspicuously aculeate, ornamentation up to 6 µm high, spines straight or curved, ends acuminate or roundish, spines often broken, germinate first at the distal part of each cell with a stalked appressorium. *Anamorph* absent.

Illustrations. In this contribution.

Hosts. Myristicaceae: *Compsoneura sprucei* (A. DC.) Warb.

Known distribution. Neotropical: Central America (Panama). *Asterina* sp. 7 occurs in Western Panama in humid lowland forests on the Caribbean side at approx. 64 m a.s.l.

Specimens examined: PANAMA. Bocas del Toro Province: Teribe river, private property of A. Jimenez above village Bonjik, ca. 64 m a.s.l., hypophyllous on *Compsoneura sprucei* (det. A. Espinosa and J.A. Polanco), with various hyperparasites, 24 Oct. 2005, *T.A. Hofmann, R. Mangelsdorff & M. Piepenbring ppMP 91*, *445*, *449* (M-0141044; PMA); same locality, host plant and associated organisms, 5 Apr. 2006, *T.A. Hofmann, M. Piepenbring & T. Trampe ppMP 552* (M-0141045; PMA); same locality, host plant and associated organisms, 15 Jul. 2006, *T.A. Hofmann, R. Mangelsdorff & T. Trampe ppMP 1170* (M-0141046; PMA); same locality, host plant and associated organisms, 13 Feb. 2007, *T.A. Hofmann, R. Mangelsdorff & T. Trampe ppMP 1293* (M-0141047; PMA); same locality, host plant and associated organisms, 2 Oct. 2007, *T.A. Hofmann & M. Piepenbring 569* (FR; PMA).

Additional specimens examined. *Asterina horsfieldiae* Hansf. INDONESIA. Java: Karawang, Tjitjadas, epiphyllous on *Horsfieldia irya* Warb., 25 May 1933, *K.B. Boedijn 2635* (type, BO 14446). ***Asterina pycnanthii* Hansf. UGANDA. Wakiso:** Entebbe road, mile 13, epiphyllous on *Pycnanthus* sp., with variuos hyperparasites, Nov. 1937, *C.G. Hansford 2280* (syntype, BPI 690339).

Notes. *Asterina* sp. 7 has some remarkable and untypical characteristics for a species of *Asterina*, especially in ascoma morphology. The mature ascomata are ellipsoidal with unfringed margins and each ascoma contains only two or very rarely three asci. The asci develop oppositely from each other on short ascogenous hyphae in the ascocarp center.

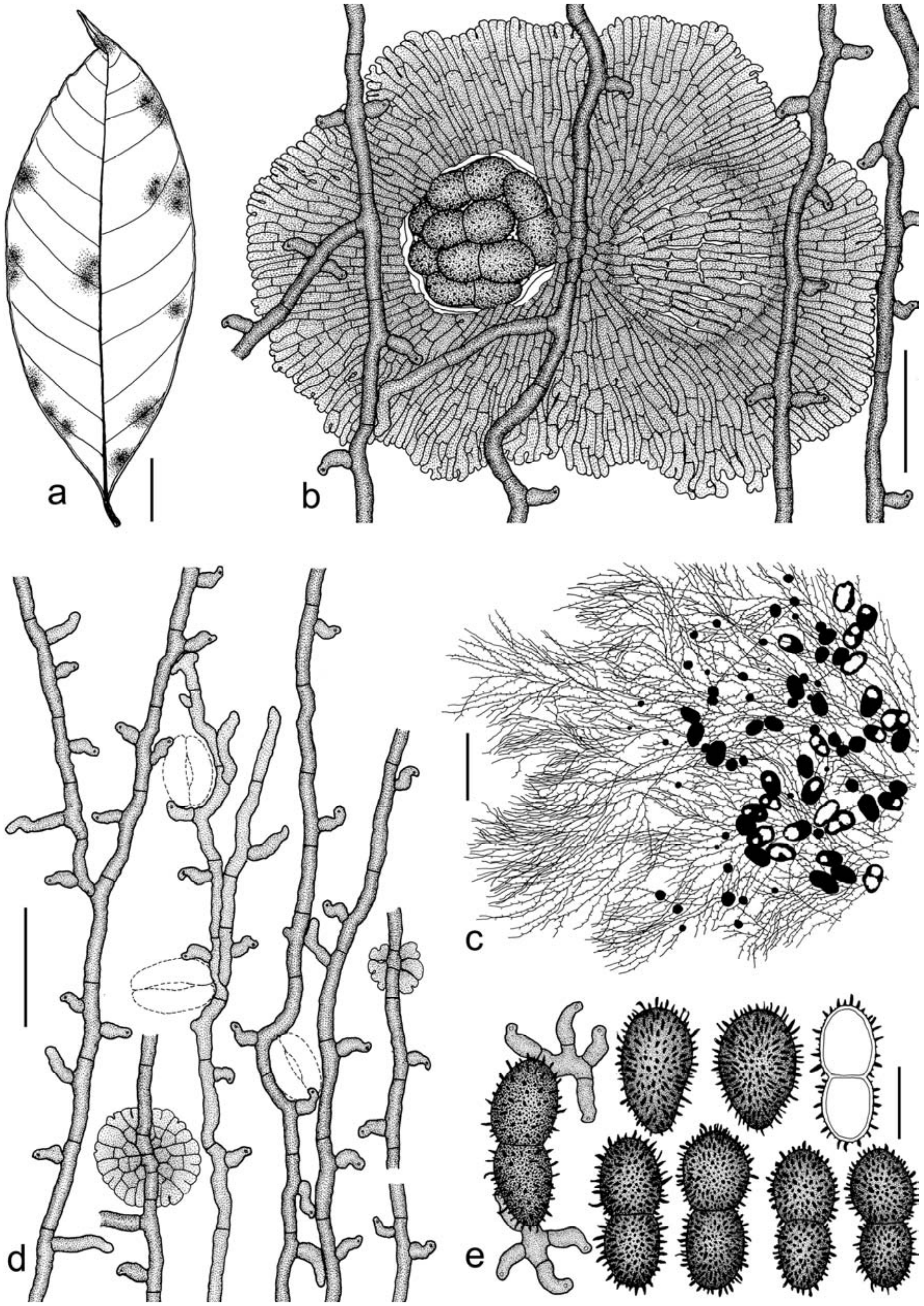

Figure 3.58: ***Asterina* sp. 7 on *Compsoneura sprucei*. a:** Abaxial side of infected leaf (ppMP 1293). Scale bar = 2 cm. **b:** Partly open thyriothecium with one mature and one immature ascus (ppMP 449). Scale bar = 40 µm. **c:** Part of the colony with thyriothecia and surface mycelium (ppMP 449). Scale bar = 500 µm. **d:** Surface mycelium with appressoria and ascoma initials (ppMP 1293), guard cells of plant stomata are indicated with dotted lines. Scale bar = 30 µm. **e:** Mature, spiny ascospores, some cells disintegrates during maturity (middle cells in upper line), left ascospore is germinating (ppMP 449, ppMP 1293). Scale bar = 20 µm.

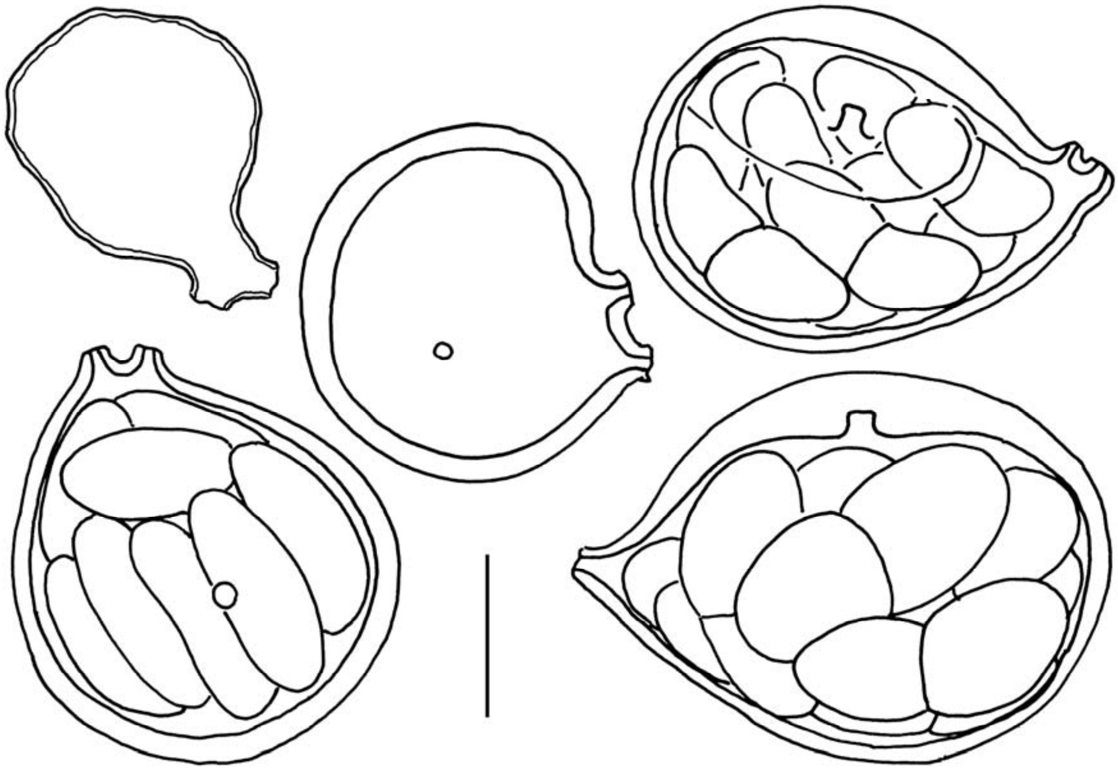

Figure 3.59: Asci of *Asterina* sp. 7 on *Compsoneura sprucei* (ppMP 569). Young asci on the left are displayed in top view, two of them with distinct central ocular chambers, right asci in side view. Scale bar = 20 µm.

At maturity the ascoma opens with irregularly circular fissures above each ascus, leaving the overripe ascoma with two circular empty cavities that are easy to observe under the steromicroscope. *A.* sp. 7 grows exclusively hypophyllous on leaves of *Compsoneura sprucei* and forms a surface mycelium with unstalked, ampulliform appressoria. Its ascospores are conspicuously large and have a very striking spinose ornamentation, with spines reaching up to 6 µm in length (Figs. 3.58e, 3.60b).

Five species of *Asterina* are described from Myristicaceae, *A. coelocaryi* Hansf. and *A. pycnanthi* Hansf. from Africa, *A. horsfieldiae* Hanf. from Indonesia, *A. horsfieldiicola* B. Song, T.H. Li and Hosag. from China and *A. knemae-attenuatae* Hosag., T. K. Abraham and T.S. Nayar from India (Hosagoudar and Abraham 2000, Hosagoudar et al. 1998b, Song et al. 2003). All five species are restricted to the Paleo-tropis and none is associated with the host genus *Compsoneura*. They have similar unstalked appressoria and produce large ascospores. Similar to *Asterina* sp. 8, *A. coelocary* has ascomata with 1–2 asci per ascoma, but the ascomata are smaller with 140–160 µm diam., the spherical appressoria are shorter and the ascospores are smooth (Hansford 1945). Examined type material of *A. pycnanthi* shows that the fungus has

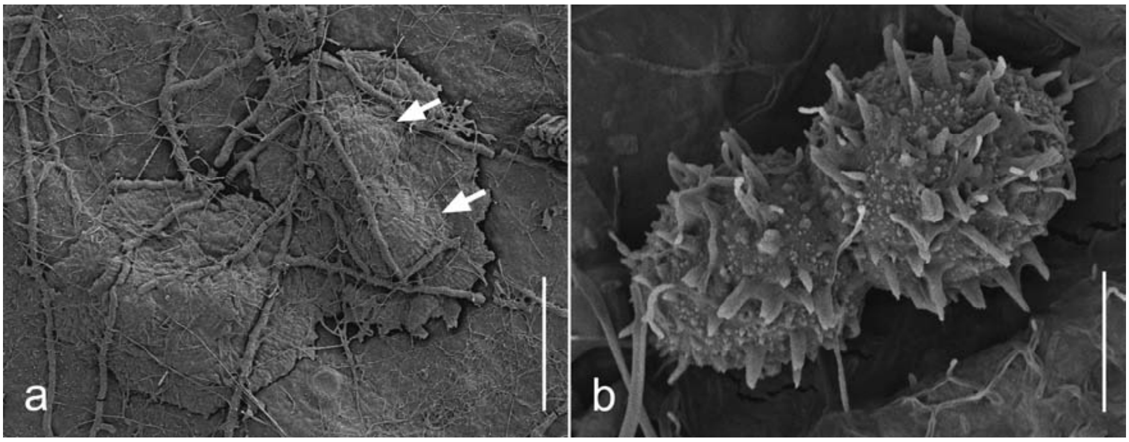

Figure 3.60: SEM photographs of *Asterina* sp. 7 on *Compsoneura sprucei* (ppMP 1170). a: Thyriothecium with two asci and surface mycelium, arrows indicate the position of two asci below the scutellum. Material is hyperparasitized by a thinner mycelium of an unknown fungus. Scale bar = 100 cm. **b:** Ascospore with spinose ornamentation. Scale bar = 10 µm.

spherical appressoria and smaller ascospores with 32–35×18–20 µm which have a more regular and shorter spinose ornamentation (Sydow 1938). *A. horsfieldiae* produces elongated ascomata with few asci per ascoma, but differs due to smaller ascomata with 150–200×100–140 µm diam., the appressoria are ovate to slightly lobed and the ornamentation of the ascospores is less distinct (Hansford 1954b). *A. horsfieldiicola* has an anamorphic *Asterostomella*-stage, spherical opposite appressoria and smaller smooth ascospores of 25–31×10.5–15 µm (Song et al. 2003) and *A. knemae-attenuatae* has smaller smooth ascospores of 25–27×11–13 µm (Hosagoudar et al. 1998b).

Asterina sp. 7 is the first record of an *Asterina* on Myristicaceae from the Americas and the Neotropis and it is the first record for the host plant genus *Compsoneura* and the host plant species *C. sprucei*. Its ascoma morphology, the few asci and the large spiny ascospores are remarkable and unique features of the species. Therefore, *Asterina* sp. 7 is probably new to science.

Interestingly, several *Asterina* spp. on Myristicaceae produce only few asci within a single ascoma, e.g. *A. coelocaryi*, *A. horsfieldiae*, *A. knemae-attenuatae* and *Asterina* sp. 7. A single ascoma of these species normally does not produce more than 16 ascospores. The extreme reduction of internal tissue and reproductive units is probably due to a limited nutrient supply on host plants belonging to Myristicaceae.

The ellipsoidal ascomata of *Asterina* sp. 7 resemble ascomata of the genus *Lembosia*. Species of *Lembosia* are segregated from species of *Asterina*, based on the presence of elongated ascomata (Hansford 1954b). However, the ascomata of species of *Lembosia* become more elongated, Y- or X-shaped and no species of *Lembosia* is known from Myristicaeae (BPI database).

Asterina sp. 8 on *Casearia commersoniana* (Salicaceae s.l.) Figs. 3.61,3.62

Colonies amphigenous, irregularly circular, single, later confluent, conspicuous and dense, on hyphophyllous side larger, 1–13 mm diam. (*n*=10), black. *Surface hyphae* variable, straight and loosely scattered at margins of colonies, undulating and dense in center, branching unilateral or alternate, dark brown, hyphal tips paler, septate, hyphal cells cylindrical, (17)20–32(40)×(3.5)4–5(5.5) µm, cell wall up to 1 µm thick, rigid, smooth. *Appressoria* numerous, variable in shape, mostly 1–4–lobate, rarely entire, irregularly circular to cylindrical, sometimes slightly bifurcate, straight or hooked, sessile or slightly stalked, without stalk cell, alternate or unilateral, (5)8–12(19)× (6.5)8–12(15) µm (*n*=80), dark brown, at margins of colony scattered, with large spaces, in center of colony crowded and densely packed. *Haustoria* inconspicuous. *Thyriothecia* superficial, develop below surface mycelium, circular, dimidiate, rarely slightly elongated, single or confluent, with fringed margins, (180)218–291(340) µm diam. (*n*=80), dark brown to blackish, open with irregular central star-shaped fissures. *Scutellum* radiate, composed of dichotomously branched filaments, scutellum cells isodiametric to cylindrical or slightly meandrical, slightly undulating at margin of ascoma, (5)6–11(15)×4–5(6.5) µm, at margins of ascoma up to 15 µm long, dark brown, at margins of ascoma paler, break of or disintegrate irregularly above hymenium during maturity. *Asci* globose to broadly ovate, with distinct ocular chambers, bitunicate, ascus walls I+, (25)27–32(35) µm diam. (*n*=20), 6–8–spored, hyaline, ascogenous hyphae indistinct, mature asci few, interascal tissue present, filamentous, septate, anastomosing. *Ascospores* 2–celled, ellipsoidal, ends rounded or slightly acuminate, deeply constricted at septum, (20)22–24(25.5) µm long (*n*=59), upper cell (10)11–12(13) µm wide, lower cell (8)9–10(11) µm, dark brown when mature, cell wall up to 1 µm thick, smooth, immature ascospores with thick gelatinous sheaths, germinate at the distal part of the lower cell with a lobed appressorium. *Anamorph* absent.

Illustrations. In this contribution.

Hosts. Salicaceae s.l. (Flacourtiaceae s.str.): <u>*Casearia commersoniana*</u> Cambess.

Known distribution. Neotropical: Central America (Panama). *Asterina* sp. 8 occurs in Western Panama in disturbed lowland forests and gallery forests at approx. 140 m a.s.l.

Specimens examined: **PANAMA. Chiriquí Province:** Los Algarrobos, border of Majagua river, galeryforest, ca. 140 m a.s.l., amphigenous on *Casearia commersoniana* (det. T.A. Hofmann), with hyperparasites, 17 Oct. 2005, *T.A. Hofmann & R. Mangelsdorff 396* (FR; PMA); same locality, host plant and associated organisms, 8 Sep. 2007, *T.A. Hofmann 524* (PMA); same locality, host plant and associated organisms, 22 Mar. 2006, *T.A. Hofmann, M. Piepenbring & T. Trampe ppMP 478* (M-0141070; PMA); same locality, host plant and associated organisms, 21 Jun. 2006, *T.A. Hofmann, R. Mangelsdorff & T. Trampe ppMP 596* (M-0141071; PMA); same locality, host plant and associated organisms, 10 Jan. 2007, *T.A. Hofmann, R. Mangelsdorff & T. Trampe ppMP 1202* (M-0141072; PMA). — Los Algarrobos, path to Majagua river, ca. 140 m a.s.l., amphigenous on *Casearia commersoniana* (det. T.A. Hofmann and A. Somoza), with hyperparasites, 11 Jun. 2006, *T.A. Hofmann 466* (PMA). — Los Algarrobos, path to Lajas river and El Salto cascade, ca. 140 m a.s.l., amphigenous on *Casearia commersoniana* (det. T.A. Hofmann), 7 Jan 2007, *T.A. Hofmann 498* (FR; PMA); same locality, host plant and associated organisms, 20 Sep. 2007, *T.A. Hofmann, M. Cuevas & J. Garay 547* (PMA).

Additional specimens examined: ***Asterina delicata*** **Doidge. SOUTH AFRICA. KwaZulu-Natal:** Durban, Mayville, on *Trimeria alnifolia* [=*Grewia lasiocarpa fide* Doidge 1942], 22 Jul. 1915, *M. Wood 9062* (type, IMI 35787). ***Asterina flacourtiae*** **Petr. PHILIPPINES. Cagayan Valley:** Cagayan Province, Aparri, on *Flacourtia indica*, Jan. 1924, *M.S. Clemens 2778* (type, BPI 689782, 689781). ***Asterostomella grewiae*** **Petr. PHILIPPINES. Cagayan Valley:** Nueva Vizscaya Province, Bambang, on *Grewia* sp., Jan. 1924, *M.S. Clemens s.n.* (type, BPI 689845, labeled as *Asterina grewiae*). **SIERRA LEONE. Eastern Province:** Kenema district, Giema, (Dama), on *Dovyalis afzeli*, 29 Jan. 1940, *F.C Deighton s.n.* (IMI 18986a). ***Asterina homalii*** **Syd. SIERRA LEONE. Southern Province:** Moyamba District, Njala, on *Homalium alnifolium*, 24 Oct. 1936, *without coll. on label* [*F.C. Deighton 1038*?] (type, IMI 19124). ***Asterina homaliicola*** **S. Hughes. GHANA. Central Region:** Agona District, on *Homalium dolichophyllum*, 12 May 1949, *S.J. Hughes s.n.* (type, IMI 44500). ***Asterina microchita*** **Syd. ECUADOR. Pichincha Province:** Mindo, on *Banara regia*, 26 Oct. 1937, *H. Sydow 1207* (BPI 690084). ***Asterina spectabilis*** **Syd. INDONESIA. Ambon Island:** Ayer putri, on *Flacourtia inermis*, 28 Jul. 1913, *C.B. Robinson 2126* (type, S F12497). ***Asterina tonduzii*** **(Speg.) Syd. COSTA RICA. San José Province:** La Caja, on *Xylosma velutinum*, 22 Dec. 1924, *H. Sydow 210* (type, S F83412); same locality, date and host plant, *H. Sydow 687* (BPI 690586 paratype?); same locality, date and host plant, *H. Sydow s.n.* (BPI 690587).

Notes. *Asterina* sp. 8 is characterized by conspicuous darkly pigmented structures (surface mycelium, appressoria, ascomata and ascospores). The surface mycelium is rigid and the ascospores are smooth and have rounded to slightly acuminate ends.

Hosagoudar and Abraham (2000) list 21 species of *Asterina* occuring on members of Salicaceae s.l. (Flacourtiaceae s.str). However, the list is incomplete and some species have to be exluded from or included into the list (Table 3.7). The South African species *A. africana* (Van der Byl) Doidge on *Xylotheca kraussiana* and *A. africana* var. *kiggelariae* Doidge on *Kiggelaria africana* have to be excluded, because

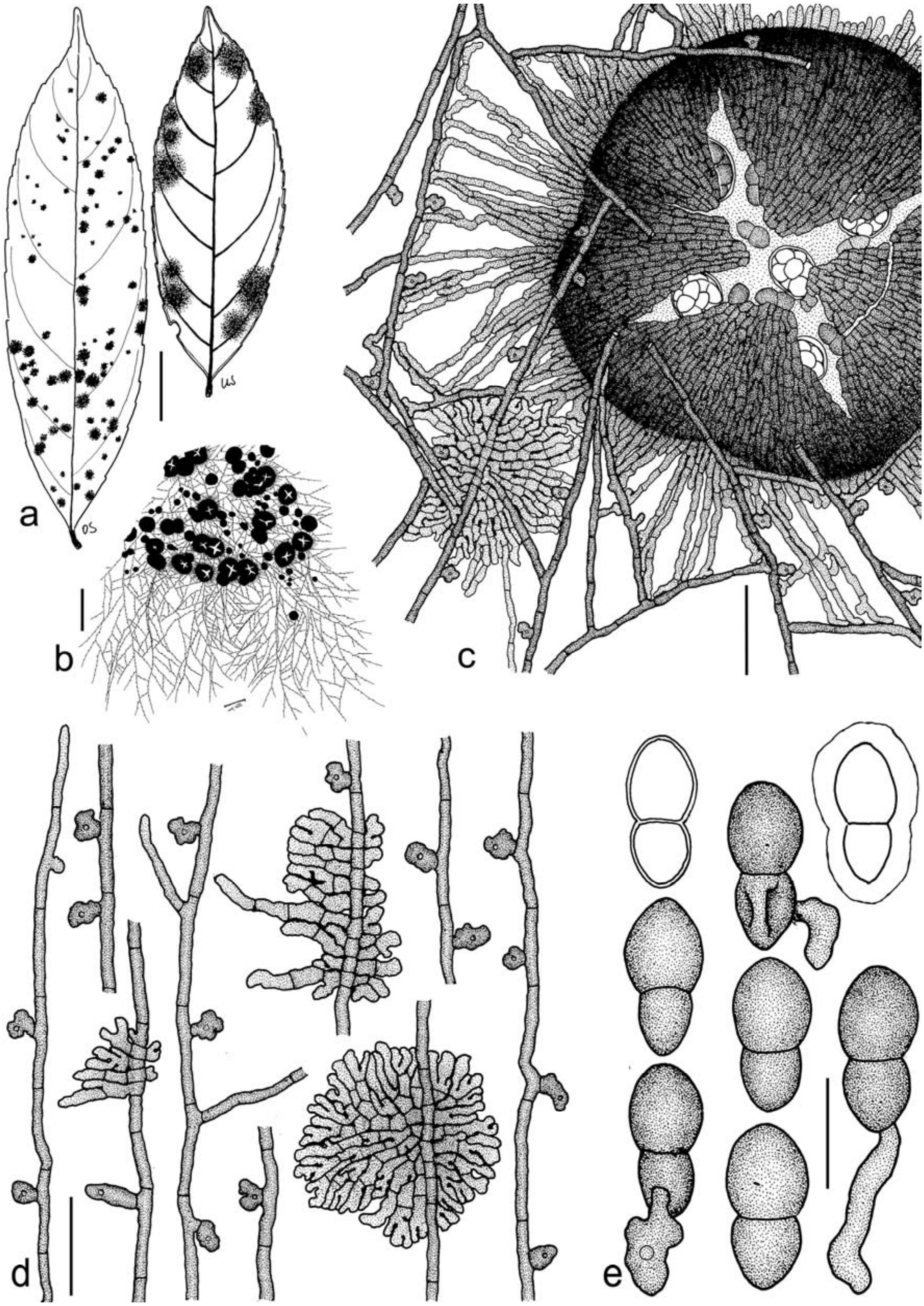

Figure 3.61: ***Asterina* sp. 8 on *Casearia commersoniana* (TH 466) a:** Adaxial (left) and abaxial (right) side of infected leaves. Scale bar = 2 cm. **b:** Part of a colony with confluent thyriothecia and surface mycelium. Scale bar = 500 µm. **c:** Open thyriothecium with mature and immature asci and one ascoma initial. Scale bar = 50 µm. **d:** Surface mycelium with appressoria and ascoma initials. Scale bar = 30 µm. **e:** Mature ascospores, some of them germinating. Spore on the upper right side is immature and embedded in a slimy sheath. Scale bar = 15 µm.

the host genera belong to the plant family Achariaceae (Mabberley 2008). *A. delicata* Doidge described on *Trimeria alnifolia* has to be removed, because the host plant of the type was misidentified by Doidge and is a Malvaceae, namely *Grewia lasiocarpa*

(Doidge 1942). *Asterina hapala* Syd. on *Scolopia luzonensis* from the Philippines has to be excluded, as it was described by Sydow as *Asterinella hapala* without any appressoria (Sydow 1934). Since 2000, two more species were described on Salicaceae s.l., *A. flacourtiaceicola* B. Song, T.H. Li & Hosag. from China (Song et al. 2003) and *A. talacauveriana* Hosag. from India (Hosagoudar et al. 2006). No species of *Asterina* is known from the host species *Casearia commersoniana* but a total of four species are known from *Casearia* spp., *A. caseariae* Hansf. and *A. caseariicola* Hansf. from Uganda, *A. caseariae-esculentae* Hosag. & T.K. Abraham from India and *A. yamamotoicola* Hosag. & T.K. Abraham from Taiwan (Hosagoudar and Abraham 2000, Table 3.7). *A. caseariae*, *A. caseariae-esculentae* and *A. yamamotoicola* differ from *Asterina* sp. 8 due to their stalked appressoria. The only species of *Asterina* on *Casearia* with unstalked appressoria is *A. caseariicola*, that differs because of its mostly opposite, entire and distinctly narrower appressoria and its larger, verrucose ascospores with a different germination modus (Hansford 1947, Table 3.7). Numerous *Asterina* spp. on other host genera of Salicaceae s.l. have unstalked appressoria, however, most of these species have entire appressoria without sinuate or lobed margins (Table 3.7). Unstalked and sublobate to lobed appressoria are present in *A. granulosa* (Hansf.) Hosag., Balakr. & Goos from Uganda, *A. grewiae* var. *zonata* Doidge from South Africa and *A. azarae* Lév. from Chile. *A. granulosa* differs from *A.* sp. 8 because of its smaller ascomata, larger ascospores and an anamorphic *Asterostomella* stage (Table 3.7, Hansford 1944, Hosagoudar et al. 1996). *A. grewiae* var. *zonata* has smaller ascomata and contains an *Asterostomella*-anamorph (Doidge 1942). *A. azarae* differs by its larger and verrucose ascospores (Saccardo 1882, Arnaud 1918). Other *Asterina* spp. on Salicaceae s.l. from the American continent are *A. tonduzii* (Speg.) Syd. from Costa Rica and *A. microchita* Syd. from Ecuador. *A. tonduzii* differs by its entire, cylindrical appressoria and the small ascomata (Sydow 1927) and *A. microchita* differs due to its significantly smaller ascomata and ascospores and the entire, cylindrical appressoria (Sydow 1939).

Asterina sp. 8 remains as an uncertain species, because of the morphological differences to other known *Asterina* spp. on Flacourtiaceae s.str. It is the first report of a species of *Asterina* on the host species *Casearia commersoniana*.

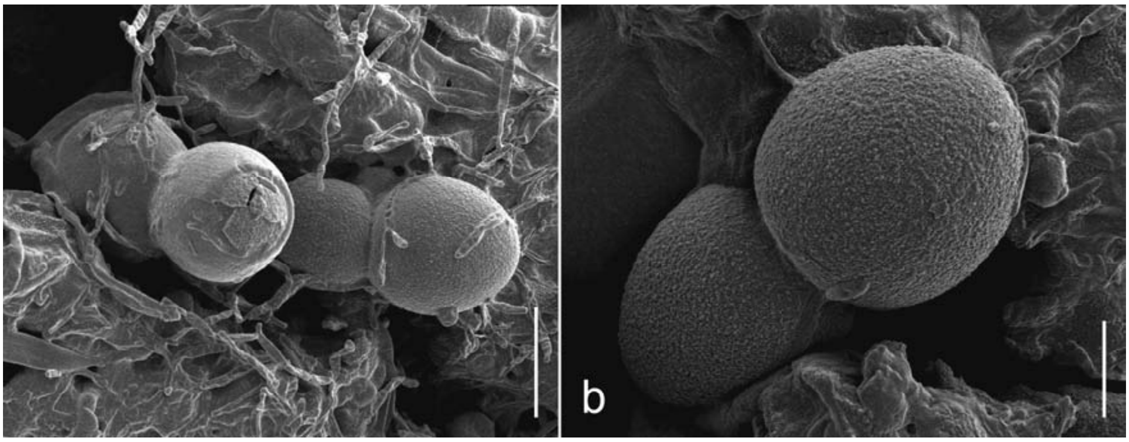

Figure 3.62: SEM photographs of *Asterina* sp. 8 on *Casearia commersoniana* (ppMP 478). a: Two ascospores, one with ruptured cell wall and associated bacteria. Scale bar = 10 µm. b: Mature ascospore. Scale bar = 5 µm.

Table 3.7: List of *Asterina* spp. on Salicaceae s.l. (Flacourtiaceae s.str.) according to literature. Species are listed in alphabetical order according to continents, Africa: *A. caseariae* to *A. uncinata*, Asia: *A. caseariae-esculentae* to *A. yamamotoicola*, Central America: *A. tonduzii*, South America: *A. azarae* to *A. microchita*. Taxa indicated with asterisks are not listed in Hosagoudar and Abraham (2000). Cited host plants and localities correspond to the protolouge of the type species only. Morphological data are cited from the original publication, revised data or own observations from examined type material are indicated in brackets. Abbreviations: Anam = anamorph, lc = lower cell, uc = upper cell.

Species	Host plant	Country	Appressoria	Ascomata	Ascospores	Anam
A. caseariae Hansf. 1943-44	*Casearia engleri*	Uganda	stalked, 10–15 µm long, head 8–12×6–9 µm, lobed	up to 140 µm diam.	16–20×8–9 µm, verrucose	yes
A. caseariicola Hansf. 1947	*Casearia esculenta*	Uganda	unstalked, 8–15×6–7 µm, ovate, entire	120–140 µm diam.	25–30×14–15 µm, verrucose	—
A. granulosa (Hansf.) Hosag., Balakr. & Goos 1996	*Scolopia* sp.	Uganda	unstalked, 8–13.5×6–8 µm, cylindrical, entire to sublobed	120–140 µm diam.	27–31×12–15.5 µm, smooth	yes
A. grewiae Cooke 1882	*Trimeria grandifolia*	South Africa	unstalked, 7.5–10×3.5–5 µm, flask-shaped, entire	100–150 µm diam.	20–25×10–12.5 µm, smooth	yes
A. grewiae var. *zonata* Doidge 1942	*Trimeria trinervis*	South Africa	unstalked, as [*A. grewiae*], uncinate to sublobed	[as *A. grewiae*]	[as *A. grewiae*]	yes
A. homalii Syd. 1939	*Homalium alnifolium*	Sierra Leone	unstalked, 6–11×3.5–4.5 µm, oblong, entire	100–160 µm diam.	22–26 µm long, uc 13–14.5 µm wide, lc 12.5–13.5 µm wide, verrucose	—
A. homaliicola S. Hughes 1952	*Homalium dolichophyllum*	Gold Coast	unstalked, 6–12×2–4 µm, cylindrical, entire	up to 120 µm diam.	16–19×9–10 µm, smooth	yes
A. scolopiae Doidge 1922	*Scolopia zeyheri*	South Africa	stalked, 10–19×3–4(5) µm, cylindrical	130–170 µm diam.	20–25×9–11 µm, smooth	yes
A. uncinata Doidge 1920*	*Scolopia mundtii*	South Africa	stalked, up to 20–40 µm long, head 10–15×5–6.5 µm, cylindrical, sublobed	200–250(280) µm diam.	29–34×16–20 µm, smooth	—
A. caseariae-esculentae (Hosag. & Goos) Hosag. & T.K. Abraham 2000	*Casearia esculenta*	India	stalked, 12–15.5 µm long, head 9–11×6–7 µm, cylindrical, entire	up to 140 µm diam.	18–22×11–13 µm, smooth	—
A. cylindrophora Syd. & P. Syd. 1917	*Scolopia* sp.	Philippines	stalked, 16–22×7–9 µm, cylindrical, entire	160–250 µm diam.	34–36×18–20 µm, verrucose	—
A. flacourtiacearum Hosag. & K. Ravik. 1996	*Scolopia crenata*	India	stalked, 9–30 µm long, head 6–9.5×9–12.5 µm, lobed	62–190 µm diam.	24–28×12–815.5 µm, smooth	yes

Species	Host plant	Country	Appressoria	Ascomata	Ascospores	Anam
A. flacourtiaceicola B. Song, T.H. Li & Hosag. 2003*	undetermined	China	unstalked, 7.5–12.5×3.5–4.5 µm, ampulliform, entire	up to 90 µm diam.	12.5–15×5–6 µm, smooth	—
A. flacourtiae Petr. 1931	*Flacourtia indica*	Philippines	stalked 12–17×6–9 µm, cylindrical, entire	150–250 µm diam.	33–42 µm long, uc 17– 20 µm wide, lc 16–18 µm wide, smooth	—
A. spectabilis Syd. 1922	*Flacourtia inermis*	Philippines	stalked, 10–20×9–12 µm, cylindrical, entire	200–300 µm diam.	35–42×18–20 µm, smooth	yes
A. talacauveriana Hosag. 2006*	*Scolopia* sp.	India	stalked, 10–16 µm kong, head 9–11×6–10 µm, lobed	up to 130 µm diam.	19–21×8–10 µm, smooth	yes
A. xylosmae J.M. Mend 1932	*Xylosma* sp.	Philippines	stalked, 11–19×10–11 µm, cylindrical	200–360 µm diam.	16–19×10–11 µm, smooth	—
A. yamamotoicola Hosag. & T.K. Abraham 2000	*Casearia merillii*	Taiwan	stalked, 11–15×4.5–7 µm, sinuate to lobed	104–140 µm diam.	16–21×8–10.5 µm, verrucose	yes
A. tonduzii [as '*tonduzi*'] (Speg.) Syd. 1927	*Xylosma velutinum*	Costa Rica	unstalked, 12–15×4–5.5 µm, cylindrical, entire	90–150 µm diam.	20–27×10–12.5 µm, smooth	yes
A. azarae Lév. 1845*	*Azara serrata*	Chile	unstalked, sessile 9–12×16 µm, straight, 13–20×9–15 µm, lobed	200–300 µm diam.	26–30×10–13 µm, verrucose, [according to Theissen 1913]	—
A. microchita Syd. 1939	*Banara regia*	Ecuador	unstalked, 8.5–11.5×5–6 µm, ovate to cylindrical, entire	60–80 µm diam.	18–20 µm long, uc 9–10 µm wide, lc 7.5–9 µm wide, smooth	—

Asterolibertia G. Arnaud

Ann. École Nat. Agric. Montp., Sér. 2, 16: 165 (1918)

= *Steyaertia* Bat. & H. Maia, in Batista and Garnier, IMUR 295: 5 (1960). Type: *S. coepiae* Bat. & H. Maia

[synonymy partly according to Arx and Müller (1975)]

Type species: *A. couepiae* (Henn.) G. Arnaud

Colonies superficial on living leaves, black. *Surface mycelium* septate, branched, brown. *Appressoria* intercalary, swollen and node-like or not swollen, with a central penetration pore, forming haustoria or hypostroma in host cells. *Haustoria* arbuscular, intracellular within epidermal host cells. *Hypostroma* present (if haustoria absent), epidermal or subepidermal, composed of bundles of intracellular hyphae, hyaline or brown. *Thyriothecia* superficial, dimidate, circular or slightly enlongated, dark, develop below surface mycelium, open with central star-shaped or irregular fissures. *Scutellum* radiate, composed of rows of syncronal and dichotomously branching cells forming a continuous plate of cells, one cell layer thick, cells isodiametrical or cylindrical, straight. *Asci* globose to ovate, shortly stalked, bitunicate, 4–8–spored, hyaline, vertical within ascoma, interascal tissue present or absent, filamentous, disintegrates early. *Ascospores* 2– or 3–celled, ellipsoidal, brown when mature.

Notes. Arnaud (1918) introduced the genus *Asterolibertia* with the type species *A. couepiae* in order to classify thyriothecioid ascomycetes with surface mycelia with intercalary appressoria and circular ascomata without internal pseudoparaphyses. The basionym of *Asterolibertia couepiae*, *Asterina couepiae* Henn. was described on *Couepia* sp. (Annonaceae, identified by Arnaud (1918) as *Couepia ovalifolia* (Schott) Benth. ex Hook.f.) from Brazil.

Together with *Asterolibertia*, Arnaud (1918) introduced the genus *Wardina*, that was separated from *Asterolibertia* due to the pseudoparaphysate ascomata. The type species of *Wardina* is *Wardina myocoproides* (Sacc. & Berl) G. Arnaud with the basionym *Asterina myocoproides* Sacc. & Berl. described on an unknown plant from Santos, Brazil (Saccardo and Berlese 1885, Arnaud 1918). Later, the host plant from Santos was identified as a Melastomataceae (Theissen 1913, Batista and Maia 1960a, Müller and Arx 1962). *A. myocoproides* was briefly illustrated by Saccardo and Berlese (1885) forming a brown surface mycelium with distinct intercalary appressoria with a hemispherical central structure. The conspicuous hemispherical central structure of the appressoria was repeatedly mentioned or illustrated by others, e.g. Theissen (1913, large central drop; Batista and Maia 1960a). The ascospores were described and illustrated as one-celled and hyaline (Saccardo and Berlese 1885). In contrast to Saccardo and Berlese (1885), other authors observed that the ascospores develop more then one transversal septum during maturity (Theissen 1912b, 1913a; Batista and Maia 1960a). Theissen (1912b) supposes that ascospores must become brown when fully mature, due to the dark brown surface mycelium originating from germinating ascospores. However, none of these authors observed or described fully mature ascospores or germinating ones. Müller and Arx (1962) synonymized the genus *Wardina* with *Asterolibertia* because both authors believe that the presence or absence of pseudoparaphyses is no criterion for the seperation of genera. They noted that *Asterolibertia myocoproides* is probably identical with *A. inaequalis*, but did not confirm or explain their theory.

Asterina myocoproides together with its respective homotypic synonyms is morphologically similar to *Platypeltella smilacis* (see Chapter 3.2.2). Especially the illustrations of *Wardina mycocoproides* by Batista and Maia (1960a) indicate that. *P. smilacis* is characterized by a brown surface mycelium with intercalary, node-like appressoria, each with a central hemipsherical structure forming a penetration peg similar to a thumbtack in profile for adhesion in the cuticule (Fig. 3.90h). The ascospores of *P. smilacis* are first one-celled and hyaline, later a septum develops in the upper third of the spore, additional septae are formed and the ascospores become darkly pigmented. Fully mature ascospores are short-living and collapse during germination (Fig. 3.91i-j). *Asterina myocoproides* is not identical with species of the genus *Asterolibertia* as proposed by Müller and Arx (1962). *A myocoproides* is probably similar to *Platypeltella smilacis*, whereas the host plant is probably a Smilacaceae, whose leaves can be confused with leaves of Melastomataceae due to a similar leaf venation. Unfortunately, type material of *A. myocoproides* could not be observed by the author until the end of this study.

With the introduction of the genera *Asterolibertia*, *Wardina*, *Cirsosia* and *Cirsosiella* in 1918, Arnaud made the first attempts to separate thyriotecioid ascomycetes with surface mycelia with 'node-like' cells or intercalary appressoria from other genera with lateral appressoria. Since 1913, species with surface mycelia with 'node-like' cells were placed by Theissen (1912b, 1913a) in '*nodulosae*-sections' in the genera *Asterina*, *Seynesia* and *Lembosia*. According to Arnaud (1918), thyriothecioid ascomycetes with intercalary appressoria and circular ascomata belonged to *Asterolibertia* and *Wardina* when pseudoparaphyses were absent or present. Species with elongated ascomata were assigned to *Cirsosia* and *Cirosiella* when pseudoparaphyses were absent or present.

Today, the genus *Asterolibertia* includes about 32 species distributed worldwide in tropical and subtropical regions on plant species belonging to 18 host plant families (Appendix, Table 7.5).

Key to species of *Asterolibertia* collected in Westerm Panama:

1 internal hypostromata present, haustoria absent 2

1* internal hypostroma absent, haustoria present .... *A. licaniicola*

  2 hypostromata spread within the epidermal layer, ascospores germinate with multicelled, multilobate appressoria .... *A. nodulosa*

  2* hypostromata restricted to single epidermal cells, ascospores germinate with stalked simple appressoria .... *Asterolibertia* sp.

Asterolibertia licaniicola **Hansf., Proc. Linn. Soc. London 160: 140 (1949).**

Figs. 3.63, 3.64

Type on *Licania* sp. (Chrysobalanaceae). Brazil, Santa Caterina, São Francisco, Juni 1885, *E. Ule Rabenhorst-Winter 3746* (type, PREM 4086!, labeled as *Asterina inaequalis*).

Colonies epiphyllous, irregularly circular, mostly single, sometimes confluent, 0.1–22 mm diam. (n=10), black, conspicuous and dense. *Surface hyphae* straight, rigid, not undulating, branching mostly opposite, rarely unilateral or alternate, brown, hyphal cells cylindrical, (9)15–28(34)×(3.5)4–4.5(5) µm, cell wall up to 1 µm thick, smooth. *Appressoria* numerous, intercalary, cylindrical with a slightly swollen central part, swollen part wider than mycelial cells, (9)10–13(14)×(6)7–8 µm, penetration pore up to 2.5 µm diam. in the center of the swollen part of the appressorium. Haustoria arbuscular, globose, ellipsoidal to ovate or reniform, (10)11–14(15)×(5)6–8(9) µm (n=10), hyaline, filling up to 1/4 of the host cell. *Hypostroma* absent. *Thyriothecia* superficial, develop laterally on surface mycelium, circular, dimidiate, single or confluent, strongly fringed at margins, (200)217–302(350)×(310)340–430(470) µm diam., dark brown to black, open with central star-shaped fissures, young and closed ascoma entire and conspicuously larger than mature and open thyriothecia. *Scutellum* radiate, composed of dichotomously branched filaments, scutellum cells isodiametric to cylindrical, straight in center and at margin of ascoma, (4)6–12(17)×(3)4–5(6) µm, dark brown to black, at tips paler. *Asci* few, globose to ovate, without ocular chambers, bitunicate, ascus wall I+, 37–40 µm diam. (n=4), 8–spored, hyaline, disintegrate early, develop on ascogenous hyphae with proliferating croziers, interascal tissue absent. *Ascospores* few, 2–celled, ellipsoidal, straight, not curved, septate, slightly constricted at septum, ends rounded, or lower end slightly acuminate, lower cell tapered, (25)26–29(30) µm long (*n*=16), upper cell 12–15 µm wide, lower cell 11–13(14) µm wide, brown, cell wall up to 1 µm thick, verrucose, lower cell collapses during germination, germinate first at the distal part of upper cell with a stalked and entire appressorium, after penetration of host upper cell forms endohyphae through collapsed lower cell to initiate growth of an appressoriate surface mycelium. *Anamorph* absent.

Illustrations. *A. licaniicola* is illustrated here for the first time.

Hosts. Chrysobalanaceae: <u>*Licania arborea*</u> Seem. and *Licania* sp. *L. arborea* is a new host species of *A. licaniicola*.

Known distribution. Neotropical: Central America (Panama) and South America (Brazil). *A. licaniicola* is a new record for Central America and Panama and occurs in Western Panama in lowland galleryforests at approx. 140 m a.s.l.

Specimens examined: **BRAZIL. Santa Caterina:** type, see above. **PANAMA. Chiriquí Province:** Los Algarrobos, border of Majagua river, ca. 140 m a.s.l., epiphyllous on *Licania arborea* (det. T.A. Hofmann) associated with *Camarotella* sp. (Phyllachorales, det. T. Trampe), 6 Oct. 2007, *T.A. Hofmann 578* (M-0141092; PMA); same locality, host species and associated organisms, 23 Oct. 2007, *T.A. Hofmann 597-A* (FR; PMA).

Additional specimens examined: *Asterolibertia inaequalis* (Mont.) Toro. BRAZIL. Santa Caterina: São Francisco, on *Licania* sp., Jun. 1885, *E. Ule, Rabenhorst-Winter 3746* (type, BPI 689922, labeled as *Asterina inaequalis*). **VENEZUELA. Bolívar:** C203-204 km S. of El Dorado, on road between El Dorado and Sta. Elena, on unknown plant, 7 Aug. 1972, K.P. Dumont, R.F. Cain, G.J. Samules and C. Blanco (BPI 690998).

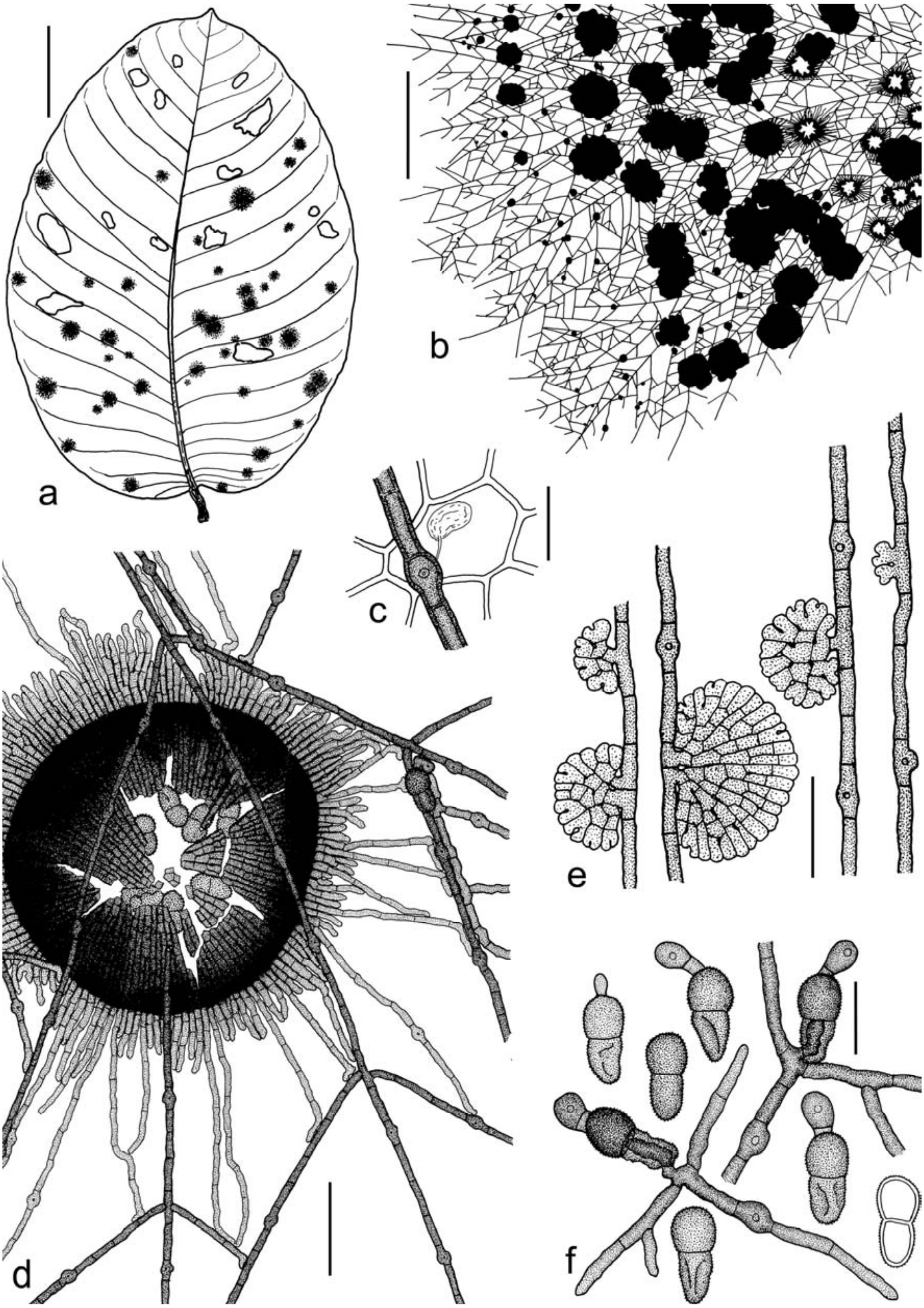

Figure 3.63: ***Asterolibertia licaniicola*** **on** ***Licania arborea*** **(TH 578). a:** Adaxial side of infected leaf. Scale bar = 4 cm. **b:** Part of the colony with large immature and smaller mature thyriothecia and surface mycelium. Scale bar = 1 mm. **c:** Haustorium within epidermal host cell. Scale bar = 15 µm. **d:** Open thyriothecium with liberated, mature ascospores. Scale bar = 50 µm. **e:** Surface mycelium with intercalary appressoria and ascoma initials. Scale bar = 25 µm. **f:** Mature, slightly verrucose ascospores, some of them germinating. Lower cell of ascospore collapses during germination and endohyphae are formed. Scale bar = 20 µm.

Notes. *Asterolibertia licaniicola* was described by Hansford (1949) on *Licania* sp. from Brazil. According to Hansford (1949), the type species is deposited in PREM. The type collection is present as *Rabenhorst-Winter, Fungi europaei 3746* exsiccata (labeled *Asterina inaequalis*) and is distributed in different herbaria worldwide (BPI, PREM, S etc.). Unfortunately, the exsiccata on *Licania* sp. contain numerous foliicolous thyriothecioid ascomycetes and most dominant is *Asterina inaequalis* Mont. (= *Asterolibertia inaequalis* (Mont.) Toro). *A. inaequalis* forms conspicuous and dense colonies with a dark and rigid surface mycelium with barrel-shaped, intercalary appressoria (Arnaud 1925). The appressoria are as wide as the hyphal cells of the surface mycelium or slightly wider and measure 9–14 µm (Müller and Arx 1962). *A. inaequalis* has 2-celled, dark brown, compressed ascospores with broadly rounded ends and with a septum in the upper third of the ascospore (Arnaud 1925) and measure 32–40×18–25 µm (Müller and Arx 1962). The ascospores are smooth and germinate at the upper cell with a stalked, entire appressorium. The type collection of *A. inaequalis* on a Melastomataceae from French Guiana was well illustrated by Arnaud (1925). The *Fungi europaei 3746* exsiccata are associated with a second thyriothecioid fungus with much more inconspicuous ascomata and surface mycelia with intercalary appressoria. This fungus was described by Hansford (1949) as *Asterolibertia licaniicola*. The ascospores are significantly smaller than those of *A. inaequalis* and the lower cell collapses during germination. The ascospores are finely verrucose (not observed by Hansford 1949) and germinate with a stalked, globose appressorium. However, *A. licaniicola* is not well developed on the *Fungi europaei* exsiccata and can be confused with the associated *A. ineaqualis*.

In Panama, *A. licaniicola* on *Licania arborea* is not associated with *A. inaequalis*. In contrast to the *Fungi europaei* exsiccata, *A. licaniicola* from Panama forms large conspicuous colonies. The straight and rigid surface mycelium contains swollen intercalary appressoria in constant intervals. Each appressorium pentrates the cuticle and forms a hyaline haustorium in an epidermal host cell (Fig. 3.63c). Circular ascomata develop with a heterogeneous morphology below the surface mycelium. Closed immature ascomata with unfringed, entire margins are located at the outer part of the colony and are significantly larger than the mature ascomata with strongly fringed margins in the center of the colony. The globose asci disintegrate early and are almost always absent in opened ascomata. The ascospores are finely verrucose and during germination the lower cell normally collapses (Fig. 3.63f, 3.64a). At the upper cell a stalked, globose appressorium develops and an endohyphae formes through the collapsed lower cell from which the surface mycelium originates (Fig. 3.63f). Sometimes larger brown ascospores with a different germination mode were observed on the host surface (Fig. 3.64b). These ascospores probably belong to *A. inaequalis*. The colonies of *A. licaniicola* are associated with various hyphomycetous and ascomycetous hyperparasites and are frequently attacked by mites.

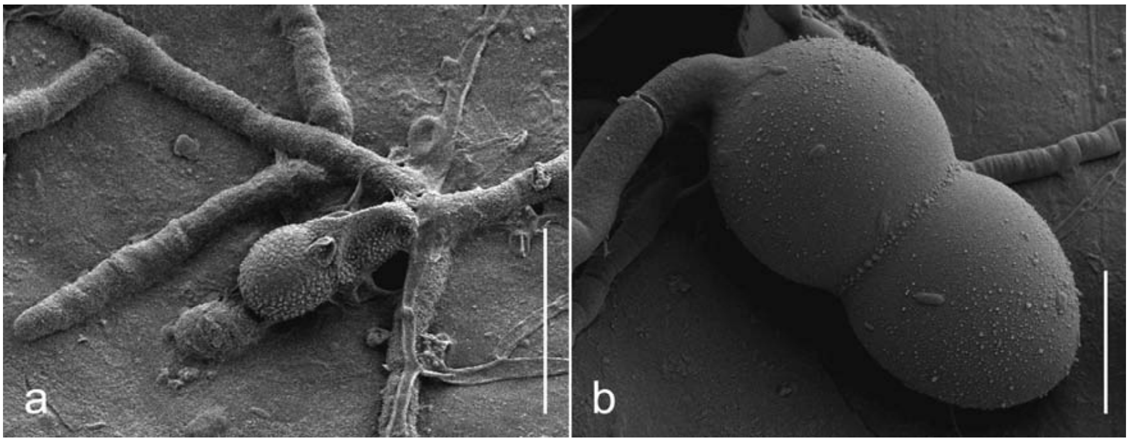

Figure 3.64: SEM photographs of *Asterolibertia licaniicola* on *Licania arborea* (TH 578). a: Germinated, verrucose ascospores. Scale bar = 30 µm. **b:** Mature ascospore of another fungus, probably *Asterolibertia inaequalis*, note the different germination mechanism. Scale bar = 10 µm.

Asterolibertia nodulosa **(Speg.) Hansf., Proc. Linn. Soc. London 160: 141 (1949).** **Figs. 3.65, 3.66, 3.67**

Type on *Tabebuia* sp. (Bignoniaceae) [= *Guatteria* sp. (Annonaceae) fide Theissen 1913]. Brazil, São Paulo, Apiahy, Oct. 1881, no. *1585* (type, LPS n.v.).

≡ *Asterina nodulosa* Speg., Bol. Acad. Nac. Cien. Córdoba 11(4): 563 (1889).

≡ *Asterina inaequalis* var. *nodulosa* (Theiss.), Abh. Zool.-Bot. Ges. Wien 11(2): 55 (1913).

[synonymy according to Theissen (1913a)]

Colonies epiphyllous, rarely hypophyllous, irregularly circular, single, 0.5–5 (*n*=10) mm diam., black, conspicuous and dense. *Surface hyphae* straight, rigid, not curved, branching opposite or rarely unilateral, brown to dark brown, at tips paler, septate, hyphal cells cylindrical, (10)19–31(33)×(3.5)4–5 µm, cell wall 0.5–1 µm thick, smooth. *Appressoria* numerous, intercalary, cylindrical cell with a swollen middle part, swollen part wider than mycelial cells, (9)10–12(15)×(8)10–12(14) µm (*n*=70), penetration pore up to 1 µm diam., in the center of the swollen part of the appressorium.

Haustoria not present, infection hyphae penetrate epidermal host cells. *Hypostroma* epidermal to subepidermal, composed of bundles of intracellular hyphae, hyaline to pale brown, filling entire epidermal host cells, infectious hyphae penetrate cuticle and form brown, thick-walled hyphae in the upper part of an epidermal cell from which a hyaline stroma is initiated, later brown, thick-walled hyphae develop in lower part of the epidermal cell to form infectious hyphae that penetrate subepidermal host cells below. *Thyriothecia* superficial, develop below surface mycelium, circular, dimidiate, crowded and confluent, strongly fringed at margins, (200)259–317(350) µm diam. (*n*=64), dark brown to black, open with central star-shaped fissures. *Scutellum* radiate, composed of dichotomously branched filaments, scutellum cells isodiametric to cylindrical, straight in center and at margin of ascoma, (4)5–12(17)×(2)3–5(6.5) µm, brown to dark brown or blackish, at tips paler. *Asci* few, globose to ovate, without ocular chambers, bitunicate, I–, (45)50–59(60.5) µm diam., 8–spored, hyaline, develop on ascogenous hyphae with proliferating croziers, disintegrate early, interascal tissue present, filamentous, septate, anastomosing. *Ascospores* few, 2– or rarely 3–celled, ellipsoidal, not curved, ends rounded, slightly tapering to one end, first septum forms in the upper third of the ascospore, slightly constricted at first septum, second septum missing or inconspicuous and thin-walled, second septum in the lower third of ascospore, not constricted at second septum, (27.5)28–32(33)×(14)15–17(17.5) µm, brown to dark brown, cell wall up to 1 µm thick, verrucose, germinate first at the distal or lateral part of the lower cell (more rarely at upper cell) with a multicelled, multilobate and dark brown appressorium from which the surface mycelium is formed laterally, upper and lower cell of ascospore collapse during development of first appressorium. *Anamorph* absent.

Illustrations. In Batista and Maia (1960a, as *Wardina nodulosa*) and this contribution.

Hosts. Annonaceae: *Guatteria dolichopoda* Donn.Sm., *Guatteria* sp., <u>*Oxandra venezuelana*</u> R.E. Fr. and *Xylopia* sp. *Oxandra* and *Xylopia* are new host genera and *O. venezuelana* is a new host species for *A. nodulosa*.

Known distribution. Neotropical: Central America (Costa Rica, Panama) and South America (Brazil). *A. nodulosa* is a new record for Panama and occurs in Western Panama in lowland galeryforests at approx. 140 m a.s.l.

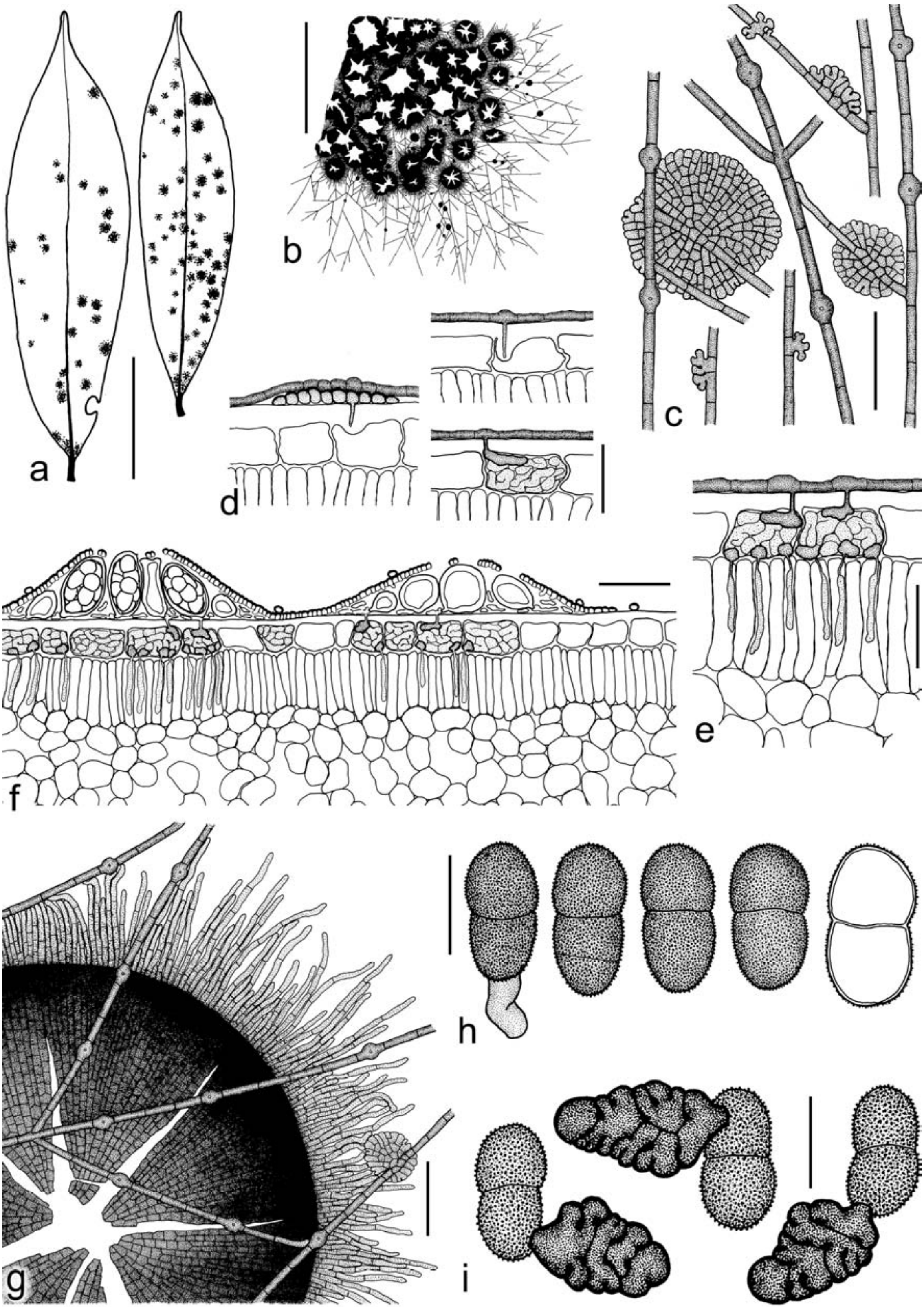

Figure 3.65: ***Asterolibertia nodulosa*** **on** ***Oxandra venezuelana*** **(TH 356). a:** Adaxial side of infected leaves. Scale bar = 3 cm. **b:** Part of the colony with confluent thyriothecia and surface mycelium. Scale bar = 1 mm. **c:** Surface mycelium with intercalary appressoria and ascoma initials. Scale bar = 40 µm. **d:** Different stages of infection of host epidermis. Scale bar = 30 µm. **e:** Advanced infection of host epidermis with single hyphae penetrating the subepidermal layer. Scale bar = 30 µm. **f:** Cross section through a mature and immature thyriothecium and infected epidermis of the host. Scale bar = 50 µm. **g:** Open, immature thyriothecium. Scale bar = 50 µm. **h:** Mature, slightly verrucose ascospores, one of them germinating. Scale bar = 20 µm. **i:** Ascospores germinate with a lobate, multicellular appressorium. Scale bar = 20 µm.

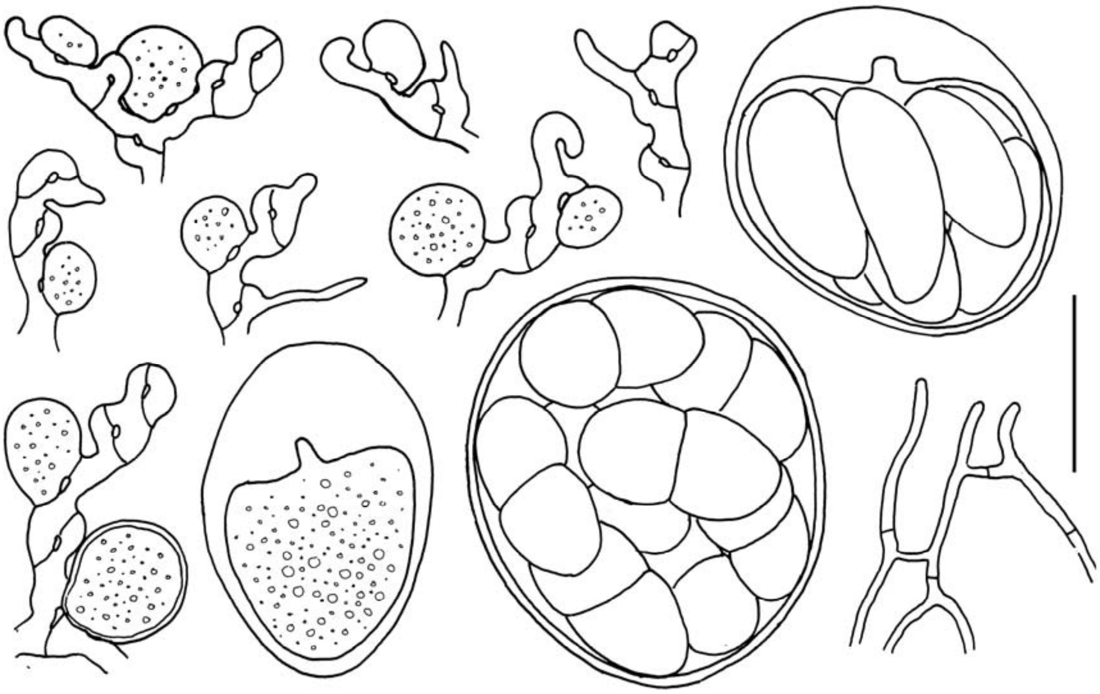

Figure 3.66: Ascogenous hyphae and young asci of *Asterolibertia nodulosa* (TH 356). Globose asci develop on proliferating croziers. Between the ascogenous hyphae and asci grow filamentous hyphae (indicated on the lower right). Scale bar = 20 µm.

Specimens examined. COSTA RICA. Alajuela Province: San Pedro de San Ramon, 2 May 1925, *H. Sydow 683* (BPI 690122, labeled as *Asterina nudulosa*). **BRAZIL. Pernambuco**: Recife, Dois Irmãos, on *Xylopia* sp., 16 Mar. 1960, *O. Soares 18841* (BPI 671071, labeled as *Asterolibertia malpighii*). **PANAMA. Chiriquí Province:** Los Algarrobos, border of Majagua river, ca. 140 m, epiphyllous on *Oxandra venezuelana* (det. T.A. Hofmann), associated with various hyperparasites, 3 Oct. 2005, *T.A. Hofmann et al. 356* (FR; PMA); same locality, host species and associated organisms, 22 Mar. 2006, *T.A. Hofmann, M. Piepenbring & T. Trampe ppMP 482* (M-0141024; PMA); same locality, host species and associated organisms, 11 Jun. 2006, *T.A. Hofmann 465* (FR; PMA); same locality, host species and associated organisms, 21 Jun. 2006, *T.A. Hofmann, R. Mangelsdorff & T. Trampe ppMP 599* (M-0141025; PMA); same locality, host species and associated organisms, 10 Jan. 2007, *T.A. Hofmann, R. Mangelsdorff & T. Trampe ppMP 1203* (M-0141026; PMA); same locality, host species and associated organisms, 8 Sep. 2007, *T.A. Hofmann 528* (PMA).

Notes. *Asterolibertia nodulosa* forms black colonies on the abaxial side of living leaves. It has a rigid surface mycelium with intercalary appressoria penetrateing the cuticle to form a spreading hypostroma within the epidermal layer of the host. The hypostroma is composed of bundles of hyaline to pale brown, intracelluar hyphae sometimes penetrating deeper, subepidermal cells (Fig. 3.65d-f). Extended hypostromata below large colonies can cause the local dying of infected epidermal host cells. Below the surface mycelium develop circular ascomata that early become crowded or confluent and contain rapidly disintegrating asci. The brown ascospores are ornamented and germinate with a muriform, cone-shaped appressorium composed of numerous lobed cells (Figs. 3.65i, 3.67c). Some appressorial cells germinate laterally and initiate a surface mycelium with intercalary appressoria (Fig. 3.67d). The specimens from *Oxandra venezuelana* from Panama are associated with various foliicolous fungi and numerous hyperparasites.

Asterina nodulosa Speg. was described by Spegazzini on *Tabebuja* sp. from Apiahy, Brazil (Spegazzini 1889). Theissen (1912a) examined the type material of *A. nodulosa* from Apiahy and revised the species as heterotypic synonym of *Asterina inaequalis* Mont. (the morphological characteristics of *A. inaequalis* were discussed before under *Asterolibertia licaniicola*). However, one year later Theissen separated *Asterina nodulosa* from *A. inaequalis* as a variety *Asterina inaequalis* var. *nodulosa* Theiss. (Theissen 1913a). Theissen rectified the host plant as *Guatteria* sp. (Annonaceae) and added minor morphologial differences between *A. ineaqualis* and the new variety *A. inaequalis* var. *nodulosa* (Theissen 1913a). Unfortunately, the variety was not recognized by later authors and *A. nodulosa* was still treated a synonym of *A. inaequalis*. Toro (1933) recombined *Asterina inaequalis* into *Asterolibertia inaequalis* (Mont.) Toro on the basis of the type material of *A. inaequalis* collected by Leprieur from French Guiana. Müller and Arx (1962) accepted Toros recombination and cite *Asterina nodulosa* as a synonym of *Asterolibertia inaequalis*, without considering Theissens rectified variety.

Hansford (1949) recombined *Asterina nodulosa* into *Asterolibertia nodulosa*, based on material collected by H. Sydow 1925 on *Guatteria dolichopoda* (*Fungi exotici exiccati 683*) in Costa Rica (labeled as *Asterina nodulosa*). Apparently, Hansford did not examined Spegazzinis type of *Asterina nodulosa* from Apiahy, Brazil. Müller and Arx (1962) cited *Asterolibertia nodulosa* together with *Asterina nodulosa* as synonyms of *Asterolibertia inaequalis*. However, *Asterolibertia inaequalis* differs from *Asterolibertia nodulosa*, by its barrel-shaped appressoria, the larger, compressed and smooth ascospores with 32–40×18–25 µm, and the ascospore germination modus with a stalked, globose and one-celld appressorium.

Unfortunately, I could not observe Spegazzinis type of *Asterina nodulosa* until the end of this study. The type of *A. nodulosa* from Brazil probably contains a fungus that differs from Sydows specimen of *A. nodulosa* from Costa Rica. If this is the case, *Asterolibertia nodulosa sensu* Hansford (1947) is wrong.

Apart from the authors cited above, Batista and Maia (1960a) recombined *Asterina nodulosa* into *Wardina nodulosa* (Speg.) Bat. & H. Maia based on the same material of *A. nodulosa* from Costa Rica (*Fungi exotici exiccati 683*) examined by Hansford 13 years earlier. Batista and Maia, appearantly, did not examined the type species of *A. nodulosa* from Brazil. The genus *Wardina* appears to be articifial due to Müller and Arx (1962) and own suggestions made before concerning the type species *W. myocoproides*.

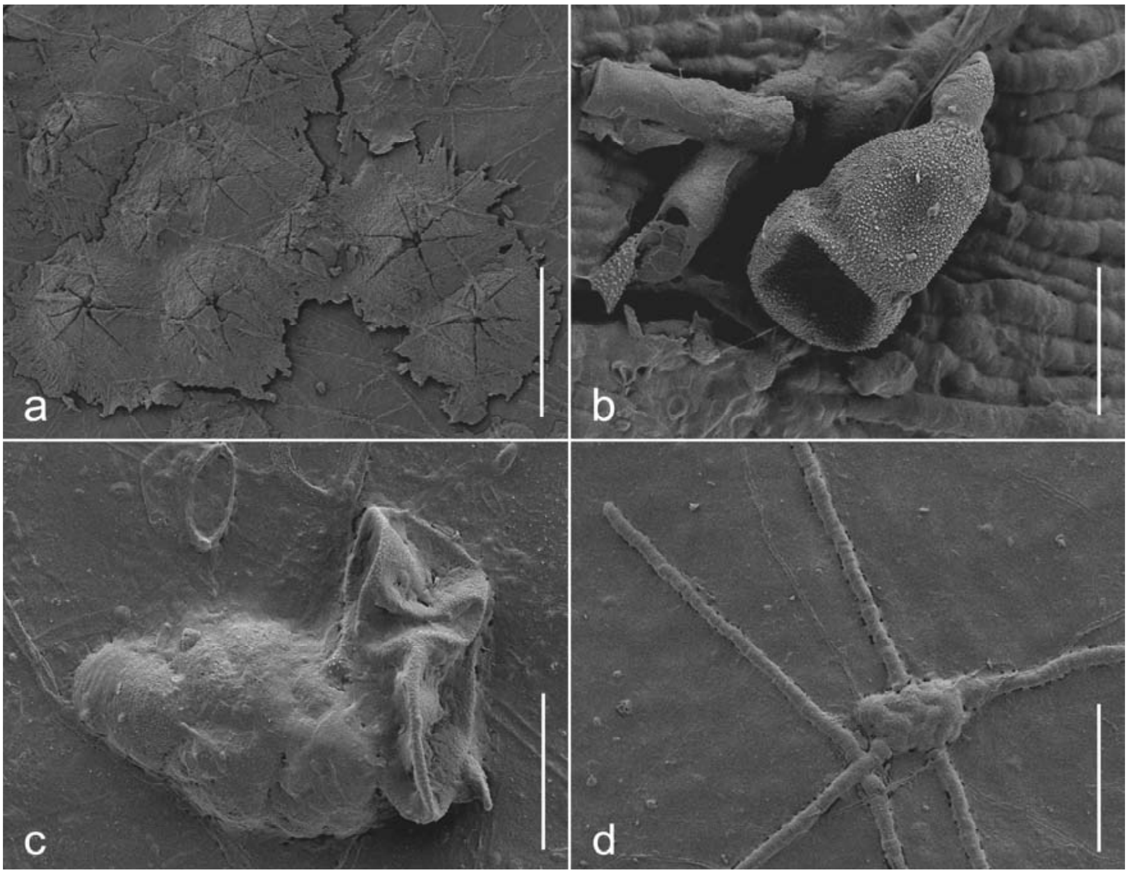

Figure 3.67: SEM photographs of *Asterolibertia nodulosa* on *Oxandra venezuelana* (TH 356). a: Group of confluent thyriothecia with central star-shaped fissures. Scale bar = 300 µm. **b:** Mature, collapsed ascospore. Scale bar = 15 µm. **c:** Collapsed ascospore (right) with primary, lobed appressorium (left). Scale bar = 15 µm. **d:** Lobed appressorium with surface mycelium. Scale bar = 40 µm.

3. *Asterolibertia* sp. on cf. Annonaceae. Figs. 3.68, 3.69, 3.70

Colonies epiphyllous, irregularly circular, single or confluent, 0.5–6 mm diam. (*n*=10), black, conspicuous and dense. *Surface hyphae* straight, rigid, not curved, branching mostly opposite, sometimes alternate or unilateral, brown to dark brown, at tips paler, septate, hyphal cells cylindrical, (10)20–37(44)×(5)6–7(8) µm, cell wall up to 1 µm thick, smooth. *Appressoria* few, intercalary, cylindrical, not swollen, similar to mycelial cells, (21)23–30(34)×(6)7–8(9) µm, penetration pore inconspicuous, up to 1 µm diam., in the center of appressorial cell. *Haustoria* absent, infection hyphae penetrate epidermal host cells. *Hypostroma* present, intraepidermal, composed of bundles of intracellular hyphae, in regular intervals below surface mycelium, intracellular hyphae pale brown to dark brown, septate, irregularly coiled and undulating, cell walls thin, fill single epidermal cells, no infection of neigbouring cells. *Thyriothecia* superficial, develop on lateral sidearms of surface mycelium, circular or slightly elongated, dimidiate, single or slightly confluent, strongly fringed at margins, (210)253–317(350) µm diam., dark brown to black, open with central star-shaped fissures or irregular slits. *Scutellum* radiate, composed of dichotomously branched filaments, scutellum cells isodiametric to cylindrical, straight in center, at margins slightly undulating, (4)5–11(16)×(2)3–5(6) µm at margins up to 50 µm long, dark brown to blackish, at margins paler. *Asci* few, evanescent, globose to ovate, ocular chambers indistinct, bitunicate, I–, (48)49–58(60) µm diam. (*n*=6), 8–spored, hyaline, develop on ascogenous hyphae with proliferating croziers, interascal tissue not observed. *Ascospores* 2– rarely 3–celled, ellipsoidal, straight or slightly curved, ends rounded or slightly acuminate, sometimes slightly tapering to one end, first septum central or in upper third of spore, slightly constricted at first septum, second septum missing or in lower third of ascospore, not constricted at second septum, (35)38–42(43) µm long, upper cell (16)17–20(21) µm wide, lower cell (14)15–17(18) µm wide, verrucose, upper cell often collapses during germination, germinate first at the distal part of the lower cell with a stalked or unstalked, entire appressorium. *Anamorph* absent.

Illustrations. In this contribution.

Hosts. cf. Annonaceae: unknown species.

Known distribution. Neotropical: Central America (Panama). *Asterolibertia* sp. occurs in Western Panama in humid mountain rain forest at approx. 1240 m a.s.l.

Specimen examined. **PANAMA. Chiriquí Province:** Fortuna, ca. 5 km before Lake Fortuna, mountain rain forest, 1240 m a.s.l., epiphyllous on unknown plant (cf. Annonaceae, det. T.A. Hofmann), 19 Feb. 2007, *T. Trampe, T.A. Hofmann & R. Mangelsdorff ppMP 1323* (M-0141027, PMA).

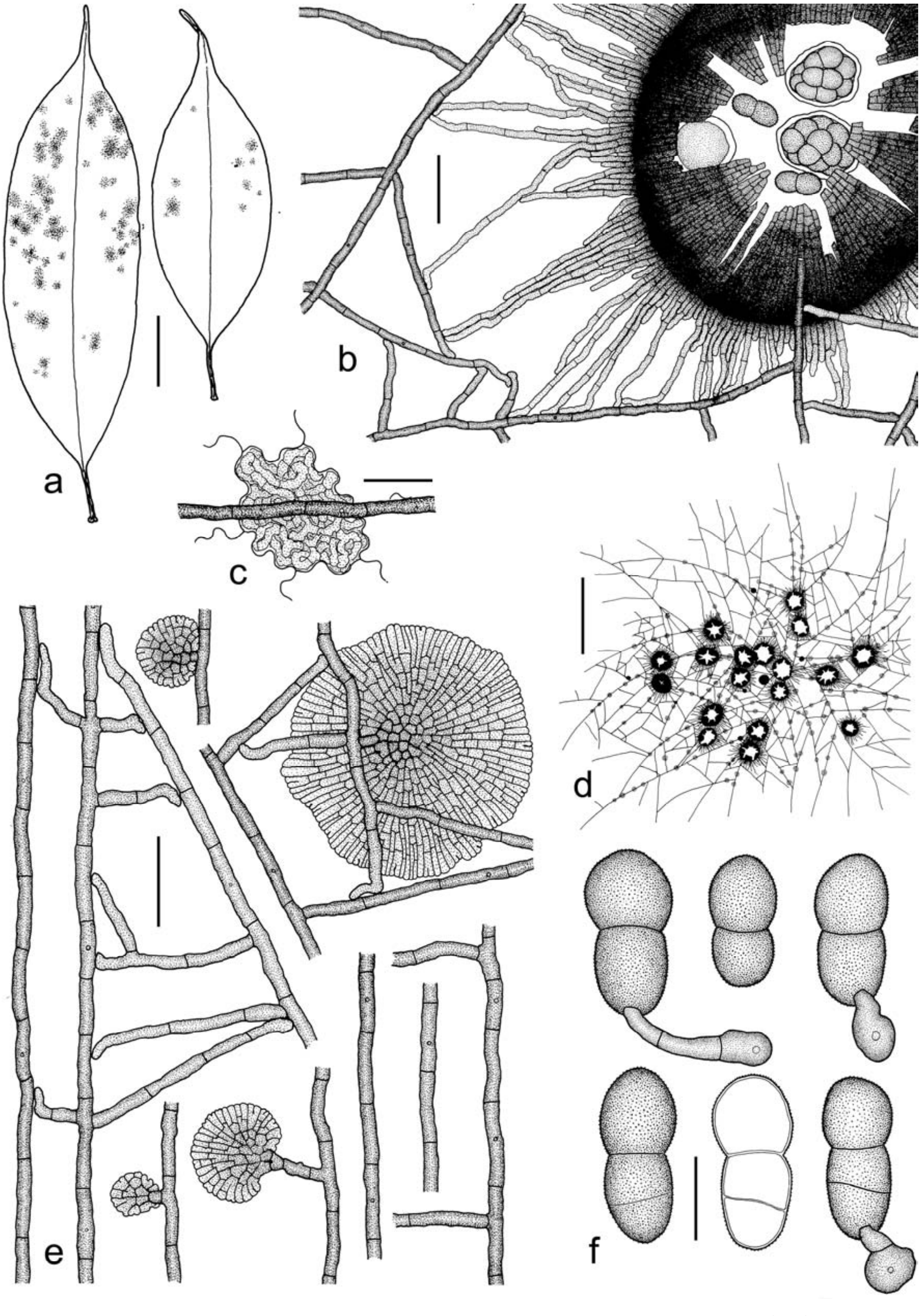

Figure 3.68: *Asterolibertia* sp. on unknown plant (ppMP 1323). a: Adaxial side of infected leaves. Scale bar = 2 cm. **b:** Open thyriothecium and mature and immature asci and liberated ascospores. Scale bar = 50 µm. **c:** Intracellullar hyphae within epidermal host cell. Scale bar = 30 µm. **d:** Part of the colony with thyriothecia and surface mycelium. Small circles indicate infected epidermal parts. Scale bar = 1 cm. **e:** Surface mycelium with intercalary appressoria and ascoma initials. Scale bar = 40 µm. **f:** Mature ascospores, some of them germinating. Scale bar = 20 µm.

Notes. *Asterolibertia* sp. occurs on a young woody plant with simple, alternate leaves, probably representing a species of Annonaceae. The plant lacks fertile structures as well as other conspicuous vegetative characteristics. *Asterolibertia* sp. is characterized by intercalary appressoria almost indistinguishable from the cells of the surface mycelium (Fig. 3.68e). The appressoria can be recognized by the small central penetration pore and the subjacent hypostroma formed inside the host epidermis. The hypostroma is restricted to a single epidermal host cell and consists of bundles of coiled and slightly pigmented hyphae (Fig. 3.68c). Under the light microscope in low magnification the darkly appearing hypostromata are arranged in regular intervals below the surface hyphae and resemble ‘pearls on a string’ (Fig. 3.68d).

Most of the *Asterolibertia* species are characterized by distinct, swollen intercalary appressoria with exception of four species, *A. crustacea* (Ellis & Everh.) Hansford on *Psidium guajava* (Myrtaceae) from San Domingo (Hansford 1954a), *A. cryptocaryae* (Cooke) Hansf. on *Cryptocarya meissneri* (Lauraceae) from Australia (Hansford 1955), *A. peruviana* Hansf. on a Bignoniaceae from Brazil (Hansford 1955) and *A. thaxteri* Hansf. on an unknown plant from Grenada, Lesser Antilles (Hansford 1957). Besides the different host preferences of the four species, they differ from *Asterolibertia* sp. from Panama in numerous morphological aspects. *A. crustacea* and *A. cryptocaryae* both do not form hypostromata but haustoria in single epidermal host cells and have smaller and smooth ascospores (Hansford 1954a, 1955). *A. peruviana* has smaller and smooth ascospores measuring 17×8 µm (Hansford 1955). And *A. thaxteri* has larger ascospores by 50–55×21–24 µm (Hansford 1957).

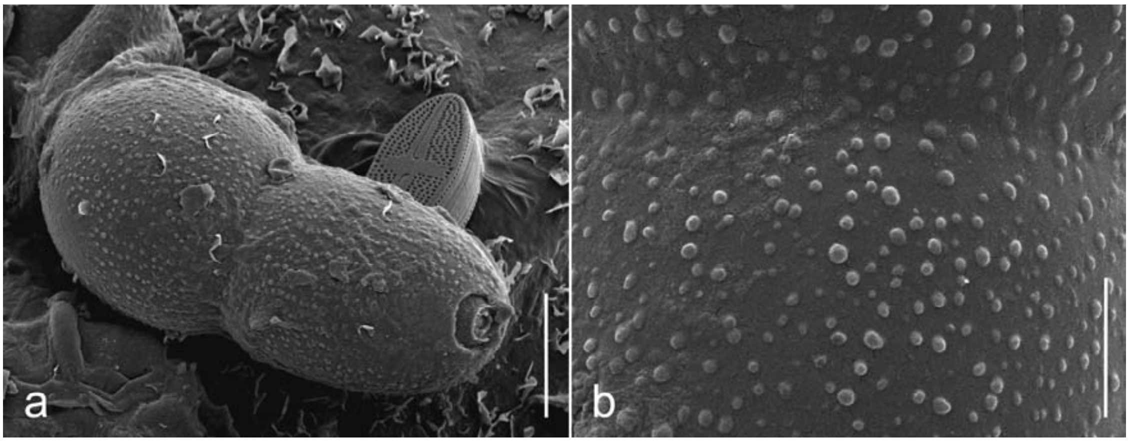

Figure 3.69: SEM photographs of *Asterolibertia* sp. on cf. Annonaceae (ppMP 1323). a: Mature, verrucose ascospore with broken germtube. Scale bar = 10 µm. **b:** Ascospore ornamentation. Scale bar = 3 µm.

Similar to *Asterolibertia* spp., where inconspicuous intercalary appressoria probably have been overlooked, are species from the genera *Asterinella* and *Prillieuxina*. *Asterinella* is characterized by a brown surface mycelium without of hyphopodia. In contrast to *Asterolibertia* spp., members of *Asterinella* have elongated cylindrical asci developing inclined towards the center of the ascoma and, therefore, they belong to the Microthyriaceae. However, it is possible that some described *Asterinella* spp. represent misidentified species of *Asterolibertia*. The species-rich genus *Asterinella* is in great need of revision and includes probably misidentified taxa belonging to *Asterolibertia*, *Prillieuxina*, *Microthyrium* and other genera of thyriothecioid ascomycetes. Similar to *Asterinella*, the genus *Prillieuxina* forms surface mycelia without appressoria. *Prillieuxina* ssp., however, develop different host infection strategies like expanded hypostromata, intercellular hyphae or penetration of the host stomata.

Asterolibertia sp. differs in some aspects from all hitherto described *Asterolibertia* spp. with inconspicuous appressoria and remains an uncertain species until the host plant can be identified properly.

As seen by transmission electron microscopy, the walls of the ascospores of *Asterolibertia* sp. contain simple, dark warts that develop on top of the exospore wall (Fig. 3.70).

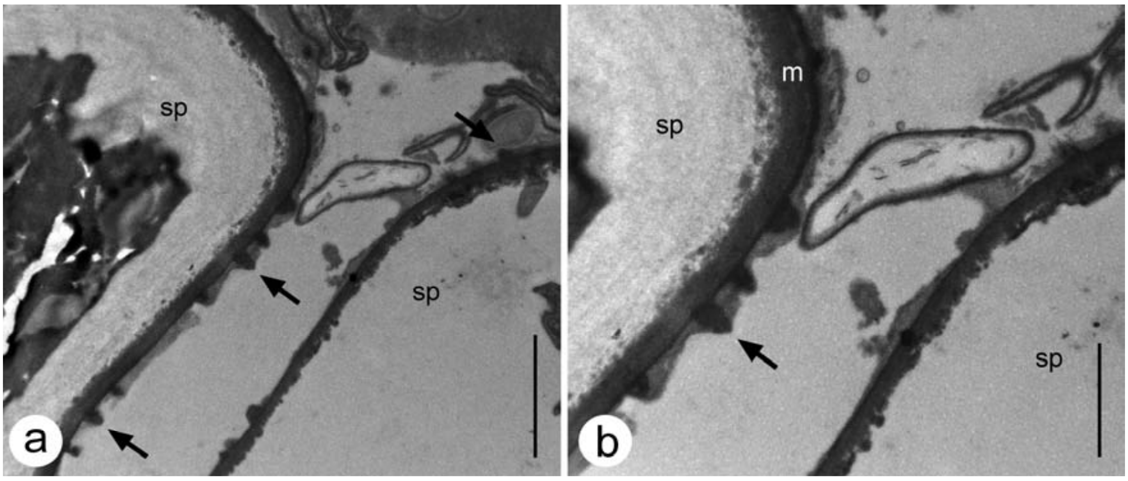

Figure 3.70: Ultrastructure of the ornamentation of ascospores of *Asterolibertia* sp. on cf. Annonaceae. a-b: Warty ornamentation of ascospores (sp) is indicated with arrows, ascospore walls are melanised (m). **a:** Scale bar = 2 µm. **b:** Scale bar = 1 µm.

Asterostomella Speg.

Anal. Soc. cient. argent. 22: 198 (1886)

Type species: *A. paraquayensis* Speg.

Teleomorph: *Asterina* Lév.

Colonies superficial on living leaves, black. *Surface mycelium* septate, branched, brown. *Appressoria* lateral, entire or lobed, unstalked or stalked, with a penetration pore. *Haustoria* arbuscular, intracellular in epidermal cells, sometimes inconspicuous. *Pycnothyria* superficial, dimidate, circular, dark, develop below surface mycelium, open with central star-shaped fissures. *Scutellum* radiate, composed of rows of syncronal and dichotomously branching cells forming a continuous plate of cells, one cell layer thick, cells isodiametrical or cylindrical, straight. *Conidiogenous cells* monoblastic, formed inside the pycnothyrial cavity by single cells of the inner part of the scutellum layer. *Conidia* 1-celled, ovate, ellipsoidal or pyrifom, broadly rounded apex, truncate hilum, brown when mature, with or without central hyaline bands.

Teleomorph present or absent, *Asterina*-like.

Notes: The genus *Asterostomella* represents the anamorphic stage of the genus *Asterina*. From the literature, numerous *Asterostomella* spp. are reported either together with the respective *Asterina*-teleomorph or without it (Appendix, Table 7.4). The connection between *Asterostomella* and *Asterina* was observed *in planta* but cultural trails to prove this connection experimentally have not been done yet (Sivanesan 1984).

Asterostomella is closely related to the genus *Mahanteshamyces* which differs only by the more angular shape of its conidia (Hosagoudar 2004). The genus concept of *Mahanteshamyces* is probably artificial and it should be considered to unite the genus with *Asterostomella* (Hofmann and Piepenbring 2008). *Asterostomella* spp. can be confused with species of *Capnodiastrum* which form similar appressoriate surface mycelia and brown, clavate conidia. However, *Capnodiastrum* spp. have typically spherical conidiomata and the related teleomorphs are species of *Rhytidenglerula* (Englerulaceae, Müller and Arx 1962).

The genus *Asterostomella* includes 80 species parasitizing on host plants from 40 different plant families with a tropical distribution. About 20 *Asterostomella* species are known to be associated with a validly described *Asterina* teleomorph and 60 species were described without a known teleomorphic stage. In Panama, numerous *Asterostomella* spp. occur with their respective teleomorph and were described and illustrated in this study, e.g. *Asterostomella* stages of *Asterina davillae*, *Asterina gaiadendricola* and *Asterina radiofissilis*, *Asterostomella stipitipodia* together with *Asterina stipitipodia* and *Asterostomella tonduzii* together with *Asterina tonduzii*. One species of *Asterostomella* was collected in Panama without a known teleomorph and is presented below.

Asterostomella dilleniicola **M.L. Farr, Mycologia 78(2): 271 (1986).**

Figs. 3.71, 3.72

Type on unknown Dilleniaceae (cf. *Doliocarpus* sp.). Brazil, Amazonas, Manaus, INPA grounds, 4 Jan. 1978, *M.L. Farr AM-28(3)* (holotype, NY n.v.; isotype, BPI 391479 A!).

Colonies epiphyllous, irregularly circular in outline, single, rarely confluent, 1–4 mm diam., black. *Surface hyphae* strongly undulating, branching unilateral, alternate or opposite, brown, at tips paler, septate, hyphal cells cylindrical, (10)15–25(29)×4–5 µm, cell wall up to 1 µm thick, smooth. *Appressoria* numerous, irregularly circular, ovate or ellipsoidal, entire, slightly sinuate or with 1–3 lobes, sessile or sometimes stalked, rarely with additional cylindrical stalk cell, unilateral or alternate, straight or slightly hooked, (7)8–11(13)×6–9(12) µm, dark brown, darker than hyphae, penetration peg inconspicuous, up to 1 µm diam., in the center or apical part of the appressorial cell. *Haustoria* inconspicuous. *Pycnothyria* superficial, develop below surface mycelium, circular, single or confluent, slightly fringed at margins, (50)53–69(80) µm diam., dark brown to blackish, open with central fissures or by irregular dehiscence of central scutellum cells. *Scutellum* radiate, composed of dichotomously branched filaments, scutellum cells isodiametric to cylindrical, straight in center, undulating at margin of ascoma, (3)4–6(7)×3–5(6) µm, at margins becoming longer, dark brown, at margins paler. *Conidiogenous cells* monoblastic, formed inside the pycnothyrial cavity by single cells of the inner part of the scutellum layer. *Conidia* numerous, 1–celled, broadly clavate, pyriform or ellipsoidal, sometimes slightly curved, with a basal truncate hilum, (18)19–22(23)×(9)10–12 µm, brown, with central hyaline band, conidiogenous loci paler, smooth, germinate first at the region of the hyaline band with a stalked appressorium, appressorial cell slightly darker than the stalk cell and the conidium.

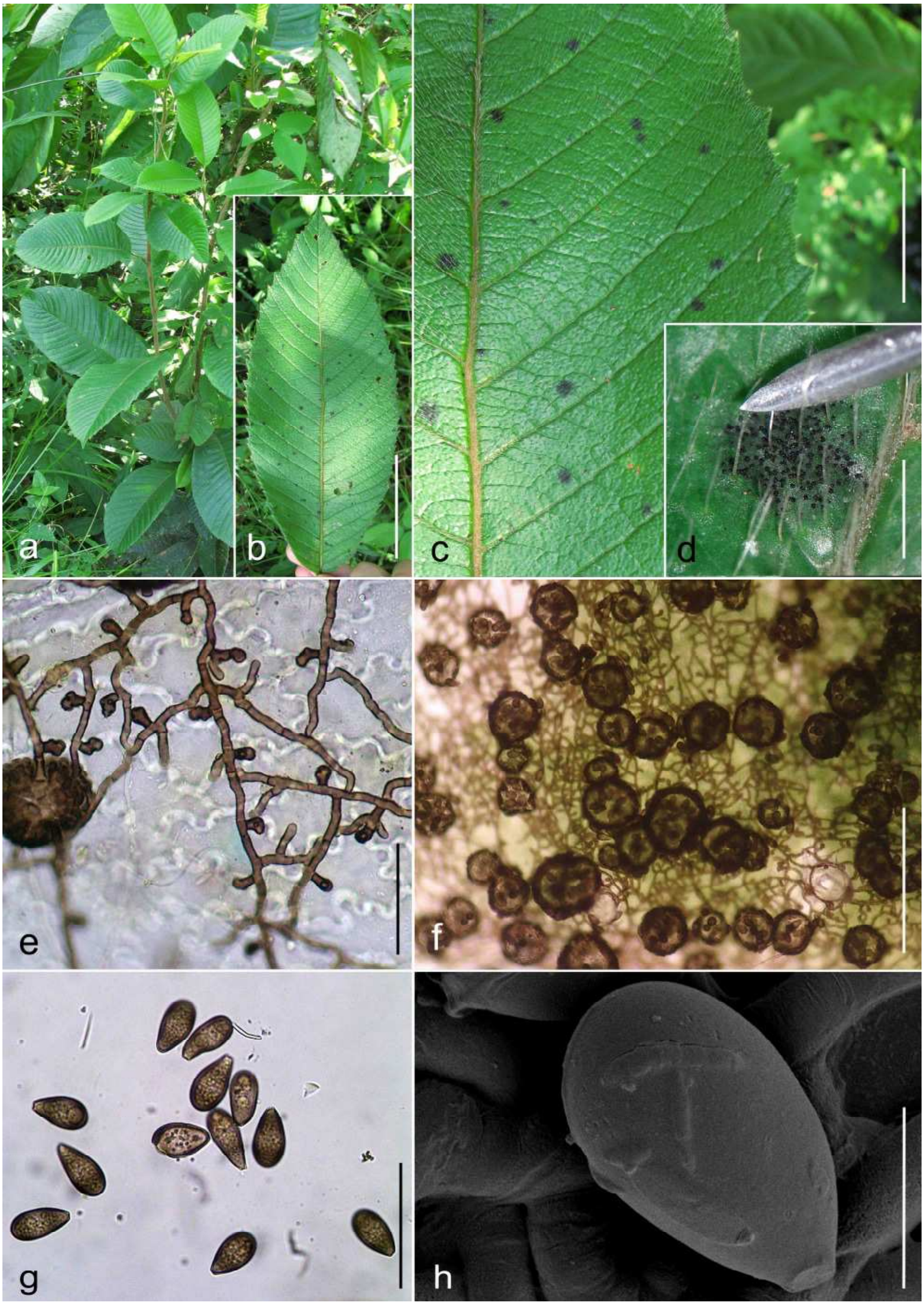

Figure 3.71: ***Asterostomella dillenicola* on *Davilla kunthii* (TH 525). a:** Host plant. **b:** Infected leaf with several, black colonies. Scale bar = 5 cm. **c:** Part of infected leaf. Scale bar = 1.5 µm. **d:** Single colony and tip of a hollow needle. Scale bar = 1.5 mm. **e:** Surface mycelium with lateral appressoria and sporoma initial (left). Scale bar = 50 µm. **f:** Mature, open pycnothyria and surface mycelium. Scale bar = 200 µm. **g:** Mass of mature conidia. Scale bar = 50 µm. **h:** SEM photograph of mature conidium with truncate hilum. Scale bar = 10 µm.

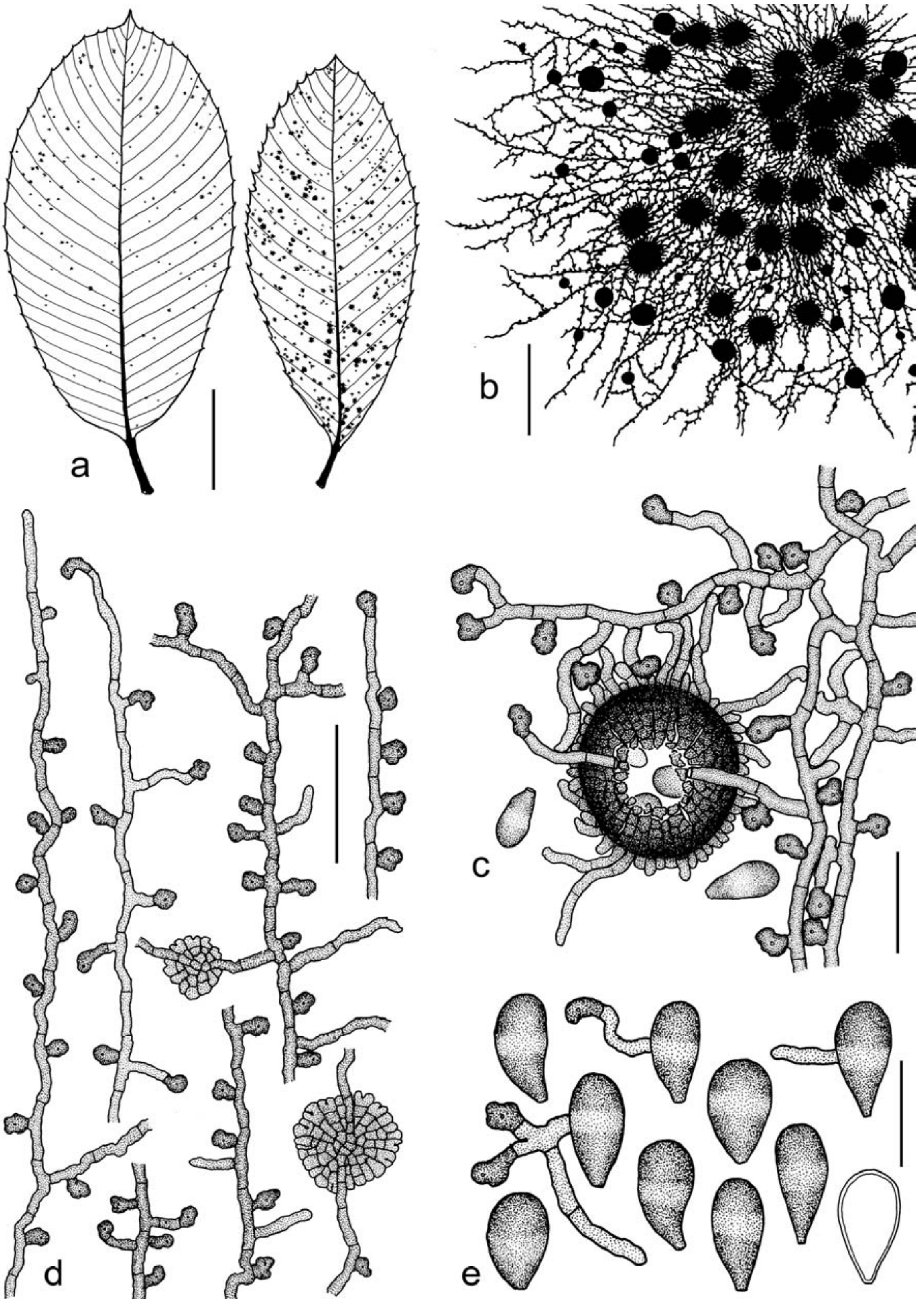

Figure 3.72: ***Asterostomella dilleniicola*** **on** ***Davilla kunthii*** **(TH 496-A). a:** Adaxial side of infected leaves. Scale bar = 4 cm. **b:** Part of the colony with pycnothyria and surface mycelium. Scale bar = 200 µm. **c:** Open pycnothyrium with liberated conidia. Scale bar = 30 µm. **d:** Surface mycelium with lobed appressoria and sporoma initials. Scale bar = 40 µm. **e:** Mature conidia with central hyaline band, some of them are germinating. Scale bar = 20 µm.

Illustrations. In Farr (1986) and this contribution.

Hosts. Dilleniaceae: *Davilla kunthii* A. St.-Hil. and an unknown Dilleniaceae (cf. *Doliocarpus* sp.). *D. kunthii* is a new host genus and species of *A. dilleniicola*.

Known distribution. Neotropical: Central America (Panama) and South America (Brazil). *A. dilleniicola* is a new record for Central America and Panama and occurs in Western Panama in disturbed lowland forests and galleryforests at approx. 140 m a.s.l.

Specimens examined: **BRAZIL. Amazonas:** isotype, see above. — Roraima Territory, along the Manaus-Boa Vista Rd. Br 174, at a point ca. 240 km, from the Intersection of Manuas-Itacoatiara Rd. Celestine, epiphyllous on unknown Dilleniaceae, 8 Dec. 1977, *K.P. Dumont, D.R. Hosford, G.J. Samuels, W.R. Buck, I. Araujo, M.A. Souza & J.C. Bernardi BR-961* (BPI 391478A, paratype). **PANAMA. Chiriquí Province:** Los Algarrobos, path to Majagua river, ca. 140 m a.s.l., epiphyllous on *Davilla kunthii* (det. T.A. Hofmann), associated with hypophyllous *Asterina stipitipodia*, 17 Apr. 2006, *T.A. Hofmann 424-A* (PMA); same locality, host plant species and associated organisms, 21 Mar. 2006, *T.A. Hofmann, M. Piepenbring & T. Trampe ppMP 470-A* (M-0141028; PMA); same locality, host plant species and associated organisms, 21 Jun. 2006, *T.A. Hofmann, R. Mangelsdorff & T. Trampe ppMP 583-A* (M-0141029; PMA); same locality, host plant species and associated organisms, 8 Sep. 2007, *T.A. Hofmann 525* (FR; PMA). — Los Algarrobos, border of Majagua river, ca. 140 m a.s.l., epiphyllous on *Davilla kunthii* (det. T.A. Hofmann), associated with hypophyllous *Asterina stipitipodia*, 22 Mar. 2006, *M. Piepenbring, T.A. Hofmann & T. Trampe ppMP 738-A* (M-0141030; PMA). — Los Algarrobos, path to Lajas river and El Salto cascade, ca. 140 m a.s.l., epiphyllous on *Davilla kunthii* (det. T.A. Hofmann), associated with hypophyllous *Asterina stipitipodia*, 7 Jan. 2007, *T.A. Hofmann 496-A* (FR; PMA).

Notes: Farr (1986) describes *Asterostomella dilleniicola* on an unknown Dilleniaceae from Brazil and compares it with other *Asterostomella*-stages known from dilleniaceous hosts. *A. dilleniicola* grows epiphyllous and does not form a related teleomorphic stage (Farr 1986). The unknown host plant from Brazil as well as *Davilla kunthii* from Panama contain a second species of *Asterostomella* on the lower leaf surface together with a teleomorphic *Asterina*-stage. Farr recognizes this fungus and publishes the species one year later as *Asterostomella stipitipodia* with the respective teleomorph *Asterina stipitipodia* (Farr 1987). *Asterostomella stipitipodia* and its teleomorph are morphologically different from *A. dilleniicola* and were described and illustrated before.

Cirsosia G. Arnaud

Ann. École Nat. Agric. Montp., Sér. 2, 16: 127 (1918)

= *Cirsosiella* G. Arnaud, Ann. Ècole Nat. Agric. Montpellier, Sér. 2, 16: 127 (1918). Type: *C. globulifera* (Pat.) G. Arnaud

= *Lembopodia* Bat., IMUR 291: 6 (1960). Type: *L. conspicua* Bat. & H. Maia

= *Morqueria* Bat. & H. Maia, in Batista et al., IMUR 229: 15 (1962). Type: *M. prinoides* (Tracy & Earle) Bat. & H. Maia

[synonymy partially according to Arx and Müller (1975)]

Type species: *Cirsosia manaosensis* (Henn.) G. Arnaud. [as '*manaoensis*']

Anamorph: *Homalopeltis* Bat. & Valle, IMUR 337: 5 (1961). **(new anamorph-teleomorph connection, see also discussion of *Cirsosia splendens* below).**

Colonies superficial on living leaves, black. *Surface mycelium* septate, branched, brown. *Appressoria* intercalary, swollen and node-like or not swollen, with central penetration pore, forming haustoria in epidermal host cells. *Haustoria* arbuscular, intracellular in epidermal host cells. *Thyriothecia* superficial, dimidate, linear, L–, Y– or X–shaped, dark, develop below surface mycelium, open with central longitudinal slits. *Scutellum* radiate, composed of rows of syncronal and dichotomously branching cells forming a continuous plate of cells, one cell layer thick, cells isodiametrical or cylindrical, straight. *Asci* globose to ovate, shortly stalked, bitunicate, 4–8–spored, hyaline, vertical within ascoma, interascal tissue present or absent, filamentous, disintegrates early. *Ascospores* 2–celled, ellipsoidal, brown when mature.

Anamorph Homalopeltis-like, present or not, sometimes dominating the teleomorph or without teleomorph. *Pycnothyria* superficial, circular, dimidate, dark, develop below surface mycelium, open with central ostiole. *Scutellum* similar to the one of the teleomorph. *Conidiogenous cells* monoblastic, formed inside the pycnothyrial cavity by single cells of the inner part of the scutellum layer. *Conidia* 2–celled, ellipsoidal, cylindrical, elongated, with truncate hilum on lower cell, brown when mature.

Notes. *Cirsosia* was described by Arnaud (1918) with the type species *C. manaosensis* on a Malpighiaceae from Brazil. In the same year and publication, Arnaud (1918) described the genus *Cirsosiella* with *C. globulifera* on *Calamus* sp. (Arecaceae) from Vietnam, differing from *Cirsosia* spp. by the absence of pseudoparaphyses. According to Müller and Arx (1962), this segragation was not justified and the genus *Cirsosiella* was placed in synonymy with *Cirsosia*. Batista and Maia (1960d) introduced the genus *Cirsosina* with the type species *C. rhododendri* Bat. & J.L. Bezerra on *Rhododendron ponticum* L. (Ericaceae). Accoring to the authors, *Cirsosina rhododendri* differed from species of *Cirsosia* by the absence of pseudoparaphyses (Batista and Maia 1960b) just like it was stated for the type species of the subsequently synonymized genus *Cirsosiella*. Following Müller and Arx (1962) the genus *Cirsosina* should be treated as a synonym of *Cirsosia*. Unfortunately, the type material of *Cirsosina rhododendri* could not be consulted until the end of this study.

Species of the genus *Cirsosia* are very similar to *Asterolibertia* spp. because they form surface mycelia with intercalary appressoria and two-celled brown ascospores. But *Cirsosia* spp. are characterized by elongated ascomata, whereas species of *Asterolibertia* form circular ascomata. However, transitions to ovate or slightly elongated ascocarps exist in some species of *Asterolibertia*. It should be considered, that *Cirsosia* and *Asterolibertia* are probably congeneric and a revision of both genera is urgently needed.

Today, *Cirsosia* includes 12 species distributed worldwide in tropical or suptropical regions on host plant species belonging to 5 plant families. In Panama, one species of *Cirsosia* was collected and is described and illustrated below.

Cirsosia splendida **Bat. & H. Maia, Rev. Biol. 2(2): 125 (1960).**

Figs. 3.73, 3.74, 3.75

Type on *Hirtella americana* (Chrysobalanaceae). Brazil, Pernambuco, Recife, *R.M. Rocha Batista s.n.* (holotype, URM 2990 n.v.).

Anamorph: *Homalopeltis chrysobalani* (Henn.) Bat. & Valle, IMUR 337: 6 (1961).
(new anamorph - teleomorph connection)

Type on *Chrysobalanus icaco* L. (Chrysobalanaceae). Brazil, Pará, Belém, Botanical Garden Goeldi, 20 Jan. 1908, *C.F. Baker 244* (syntypes, B n.v., HBG n.v., MG 20408 n.v., BPI 391611!, S F40793 n.v., labeled as *Leptothyrella chrysobalani*)

≡ *Leptothyrella chrysobalani* Henn., Hedwigia 48: 114 (1908).

[synonymy according to Batista and Valle (1961)]

= *Leprieurina radiata* Toro, Journ. Dept. Agric. Porto Rico 5: 16 (1926). Type on *Chrysobalanus icaco* L. (Chrysobalanaceae). Puerto Rico. Loíza, 16 Nov. 1925, *R.A. Toro 428* (type, BPI 391581). **syn. nov.**

Colonies amphigenous, irregularly circular, single, later becoming confluent, 0.5–4 mm (*n*=10), conspicuous and dense on *Chrysobalanus icaco* leaves, often covering large parts of the leaves, very inconspicuous and discrete on *Hirtella triandra* leaves, black. *Surface hyphae* straight to undulating, branching mostly opposite, sometimes unilateral or alternate, brown to dark brown, at tips paler, septate, hyphal cells cylindrical, (5)11–22(32)×(2.5)3–5(5.5) µm, cell wall 0.5 µm thick, smooth. *Appressoria* numerous, intercalary, cylindrical cell with a slightly swollen middle part, swollen part mostly on one side of the hyphae, (8.5)10–13(15)×(4)5–6(7.5) µm (*n*=60), penetration pore up to 1 µm diam., in the center of the swollen part of the appressorium. *Haustoria* ellipsoidal, saucer-shaped, reniform or U–shaped, arbuscular, (11)12–16(17)×5–6 µm (*n*=10), hyaline, filling up to 1/5 of the host cell. *Thyriothecia* superficial, develop below surface mycelium, elongated, L–, Y– or X–shaped, dimidiate, single or confluent, fringed at margins, (150)227–544(600)×(110)135–368(500) µm (*n*=27), brown to dark brown, open with central longitudinal slits. *Scutellum* radiate, composed of dichotomously branched filaments, scutellum cells isodiametric to cylindrical, straight in center, undulating at margins of ascoma, (3)4–7(10)×2–5(6) µm (*n*=60), brown to dark brown, at tips paler. *Asci* numerous, globose to broadly clavate, or ovate, with ocular chambers, bitunicate, ascus walls I+, 22–27(28) µm diam. (*n*=9), 8–spored, develop on ascogenous hyphae with proliferating croziers, interascal tissue not observed. *Ascospores* few, 2–celled, ellipsoidal, elongated, straight or slightly bent, ends broadly rounded, lower cell sometimes acuminate and tapered to one end, septum in upper third of spore, constricted at septum, 18–21(22) µm long (*n*=11), upper cell 7–9(10) µm wide, lower cell (6)7–8 µm wide, pale brown to brown, cell wall up to 1 µm thick, slightly verrucose, germinating ascospores not observed.

Anamorph present, = *Homalopeltis chrysobalani* (Henn.) Bat. & Valle. *Pycnothyria* numerous, superficial, developing below surface mycelium, circular, dimidiate, single or confluent, fringed at margins, (70)102–188(260) µm diam. (*n*=60), brown to dark brown, with a central ostiole, (6)7–9(10) µm diam. (*n*=40). *Conidiogenous cells* monoblastic, formed inside the pycnothyrial cavity by single cells of the inner part of the scutelum layer. *Conidia* very numerous, first 1–celled, later become 2–celled, ellipsoidal, elongated, upper end rounded or acuminate, lower end with truncate hilum, septum develops central or in upper third of mature conidium, not constricted at septum, with truncate hilum, (19)21–24(25)×4–7(8) µm (*n*=60), first hyaline, later pale to dark brown when fully mature, smooth, hilum of hyaline conidia sometimes with mucuous droplet, development of septum and pigmentation not until spore discharge, germinate first at distal part of upper cell with a stalked simple appressorium, lower cell collapses during germination, after successful penetration of host by first appressorium upper cell forms endohyphae through collapsed lower cell to initiate growth of appressoriate surface mycelium.

Illustrations. teleomorph: In Batista and Maia (1960b) and this contribution. **anamoph:** In Toro (1926 as *Leprieurina radiata*), Batista and Valle (1961) and this contribution. The surface composition of ascomata, pycnidia, conidia and the ornamentation of the ascospores are illustrated here for the first time (Fig. 3.75).

Hosts (teleomorph and anamorph). Chrysobalanaceae: *Chrysobalanus icaco* L., *Hirtella americana* L. and *H. triandra* Sw. *C. icaco* and *H. triandra* are new host species of *C. splendida.* For *H. chrysobalani*, *Hirtella* is a new host genus and *H. americana* and *H. triandra* are new host species.

Known distribution. teleomorph: Neotropical: Central America (Panama) and South America (Brazil). **anamorph:** Neotropical: Caribbean (Puerto Rico), Central America (Panama), North America (USA, Florida), and South America (Brazil). *C. splendida* with its anamorph *H. chrysobalani* are new records for Central America and Panama. Both anamorph and teleomorph occur in Western Panama on the pacific coast, from 0 to about 5 m a.s.l., and in lowland forests at ca. 150 m a.s.l.

Specimens examined (teleomorph and anamorph): **BRAZIL. Pará:** syntype of *H. chrysobalani*, see above; same locality and host plant, 15 Apr. 1908, *C.F. Baker 244* (BPI 391607, BPI 391609, BPI 391610, BPI 391612, labelled as *Leptothyrella chrysobalani*); same locality and host plant, Apr., *C.F. Baker, comm. H. Rehm* (BPI 391605, BPI 391608, labeled as *Leptothyrella chrysobalani*). **PANAMA. Chiriquí Province:** La Barqueta, pacific coast, ca. 5 m a.s.l., amphigenous on *Chrysobalanus icaco* (det. M. Piepenbring); 19 Feb. 2003, *M. Piepenbring & R. Kirschner 3175* (PMA); same locality and host plant, associated epiphyllous with a parasitic algae *Cephaleuros* cf. *tumidae-setae* (Trentepohliales), epiphyllous *Plochmopeltis* sp. (Schizothyriaceae) and hypophyllous *Halbanina* sp. nov. (Asterinaceae) and other Micropeltidaceae, 18 Oct. 2005, *T.A. Hofmann, M. Piepenbring & R. Mangelsdorff ppMP 422* (M-0141050; PMA); same locality, host species and associated organisms, 13 Apr. 2006, *T.A. Hofmann, M. Piepenbring & T. Trampe ppMP 571* (M-0141051; PMA); same locality, host species and associated organisms, 11 Jul. 2006, *T.A. Hofmann, R. Mangelsdorff & T. Trampe ppMP 1145* (M-0141052; PMA); same locality, host species and associated organisms, 22 Jan. 2007, *T.A. Hofmann, R. Mangelsdorff & T. Trampe ppMP 1264* (M-0141053; PMA); same locality, host species and associated organisms, 6 Sep. 2007, *T.A. Hofmann 516* (FR; PMA); same locality, host species and associated organisms, 31 Oct. 2007, *T.A. Hofmann 604* (PMA); Los Algarrobos, border of Majagua river, ca. 140 m a.s.l. amphigenous on *Hirtella triandra* (det. T.A. Hofmann), associated amphigenous with Micropeltidaceae, 21 Jun. 2006, *T.A. Hofmann, R. Mangelsdorff & T. Trampe ppMP 589* (M-0141054; PMA); same locality, host plant and associated organisms, 10 Jan. 2007, *T.A. Hofmann, R. Mangelsdorff & T. Trampe ppMP 1207* (M-0141055; PMA). **PUERTO RICO. Arecibo:** Arecibo & Lores Road, on *Hirtella triandra*, 21 Jun. 1915, *F.L. Stevens 7303* (BPI 689911, BPI 689917, labeled as *Asterina inaequalis* var. *nodulosa*). **Guanajibo:** on *Chrysobalanus icaco*, 19 Jun. 1915, *F.L. Stevens 7203* (BPI 690403, labeled as *Asterina schroeteri*). **Las Piedras:** on *Chrysobalanus icaco*, 12 Aug. 1915, *F.L. Stevens 9323* (BPI 690405, labeled as *Asterina schroeteri*). **Loíza:** type of *Leprieurina radiata* Toro, see above. **Mayagüez:** on *Chrysobalanus icaco*, 29 Jun. 1915, *F.L. Stevens 7413* (BPI 690401, BPI 690404, labeled as *Asterina schroeteri*). **USA. Florida:** Miami, intercepted at Miami 004783 Florida, 11 Jul. 1973, *M. Kuck* (BPI 391606, labeled as *Asterina schroeteri*).

Notes. *C. splendida* is characterized by a fine surface mycelium with relatively inconspicuous intercalary appressoria forming saucer-shaped haustoria in single epidermal cells. The fungus forms elongated ascomata opening with central slits or fissures and contains ornamented ascospores with the septum in the upper third of the spore (Batista and Maia 1960b). The teleomorph grows intermixed with smaller, circular pycnothyria that represent the anamorphic stage of *C. splendida* (Batista and Maia 1960b).

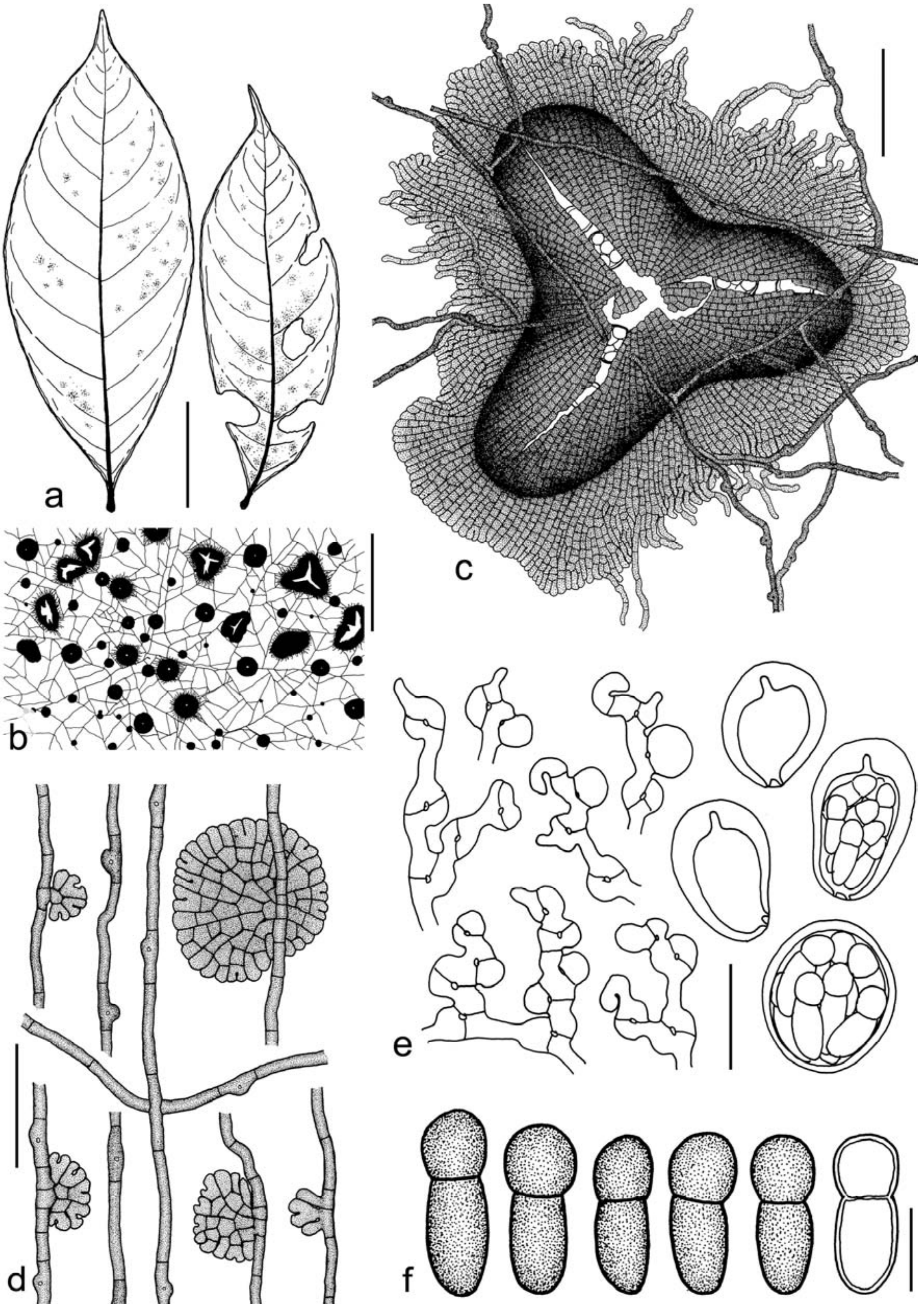

Figure 3.73: ***Cirsosia splendida*** **on** ***Hirtella triandra*** **(ppMP 1207). a:** Infected leaves of *Hirtella triandra*. Scale bar = 2.5 cm. **b:** Part of the colony with elongated thyriothecia, circular pycnothyria and surface mycelium. Scale bar = 600 µm. **c:** Y-shaped ascoma with central slits and surface mycelium. Scale bar = 50 µm. **d:** Surface mycelium with intercalary appressoria and ascoma initials. Scale bar = 30µm. **e:** Young asci develop on ascogenous hyphae with proliferating croziers. Scale bar = 20 µm. **f:** Mature ascospores, ornamentation not shown. Scale bar = 10 µm.

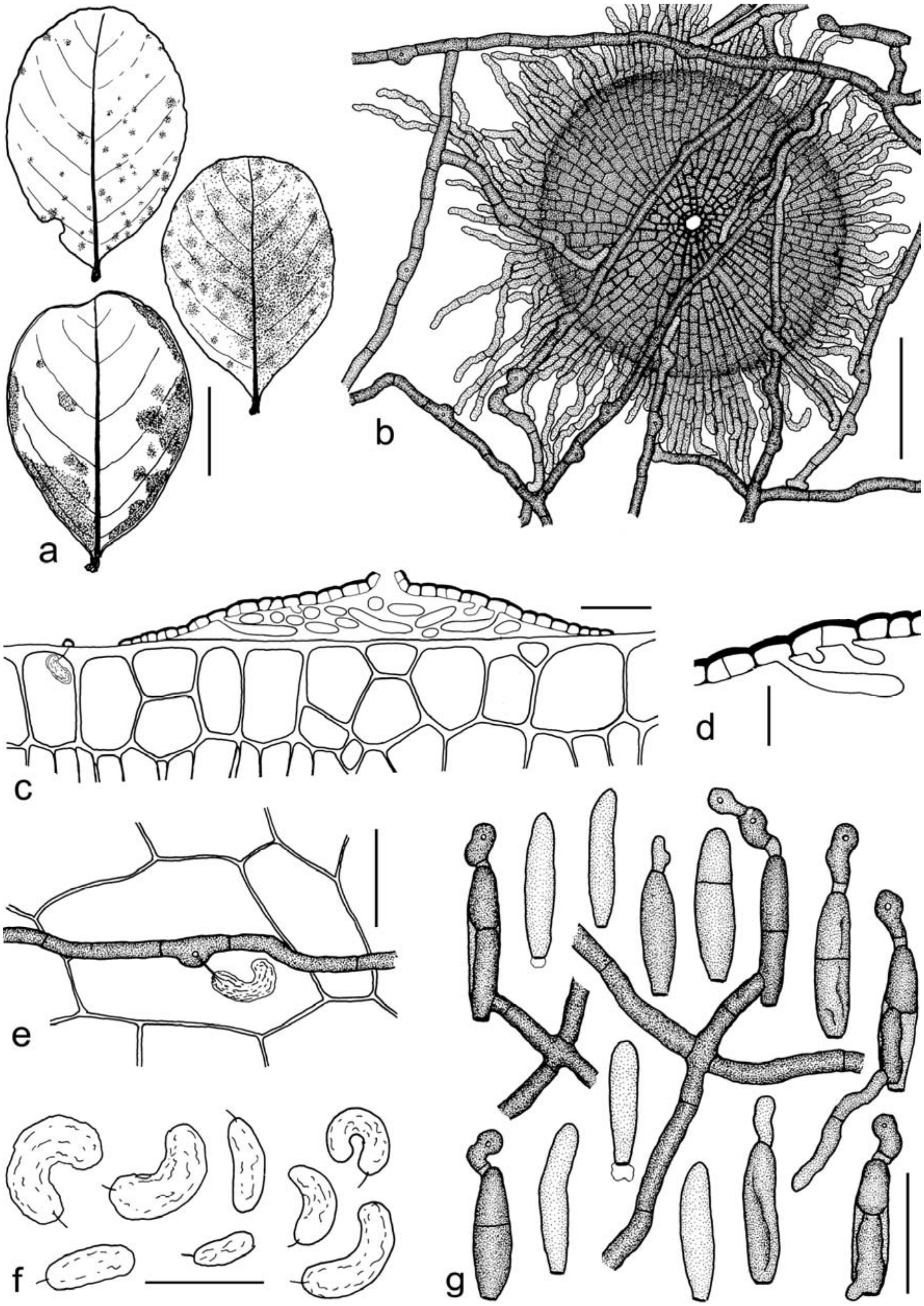

Figure 3.74: ***Homalopeltis chrysobalani*** **on** ***Chrysobalanus icaco*****.** **a:** Infected leaves (ppMP 1145). Scale bar = 2 cm. **b:** Mature pycnothyrium with a central pore (MP 3175). Scale bar = 40 µm. **c:** Cross section through a mature pycnothyrium and host tissue (ppMP 571). Scale bar = 25 µm. **d:** Part of scutellum layer with conidiogenous cells and young conidia (ppMP 571). Scale bar = 10 µm. **e:** Haustorium within epidermal host cell (ppMP 1207). Scale bar = 15 µm. **f:** Shapes of haustoria (ppMP 1207). Scale bar = 15 µm. **g:** 1-celled, immature and 2-celled, mature conidia, some of them germinating. Lower cell of conidium collapses during germination and endohyphae develops (ppMP 1207). Scale bar = 20 µm.

The pycnothyria open with small, central pores and contain unicellular, bacillary and hyaline conidia (Batista and Maia 1960b). However, the connection between the small, hyaline conidia and to the brown, appressoriate surface mycelium was not discussed by Batista and Maia (1960b). Unfortunately, type material of *C. splendida* could not be obtained from Brazil even after numerous loan requests.

In Panama, an anamorphic fungus was collected, that formed dense colonies amphigenous on living leaves of *Chrysobalanus icaco* (Chrysobalanaceae) (Fig. 3.74a). The dark colonies were composed of circular pycnothyria and a brown surface mycelium with intercalary appressoria (Fig. 3.74b). Masses of conidia developed inside the pycnothyrial cavities directly from single scutellum cells and when they detached from the conidiophores, a truncate hilum remained at the base of the lower cell. The conidia were fusiform, two-celled and brown when fully mature (Fig. 3.74g). A single conidium germinated first at the upper cell with a stalked spherical appressorium, whereas afterwards, an appressoriate surface mycelium developed from outgrowths of the lower cell (Fig. 3.74g). The anamorphic pycnothyrial fungus from Panama was identified as *Homalopeltis chrysobalani* (Henn.) Bat. & Valle described in the first place as *Leptothyrella chrysobalani* Henn. on *Chrysobalanus icaco* from Brazil (Hennings 1908, Batista and Valle 1961). The autors did not assigned a teleomorphic stage to *H. chrysobalani*. The material of *H. chrysobalani* from Panama, however, contained a teleomorph mostly in older and very dense colonies. The teleomorph was characterized by elongated, L– or Y–shaped ascomata and verrucose ascospores with one septum in the upper third of each spore (Figs. 3.75a-b). The teleomorph observed next to *H. chrysobalani* corresponded in all aspects with *Cirsosia splendida,* except the small bacillary conida assigned to the anamorphic stage by Batista and Maia (1960b). A connection of the small conidia with the brown, appressoriate surface mycelium was not demonstrated by the authors. The small, bacillary spores were probably a contamination of another fungus.

Living leaves of *Hirtella triandra* (Chrysobalanaceae) with very inconspicuous fungal colonies were collected from a different location in Western Panama. Examination of the fungus on *H. triandra* revealed its identity with *Cirsosia splendens* and its anamorph *H. chrysobalani* collected on *Chrysobalanus icaco* leaves. The colonies of *C. splendida* and its anamorph on *H. triandra* leaves were significantly smaller and hardly visible with the naked eye (Fig. 3.73a). The sporomata were scattered and not as densely packed as on *C. icaco* leaves. On *H. triandra*, the ascomata of the teleomorph were smaller, less elongated and the anamorph did not dominated the teleomorph as on *C. icaco*.

In 1926, Toro described *Leprieurina radiata* Toro on *Chrysobalanus icaco* from Puerto Rico. The type material of *L. radiata* from BPI was examined and is identical with *Homalopeltis chrysobalani***,** the anamophic stage of *Cirsosia splendida*.

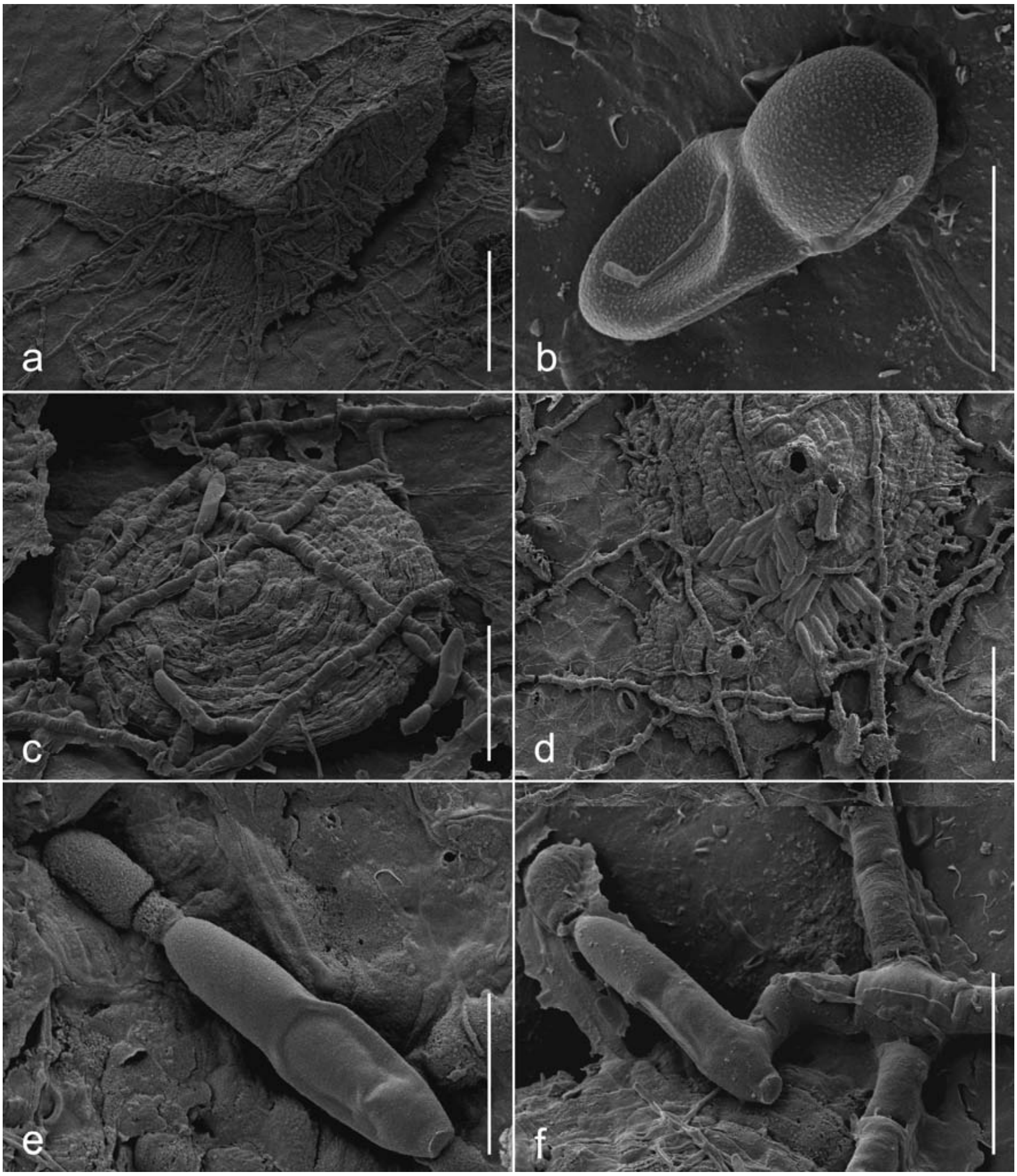

Figure 3.75: SEM photographs of *Cirsosia splendida* and its anamorph *Homalopeltis chrysobalani* on *Chrysobalanus icaco* (Chrysobalanaceae) (ppMP 517). a-b: Teleomorph *Cirsosia splendida*. **c-f:** Anamorph *Homalopeltis chrysobalani*. **a:** Elongated, L-shaped thyriothecium. Scale bar = 100 µm. **b:** Mature, verrucose ascospore. Scale bar = 10 µm. **c:** Young pycnothyrium with surface mycelium and liberated, germinating conidia. Scale bar = 35 µm. **b:** Two mature pycnothyria with central pores and a masses of liberated conidia. Scale bar = 50 µm. **e:** Mature, germinating conidium with collapsed lower cell. Scale bar = 10 µm. **f:** Mature, germinating conidium with a truncate hilum and surface mycelium. Scale bar = 15 µm.

Halbanina G. Arnaud

Ann. École Nat. Agric. Montp., Sér. 2, 16: 127 (1918)

Type species: *Halbanina irregularis* (Syd.) G. Arnaud.

Colonies superficial, hypophyllous on living leaves, black. *Surface mycelium* septate, branched, brown, without appressoria, hyphae penetrate host stomata and grow intercellularly within stomatal cavity. *Thyriothecia* superficial, dimidate, circular to elongated, dark, develop below surface mycelium, open with central star-shaped or irregular fissures. *Scutellum* radiate, composed of rows of syncronal and dichotomously branching cells forming a continuous plate of cells, one cell layer thick, cells isodiametrical or cylindrical, straight. *Asci* globose to ovate, shortly stalked, bitunicate, 4–8–spored, hyaline, vertical within ascoma, interascal tissue present, filamentous, disintegrates early. *Ascospores* 2–celled, ellipsoidal, brown when mature. *Anamorphs* absent.

Notes. The genus *Halbanina* was described by Arnaud (1918) with the type species *H. irregularis* (basionym: *Asterina irregularis* Syd.) on *Vatica obtusifolia* (Dipterocarpaceae) from the Philippines. Species of *Halbanina* were desribed as exclusively hypophyllous, forming non-appressoriate, brown surface mycelia that penetrate the stomata of the host plants. Halbanina spp. form circular to slightly elongated ascomata, globose asci and 2-celled ascospores becoming brown at maturity. According to Arnaud (1918), *Halbanina* is closely related to the genus *Halbania* Racib., because species of both genera lack appressoria but form surface mycelia that penetrate exclusively host stomata. However, species of *Halbania* differs due to the presence of 3–septate ascospores.

Müller and Arx (1962) synonymized *Halbanina* with the genus *Cirsosia* because Arnaud (1918) recombined the basionym *Asterina irregularis* Syd. to the genus *Cirsosiella* (= *Cirsosia*, according to Müller and Arx 1962) as a result of his research on literature of *Lembosia* (Theissen 1913b). In the same publication, however, Arnaud (1918) defined the genus *Halbanina* on basis of the same basionym *Asterina irregularis*, which is illegitimate. Investigation on the type material of *Asterina irregularis* revealed that the species should be placed in *Halbanina* and not in *Cirsosia*, because the brown surface mycelium enters the stomata of the host and lacks intercalary appressoria, typical for species of *Cirsosia*. Hence *Cirsosia irregularis* (Syd.) Arx was erected by mistake and should be retransferred to *Halbanina irregularis* (Syd.) G. Arnaud.

Halbanina contains two species, *H. irregularis* (discussed above) and *H. byroniae* G. Arnaud on *Bryonia sandwichensis* (Aquifoliaceae) from Hawaii. *H. byroniae* was described 1931 by Arnaud, based on Hawaiian material collected by F.L. Stevens. Stevens (1925) identified the fungus on *Byronia sandwichensis* as *Asterinella humiriae* (Henn.) Theiss. *A. humiriae* was originally described as *Seynesia humiriae* Henn. on *Humiria floribunda* (Humiriaceae) from Brazil (Hennings 1905, Theissen 1912c). According to Arnaud (1931), the hosts of *A. humiriae* from Brazil and Hawaii differ significantly and the author excluded the Hawaiian material on *Byronia sandwichensis* as *Halbanina byroniae*.

The type material of both *H. irregularis* and *H. byroniae* was examined. *H. irregularis* forms elongated ascomata and surface mycelia with pegs above the stomata of the host. The terminal part of a hyphal cell of the surface mycelium forms a unicellular peg within a stoma of the host. The peg is not further divided and fills the host stoma partly or completely. No deeper hyphal penetration of the stomatal chamber occurs. Unfortunately, the type material is strongly hyperparazitized and no germinating ascospores are present. In contrast to *H. irregularis*, *H. byroniae* forms circular ascomata and the surface mycelium penetrates the stomata of the host with multicellular pegs (Arnaud 1931). The pegs are formed by terminal parts of hyphal cells of the surface mycelium and fill the stomata completely. No deeper penetration of the stomatal cavity occurs. Only germinating ascospores form appressoria to maintain their attachment to the host surface and to obtain the nutrients necessary for further development. The appressoria are 1-celled and ampulliform to irregularly circular (Arnaud 1931). The material on *Byronia sandwichensis* is strongly hyperparasitized.

The infection mode for numerous genera of thyriothecioid ascomycetes is not yet investigated or understood. Heterogeneous genera with non-appressoriate, brown surface mycelia and 2-celled brown ascospores, such as *Asterinella*, *Prillieuxina* and *Morenoella* probably contain species with specialized surface mycelia penetrating exclusively host stomata. Therefore, it is possible that more species of plant parasitic thyriothecioid ascomycetes have to be assigned to the genus *Halbanina*.

***Halbanina* sp. on *Chrysobalanus icaco* (Chrysobalanaceae).**

Figs. 3.76, 3.77, 3.78, 3.79

Colonies hypophyllous, irregularly circular, single, later becoming confluent, 2–10 mm diam. (*n*=10), black, conspicuous and dense. *Surface hyphae* straight or slightly undulating, rigid, branching unilateral, alternate or opposite, brown to dark brown, at tips paler, septate, hyphal cells cylindrical, (17)23–40(47)×5–6 µm, cell wall up to 1 µm thick, smooth. *Appressoria* absent, surface hyphae enter stomata and form a brown, thick-walled, septate peg in stomatal pore, from peg brown, intercellular, finger-like protuberances grow into stomatal cavity. *Haustoria* absent. *Thyriothecia* superficial, develop below surface mycelium, irregular circular, dimidiate, single or crowded and confluent, strongly fringed at margins, (200)287–437(500) µm diam. (*n*=40), dark brown to black, open with central star-shaped fissures or with irregular slits. *Scutellum* radiate, composed of dichotomously branched filaments, scutellum cells isodiametrical to cylindrical, straight in center, at margins undulating, (7)10–16(18)×(3)4–5(7) µm, at margins sometimes longer, dark brown to blackish, at tips paler, sometimes penetrate stomata at margins of ascomata. *Asci* numerous, conspicuous and large, globose to ovate, without ocular chambers, bitunicate, I–, (45)52–69(75) µm diam. (*n*=40), 4–8–spored, with a thick endotunica, even in mature asci up to 3 µm thick, develop on conspicuous ascogenous hyphae with proliferating croziers, interascal tissue present, septate, originate from ascogenous hyphae. *Ascospores* numerous, 2–celled, broadly ellipsoidal, straight, sometimes slightly curved, ends rounded, lower cell sometimes slightly acuminate and tapering, deeply constricted at septum, (36)39–44(45) µm long (*n*=40), upper cell (19)20–22(23) µm wide, lower cell (16.5)18–21(21.5) µm wide, brown to dark brown when mature, cell wall up to 1 µm thick, verrucose, immature ascospores with gelatinous sheaths, germinate first in the distal or lateral part of the upper cell to form surface mycelium. *Anamorph* absent.

Illustrations. In this contribution.

Hosts. Chrysobalanaceae: Chrysobalanus icaco L.

Known distribution. Neotropical: Carribbean (Puerto Rico) and Central America (Panama). This is the first record of the genus *Halbanina* for the American Continent, the Caribbean, Central America and Panama. *Halbanina* sp. occurs in Western Panama on the pacific coast from 0 to about 5 m a.s.l.

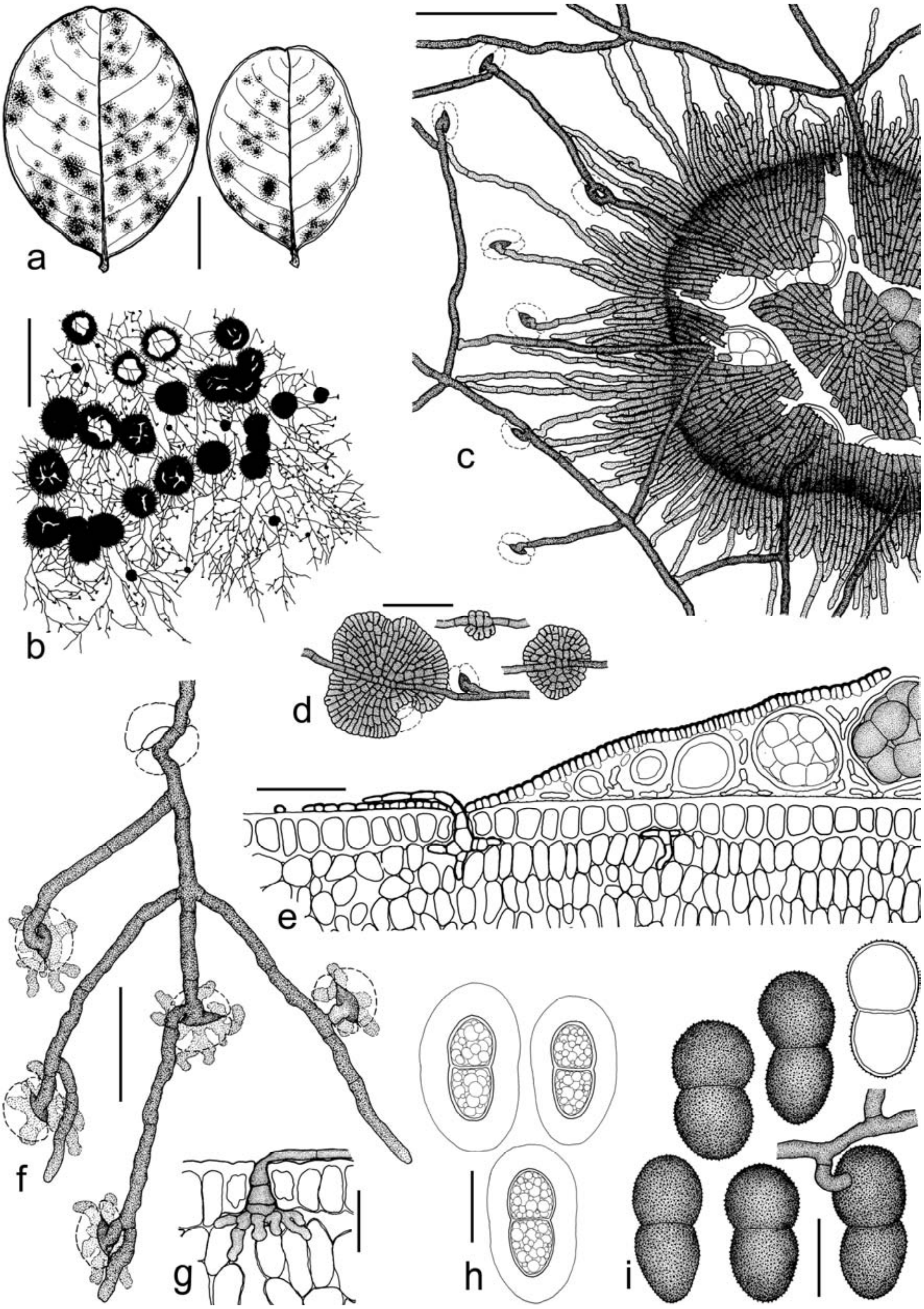

Figure 3.76: ***Halbanina* sp. on *Chrysobalanus icaco*.** Host stomata are indicated with dotted lines. **a:** Abaxial side of infected leaves (TH 603). Scale bar = 2 cm. **b:** Part of the colony with thyriothecia and surface mycelium (ppMP 1146). Scale bar = 750 µm. **c:** Part of an open thyriothecium with immature asci and liberated ascospores (ppMP 1146). Scale bar = 100 µm. **d:** Ascoma initials (ppMP 1265). Scale bar = 50 µm. **e:** Cross section through part of a mature thyriothecium and infected host tissue. Scale bar = 50 µm. **f:** Surface mycelium infecting stomata of host. Scale bar = 50 µm. **g:** Cross section through a stomata with penetration plug, finger-like protusions enter stomatal cavity. Scale bar = 40 µm. **h:** Immature ascospores, each with a gelatinous sheath. Scale bar = 25 µm. **i:** Mature, slightly verrucose ascospores, one of them germinating. Scale bar = 20 µm.

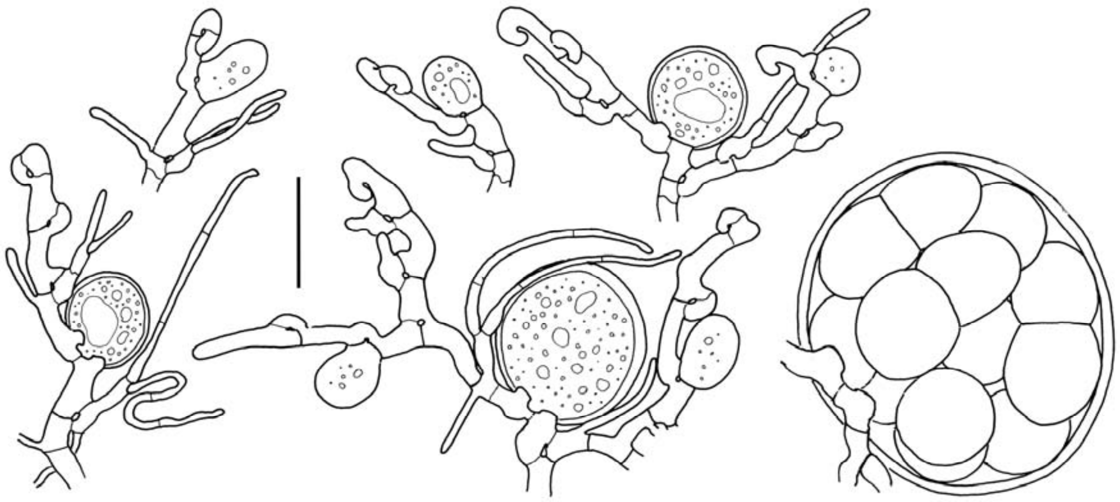

Figure 3.77: Ascus development of *Halbanina* sp. (TH 603). Ascogenous hyphae with proliferating croziers and young asci. Note the septated hyphal filaments that arise laterally from croziers or ascogenous hyphae. Scale bar = 25 µm.

Specimens examined: **PANAMA. Chiriquí Province:** La Barqueta, pacific coast, ca. 5 m a.s.l., hypophyllous on *Chrysobalanus icaco* (det. T.A. Hofmann), associated with epiphyllous parasitic algae *Cephaleuros* cf. *tumidae-setae* (Trentepohliales), epiphyllous *Plochmopeltis* sp. (Schizothyriaceae) and amphigenous *Cirsosia splendida* and its anamorph *Homalopeltis chrysobalani* (Asterinaceae), 11 Jul. 2006, *T.A. Hofmann, M. Mangelsdorff & T. Trampe ppMP 1146* (BPI; M-0141048; PMA); same locality, host species and associated organisms, 22 Jan. 2007, *T.A. Hofmann, R. Mangelsdorff & T. Trampe ppMP 1265* (BPI; M-0141049; PMA); same locality, host species and associated organisms, 6 Sep. 2007, *T.A. Hofmann 515* (FR; PMA); same locality, host species and associated organisms, 31 Oct. 2007, *T.A. Hofmann 603* (PMA). **PUERTO RICO. San Juan:** intercepted at San Juan No. 15150, on *Chrysobalanus icaco*, 4 Dec. 1960, *A. Cochran* (BPI 690964, labeled as *Asterinella uleana*).

Additional specimens examined: ***Halbanina byroniae*** **G. Arnaud. HAWAII, USA. Hawaii:** Tumakus, on *Byronia sandwichensis*, next to *Asterina* sp., 31 Jul. 1921, *F.L. Stevens 1061* (BPI 690895, labeled as *Asterinella humiriae*). **Kauai:** Kalalau Trail, on *Byronia sandwichensis*, 16 Jun. 1921, *F.L. Stevens 493* (syntypes, BPI 690892, 690893, 690897, labeled as *Asterinella humiriae*). **Oahu:** lower slopes of Konahuanui, above Manoa, on *Byronia sandwichensis*, 22 Apr. 1895, *A.A. Heller 2186* (BPI 689159, as *Asterinella* sp.). — Mt. Kaala, in *Byronia sandwichensis*, 1 Feb. 1928, *C.L. Shear* s.n. (BPI 690896 labeled as *Asterinella humiriae*). ***Halbanina irregularis*** **(Syd.) G. Arnaud. PHILIPPINES. Western Visayas Region:** Palawan Province, Puerto Princesa (Mt. Pulgar), on *Vatica obtusifolia*, Apr. 1911, *D. E. Elmer 12964* (type, S F9157, labeled as *Asterina irregularis*).

Notes. *Halbanina* sp. grows exclusively on the abaxial side of living leaves of *Chrysobalanus icaco*. The fungus is characterized by a dark surface mycelium entering the host stomata with the terminal ends of the hyphal cells (Fig. 3.76f). Each terminal end forms a multicellular, brown peg or plug filling the complete host stoma. The plug enters the stomatal cavity with brown finger-like protusions growing intercellularly between epidermal host cells (Fig. 3.76g). No intracellular hyphae or haustoria were observed. The fungus forms relatively large circular ascomata with conspicuous ascogenous hyphae with proliferating croziers, large globose asci and septated hyphal elements (Fig. 3.77). The immature ascospores are embedded in mucous sheaths and become brown at maturity (Fig. 3.76h-i). The ascospore surface is covered with a fine verrucose ornamentation (Fig. 3.78b). During ascospore germination a brown, non-appressoriate surface mycelium is formed (Fig. 3.76i).

Halbanina sp. differs from *H. irregularis* and *H. byroniae* due to the formation of finger-like protusions in the stomatal cavity. Both *H. irregularis* and *H. byroniae* do not penetrate the stomatal cavity. Additionally, *H. irregularis* forms elongated ascomata and *H. byroniae* forms smaller and smooth ascospores germinating with 1–celled, ampulliform appressoria. *Halbanina* sp. on *Chrysobalanus icaco* from Panama is probably new to science. Nevertheless, *Chrysobalanus icaco* is a very common plant in coastal regions of tropical America and it would not be surprising, if the observed fungus was described earlier under a different name.

Ultrastructural analysis of young ascomata of *Halbanina* sp. revealed that the scutellum is composed of a single layer of scutellum cells. The cells are highly melanized, especially in or above the upper and lateral cell walls (Fig. 3.79). The lower cell walls of the scutellum cells, orientated towards the ascomatal cavity, are not melanized but conspicuously thickened. The scutellum cells probably produce a mucuous substance that is secreted into the ascomatal cavity to protect internal hyphae against dessication. Concentric bodies are present within scutellum cells (Fig. 3.79b), indicating the relative

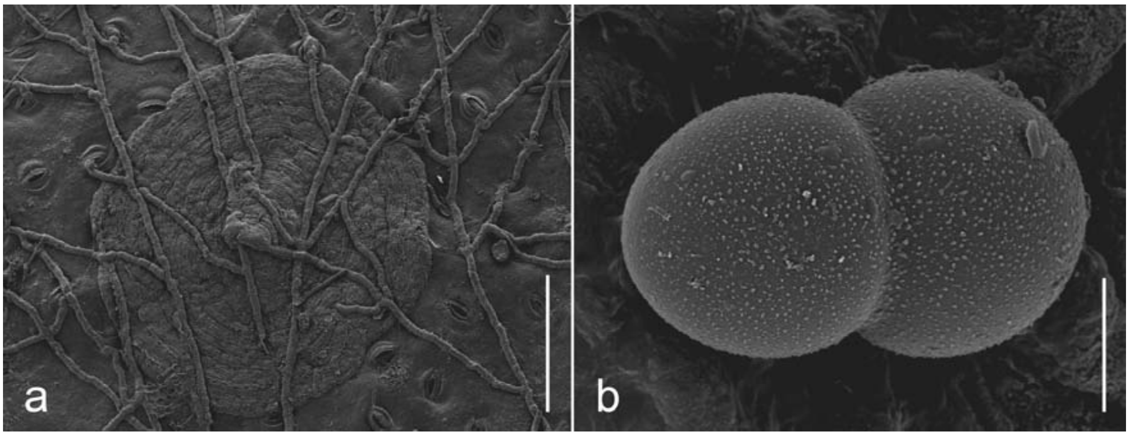

Figure 3.78: SEM photographs of *Halbanina* sp. on *Chrysobalanus icaco* (ppMP1146). a: Young ascoma and surface mycelium. Scale bar = 100 µm. **b:** Mature, slightly verrucose ascospore. Scale bar = 10 µm.

longevity and desiccation tolerance of the cells (Honegger 2001). Concentric bodies are reported for the first time for a member of Asterinaceae and a thyriothecioid ascomycete. Some scutellum cells grow downwards into the ascomatal cavity and initiate the development of highly vacuolated internal hyphae (Fig. 3.79a).

Interestingly, living leaves of *Chrysobalanus icaco* are associated with various foliicolous fungi and other organisms like algae or mites. Together with *Halbanina* sp., occurs a second plant parasitic thyriothecioid ascomycete identified as *Cirsosia splendida* with its anamorph *Homalopeltis chrysobalani* (see page 204). Additionally, thyriothecioid commensals are present, e.g. different species of Micropeltidaceae and *Plochmothea* sp., a member of Schizothyriaceae. On the adaxial side grows a parasitic algae identified as *Cephaleuros* cf. *tumidae-setae* (Trenthepohliales) and often mites were feeding on colonies of *Halbanina* sp.

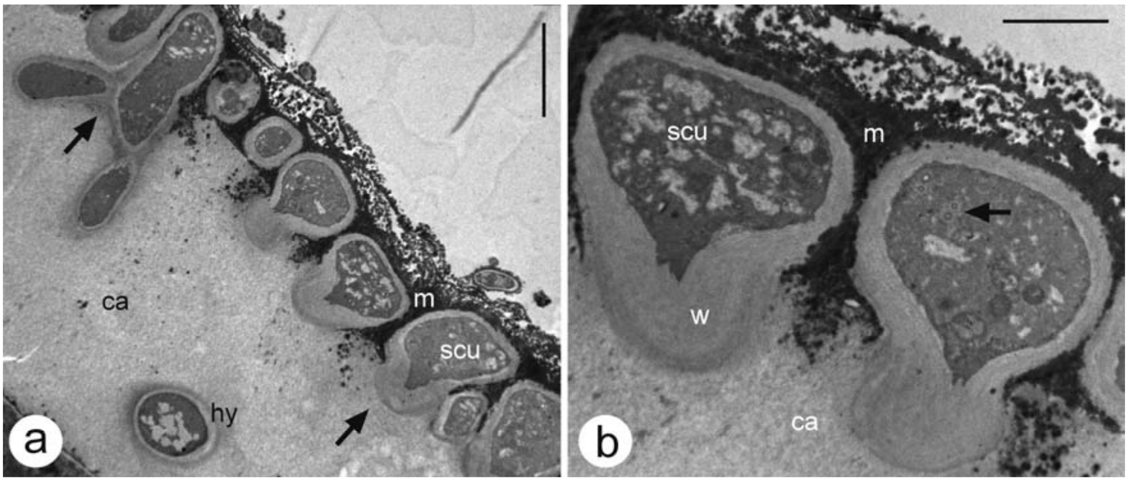

Figure 3.79: Ultrastructure of the scutellum cells of *Halbanina* sp. (ppMP1265). a: Part of scutellum of a young ascoma, one cell layer thick. Note electron-dense melanin deposits (m) external to scutellum cell walls. Arrows indicate scutellum cells (scu) that expand and divide downwards into the ascomatal cavity (ca). Internal hyphae (hy) are highly vacuolate. Scale bar = 5 µm. **b:** Two scutellum cells that expand towards ascomatal cavity, note thickened lower cell wall (w), arrow indicates concentric bodies. Scale bar = 2 µm.

Mahanteshamyces **Hosag. [as '*Mahateshamyces*']**

J. Econ. Taxon. Bot. 28(1): 189 (2004)

Type species: *M. agrostistachydis* Hosag. [as '*Mahateshamyces agrostistachydis*']

Teleomorph: *Asterina* Lév.

Colonies superficial on living leaves, black. *Surface mycelium* septate, branched, brown, hyphae sometimes penetrate host stomata. *Appressoria* lateral, lobed unstalked, with a penetration pore. *Haustoria* arbuscular, intracellular in epidermal host cells, sometimes inconspicuous. *Pycnothyria* superficial, dimidate, circular, dark, develop below surface mycelium, open with central star-shaped fissures. *Scutellum* radiate, composed of rows of syncronal and dichotomously branching cells forming a continuous plate of cells, one cell layer thick, cells isodiametrical or cylindrical, straight. *Conidiogenous cells* monoblastic, formed inside the pycnothyrial cavity by single cells of the inner part of the scutellum layer. *Conidia* 1–celled, triangular, flattened, with truncate hilum, brown when mature, with or without hyaline germ pores.

Teleomorph present or absent, *Asterina*-like.

Notes. The monotypic genus *Mahanteshamyces* Hosag. was described 2004 from India with the species *Mahanteshamyces agrostistachydis* Hosag. (as "*Mahateshamyces agrostistachydis*" Hosag.) growing on the abaxial side of leaves of *Agrostistachys indica* Dalz. (Euphorbiaceae). *M. agrostistachydis* was described without a related teleomorph (Hosagoudar 2004).

The genus *Mahanteshamyces* is morphologically similar to *Asterostomella* and is separated from *Asterostomella* by only one morphological characteristic, the angular shape of the conidia. According to Hofmann and Piepenbring (2008), this segregation on genus level appears artificial. Numerous species of *Asterina* and their related *Asterostomella* anamorphs are known to produce angular conidia, like *Asterina homaliicola* S. Hughes (Hughes 1952), *Asterina meliosmae* Yamam. (Yamamoto 1957) (its anamorph was described separately 4 years later by Batista and Bezerra (1961) as *Asterostomella meliosmae* Bat. & J.L. Bezerra), and *Asterina scolopiae* Doidge (Doidge 1942). Therefore, the maintenance of the genus *Mahanteshamyces* should be reconsidered.

Mahanteshamyces sp. on *Schlegelia parviflora* (Schlegeliaceae).

Figs. 3.80, 3.81

Colonies hyphophyllous, rarely epiphyllous, irregularly circular, single or confluent, conspicuous and dense, 0.5–3 mm diam. (*n*=10), black. *Surface hyphae* straight or slightly undulating, branching opposite, alternate or unilateral, brown, at tips paler, septate, hyphal cells cylindrical (15)21–34(37)×3–5(5.5) µm, cell wall up to 1 µm thick, smooth, sometimes penetrate stomata of host and enter stomatal cavity. *Appressoria* numerous, multilobate, with 3–6 deep lobes, and various smaller lobes, lobes asymmetrical, unilateral or alternate, sessile or slightly stalked, straight or hooked, without stalk cell, (6)7–12(16)×(7)8–11(13) µm (*n*=50), brown, penetration peg 1 µm diam., mostly in central part of appressorium. *Haustoria* inconspicuous. *Pycnothyria* numerous, superficial, develop below surface mycelium, circular, single or confluent, fringed at margins, (60)83–113(130) µm diam. (*n*=50), brown to dark brown, open with irregular or star-shaped central fissures. *Scutellum* radiate, composed of dichotomously branched filaments, scutellum cells isodiametric to cylindrical, straight in center, undulating at margin of pycnothyrium, (2.5)3–6(7)×(2)3–4(4.5) µm, brown to dark brown at margins slightly paler. *Conidiogenous cells* monoblastic, formed inside the pycnothyrial cavity by single cells of the inner part of the scutellum layer. *Conidia* very numerous, 1–celled, triangular, flat, straight or slightly curved, with a basal truncate hilum, 10–13(15)×(6.5)8–11(12) µm (*n*=50), pale brown to brown, with each one hyaline germ pore on front and back side, germinate first through germ pore with a stalked or unstalked, lobed appressorium.

Illustrations. In Hofmann and Piepenbring (2008) and this contribution.

Hosts. Schlegeliaceae: *Schlegelia parviflora* (Oerst.) Monach.

Known distribution. Neotropical: Central America (Panama). *Mahanteshamyces* sp. occurs in Western Panama in humid rainforest on the continental divide (bushy, dwarf vegetation, exposed constantly to strong winds) at approx. 1280 m a.s.l.

Specimens examined: **PANAMA. Chiriquí Province:** Fortuna, Quijada del Diablo, ridge on continental divide, ca. 1280 m a.s.l., hypophyllous on *Schlegelia parviflora* (det. R. Mangelsdorff), associated with *Asterina schlegeliae* and its *Mahanteshamyces* anamorph (epiphyllous) and other fly-

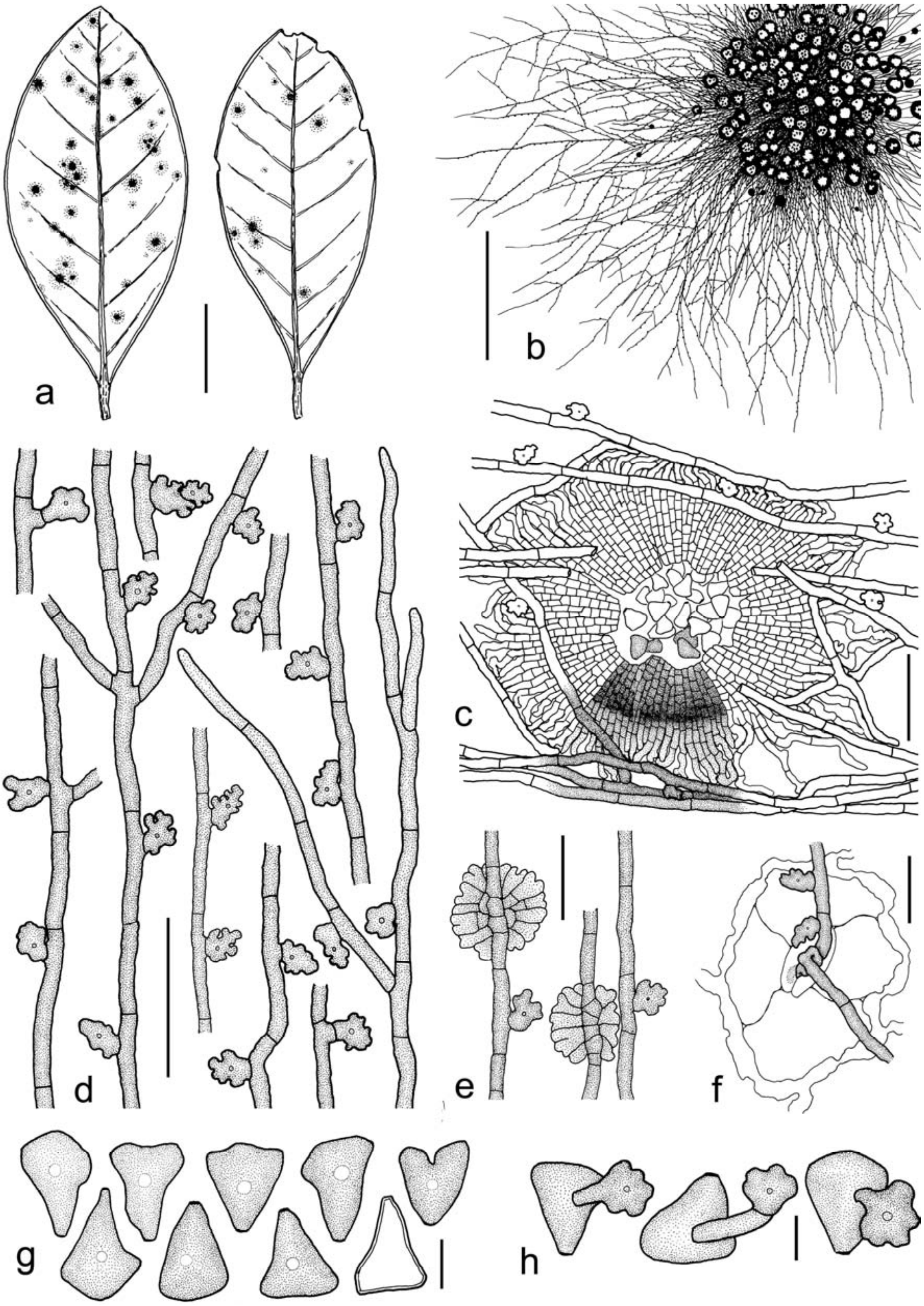

Figure 3.80: ***Mahanteshamyces* sp. on *Schlegelia parviflora* (TH 389) a:** Abaxial side of infected leaves. Scale bar = 2 cm. **b:** Part of the colony with pycnothyria and surface mycelium. Scale bar = 400 µm. **c:** Open pycnothyrium with conidia. Scale bar = 45 µm. **d:** Surface mycelium with lobed appressoria. Scale bar = 40 µm. **e:** Ascoma initials. Scale bar = 20 µm. **f:** Surface hyphae penetrating stomata of host. Scale bar = 20 µm. **g:** Mature, angular conidia each with a central hyaline pore. Scale bar = 5 µm. **h:** Germinating conidia. Scale bar = 5 µm.

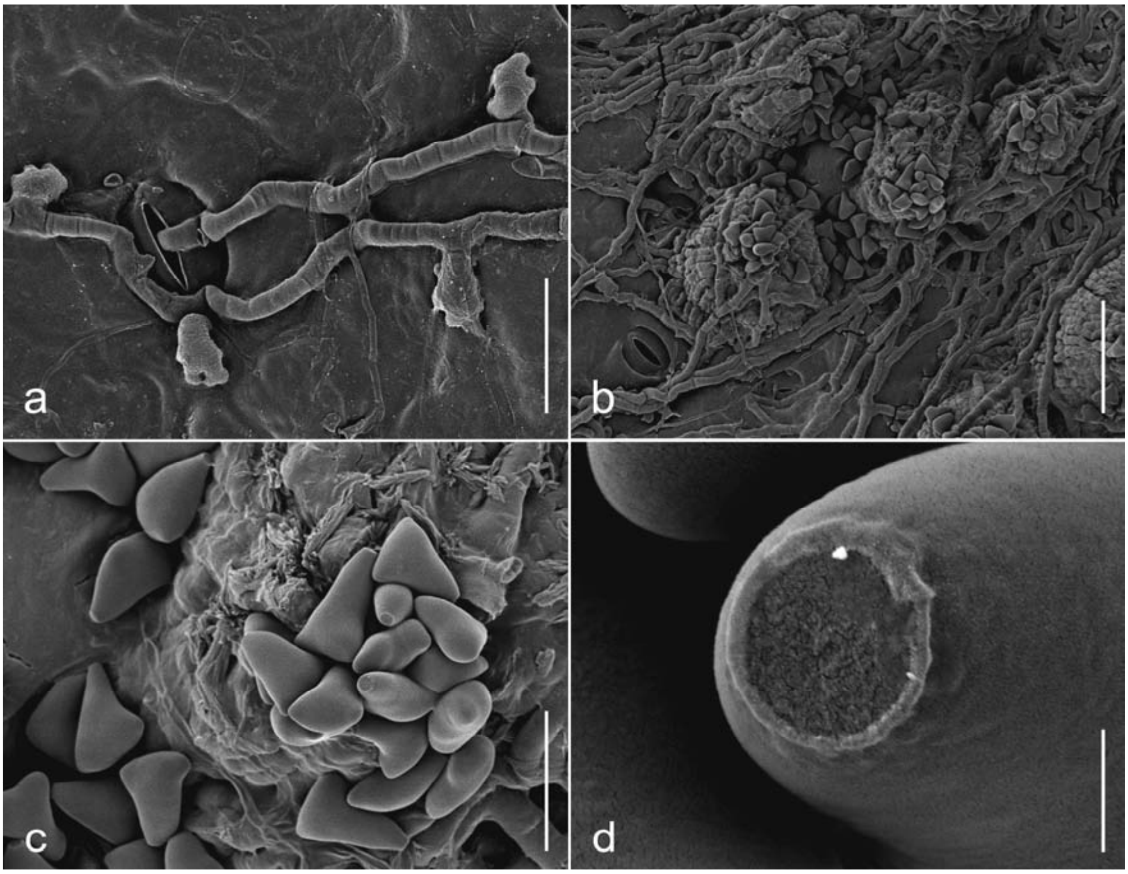

Figure 3.81: SEM photographs of *Mahanteshamyces* sp. on *Schlegelia parviflora* (TH 389). a: Surface hyphae with lateral appressoria, one penetrates stomata of the host. Scale bar = 20 µm. **b:** Mature pycnothyria with masses of conidia and surface mycelium. Scale bar = 50 µm. **c:** Mass of mature triangular conidia. Scale bar = 15 µm. **d:** Truncate hilum with outer ring locus. Scale bar = 1 µm.

speck fungi, 15 Oct. 2005, *T.A. Hofmann & R. Mangelsdorff 389* (M-0141077; PMA); same locality, host species and associated organisms, 1 Aug. 2006, *R. Mangelsdorff 454-B* (FR; PMA); same locality, host species and associated organisms, 23 Feb. 2007, *T.A. Hofmann, R. Mangelsdorff & T. Trampe 512-B* (FR; PMA); same locality, host species and associated organisms, 13 Oct. 2007, *T.A. Hofmann 588* (M-0141078; PMA).

Notes. *Mahanteshamyces* sp. occurs together with *Asterina schlegeliae* and its *Mahanteshamyces* anamorph (see page 113) on leaves of *Schelgelia parviflora* (Schlegeliaeceae). In contrast to *A. schlegeliae* and its anamorph, *Mahanteshamyces* sp. grows on the adaxial side of the leaves of the host plant and forms very dense, blackish colonies with confluent pycnothyria. The surface mycelium is similar to that of *A. schlegeliae*, however, the appressoria of *Mahanteshamyces* sp. lack the conspicuous large, arbuscular haustoria present in *A. schlegeliae*. *Mahanteshamyces* sp. develops triangular conidia, similar to the *Mahanteshamyces*-anamorph of *Asterina schlegeliae*. However, the conidia of *Mahanteshamyces* sp. are significantly smaller (Figs. 3.27h-I, 3.80g-h). Additionally, *Mahanteshamyces* sp. penetrates the stomata of the host plant with its surface mycelium (Fig. 3.80f). So far, this way of infection was not reported from *Mahanteshamyces* species. The dense colonies of the hypophyllous *Mahanteshamyces* sp. affect the plant stronger than those of *A. schlegeliae*, because a discoloration of the host tissue occurs in later developmental stages.

Mahanteshamyces sp. probably represents another species or the morphological differences to the anamorph of *A. schlegeliae* are due to its hypophyllous growth. Molecular data might help to resolve this question. In spite of several attempts, however, DNA could only be isolated from *Mahanteshamyces* sp. (compare Table 2.1) but not from *A. schlegeliae* and a comparative molecular study between these two morphologically different fungi could not be realised. *Mahantheshamyces* sp. clusters within *Asterina* spp. in the presented molecular phyolgenetic analysis based on SSU and LSU rDNA sequence data (Fig. 3.100). The molecular data indicate a close relationship of *Mahanteshamyces* with species of *Asterin*a. A broader taxon sampling, including anamorphic *Asterostomella* spp., might support the theory that both genera are identical.

***Prillieuxina* G. Arnaud**

Ann. École Nat. Agric. Montp., Sér. 2, 16: 161 (1918).

Type species: *Prillieuxina winteriana* (Pazschke) G. Arnaud

Anamorph: *Leprieurina* G. Arnaud

Colonies superficial on living leaves, black. *Surface mycelium* septate, branched, brown, without appressoria. *Hypostroma* present epidermal, composed of bundles of intracellular hyphae, hyaline or brown, initiated by scutellum cells that form tubes through ascomatal cavity to penetrate the cuticle. *Thyriothecia* superficial, dimidate, circular, slightly elongated or angular, dark, develop below or lateral from surface mycelium, open with central star-shaped fissures. *Scutellum* radiate, composed of rows of syncronal and dichotomously branching cells forming a continuous plate of cells, one cell layer thick, cells isodiametrical or cylindrical, straight. *Asci* globose to ovate, shortly stalked, bitunicate, 4–8–spored, hyaline, vertical within ascoma, interascal tissue present or absent, filamentous, septate, disintegrates early. *Ascospores* 2–celled, ellipsoidal, brown when mature.

Anamorph Leprieurina-like, sometimes dominates teleomorph. *Pycnothyria* superficial, circular, dimidate, dark, develop below surface mycelium, open with central star-shaped fissures. *Scutellum* similar to the one of the teleomorph. *Conidiogenous cells* monoblastic, formed inside the pycnothyrial cavity by single cells of the inner part of the scutellum layer. *Conidia* 2–celled, broadly clavate, pyriform or ellipsoidal, with truncate hilum on lower cell, brown when mature.

Notes. *Prillieuxina* is characterized by a brown surface mycelium without appressoria but an epidermal hypostroma. The hypostroma is initiated by scutellum cells that grow downwards into the ascomatal or pycnothyrial cavity and penetrate the cuticule of the host. The asci of *Prillieuxina* are globose and develop vertical and parallel within the ascomata, similar to other genera of Asterinaceae. The genus *Prillieuxina* was described and illustrated in detail by Arnaud (1918) with the type species *P. winteriana* and its anamorph *Leprieurina winteriana* on *Annona* sp. (Annonaceae) from Brazil. In former times, *Prillieuxina* spp. were included in the genus *Asterinella* due to the absence of mycelial appressoria. However, *Asterinella* belongs to the Microthyriaceae and is characterized by cylindrical asci developing inclined within circular ascomata with lysogenous pores. Müller and Arx (1962) broaden the genus concept of *Prillieuxina* and include all species of Asterinaceae devoid of mycelial appressoria. *Prillieuxina sensu* Müller and Arx includes numerous species with heterogeneous infection strategies like intracellular hypostromata, hyphal penetration of host stomata or intercellular hyphae.

Today, the genus *Prillieuxina* contains about 66 species that parasitize approx. 42 different host plant families (see Apprendix, Table 7.9). In Panama, only the type species *P. winteriana* and its anamorph *Leprieurina winteriana* were collected so far.

Prillieuxina winteriana **(Pazschke) G. Arnaud, Ann. École Nat. Agric. Montp., Sér. 2, 16: 161 (1918).** **Figs. 3.82, 3.83, 3.84**

Type on *Rollinia* sp. (Annonaceae). Brazil, Santa Caterina, São Francisco, Jul. 1884, *E. Ule 204* (type, B? n.v.).

≡ *Asterina winteriana* Pazschke, Hedwigia 31(3): 104 (1892).

≡ *Asterinella winteriana* (Pazschke) Theiss., Broteria 10: 122 (1912).

= *Asterina annonicola* Henn. [as '*anonicola*'], Hedwigia 41: 107 (1902). Type on *Annona* sp. (Annonaceae). Brazil, State São Paulo, São Paulo, Botanical Garden, 29 Apr. 1900, *A. Puttemans 149* (syntypes, BPI 689239!, S F12335!).

= *Aulographum juruanum* Henn., Hedwigia 43: 382 (1904). Type on *Rollinia* sp. (Annonaceae). Brazil, Amazonas, Juruá river, Jurúa-Miry, Jul. 1901, *E. Ule 3068* (syntypes, HBG n.v., S F12253!).

= *Asterinella puyana* Petr., Sydowia 4: 458 (1950). Type on unknown plant (Euphorbiaceae?). Ecuador, Pastaza Province, Puyo, 8 Feb. 1938, *H. Sydow 822a* (type: S F12370 n.v.)

[synonymy according to Müller and Arx (1962)]

Anamorph: *Leprieurina winteriana* G. Arnaud, Ann. École Nat. Agric. Montpellier, Sér. 2, 16: 211 (1918).

Type same type as *A. annonicola*, see above.

Colonies epiphyllous, rarely hypophyllous, irregularly circular, sometimes slightly star-shaped, single, later confluent, 0.5–2 mm diam. (*n*=10), black, conspicuous and dense. *Surface mycelium* straight, sometimes slightly undulating, branching unilateral, alternate or opposite, not often branched, brown to dark brown, hyphal tips paler, septate, hyphal cells cylindrical (14)21–29(32)×(3)4–5(6) µm (*n*=40), cell wall up to 1 µm thick, smooth. *Appressoria* circular, simple, with central penetration pore, develop only from mature, germinating ascospores or conidia, brown to dark brown, slightly darker than germ tube. *Haustoria* absent, penetration of cuticle leads to formation of a brown, thick-walled cell in the upper part of the epidermal host cell, from the brown cell an internal stroma develops. *Internal stroma* present, intraepidermal, composed of bundles of hyaline, intracellular hyphae, develop from appressoria of germinating spores or from scutellum cells of sporomata that elongate through the sporomatal cavity with brown hyphal tubes which penetrate the cuticle and the epidermal host cell, in older colonies intraepidermal brown stroma-initiating cells produce superficial hyphae by the reverse outgrowth through the intracuticular penetration channel. *Thyriothecia* superficial, develop below surface mycelium, irregularly circular or linear, mostly elongated or slightly triangular, dimidate, mostly confluent and crowded, fringed at margins, (220)242–350(430)×(185)211–277(320) µm (*n*=37), dark brown to black, open with central star-shaped to linear fissures, at maturity sometimes wide open to expose mature and immature asci. *Scutellum* radiate, composed of dichotomously branched filaments, scutellum cells isodiametric to cylindrical, straight in center, not undulating at margin of ascoma, (3.5)5–12(17.5)×(2)3–6(7) µm, dark brown to black, at margins of ascoma paler. *Asci* numerous, globose to ovate, without persistent ocular chambers, bitunicate, I–, (39)45–54(60) µm diam., 8–spored, hyaline, develop on ascogenous hyphae with proliferating croziers, interascal tissue present, filamentous, septate, originates probably from ascogenous hyphae. *Ascospores* 2–celled, ellipsoidal, ends rounded, constricted at septum, lower cell tapered, (30)31–35(40) µm long, upper cell (14)15–18(20) µm wide, lower cell (13)14–17(18) µm wide, brown, cell wall up to 1 µm thick, smooth, germinate first at the distal part of the lower cell with a stalked, entire appressorium.

Anamorph present, *Leprieurina winteriana* G. Arnaud. *Pycnothyria* numerous, superficial, developing from below the surface mycelium, circular, dimidiate, single or confluent, fringed at margin (100)127–166(210) µm diam. (*n*=73), dark brown to blackish, open with central star-shaped fissures, smaller than thyriothecia and always circular. *Scutellum* radiate, similar to the one of the thyriothecia. *Conidiogenous cells*, monoblastic, formed inside the pycnothyrial cavity by single cells of the inner part of the scutellum layer. *Conidia* numerous, 2–celled, broadly clavate, pyriform or ellipsoidal, sometimes slightly triangular, straight or slightly curved, septum in central part of conidium or in lower third, not constricted at septum, (25)28–34(40)×(11)17–

20(24) µm (n=77), brown to dark brown, at septum black, with pale and truncate hilum, smooth, germinate first through hilum of lower cell with a stalked, entire appressorium.

Illustrations. teleomorph: In Hennings (1904) as *Aulographum juruanum*. **teleomorph and anamorph:** In Theissen (1912c) as *Asterinella winteriana*, in Arnaud (1918), Müller and Arx (1962) and this contribution. Ascus development (Fig. 3.83) and the surface composition of an ascospore and conidia are illustrated here for the first time (Fig. 3.84).

Hosts (teleomorph and anamorph). Annonaceae: <u>*Annona montana* Macfad.</u>, *Annona muricata* L., *Annona* sp. and *Rollinia* sp.

Known distribution (teleomorph and anamorph). Neotropical: Caribbean (Dominican Republic, Haiti, Jamaica) Central America (Honduras, Panama) and South America (Brazil, Colombia, Ecuador). ***P. winteriana*** with its anamorph ***L. winteriana*** is a new record for Panama. Both anamorph and teleomorph are common in Western Panama due to the cultivation of its host, the species occurs in the lowlands from 15 to about 600 m a.s.l.

Specimens examined (labeled as *Prillieuxina winteriana* or *Leprieurina winterana*). **BRAZIL. Amazonas:** syntype of *Aulographum juruanum*, see above. **Minas Gerais:** Viçosa, college, on *Annona muricata*, 20 May 1934, *A.S. Müller 795* (BPI 391577). **São Paulo:** syntypes of *Asterina annonicola*, see above. **DOMINICAN REPUBLIC.** — intercepted Elizabeth New Jersey 017400, on *Annona* sp., 20 Jan. 1993, *I. Zwillman* (BPI 1113216). — intercepted at JFKIA NY 003990, on *Annona muricata*, 10 Jul. 1970, *R. Heliczer* (BPI 391576). — intercepted at JFKIA NY 004575, on *Annona muricata*, 29 Nov. 1970, *J. Orench* (BPI 391584). — intercepted at JFKIA NY 008835, on *Annona* sp., 9 Jan. 1972, *C. Riggio* (BPI 391574). — intercepted at JFKIA NY 030827, on *Annona* sp., 25 Sep. 1979, *D. Kepich* (BPI 690983). — intercepted at San Juan Puerto Rico 005200, on *Annona* sp, 25 Jan. 1974, *F. Rodriguez* (BPI 690984). **Espailat Province:** Moca, National Agronomy Station, on *Annona muricata*, 16 Oct. 1930, *Ekman & R. Ciferri 4317* (BPI 391578A). **HAITI.** intercepted at JFKIA NY 005299, on *Annona* sp., 23 Feb. 1971, *J. Dooley* (BPI 391583). — intercepted at JFKIA NY 005286, on *Annona muricata*, 23 Feb. 1971, *J. Dooley* (BPI 391579). **HONDURAS.** intercepted at Miami 282, on *Annona muricata*, 15 Dec. 1969, *F. Matthews* (BPI 689156, labeled as *Asterina* sp.). **JAMAICA.** intercepted at New York City, on *Annona muricata*, 16 Apr. 1937, leg. Lennox NY *69811* (BPI 391573, labeled as *Leprieurina megalospora*). — intercepted at JFKIA NY 005298, on *Annona muricata*, 4 Mar. 1970, *R. Heliczer* (BPI 391585). — intercepted at JFKIA NY 001712, on *Annona muricata*, 5 Apr. 1970, *D. Wong* (BPI 391575). **PANAMA.** intercepted at Miami Florida 1122, on *Annona* cf. *muricata* (det. T.A.

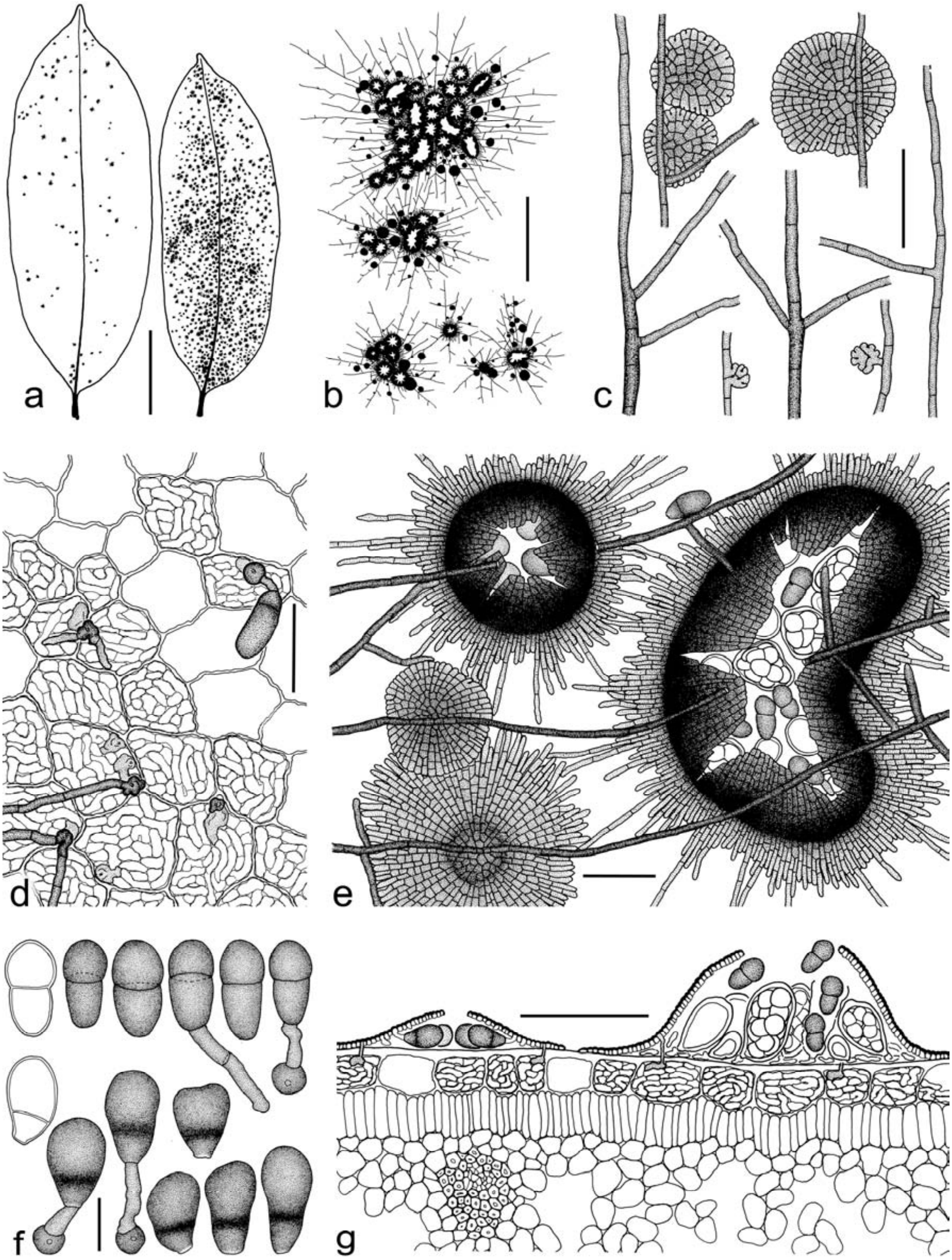

Figure 3.82: *Prillieuxina winteriana* on *Annona montana*. a: Adaxial side of infected leaves (TH 317). Scale bar = 3 cm. **b:** Various colonies with confluent thyriothecia, pycnothyria and surface mycelium (TH 327). Scale bar = 750 µm. **c:** Surface mycelium with ascoma initials (TH 474). Scale bar = 50 µm. **d:** Stroma of intracellular hyphae within epidermal host cells, formed by a germinating conidium. Surface hyphae arise from large internal stromata that germinate upwards through the darkly pigmented stroma initial (TH 474). Scale bar = 50 µm. **e:** Open, elongated thyiothecium with mature and immature asci, an open pynothyrium and two sporoma initials (TH 317). Scale bar = 50 µm. **f:** Mature ascospores (upper line) and conidia (lower lines), some of them germinating (TH 317). Scale bar = 20 µm. **g:** Cross section through a pycnothyrium, a thyriothecium and host tissue. Hyaline intracellular hyphae fill entire epidermal cells (TH 317). Scale bar = 100 µm.

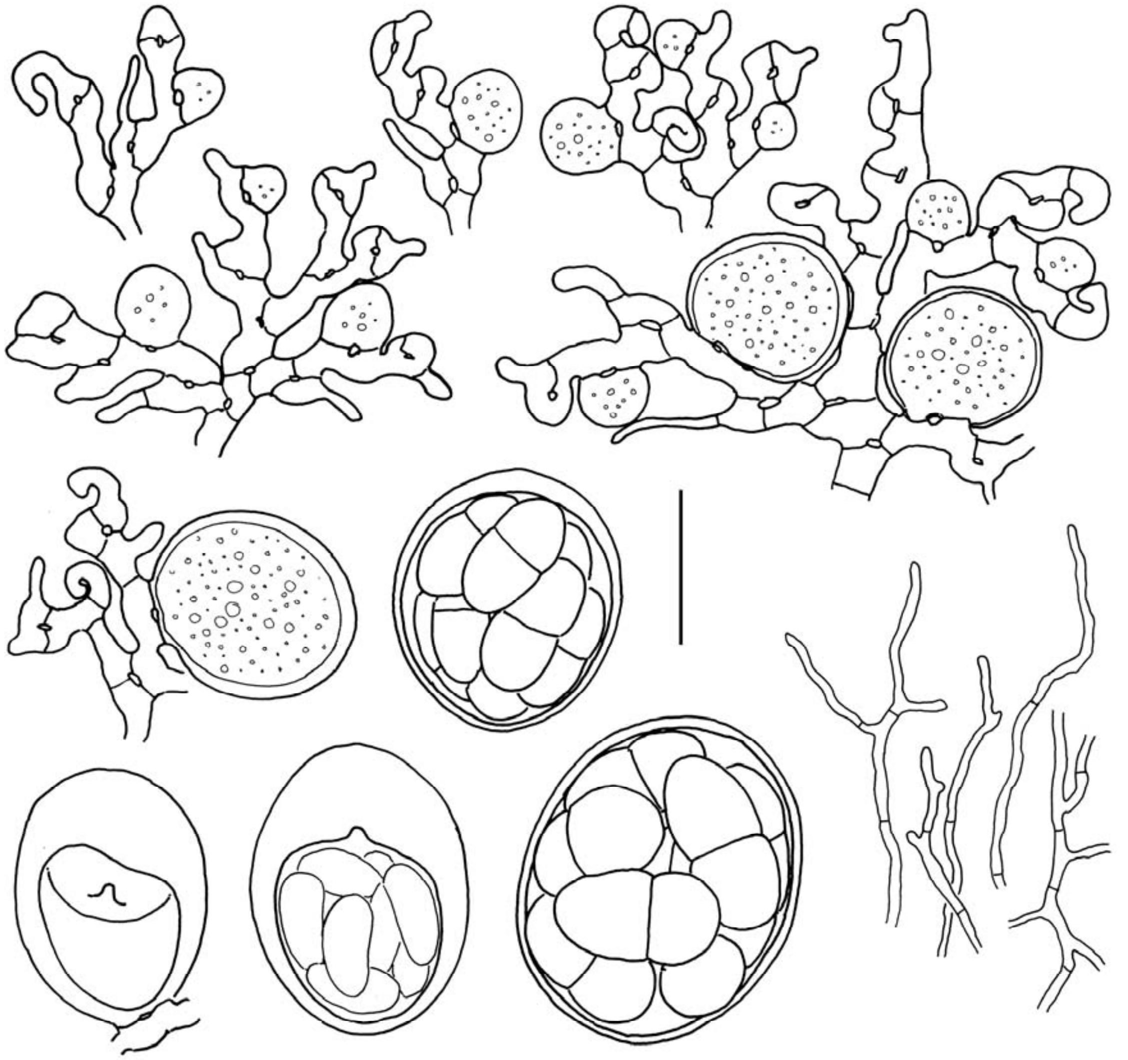

Figure 3.83: Ascogenous hyphae and young asci of *Prillieuxina winteriana* (TH 317). Globose asci are formed on proliferating croziers, asci mostly without defined ocular chambers, thinner branched hyphae (lower right) occur next to ascogenous hyphae within ascoma. Scale bar = 25 µm.

Hofmann), 30 Jan. 1970, *E.R. Bartley* (BPI 391582 A, B). **Chiriquí Province:** Bugaba, La Conceptión, amphigenous on *Annona montana* (det. T.A. Hofmann), 16 Apr. 2006, *T.A. Hofmann 422* (PMA). — Los Algarrobos, private garden of M. Piepenbring, ca. 140 m a.s.l., amphigenous on *Annona montana* (det. M-. Piepenbring), 17 Jun. 2006, *T.A Hofmann 474* (FR; PMA); same locality and host species, 12 Sep. 2007, *T.A. Hofmann 533* (PMA); same locality and host species, 1 Nov. 2007, *T.A. Hofmann 606* (PMA); same locality and host species, 26 Mar. 2008, *T. Trampe & A. Pfaff 630* (PMA). — David, private garden, amphigenous on *Annona montana* (det. T.A. Hofmann), 13 Aug. 2005, *M. Vega TH 328* (FR; PMA). — Remédios, Mangroves, ca. 15 m a.s.l., amphigenous on *Annona montana* (det. T.A. Hofmann), 19 Sep. 2005, *T.A Hofmann et al. 317* (BPI 878181 A,B; FR; PMA). **Bocas del Toro Province:** El Valle, Finca Celestine, ca. 600 m alt, amphigenous on *Annona montana* (det. T.A. Hofmann), 28 Sep. 2005, *T.A. Hofmann et al. 327* (BPI 878182 A,B; PMA). — Teribe river, Wekso Station, epiphyllous on *Annona montana* (det. T.A. Hofmann), 5 Apr. 2006, *T.A. Hofmann 416* (FR; PMA).

Notes. The circular conidiomata of the anamorph *Leprieurina winteriana* are easy to distinguish from the more stretched and elongated ascomata of the teleomorph *Prillieuxina winteriana* (Fig. 3.82e). In young colonies, the anamorph often dominates the teleomorph. Therefore, in some specimens from Panama (e.g. TH 327), sexual reproductive structures of *P. winteriana* are hard to find. Ascoma production is normally seen in older and larger fungal colonies on strongly infected leaves.

The penetration of the host is initiated by a mature, germinating ascospore or conidium, which forms a stalked, simple appressorium (Fig. 3.82f). The appressorium penetrates the cuticle and generates a brown, thick-walled hyphal cell or stroma initial in the upper part of the epidermal cell (Fig. 3.82d upper part, g). From the stroma initial bundles of hyaline intracellular hyphae are formed, that may spread to neighbouring epidermal cells and lead to the formation of an intraepidermal stroma in the host plant. Additionally, sporomatal scutellum cells can initiate intraepidermal stroma. During this process, single scutellum cells elongate to form brown hyphal tubes that penetrate the cuticle and enter epidermal cells to initiate the same kind of stroma produced by germinating spores (Fig. 3.82g, Arnaud 1918).

In older colonies, superficial mycelia and sporomata sometimes strip off due to mechanical forces produced by rain, wind or animals crossing the leaf. If this occurs, the brown, stroma-initiating cell within the host epidermis can grow backwards through the intracuticular channel that remained from the primary cuticular infection. This reverse outgrowth yields to the formation of a brown irregularly coiled hyphal cell on the surface of the host (Fig. 3.82d, lower part). This cell initiates a superficial mycelium that again can form new reproductive structures on the leaf surface to ensure proliferation of fungal spores.

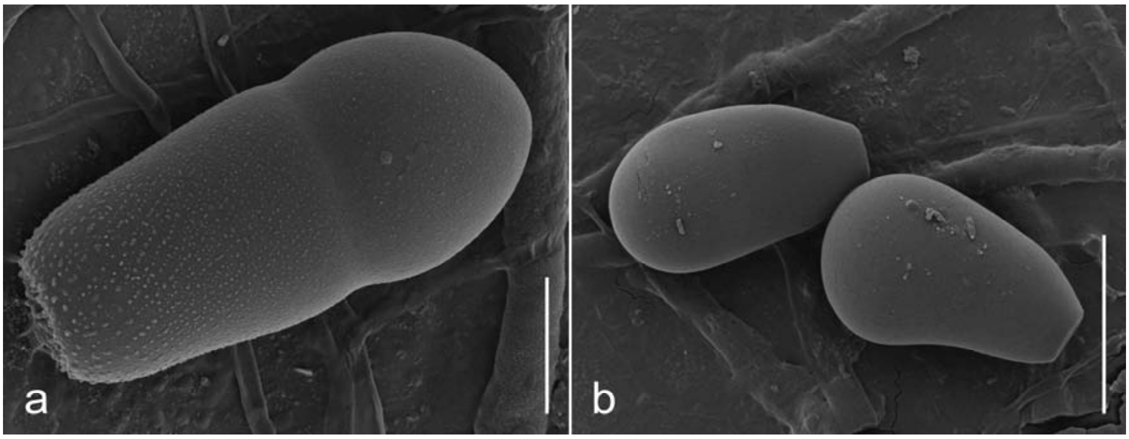

Figure 3.84: SEM photographs of *Prillieuxina winteriana* on *Annona montana* (TH 317). a: Mature ascospore. Scale bar = 10 µm. **b:** Mature conidia each with a basal truncate hilum. Scale bar = 20 µm.

3.3.2 MICROTHYRIACEAE Sacc. (1883)

Type genus: *Microthyrium* Desm.

Saprotrophs, leaf or fungal parasites, on leaves or stems, surface mycelium mostly present, but inconspicuous, septate, brown or hyaline, branched, with lateral or intercalary appressoria forming haustoria, or mycelium without appressoria but forming hypostroma within the host, thyriothecia superficial, dimidiate, circular or elongated, brown, develop below surface mycelium, open with central pores or linear slits, scutellum radiate, composed of rows of syncronal and dichotomously branching cells forming a continuous cell-plate, one to various cell layers thick, scutellum cells isodiametric or cylindrical, straight or meandrical, asci cylindrical to elongate, bitunicate, 8–spored, develop inclined towards a sterile column of sterile cells within ascoma, interascal tissue present, filamentous, septate, ascospores mostly 2–celled or many celled, hyaline or brown at maturity, sometimes ciliate.

Anamorphs rarely present, poorly studied.

Notes: Saccardo (1883) introduced the family Microthyriaceae with the aim to unite morphologically similar fungi with dimidiate, flat ascomata. Species of Microthyriaceae are saprotrophs on dead plant material, parasites on living plants or hyperparasites on foliicolous ascomycetes or lichens. *Microthyrium*, *Palawania* and *Arnaudiella* are some of the few saprotrophic genera also present in temperate regions (Ellis 1976). However, most genera of the Microthyriaceae are obligate plant parasites with a tropical or subtropical distribution (Müller and Arx 1962). Hyperparasitic species are commonly found in tropical and subtropical regions where their respective hosts occur (Matzer 1996), but they occur also in temperate regions (Ellis 1977, Spooner and Kirk 1990). Members of Microthyriaceae are characterized by flat thyriothecia, composed of a radiating scutellum, opening with a central pore at maturity. Inclined within the ascomata develop elongated, cylindrical asci that are orientated with the apex towards the ascocarp center. The bitunicate asci are arranged ring-like around the ascomatal center, which is often filled with a column of sterile cells (Müller and Arx 1962). The ascomata are formed from a more or less darkly pigmented surface mycelium or from internal hypostromata.

Most species of Microthyriaceae form dimidiate thyriothecia with a distinct upper wall composed of numerous layers of radiate scutellum cells and without a lower ascoma wall. Species of *Actinopeltis*, *Lichenopeltella*, *Trichothyriopsis* and *Trichothyrium*, however, form dimidiate ascomata with distinct upper and lower walls, a type of fruitingbody referred to as catathecium. Fungiicolous ascomycetes with catathecioid ascomata were formerly placed in an own family Trichothyriaceae (Theissen 1914, Höhnel 1917, Ellis 1977, Spooner and Kirk 1990).

Anamorphic states of Microthyriaceae are almost unknown, only Ramaley (1999) reported a hyphomycetous *Zalerion* state for *Microthyrium guadalupensis* that was obtained by cultivation experiments.

The Microthyriaceae are thought to be closely related to the Micropeltidaceae and Vizellaceae because of morphologically similar ascomata (Arx and Müller 1975). Species of Micropeltidaceae, however, show differently structured ascomata walls composed of nonradiate, epidermoidal cells, and form hyaline net-like surface mycelia (Batista 1959, Gómez Acosta 1995). Species of Vizellaceae develop exclusively subcuticular in living leaves, form surface mycelia with distinctly thickened septa and develop one-celled, brown ascospores with hyaline bands (Swart 1971). The Microthyriaceae are not closely related to Asterinaceae, although plant parasitic species of Microthyriacaee are often confused with Asterinaceae (Müller and Arx 1962).

The Microthyriaceae include about 54 genera and about 278 species (Kirk et al. 2008) with a worldwide distribution. Numerous genera of the Microthyriaceae are thought to be artificial (Kirk et al. 2001). The family belongs to the order Microthyriales which is provisionally included in the class Dothideomycetes because molecular data are missing (Kirk et al. 2008).

Key to genera of Microthyriaceae collected in Western Panama:

1 appressoria intercalary .... *Platypeltella*
1* appressoria lateral 2
  2 appressoria in axils of branching surface hyphae .... *Maublancia*
  2* appressoria lateral, not in axils of surface hyphae .... *Xenostomella*

Maublancia G. Arnaud

Ann. École Nat. Agric. Montp., Sér. 2, 16: 158 (1918)

= *Caudellopeltis* Bat. & Maia, in Batista et al., IMUR 227: 4 (1960). Type: *C. eugeniae* Bat. & Maia

[synonymy according to Arx and Müller (1975)]

Type species: *M. myrtacearum* G. Arnaud.

Colonies superficial on living leaves, black. *Surface mycelium* present, hyphae septate, branched, brown. *Appressoria* lateral or axillar, rarely terminal, 1–, 2– or rarely 3–celled, stalked or unstalked, with penetration pore. *Haustoria* or penetration pegs present. *Thyriothecia* circular, dimidiate, dark, develop below surface mycelium, open with irregular central pores. *Scutellum* radiate, composed of rows of synchronal and dichotomously branching cells forming a continuous plate of cells, several cell layers thick, cells isodiametrical, cylindrical to irregularly meandrical. *Asci* elongated, clavate to cylindrical, bitunicate, 8–spored, hyaline, inclined towards center of sterile filamentous pseudo?paraphyses. *Ascospores* 2–celled, ellipsoidal, septum in center or lower third, brown when fully mature.

Notes. Arnaud (1918) introduced the genus *Maublancia* with the type species *M. myrtacearum* on an unknown Myrtaceae from Brazil. *Maublancia fide* Arnaud is closely related to *Asterinella* because species of both genera form brown surface mycelia and ascomata with elongated asci that develop inclined towards a central column of sterile pseudoparaphyses. However, *Maublancia* spp. form surface mycelia with conspicuous lateral or axillar appressoria, whereas appressoriate surface mycelia are lacking in species of *Asterinella* (Arnaud 1918). *Maublancia* spp. belong to the Microthyriaceae, even if the dark appressoriate surface mycelium might indiacte a closer relationship to species of Asterinaceae.

The genus *Maublancia* contains seven species (Appendix, Table 7.6) parasitizing on members of Myrtaceae, Ericaceae, Hamamelidaceae, Orchidaceae and Salicaceae s.l. (Flacourtiaceae s.str.). The morphology of the appressoria is heterogeneous in *Maublancia* spp., e.g. *M. juruana* forms lateral and unstalked appressoria (Arnaud 1918), *M. myrtacearum* lateral and stalked appressoria (Arnaud 1918) and *M. uleana* forms unstalked, but 2–celled appressoria in axils of branching hyphae (see below, Müller and Arx 1962).

Maublancia uleana **(Pazschke) Arx, Beitr. Kryptgfl. Schweiz 11(2): 524 (1962). Figs. 3.85, 3.86, 3.87**

Type on Myrtaceae. Brazil, Santa Catarina, São Francisco, Aug.-Nov. 1884, *E. Ule 165*, (syntype, n.v.) *166* (syntype n.v.) *184* (syntype, n.v.), *281* (syntype, HBG 1683!, specimen without visible cells of *Asterina uleana*).

≡ *Asterina uleana* Pazschke, Hedwigia 31(3): 104 (1892).

≡ *Asterinella uleana* (Pazschke) Theiss., Broteria 10: 109 (1912).

= *Caudellopeltis eugeniae* Bat. & Maia, in Batista et al., IMUR 227: 5 (1960). Type on *Eugenia monticola* DC (Myrtaceae). Dominica, Cordillera Central, 3 Jan. 1929, *R. Ciferri 263* (type, PAD? n.v.).

= *Seynesia megas* Rehm, Hedwigia 37: 325 (1898). Type on unknown plant [= Myrtaceae, det. T.A. Hofmann]. Brazil, location and date unknown, *E. Ule 1175* (syntype, S F49099!); on *Chrysobalanus* sp. [= Myrtaceae, det. T.A. Hofmann]. Brazil, Santa Caterina, Blumenau, Oct. 1888, *E. Ule 1282* (syntypes, S F49100!, S F49107!); on cf. *Byrsonima* sp. [= Myrtaceae, det. T.A. Hofmann]. Brazil, Minas Gerais, Ouro Petro, Mar. 1892, *E. Ule 1832* (syntype, S F12378!).

= *Seynesia megas* var. *macrospora* Starbäck, Arkiv. för Botan. 2: 13 (1904). Type on unknown plant [= Myrtaceae, det. T.A. Hofmann]. Brazil, Matto Grosso, Lagoinha, 13 Jan. 1894, *C. A. M. Lindmann 492* (type, S F49163!).

[synonymy according to Müller and Arx (1962)]

= *Asterina myrciae* R. W. Ryan, Mycologia 16(4): 186 (1924). Type on *Eugenia* sp. (Myrtaceae). Puerto Rico, San Germán, Rosario, 4 Aug. 1915, *F.L. Stevens 9494* (syntypes, BPI 690099!, BPI 690100!). **syn. nov.**

Colonies epiphyllous, circular, single, conspicuous and dense, 1–7 mm diam. (*n*= 10), black. *Surface hyphae* straight to irregularly undulating, branching bifurcate, opposite, alternate or unilateral, brown to dark brown, at tips paler, septate, hyphal cells cylindrical, (10)16–35(40)×4–5(6) µm, cell wall up to 1 µm thick, smooth. *Appressoria* numerous, in axils of bifurcating hyphae, rarely terminal or lateral, 2– or rarely 3–celled, septum in central or upper third of appressorium, sometimes on lateral side of appressorium, slightly constricted at septum, in total (18)19–24(26) µm long, lower cell broadly sessile in axils, with sinuate to slightly lobed margins, (9)11–14(15)×(9)12–17(20) µm, brown to dark brown, often slightly darker than surface mycelium, penetration pore thick-walled, up to 3 µm diam., central part or in lateral lobe of lower appressorium, upper cell mostly terminal or rarely lateral to lower cell, slightly sinuate or entire, with rounded apex, (7)8–11(13)×(5)8–12(13) µm, slightly paler than lower cell, penetration pore smaller and thin-walled, in central part of upper appressorium.

Haustoria intracellular in single palisade mesophyll cells, develop from a brown, thickwalled penetration tube, intercellular between epidermal cells. *Thyriothecia* superficial, develop below surface mycelium, circular, dimidiate, single or slightly confluent, strongly fringed at margins, (350)367–424(450) µm diam., dark brown to black, open with a central ostiole, 20–34(40) µm diam., ostiole ruptures at maturity of ascoma. *Scutellum* radiate, composed of dichotomously branched filaments, scutellum cells isodiametric to cylindrical, straight in center, undulating and meandrical towards margin of ascoma, (2)4–14(25)×(2)3–5(6) µm, brown to dark brown or black, at tips paler. *Asci* numerous per ascoma, elongated, clavate to ellipsoidal, ovate, base narrow and acuminate, apex broadly rounded, with flat and broad ocular chambers, bitunicate, I−, (94)99–115(125)×(35)37–43(46) µm (n=17), hyaline, 8–spored, hyaline, develop on ascogenous hyphae with proliferating croziers, inclined towards the ascoma center, interascal tissue present, filamentous, septate, anastomosing. *Ascospores* 2–celled, ellipsoidal, straight, ends acuminate, slightly constricted at septum, (34)35–40(42) µm long (n=10), upper cell with a thickened wall in the equatorial region, (19)20–22(23) µm wide, lower cell tapering to one end, 13–15(16) µm wide, spores pale brown to dark brown when mature, germinate first at distal part of lower cell to form surface mycelium with 2–celled appressoria, upper cell collapses and ruptures along the equatorial wall thickening, later infectious hyphae may be formed upwards through septum of ascospore. *Anamorph* absent.

Illustrations. In Theissen (1912c, as *Asterinella uleana*), Batista et al. (1960, as *Caudellopeltis eugeniae*), Batista and Maia (1960, as *Trichasterina myrtaceicola*), Müller and Arx (1962) and this contribution. The infection mechanism, ascus development, germinating ascospores and the ultrastructure of *M. uleana* are illustrated here for the first time (Figs. 3.85, 3.86., 3.87).

Hosts. Chrysobalanaceae: *Chrysobalanus icaco* L. [plant probably misidentified] **Myrtaceae:** *Eugenia monticola* DC, *Eugenia* sp. and *Myrica splendens* (Sw.) DC.

Known distribution. Neotropical: Caribbean (Puerto Rico, Dominica, Virgin Island, West Indies), Central America (Panama) and South America (Brazil, Venezuela). *M. uleana* is a new record for Central America and Panama and occurs in Western Panama in lowland galleryforests at approx. 140 m a.s.l.

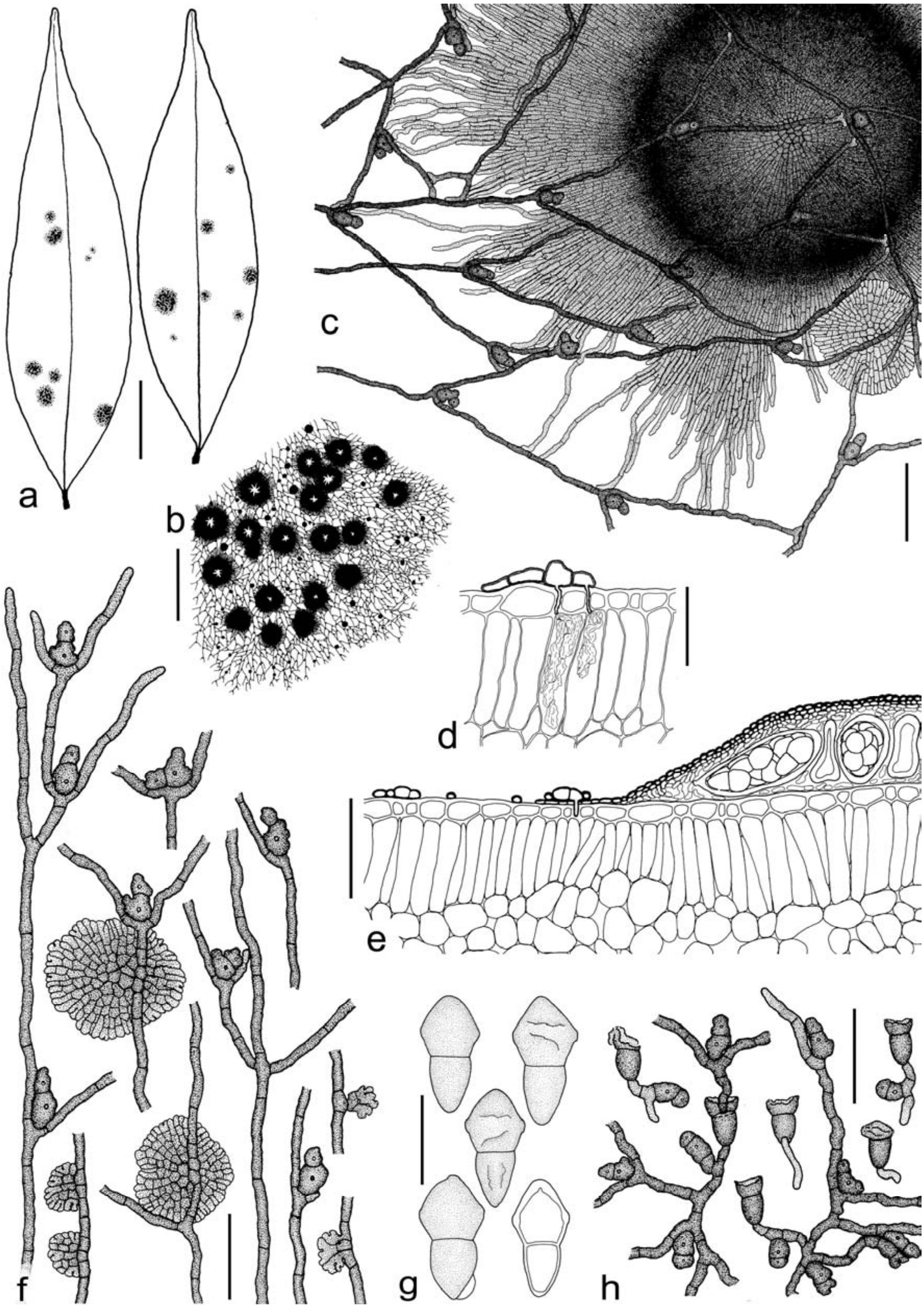

Figure 3.85: *Maublancia uleana* on *Myrcia splendens* (ppMP 1206). a: Adaxial side of infected leaves. Scale bar = 2 cm. **b:** Part of the colony with thyriothecia and surface mycelium. Scale bar = 1 mm. **c:** Part of a young, closed thyriothecium. Scale bar = 50 µm. **d:** Cross section through 2–celled appressorium, penetration tubes and haustoria in mesophyll cells. Scale bar = 30 µm. **e:** Cross section through a part of a mature ascoma and host tissue. Scale bar = 50 µm. **f:** Surface mycelium with axillar 2–celled appressoria and ascoma initials. Scale bar = 40 µm. **g:** Mature ascospores, some collapsing. Scale bar = 30 µm. **h:** Germinating ascospores, upper cell ruptures during germination. Scale bar = 50 µm.

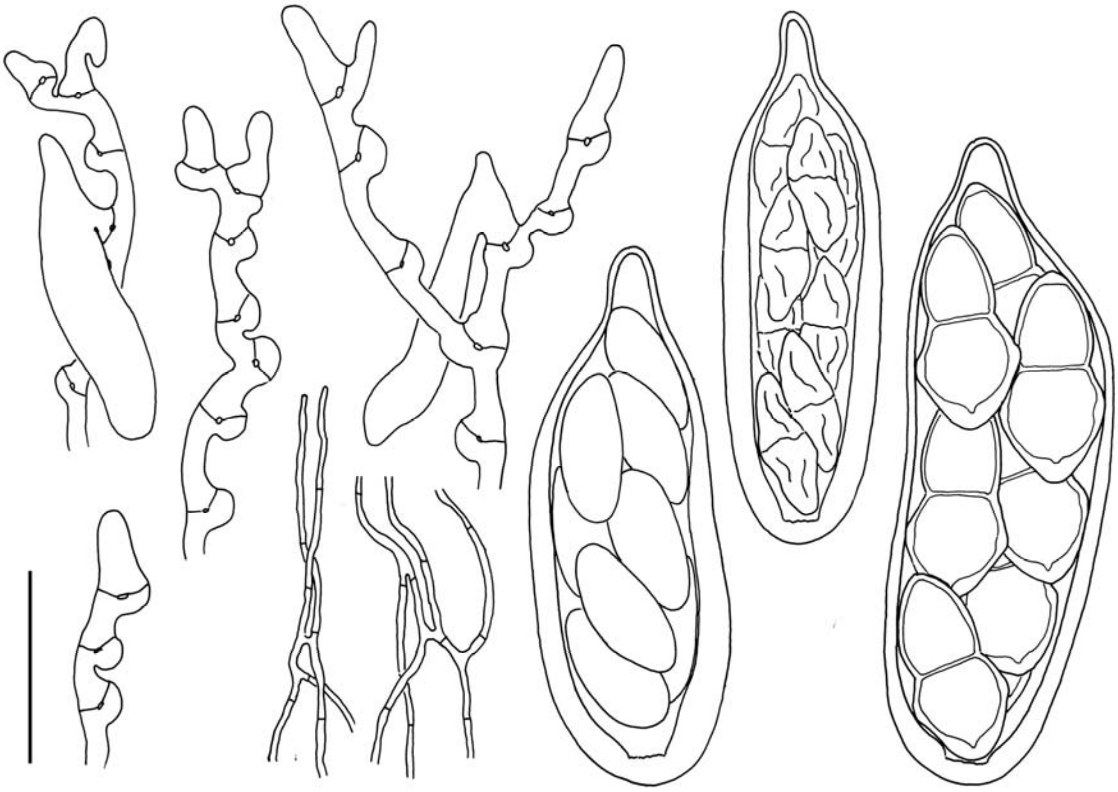

Figure 3.86: Ascogenous hyphae and young asci of *Maublancia uleana* (ppMP 1206). Asci develop on proliferating croziers and form a hooked base, filamentous and anastomosing interascal tissue is situated between the asci. Scale bar = 30 µm.

Specimens examined: BRAZIL. Syntypes of *Seynesia megas*, see above. **Matto Grosso:** Type of *Seynesia* var. *macrospora*, see above. **PANAMA. Chiriquí Province:** Los Algarrobos, border of Majagua river, ca. 140 m a.s.l., epiphyllous on *Myrica splendens* (det. M. Piepenbring), 10 Jan. 2007, *T. Trampe, T.A. Hofmann & R. Mangelsdorff ppMP 1206* (M-0141035; PMA). **PUERTO RICO. San Germán:** Syntypes of *Asterina myrciae*, see above. **Maricao:** epiphyllous on *Myrcia splendens*, 19 Jul. 1915, *F.L. Stevens 8831* (BPI 690101, labeled as *Asterina myrciae*) **Mayagüez:** Mesa, epiphyllous on *Myrcia splendens*, 25 Jun. 1915, *F.L. Stevens 7473* (BPI 690102, 690103, labeled as *Asterina myrciae*), same locality and host plant, 29 Jun. 1915, *F.L. Stevens 7561* (BPI 690104, labeled as *Asterina myrciae*). **VENEZUELA. Bolívar:** road between El Dorado and Santa Elena, 203-204 S of El Dorado, on Myrtaceae, 7 Aug. 1972, *K.P. Dumont, R.F. Cain, G.J. Samuels & C. Blanco Dumont-VE 7293* (BPI 691050, labeled as *Caudellopeltis eugeniae*).

Notes. *Maublancia uleana* is characterized by unique two-celled appressoria developing in the axils of branching surface hyphae (Fig. 3.85f). The first appressorial cell is located in the axils, whereas the second one develops on top of or lateral from the first cell. Each appressorium contains a central penetration pore, but the pore of the lower and older cell appears more conspicuous.

When Pazschke (1892) described the basionym *Asterina uleana* he recognized the two-celled appressoria. Theissen (1912c) illustrated the appressoria but disagreed with Pazschke and interpreted the structures as ascoma initials which he termed "Brutknospen" (Theissen 1912b). Analysis of semi thin-sections of mycelia of *M. uleana* revealed that each appressorium penetrates the cuticle with a darkly pigmented tube (Fig. 3.85d). The tube grows intercellularly between epidermal cells, until it contacts a palisade mesophyll cell and penetrates it to form an inconspicuous, intracellular, hyaline haustorium-like structure.

The asci of *M. uleana* are formed on ascogenous hyphae with proliferating croziers and are connected at two points with their originating hyphae (Fig. 3.86). The ascus initial forms a hook and grows beyond the ascogenous hyphae towards the center of the ascoma. As the ascus stretches and enlarges, its narrow and hooked base is still attached to the crozier. The endotunica of the ascus thickens and eight ascospores develop in each ascus. The ascospores are two–celled and the upper cell of the ascospore has a thickened wall in its equatorial region (Fig. 3.85g). Mature ascospores become slightly pigmented and collapse very rapidly. After numerous attempts germinating ascospores could be observed. During germination the upper cell of the ascospore collapses along the region of the equatorial wall thickening (Fig. 3.85h). The lower cell germinates to form the first two-celled appressorium. Lateral outgrowths below the first appressorium generate a branched surface mycelium with axillar appressoria. Later, the lower cell of the ascospore germinates through the septum into the cavity of the upper, collapsed cell and give rise to new a appressoriate surface mycelium (Fig. 3.85h).

Ultrastructural analysis of ascomata of *M. uleana* show that the scutellum is composed of several cell layers. The uppermost scutellum cells contain cell walls with thick melanin deposits (Fig. 3.87a-c). The walls of the scutellum cells get thinner and less melanized towards the ascomatal cavity (Fig. 3.87b). The scutellum cells contain concentric bodies (Fig. 3.87b), that indicate relative longevity and dessication tolerance of the cells in which they occur (Honegger 2001). Concentric bodies are reported for the first time for a member of Microthyriaceae and a species of *Maublancia*. The lowest cells of the scutellum are hyaline and give rise to morphologically similar internal ascocarp hyphae (Fig. 3.87c). Bitunicate asci with two distinguishable cell walls are situated within the ascocarp and contain ascospores with large vacuoles (Fig. 3.87c-d).

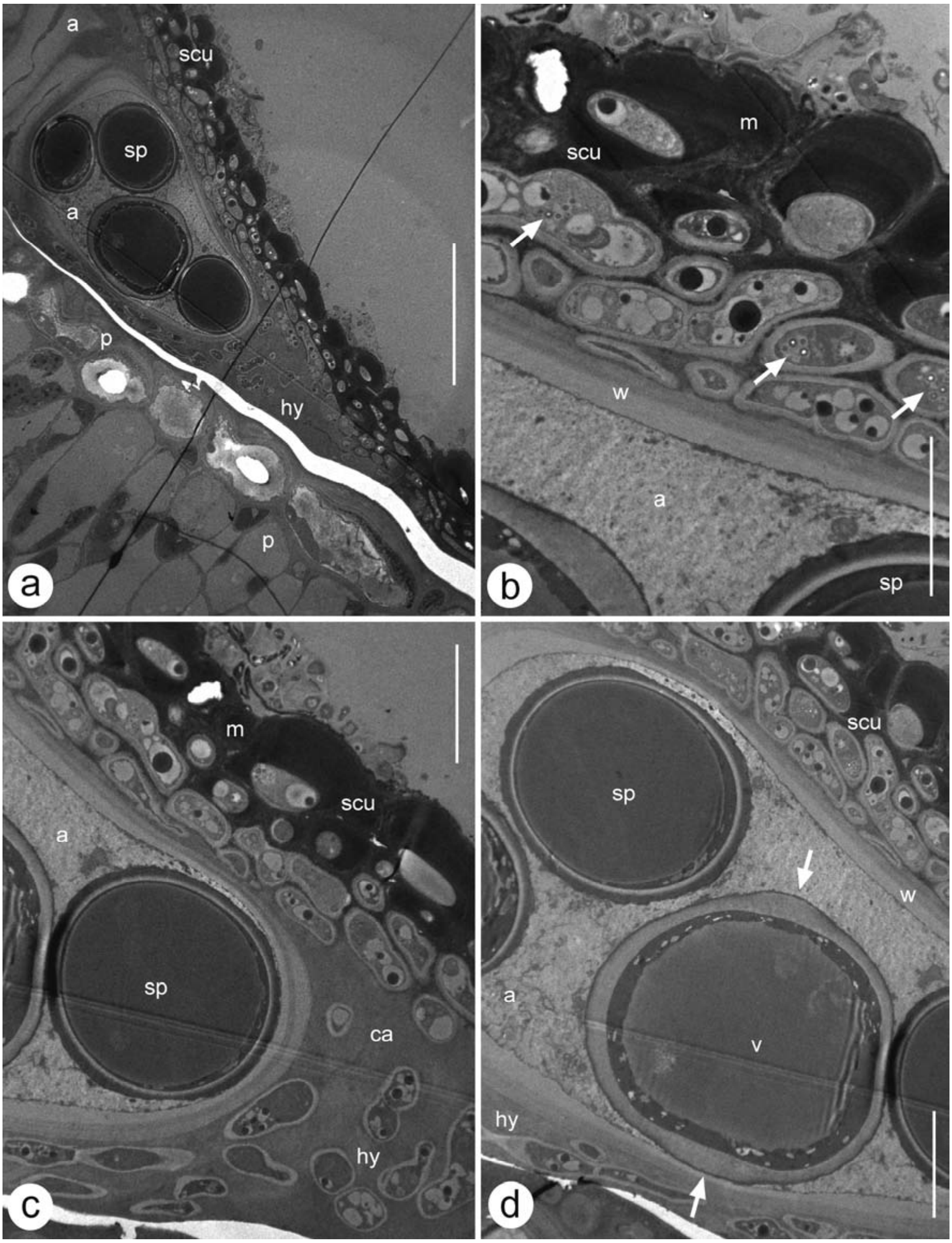

Figure 3.87: Ultrastructure of *Maublancia uleana* on *Myrcia splendens* (ppMP 1206). a: Part of ascoma on healthy plant tissue (p), with internal ascocarp hyphae (hy), bitunicate asci (a) and ascospores (sp). Scutellum layer is various cells (scu) thick. Scale bar = 20 µm. **b:** Scutellum composed of upper cells with thick melanin deposits (m) and lower cells with thinner cell walls, arrows indicate concentric bodies. Below lies a bitunicate ascus with a two-layered cell wall (w) and ascospores. Scale bar = 4 µm. **c:** Part of ascoma with scutellum cells, internal ascocarp hyphae (hy) in the ascomatal cavity (ca) and a bitunicate ascus with ascospores. Note the similarity of internal ascocarp hyphe and lower scutellum cells. Scale bar = 5 µm. **d:** Bitunicate ascus with ascospores with large vacuoles (v). Note the wall thickenings in the equatorial region of the upper cell of the ascospore (arrows). Scale bar = 5 µm.

Ryan (1924) described *Asterina myrciae* on *Eugenia* sp. and *Myrcia splendens* (Myrtaceae) from Puerto Rico. In the protolouge, Ryan (1924) described two-celled appressoria located in the axils of branching hyphae. The examination of the syntypes of *Asterina myrciae* revealed its identity with *Maublancia uleana*.

Batista et al. (1960) presented a new, monotypic genus *Caudellopeltis* with the type species *Caudellopeltis eugeniae* on *Eugenia monticola* (Myrtaceae) from Dominica, Lesser Antilles. The species was illustrated by Batista et al. (1960) and is identical with *Maublancia uleana* (Müller and Arx 1962). In the same year, Batista and Maia (1960) introduced a new species *Trichasterina myrtaceicola* on *Myrtus communis* (Myrtaceae) from Brazil. Due to the description and illustration of *T. myrtaceicola*, the species is probably identical with *Maublancia uleana*. According to Batista and Maia (1960), *T. myrtaceicola* has a setose surface mycelium. The ‘setae’ probably represent conidiophores of a hyphomycetous hyperparasite and were misinterpreted by the authors. Unfortunately, type material of *T. myrtaceicola* could not be obtained from the Herbarium (URM) in Brazil.

***Platypeltella* Petr.**

in Sydow and Petrak, Ann. Mycol. 27(1/2): 62 (1929)

= *Asterinopeltis* Bat. & H. Maia, in Batista et al., Rev. Biol. Lisboa 1(3-4): 293 (1958). Type: *A. pulcherrima* Bat. & H. Maia

[synonymy according to Arx and Müller (1975)]

Type species: *P. smilacis* Petr.

Colonies superficial on living leaves, black. *Surface mycelium* present, hyphae septate, branched, brown. *Appressoria* intercalary, swollen and node-like, with a complex central penetration apparatus. *Haustoria* absent, penetration peg present, thumbtack-like, black. *Thyriothecia* superficial, circular, dimidiate, dark, develop lateral from surface mycelium, open with irregular central pores. *Scutellum* radiate, composed of rows of synchronal and dichotomously branching cells forming a continuous plate of cells, one cell layer thick, cells isodiametrical, cylindrical to irregularly meandrical. *Asci* elongated, ellipsoidal to cylindrical, bitunicate, 8–spored, hyaline, inclined towards center of ascoma, center sometimes with a column of septate pseudo?paraphyses or interascal tissue absent. *Ascospores* 2– or 3(–5)–celled, ellipsoidal, first hyaline, pale brown when fully mature, collapse during germination. *Anamorphs* absent.

Notes. The genus *Platypeltella* Petr. includes three species that occur exclusively on neotropical monocots (Farr 1982). The type species *P. smilacis* occurs on *Smilax* sp. (Smilacaceae) from Costa Rica (Sydow and Petrak 1929). The two other species are *P. angustispora* on *Chamaedorea* sp. (Arecaceae) from Mexico (Farr and Pollack 1969) and *P. irregularis* on *Puya* sp. (Bromeliaceae) from Colombia (Farr 1982).

Platypeltella spp. are characterized by surface mycelia with intercalary appressoria. Each appressorium forms a complex penetration apparatus visible as a three-dimensional central hemispherical structure. The dimidiate thyriothecia contain elongated asci, arranged in a ring around the center of the ascoma. Some species form a column of sterile filamentous hyphae (pseudo?paraphyses) in the center of the ascocarp, e.g. *P. irregularis*. The ascomata open with central pores or delimited star-shaped fissures, that develop due to the breakdown or disintegration of central scutellum cells. The ellipsoidal ascospores are 2–3–(rarely 1–)celled, become light brown at maturity and collapse rapidly during germination.

A remarkable feature of species of *Platypeltella* is the morphology of the intercalary appressoria. Each appressorium forms a central three-dimensional hemispherical structure enclosing a disc with a central penetration pore (top view, Fig. 3.88e, 3.90g, 3.91j). From the disc a pigmented penetration peg is protruded into the host cuticle (Fig. 3.88d, 3.90h). Farr (1982) describes the apressorial cell with its cuticular projection similar to a thumbtack in profile. In accordance with Farr (1982), I could not observe a deeper penetration of epidermal or subepidermal host tissue, either in semi-thin cuts or by ultrastructural analysis (Fig. 3.91, 3.95). The fungus probably takes up nutrients from its host through the penetration peg or the pegs function in keeping the colony attached to the substrate. When Petrak erected the new genus *Platypeltella* he did not recognize the intercalary appressoria with the special penetration apparatus (Sydow and Petrak 1929). In the protolouge, the surface mycelia were described without appressoria but with nonfunctional node-cells (Sydow and Petrak 1929).

Saccardo and Berlese (1885), described and illustrated *Asterina myocoproides,* a species that is morphologically very similar to the type species of *Platypeltella, P. smilacis*. *A. myocoproides* and its synonyms were discussed in detail before (see notes of the genus description of *Asterolibertia*). *A. myocoproides* probably has to be placed in synonymy with *Platypeltella smilacis*. However, type material of *A. myocoproides* could not be obtained until the end of this study

Farr and Pollack (1969) assume that *Platypeltella* corresponds in all aspects with the didymosporous genus *Asterolibertia* (Asterinaceae) except in ascospore septation. *Asterolibertia* spp., however, are characterized by surface mycelia with intercalary appressoria without a complex penetration apparatus, globose asci that develop more or less vertical with in the ascoma and darkly pigmented 2-celled ascospores. Species of *Platypeltella* differ in some major aspects from *Asterolibertia* spp. and other genera of thyriothecioid ascomycetes with intercalary appressoria, especially in development and morphology of the elongated asci, their inclined position within the ascoma and the slightly pigmented, fragile ascospores. *Platypeltella* belongs to the family Microthyriaceae (Arx and Müller 1975). The genus can be easily determined and segregated from other thyriothecioid ascomycetes, even if bad developed material without fertile elements is analysed, because of the special penetration apparatus of the intercalary appressoria

Key to species of *Platypeltella* collected in Western Panama:

1 appressoria less than 15 µm wide, interascal tissue present.................. *P. irregularis*
1* appressoria more than 15 µm wide, interascal tissue absent .... *P. smilacis*

Platypeltella irregularis **M.L. Farr, Mycotaxon 15: 448 (1982).**

Figs. 3.88, 3.89

Type on *Puya* sp. (Bromeliaceae). Colombia, Cundinamarca, Paramo de Cruz Verde, road between Bogotá and Choachí, 2 Jul. 1974, *K.P. Dumont, J.H. Haines & J.M. Idrobo Dumont CO-513* (holotype, BPI 691029!; isotype, NY n.v.).

Colonies amphigenous, irregularly circular, single, later confluent and cover large leaf parts, 1–20 mm diam. (*n*=10), black. *Surface hyphae* straight, rigid, rarely curved, branching unilateral or opposite, dark brown, in KOH blackish, hyphal tips paler, septate, septum conspicuous, sometimes septal porus visible, hyphal cells exclusively cylindrical, (4)7–19(27.5)×4–5(6) µm (*n*=50), cell wall up to 1 µm thick, smooth. *Appressoria* numerous, intercalary, node-like, swollen, wider than mycelial cells, (8)9–14(20)×(7.5)8–10(11) µm (*n*=50), with a central hemispherical structure (4.5–5.5 µm diam.) surrounding the small penetration pore (1–1.5 µm diam.), brown, in young appressoria hemispherical structure not completely developed. *Haustoria* or intracellular hyphae absent, penetration peg intraparietal, intracuticular, thick-walled, brown. *Thyriothecia* superficial, develop terminally on lateral hyphae, irregular cirular in outline, dimidiate, single or confluent, margins deeply fringed, (200)272–398(460) µm diam. (*n*=50), brown, paler than surface hyphae, open with a central pore, (9)10–17(18) µm diam. (*n*=10). *Scutellum* radiate composed of dichotomously branched filaments, scutellum cells isodiametrical to cylindrical in the center, straight, becoming undulating to meandrical towards the ascoma margin, (3.5)6–11(13)×3–5(6.5) µm, longer at margins, brown, at margins and in the center paler. *Asci* numerous, elongated, cylindrical, without ocular chambers, bitunicate, I–, (79)81–104(120)×(12)14–16(17) µm, 8–spored, hyaline, with conspicuous thickened endotunica in the apex, develop on ascogenous hyphae with proliferating croziers, attached at three points with originating hyphae, inclined towards the center of the ascocarp, pseudo?paraphyses present, cluster in central column below ascoma pore, filamentous, septate, originate from basal hyphae of the ascocarp, up to 5 µm broad, hyaline. *Ascospores* 2–4, rarely 5–celled, elliptical,

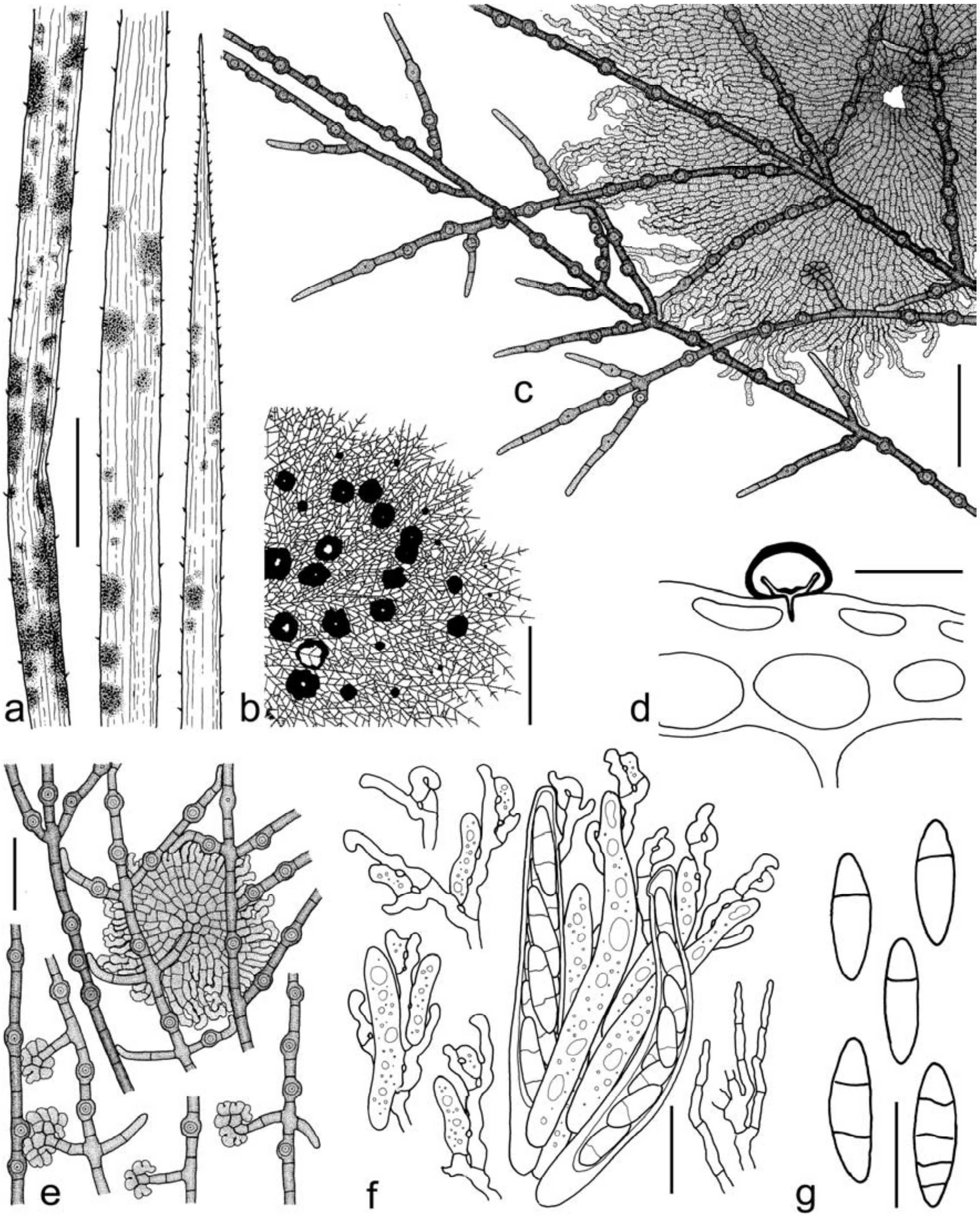

Figure 3.88: ***Platypeltella irregularis*** **on** ***Greigia sylvicola*****. a:** Infected leaves (ppMP 567). Scale bar = 3 cm. **b:** Part of the colony with thyriothecia and surface mycelium (ppMP 567). Scale bar = 1 mm. **c:** Part of a young thyriothecium with central ostiole and surface mycelium with intercalary appressoria (ppMP 406). Scale bar = 50 µm. **d:** Cross section through an appressorium with a thumbtack-like projection into the cuticle (ppMP 567). Scale bar = 20 µm. **e:** Surface mycelium with intercalary appressoria and ascoma initials (ppMP 406). Scale bar = 30 µm. **f:** Asci and ascogenous hyphae with proliferating croziers. Septated pseudo?paraphyses of ascocarp center on the lower right. (TH 558). Scale bar = 25 µm. **g:** Liberated, hyaline ascospores (TH 406). Scale bar = 10 µm.

ends slightly acuminate, first septum in upper third of spore, not constricted at septum, (22)23–26(29)×6–8(9) µm, hyaline to pale brown, smooth, collapsing early, germination of ascospores not observed. *Anamorph* absent.

Illustrations. In Farr (1982) and this contribution. The development of the asci and the ultrastructure of the penetration pegs of *P. irregularis* are illustrated here for the first time (Figs. 3.88, 3.89).

Hosts. Bromeliaceae: *Puya* sp. and *Greigia sylvicola* Standl. *Greigia* is is a new host genus and *G. sylvicola* is a new host species for *P. irregularis*.

Known distribution. Neotropical: Central America (Panama) and South America (Brazil, Colombia). *P. irregularis* is a new record for Central America and Panama. The species occurs in Western Panama in humid mountain rainforest of higher altitudes at approx. 2550 m a.s.l.

Specimen examined. **COLOMBIA. Cundinamarca:** holotype, see above. **PANAMA. Chiriquí Province:** Parque International La Amistad (PILA), Cerro Picacho, ca. 2550 m a.s.l., amphigenous on *Greigia sylvicola* (det. R. Mangelsdorff and M. Piepenbring), 12 Oct. 2005, *T.A. Hofmann, R. Mangelsdorf & M. Piepenbring ppMP 406* (M-0141036; PMA); same locality and host species, 10 Apr. 2006, *T.A. Hofmann, M. Piepenbring & T. Trampe ppMP 567* (M-0141037; PMA); same locality and host species, 2 Jul. 2006, *T.A. Hofmann, R. Mangelsdorff & T. Trampe ppMP 1139* (M-0141038; PMA); same locality and host species, 25 Sep. 2007, *T.A. Hofmann 558* (FR; PMA).

Notes. Mature ascospores of *P. irregularis* collapse rapidly during germination and, therefore, could not be observed in the material from Panama and Colombia. *P. irregularis* differs in some major aspects from *P. smilacis*, the type species of the genus *Platypeltella*. *P. irregularis* forms significantly longer and slender asci that are inclined towards the center of the ascomata. The center is filled by a mass of sterile and septated pseudoparaphyses that arise from basal ascocarp cells. Ascocarps of *P. smilacis* lack any hamathecial structures between the ascogenous hyphae. Additionally, *P. irregularis* has smaller appressoria, narrower surface hyphae and the ascospores are slightly shorter.

Ascus development of *P. irregularis* is similar to the one of *P. smilacis* and is discussed and illustrated in detail later (Fig. 3.91, see notes of *P. smilacis*).

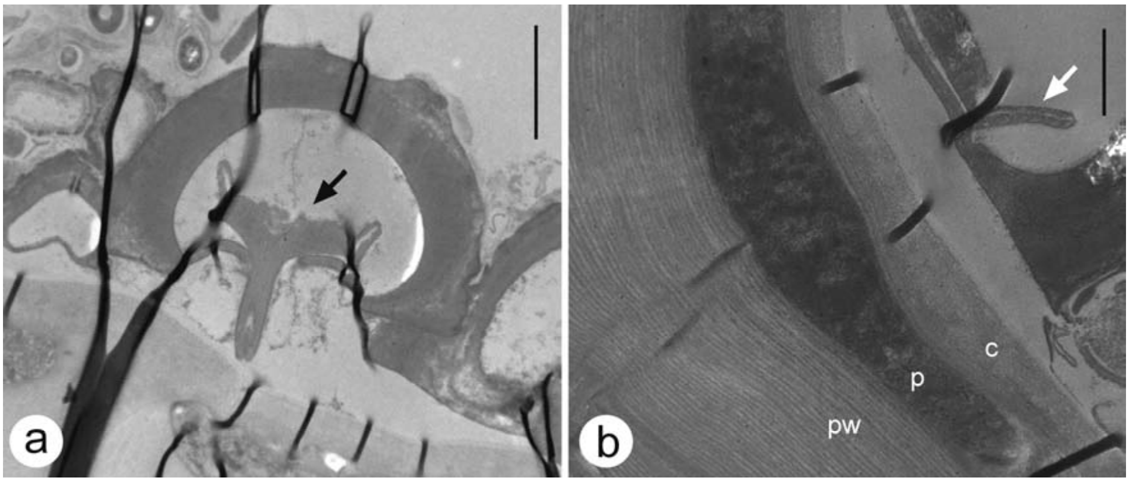

Figure 3.89: Ultrastructure of *Platypeltella irregularis* (ppMP 567). a: Cross section through an appressorium with thumbtack-like penetration peg (arrow). Scale bar = 2 µm. **b:** Lower part of appressorium with penetration apparatus (arrow) and adjacent plant tissue showing a thin cuticule (c) and a flattened epidermal plant cell (p). Note the banded pattern of the lower plant cell wall (pw). Scale bar = 1 µm.

Platypeltella smilacis **Petr., in Sydow and Petrak, Ann. Mycol. 27(1/2): 62 (1929). Figs. 3.90-3.94**

Type on *Smilax* sp. (Smilacaceae). Costa Rica, Alajuela Province, San Pedro de San Ramon, 8 Jan. 1927, *A.M. Brenes 257* (holotype, W n.v.).

Colonies amphigenous, irregularly circular, single, later becoming confluent and cover large leaf parts, 0.5−6 mm diam. (*n*=10), black. *Surface hyphae* straight, sometimes slightly curved, branching opposite, alternate or unilateral, brown to dark brown or blackish, hyphal tips paler, septate, hyphal cells cylindrical, (13)20−40(48)×7−9(11) µm, cell wall 0.5−1.5 µm thick, smooth. *Appressoria* numerous, intercalary, node-like, swollen, wider than mycelial cells, (11)16−26(36) ×(16)17−20(23) µm, with a central three-dimensional hemispherical structure (7.5−9 µm diam.) surrounding the small penetration pore (0.5−1 µm diam.), brown to dark brown or blackish. *Haustoria* or intracellular hyphae absent, penetration peg intraparietal, intracuticular, thick-walled, black. *Thyriothecia* superficial, develop terminally on lateral hyphae, irregularly circular in outline, dimidiate, single or confluent, margins deeply fringed, (240)275−352(400) µm diam., brown, paler than surface hyphae, open with central pore-like fissures. *Scutellum* radiate, composed of dichotomously branched filaments, scutellum cells isodiametrical to cylindrical, straight, slightly lobed towards the margin of ascoma, (5)7−15(20)×(4)5−7(8) µm, at margins up to 45 µm long, brown, hyphae at margins sometimes form appressoria. *Asci* broadly ellipsoidal, ovate or cylindrical, base acuminate, apex broadly rounded, with small ocular chambers, bitunicate, I–, (67)69−82(90)×(20)21−26(30) µm (*n*=21), 8–spored, hyaline, with conspicuous thickened endotunica, develop on ascogenous hyphae with proliferating croziers, attached at three points with originating hyphae, inclined towards center of ascoma, interascal tissue absent. *Ascospores* 2–3 celled (rarely 1–celled), ellipsoidal to ovate, upper end broadly rounded, lower end slighty acuminate, if 2–or 3–celled constricted at first septum in upper ¼ of spore, not or slightly constricted at second septum in lower 1/2 of spore, (23)25−30(34)×11−13(14) µm, hyaline to pale brown, cell wall up to 1 µm thick, smooth, cells collapse early, germinate first at the distal part of the upper or lower cell with a thick-walled, dark-brown and stalked appressorium, which initiates the growth of the surface mycelium. *Anamorph* absent.

Illustrations. In Saccardo and Berlese (1885) as *Asterina mycocoproides*, Batista and Maia (1960) as *Wardina myocoproides*, Farr (1982) and this contribution. Ascus development, germinating ascospores and the ultrastructure of appressoria and a young ascoma of *P. smilacis* are illustrated here for the first time (Figs. 3.90.-3.94).

Hosts. Bromeliaceae: *Guzmania plumieri* Mez. **Smilacaceae:** *Smilax* sp.

Known distribution. Neotropical: Caribbean (Dominica), Central America (Costa Rica, Panama) and South America (Brazil). *P. smilacis* is a new record for Panama and occurs in Western Panama in humid mountain rainforest at about 1200 m a.s.l.

Specimens examined. BRAZIL. Santa Caterina State: Isola S. Francisco, on Bromeliaceae, *E. Ule 87* (S F114235, labeled as *Asterolibertia myocoproides*). **DOMINICA. St. Peter:** summit of Morne Diablotins, elfin woodland, alt. 4500-4600 ft., on *Guzmania plumieri*, 28 Jan. 1966, *M.L. Farr 2405* (BPI 1108576, labeled as *Asterolibertia myocoproides*). **PANAMA. Chiriquí Province:** Fortuna, ca. 5 km before Lake Fortuna, mountain rain forest, 1240 m a.s.l., amphigenous on *Smilax* sp. (det. T.A. Hofmann), associated with *Phycopeltis* sp. (Trentepohliales), 22. Sep 2007, *V. Araúz, T.A. Hofmann & M. Piepenbring ppMP 1346* (M-0141039, PMA).

Additional specimens examined. *Platypeltella irregularis* M.L. Farr COLOMBIA. Cundinamarca: Paramo de de Cruz Verde, road between Bogotá and Choachí, on *Puya* sp., 2 Jul. 1974, *K.P. Dumont, J.H. Haines & J.M. Idrobo CO-513* (holotype, BPI 691029). **PANAMA. Chiriquí Province:** Parque International La Amistad (PILA), Cerro Picacho, ca. 2550 m a.s.l., amphigenous on *Greigia sylvicola* (det. T.A. Hofmann), 10 Apr. 2006, *T.A. Hofmann, M. Piepenbring & T. Trampe ppMP 567* (M-0141089; PMA).

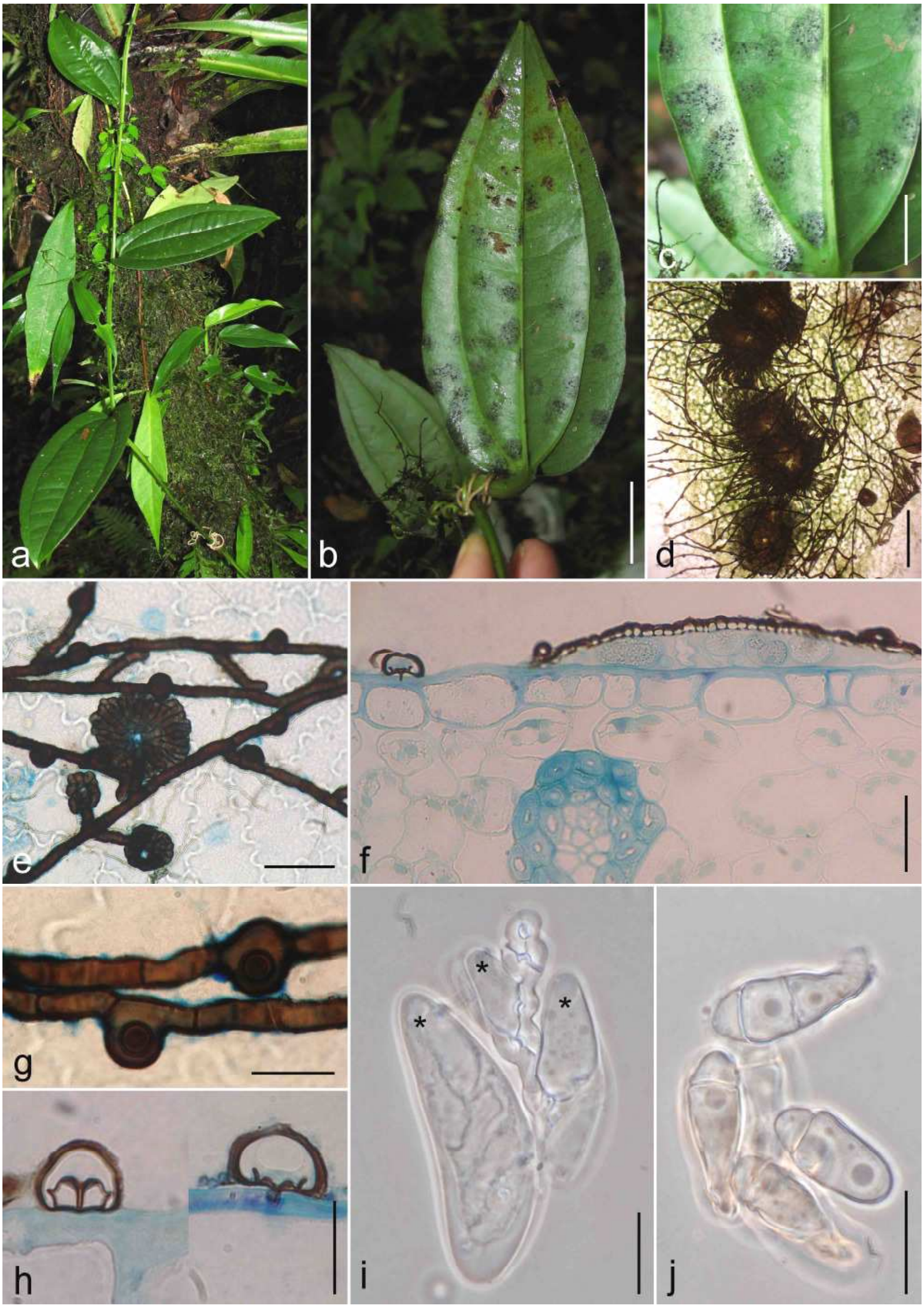

Figure 3.90. Photographs of *Platypeltella smilacis* on *Smilax* sp. (ppMP 1346). a: Habit of the host plant. **b:** Abaxial side of a leaf with numerous colonies. Scale bar = 2 cm. **c:** Part of a living leaf with colonies. Scale bar = 1 cm. **d:** Part of a single colony with surface mycelium and thyriothecia. Scale bar = 300 µm. **e:** Surface mycelium with intercalary appressoria and laterally developing ascoma initials. Scale bar = 50 µm. **f:** Cross section through an appressorium (left) and a thyriothecium (right) and host plant tissue. Scale bar = 30 µm. **g:** Surface mycelium with intercalary appressoria with central hemispherical structure. Scale bar = 20 µm. **h:** Cross section throught appressoria. Scale bar = 15 µm. **i:** Asci (asterisk) and ascogenous hyphae. Scale bar = 20 µm. **j:** Ascospores, some of them germinating. Scale bar = 20 µm.

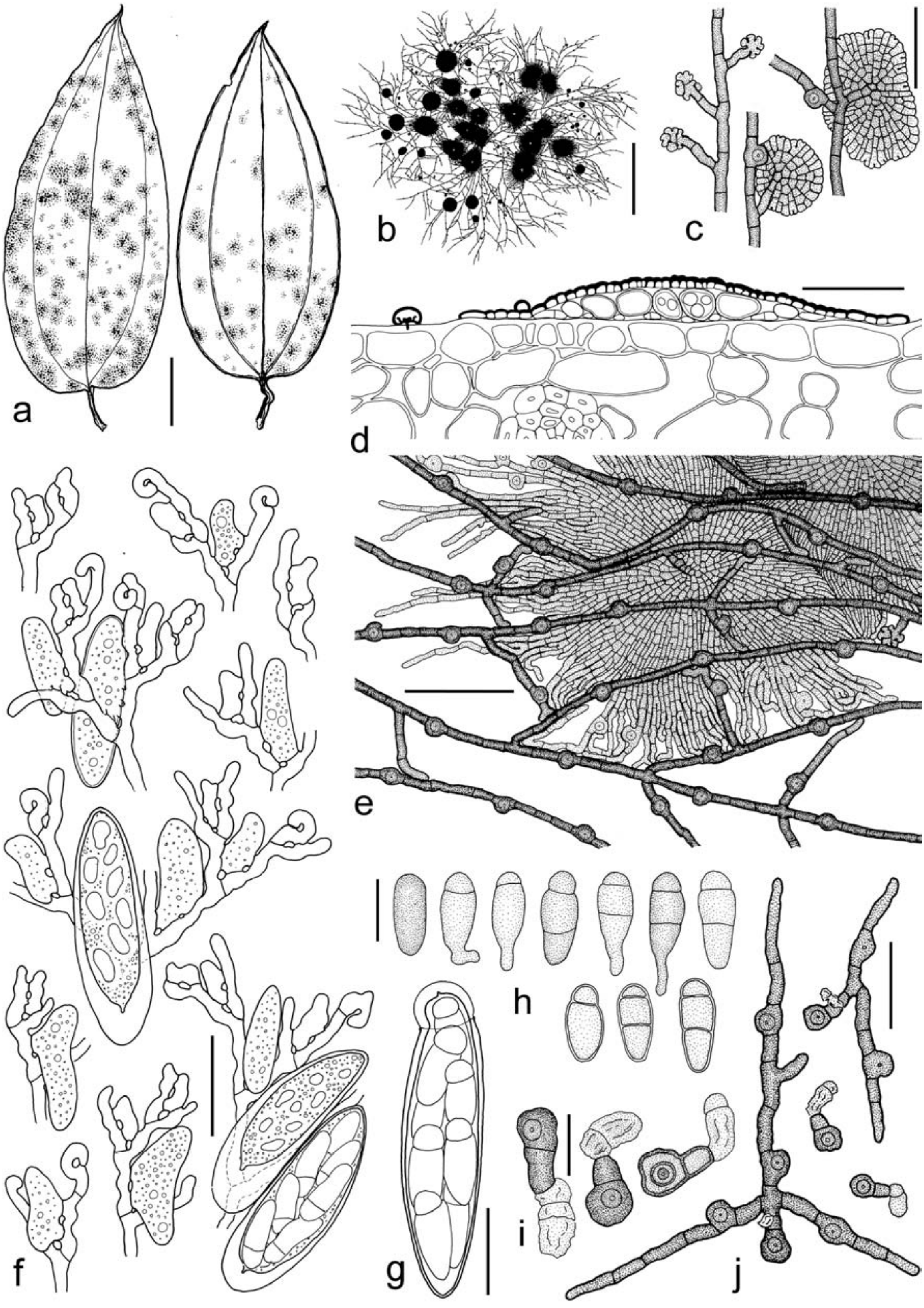

Figure 3.91: *Platypeltella smilacis* on *Smilax* sp. (ppMP 1346). a: Infected leaves. Scale bar = 2 cm. **b:** Entire colony with thyriothecia and surface mycelium. Scale bar = 1 mm. **c:** Surface mycelium with intercalary appressoria and ascoma initials. Scale bar = 60 µm. **d:** Cross section through a young thyriothecium and an appressorium. Scale bar = 25 µm. **e:** Young, confluent thyriothecia and surface mycelium with intercalary appressoria. Scale bar = 100 µm. **f:** Asci and ascogenous hyphae with proliferating croziers. Scale bar = 30 µm. **g:** Mature ascus. Scale bar = 25 µm. **h:** Mature ascospores, some of them germinating. Scale bar = 20 µm. **i:** Germinating ascospores with first appressorium, note collapsing ascospore cell walls. Scale bar = 25 µm. **j:** Germinating ascospores and young surface mycelia, with remnants of cell walls of collapsed ascospores. Scale bar = 50 µm.

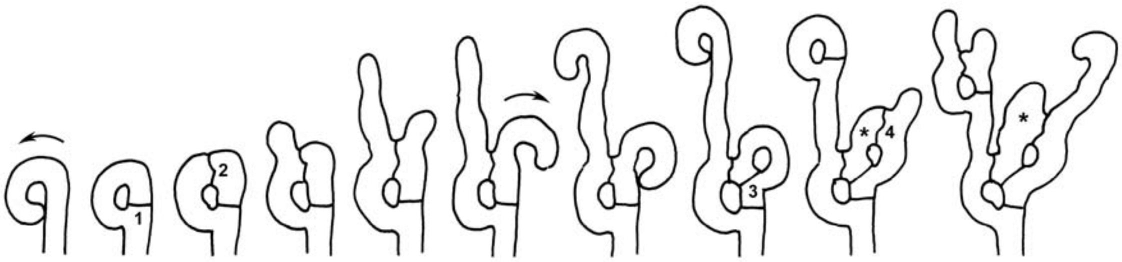

Figure 3.92: Sequence of ascus development of *Platypeltella smilacis* on ascogenous hyphae with proliferating croziers. Formation of two subsequent, contrariously orientated hooks (arrows) together with four consecutive septation events (1-4) lead to the generation of an ascus initial (asterisk) that is attached at three points to the ascogenous hyphae.

Notes. Ascus development in *P. smilacis* is initiated with the formation of a hook at the tip of an ascogenous hyphae (Fig. 3.92). The hook fuses with its originating hyphae and a septum is formed right above the point of fusion and in the middle of the formed crozier a small hole remains. Later a second septum is formed in the apical region of the crozier. The upper part of the crozier, now separated by the second septum, proliferates on both sides of the septum. One proliferating part forms a new hook with the same orientation as the first hook but the other proliferating part forms a second hook that is contrariously orientated to the first one. The second contrarious hook fuses laterally with the margin of the first hook and a third septum is formed right above the point of fusion. The resulting second crozier now develops the fourth septum in its apical part, similar to the septation mechanism of the first crozier. The upper part of the second crozier, now separated by the fourth septum, again proliferates and further hooks are formed on one side. As a result, a cell was generated between the two croziers, that is connected to them at three points. This cell represents the ascus initial that elongates and streches, whereas the ascogenous hyphae on both sides of the ascus grow further and produce new proliferating croziers. The growing ascus stretches beyond the hyphae and orientates its apex towards the ascoma center and its free base towards to the ascoma margin (Fig 3.91f). The ascus grows further and the endotunica enlarges especially in the apical part of the ascus.

The ascus development of *P. smilacis* is apparently unique among ascomycetes, because the ascus develops on two proliferating but contrariously orientated croziers and is laterally connected at three points to its originating ascogenous hyphae. This type of development is reported here for the first time and is unknown for any other ascomycetous fungus so far. Members of ascomycetes are known to generate ascus

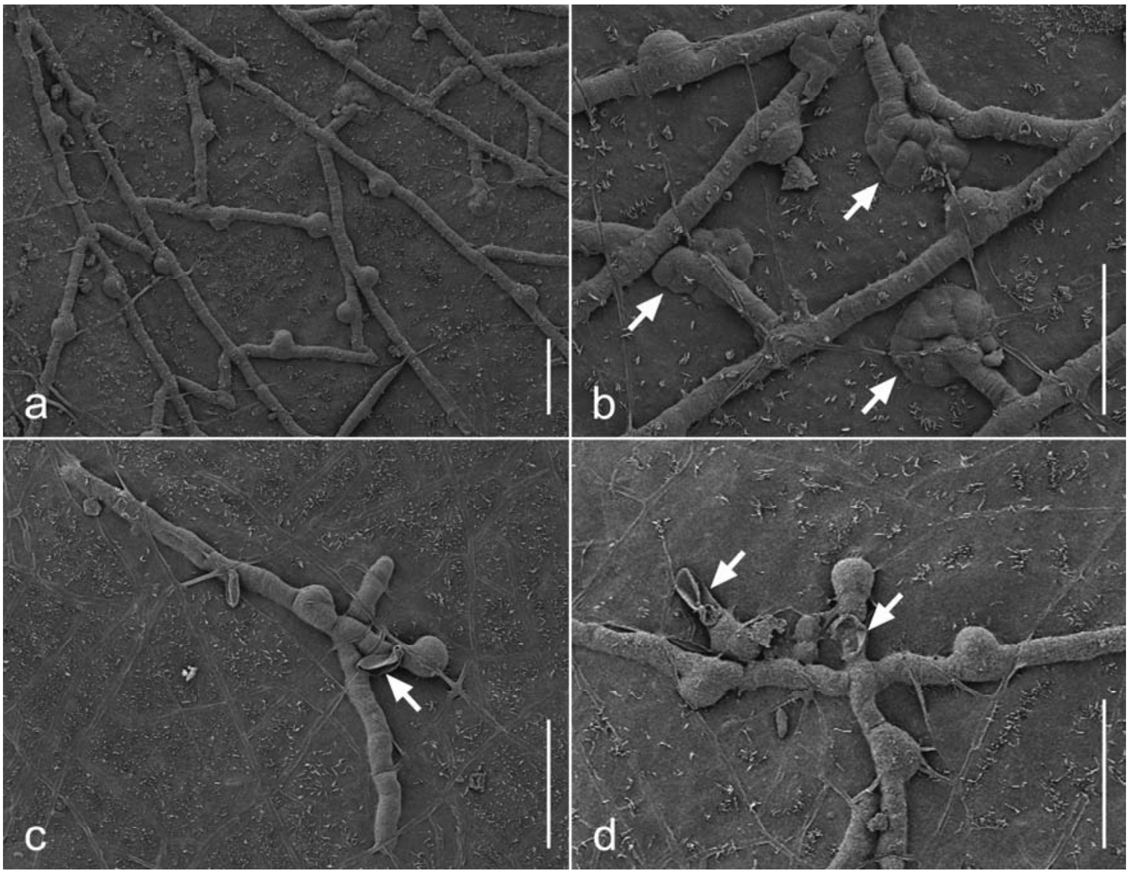

Figure 3.93: SEM photographs of *Platypeltella smilacis* on *Smilax* sp. (ppMP 1346). a-d: Scale bar = 50 µm. **a:** Surface mycelium with intercalary, swollen appressoria. **b:** Surface mycelium with lateral ascoma initials (arrows). **c-d:** Surface mycelium and remnants of cell walls of collapsed ascospores (arrows).

initials that are connected at two points with the originating crozier (Gäumann 1964, Wilson 1952). The additional third connection present in developing asci of *Platypeltella* spp. is probably crucial for the correct orientation of the ascus within the dimitate ascoma. The ascomata of *P. smilacis* do not contain any hamathecial tissue.

The ascospores of *P. smilacis* are fragile and collapse during germination. Each ascospore germinates with a stalked appressorium, with both stalk cells and appressoria with conspicuous thick cell walls and with darker pigmention than the ascospore. The cytoplasm of the ascospore moves through the stalk cell into the appressorium and the ascospore collapes. From the basal part of the stalk cell a dark brown surface mycelium develops. The morphology of germinating ascospores of *P. smilacis* and their connection to the surface mycelium is reported and illustrated here for the first time (Fig. 3.91h-j).

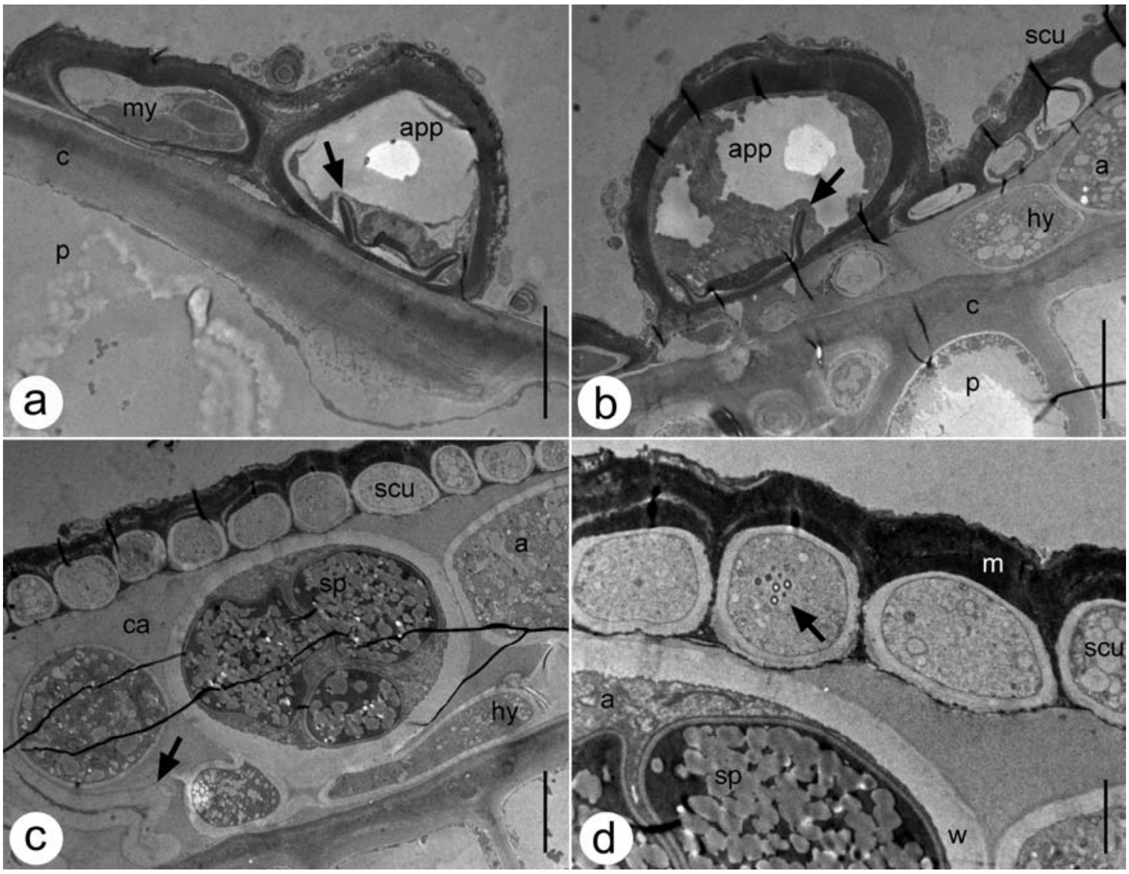

Figure 3.94: Ultrastructure of *Platypeltella smilacis* (ppMP 1346). a: Surface hyphae (my) and adjacent appressorium (app) with the disc-shaped part (arrow) of the central penetration apparatus (penetration peg not in the same plain). Note the thickening of the cuticule (c) and the slight emargination of the plant cell (p) below the appressorium. Scale bar = 5 µm. **b:** Appressorium (app) with the disc-shaped part of the penetration apparatus (penetration peg in another plain) and part of a thyriothecium with scutellum cells (scu), internal hyphae (h) and asci (a). Scale bar = 5 µm. **c:** Part of a thyriothecium, with one layer of scutellum cells (scu) and immature asci (a) that develop above the ascogenous hyphae (hy). One ascus contains ascospores (sp) and one ascus collapsed (arrow). Scale bar = 5 µm. **d:** Scutellum cells with thick melanin deposits (m) and concentric bodies (arrow). Below lies an ascus (a) with ascospores (sp). Note the structurally different contents of the ascospore cytoplasm and the simple ascus walls (w). Scale bar = 2 µm.

The complex penetration apparatus of *Platypeltella smilacis* is equal to the one found in *P. irregularis* (Fig. 3.94). In both species, the appressoria form basal disc-shaped structures that are attached to the cuticule of the host plant (Fig. 3.94a-b). From these discs penetration pegs enter the cuticule, but do not penetrate deeper host plant tissue. The scutellum of *P. smilacis* is composed of a single layer of scutellum cells with thick melanin deposits at the upper cell walls (Fig. 3.94c-d). The lower cell walls of the scutellum cells are almost not melanized and the cells contain concentric bodies (Fig. 3.94d). This is the first report of concentric bodies in cells of species of *Platypeltella*. Downwards divinding scutellum cells were not observed in the ascomatal cavity. The flat ascoma is filled with horizontally positioned asci that develop above the ascogenous hyphae (Fig. 3.94c). The walls of the asci become thicker during maturity, although they remain undifferentiated without a visible ecto- or endotunica (Fig. 3.94c-d).

Asterina myocoproides is probably a synonym of *Platypeltella smilacis*. Examined specimens from BPI and S labeled as *A. myocoproides* are identical with *Platypeltella smilacis*. *A. myocoproides* was disscussed in detail before (see notes of the genus description of *Asterolibertia*).

Xenostomella Syd.

Ann. Mycol. 28: 130 (1930)

= *Plochmothea* Syd., Ann. Mycol. 37: 395 (1939). Type: *P. monninae* Syd.

[synonymy according to Arx and Müller (1975)]

Type species: *X. tovarensis* Syd.

Colonies superficial on living leaves, black. *Surface mycelium* present, hyphae septate, branched, brown. *Appressoria* lateral, lobed or entire, unstalked, with a penetration pore. *Haustoria* absent. *Hypostromata* present, multicellular, composed of coiled hyaline hyphae, penetration hyphae subcuticular or intercellular, hypostromata intracellular. *Ascomata* superficial, uni- or multilocular, dimidiate, irregularly circular, confluent, dark, develop below surface mycelium, open with irregular central fissures above each locule. *Scutellum* not radiate, composed of irregularly coiled and interwoven cells, several cell layers thick, cells irregularly cylindrical to irregularly meandrical or epidermoidal. *Asci* elongated, clavate to broadly ellipsoidal, bitunicate, 8–spored, hyaline, develop vertical or inclined towards a center of sterile, filamentous pseudoparaphyses. *Ascospores* 2–celled, ellipsoidal, first hyaline, pale brown when mature.

Notes. The genus *Xenostomella* was introduced by Sydow (1930) with the type species *X. tovarensis* Syd. on *Lycianthes xylopiifolia* (Solanaceae) from Venezuela. *Xenostomella* is characterized by dark multilocular ascomata that develop below a brown, appressoriate surface mycelium. The appressoria give rise to infectious penetration hyphae that generate intercellular hypostromata composed of coiled hyphae in the epidermis and mesophyll cells of the host plant. Within the ascomata develop elongated asci in confluent locules between pseudoparaphyses and produce 2−celled, light brown ascospores. Each locule of the ascoma opens with central irregular fissures due to the breakdown or disintegration of central scutellum cells.

Sydow (1930) assigns the genus *Xenostomella* to the Polystomellaceae due to the presence of multilocular ascomata. Müller and Arx (1962) place the genus in the Microthyriaceae because of the structure and opening mechanism of the locules of the ascomata, the cylindrical, inclined asci and the 2−celled ascospores. According to Hansford (1946), *Xenostomella* belongs to the Asterinaceae because of the presence of an appressoriate surface mycelium and the formation of epidermal and subepidermal hyphostromata, interpreted as unicellular haustoria. Today, *Xenostomella* is assigned to the Microthyriaceae (Kirk et al. 2008) and contains three species restricted to the Neotropis, *X. tovarensis* Syd., *X. monninae* (Syd.) Arx and *X. meridiensis* Toro. *X. meridiensis* was decribed by Toro (Chardon and Toro 1934) on *Miconia* sp. (Melastomataceae) from Venezuela. In 1939, Sydow described the monotypic genus *Plochmothea* with the type species *P. monninae* on *Monnina pilosa* (Polygalaceae) from Ecuador. The genus *Plochmothea*, however, corresponds in all aspects with *Xenostomella* and was synonymised with the latter by Müller and Arx (1962).

In Western Panama, we collected *Monnina xalapensis* (Polygalaceae) which was parasitized by a species of *Xenostomella*. The species was identified as *X. tovarensis* and is decribed and illustrated below.

Xenostomella tovarensis **Syd., Ann. Mycol. 28: 130 (1930).**

Figs. 3.95. 3.96, 3.97

Type on *Lycianthes xylopiifolia* Bitter (Solanaceae) [misidentified by Sydow, correct name is probably *Monnina* sp. (Polygalaceae, det. T.A. Hofmann)]. Venezuela, Aragua, Colonia Tovar, *H. Sydow 344* (type, n.v.).

Colonies epiphyllous, irregularly circular, single, sometimes confluent, conspicuous and dense, 0.5−2 mm diam., black. *Surface hyphae* irregularly undulating and zigzag-like, branching alternate or unilateral, pale brown to brown, hyphal tips paler, septate, hyphal cells cylindrical, (10)15−21(22)×(3.5)4−5(5.5) µm (*n*=34), cell wall up to 0.5 µm thick, smooth. *Appressoria* numerous, globose, lobed, with 3−5 lobes, without a stalk cell, sessile or with narrow base, alternate or unilateral, (6)7−10(13)×(6)7−10(11) µm (n=58), brown, slightly darker than mycelial cells, penetration pore 1−1.5 µm diam., in center of appressorium, lead to formation of intercellular penetration hyphae. *Haustoria* not present. *Hypostromata* present, composed of multicellular complexes of coiled and interwoven hyphae, penetration hyphae intercellular, subcuticular to subepidermal, cell complexes intracellular, epidermal or subepidermal, hyaline, fill up to ½ of infected host cell. *Ascomata* superficial, multilocular, develop below surface mycelium, irregularly circular in outline, dimidiate, confluent, irregularly fringed at margins, (280)378−679(840) µm diam. (*n*=40), dark brown to blackish, paler at the center of each locule and at margins of ascoma, open with central irregular fissures above each locule due to slimy dehiscence of central scutellum cells. *Scutellum* not radiate, composed of irregularly coiled and interwoven cells, numerous cell layers thick, scutellum cells cylindrical to irregularly meandrical or epidermoidal, brown to dark brown. *Asci* numerous, elongated, clavate to broadly ellipsoidal, with ocular chambers, bitunicate, I−, (42)48−61(68)×(16)18−23(26) µm, 8−spored, hyaline, develop on indistinct ascogenous hyphae with proliferating croziers, vertical or inclinded towards the center of the ascoma, pseudoparaphyses present. *Ascospores* 2−celled, ellipsoidal, straight, ends broadly rounded or slightly acuminate, slightly constricted at septum, sometimes slightly tapering to one end, (19)20−22 µm long, upper cell (7)8−9 µm wide, lower cell 7−8 µm wide, pale brown when mature, collapse rapidly, germinate first at the distal part of both cells with an unstalked, darkly pigmented appressorium. *Anamorph* absent.

Illustrations. In Hansford (1946), Müller and Arx (1962), Hofmann (2005) and this contribution. The ultrastructure of *X. tovarensis* is illustrated here for the first time (Fig. 3.97).

Hosts. Solanaceae: *Lycianthes xylopiifolia* Bitter (Solanaceae). I suppose that the host plant from the type specimen of *X. tovarensis* was misidentified by Sydow and represents probably a species of *Monnina* (Polygalaceae). **Polygalaceae:** <u>*Monnina xalapensis*</u> Kunth. *M. xalapensis* is a new host species of *X. tovarensis*.

Known distribution. Neotropical: Central America (Panama) and South America (Venezuela). *X. tovarensis* is a new record for Central America and Panama. The species occurs in Western Panama in humid mountain rainforests of higher elevations at approx. 2300 m a.s.l.

Specimens examined: **Venezuela. Aragua:** Colonia Tovar, on *Lycianthes xylopiifolia* [plant probably misidentified, correct name: *Monnina* sp., det. T.A. Hofmann], 19 Jan. 1928, *H. Sydow 843* (BPI 653091, S F6482). **PANAMA. Chiriquí Province:** Parque Nacional Volcán Barú (PNVB), Los Quetzales trail, ca. 2300 m a.s.l., epiphyllous on *Monnina xalapensis* (det. R. Mangelsdorff and T.A. Hofmann), 8 Feb. 2004, *B. Koch 113* (M-0141093; PMA), same locality and host species, 5 Jun. 2006, *T.A. Hofmann 456* (FR; PMA).

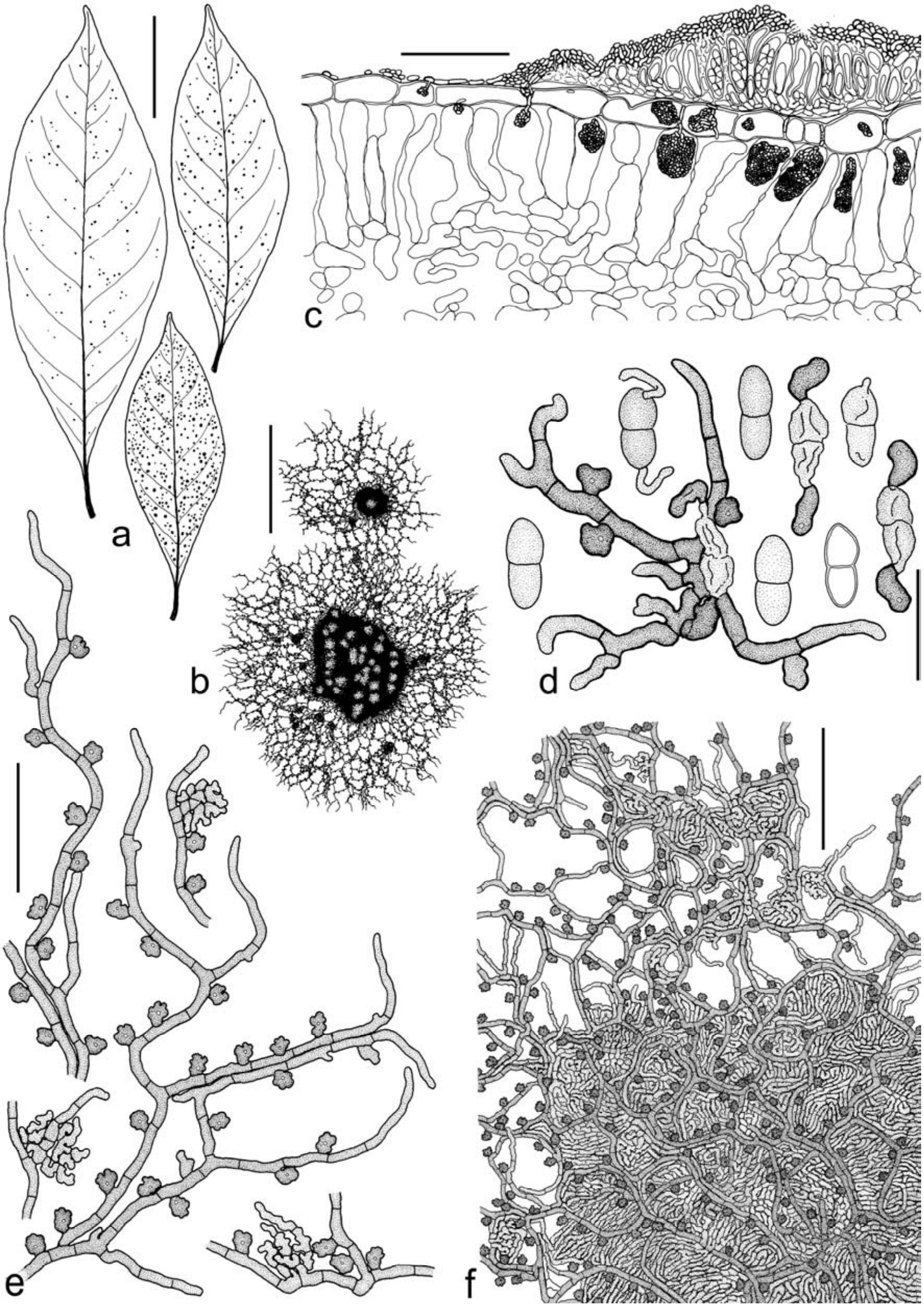

Figure 3.95: ***Xenostomella tovarensis*** **on** ***Monnina xalapensis*****. a:** Infected leaves (TH 456). Scale bar = 3 cm. **b:** Younger and older colony with confluent ascomata and surface mycelium (TH 456). Scale bar = 500 µm. **c:** Cross-section through ascomata and infected host tissue (TH 456). Scale bar = 100 µm. **d:** Mature ascospores, some of them germinating (TH 456). Scale bar = 25 µm. **e:** Surface mycelium with lateral appressoria and ascoma initials (TH 456). Scale bar = 50 µm. **f:** Part of a multiloculate stroma with surface mycelim (TH 456). Scale bar = 100 µm.

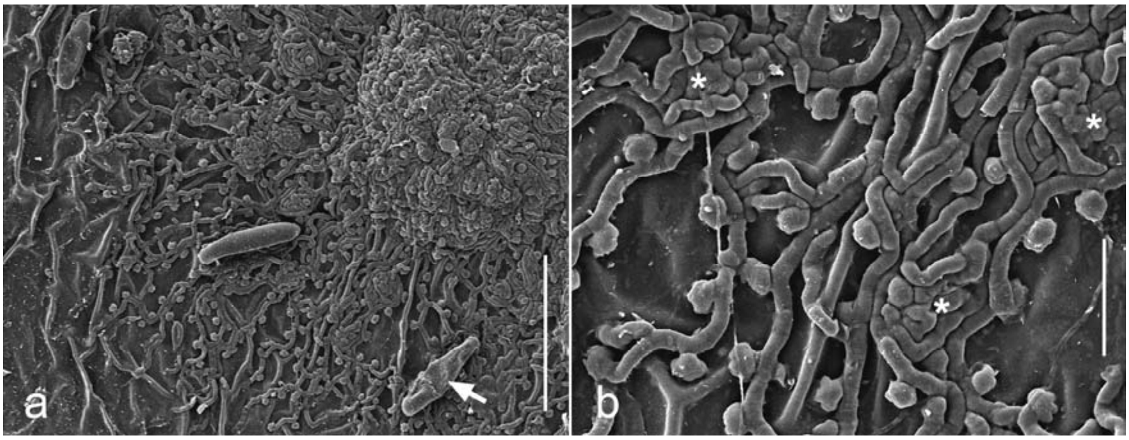

Figure 3.96: SEM photographs of *Xenostomella tovarensis* on *Monnina xalapensis* (BoKo 113). a: Multilocular sporoma (upper right) and surface mycelium, arrow indicates a hair of the host plant. Scale bar = 150 µm. **b:** Surface mycelium with lateral, lobed appressoria and coiled sporoma initials (*). Scale bar = 30 µm.

Additional specimens examined: *Xenostomella monninae* (Syd.) Arx (specimens labeled as *Plochmothea monninae* Syd.). ECUADOR. Tungurahua Province: Hacienda San Antonio pr. Baños, ca. 2000-2400 m a.s.l., epiphyllous on *Monnina pilosa* (Polygalaceae), 3 Jan. 1938, *H. Sydow 662* (type, S F8312); same locality and host species, 19 Dec. 1937, *H. Sydow 493* (paratype, S F8313), *H. Sydow 1212* (paratype, S F5813); same locality and host species, 31 Dec. 1937, *H. Sydow 645* (paratype, S F61518). ***Xenostomella meridiensis* Toro. VENEZUELA. Mérida:** Mérida, Outskirsts of Mérida, on *Miconia* sp., 3-5 Sept. 1932, *C.E. Chardon 1102* (type, BPI 653089). **TRINIDAD AND TOBAGO. Port of Spain:** Maraual Valley, on *Miconia* sp., 1912-1913, *R. Thaxter Farlow 7486* (BPI 653090).

Notes. *X. tovarensis* was described on *Lycianthes xylopiifolia* (Solanaceae) from Venezuela (Sydow 1930). *X. tovarensis* is morphologically very similar to *X. monninae* (Müller and Arx 1962), but differs from it by the more undulating mycelium with lobed appressoria and the confluent ascomata concentrated in the center of the colony. In contrast, *X. moninnae* is characterized by a relatively straight surface mycelium with uniformly entire appressoria and ascomata that develop separately and may become confluent laterally. The unilocular origin of the ascomata of *X. moninnae* is always evident, whereas ascomata of *X. tovarensis* appear multiloculate.

As seen by transmission electron microscopy, the scutellum of an ascoma of *X. tovarensis* is composed of various layers of scutellum cells (Fig. 3.97a). The upper scutellum cells have thick, probably melanized cell wall deposits and the septae between neighbouring scutellum cells are accompanied by woronin bodies (Fig. 3.97b).The appressoria of the surface mycelium give rise to infectious hyphae and

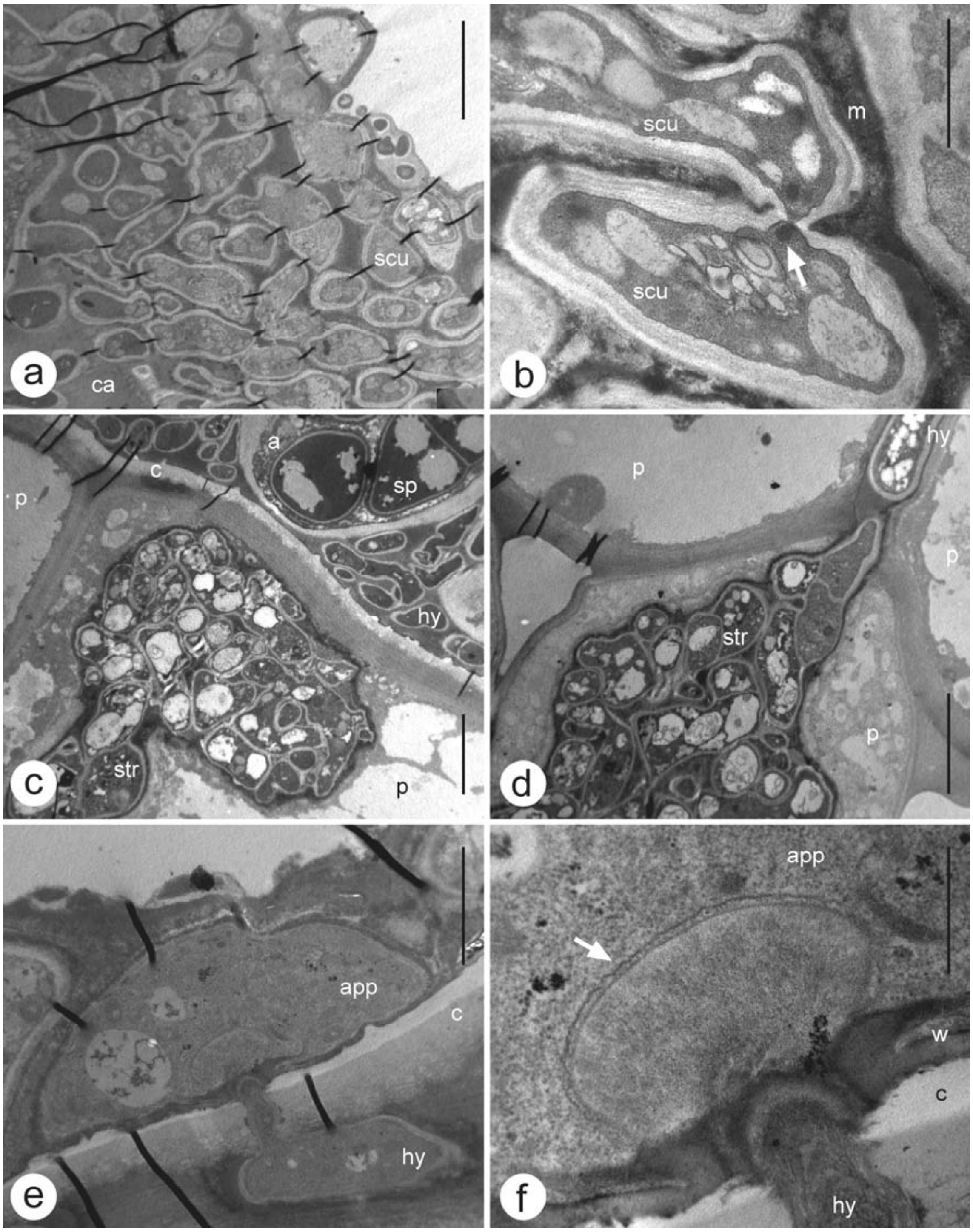

Figure 3.97: Ultrastructure of *Xenostomella tovarensis*. (TH 456) a: Part of the scutellum composed of numerous layers of scutellum cells (scu). The content of the scutellum cells changes towards the ascomatal cavity (ca). Scale bar = 5 µm. **b:** Two neigboring scutellum cells (scu) with melanized cell wall deposits (m). The hyphal pore between the scutellum cells is accompanied by woronin bodies (arrow). Scale bar = 1 µm. **c:** Part of an ascomata with asci (a) ascospores (sp) and internal hyphae (hy) above the plant cuticle (c) and intracellular hypostroma (str) in epidermis cells of the plant (p). Scale bar = 5 µm. **d:** Intracellular hypostroma (str) within plant cells (p) arising from an intercellular infection hyphae (hy). Scale bar = 5 µm. **e:** Superficial appressorium that penetrates the host cuticle (c) to form subcuticular, intercellular infection hypae (hy) within the plant tissue. Scale bar = 2 µm. **f:** Part of the appressorial center with a hemispherical structure (arrow) surrounding the penetration pore with a subjacent infectious hyphae (hy) that penetrates the host cuticle (c). Note the melanized wall (w) of the appressorial cell. Scale bar = 0.5 µm.

during the penetration process a hemisphearical structure is formed above the penetration porus. The structure seems to be surrounded by a double membrane (Fig. 3.97f), however, the true function of the structure could not be determined. Infectious hyphae that enter the host plant tissue can grow either inter- and intracellular (Fig. 3.97c-d). When entering a host plant cell, the hyphae form cell complexes composed of coiled hyphae. The complexes are formed within epidermal or subepidermal host plant cells and are surrounded by a thin, electron dense zone (Fig. 3.97c-d). Hansford described the cell complexes as coralloid haustoria (Hansford 1946).

3.3.3 Anamorph with uncertain placement (‘Pycnothyriales’)

In Western Panama, an interesting anamorphic fungus was collected on *Magnolia sororum* (Magnoliacaee). The fungus forms sporomata with numerous conidia-producing loculi below a scutellum composed of a single layer of scutellum cells. The conidia develop in pycnothyria and are 2−celled and darkly pigmented each with a central hyaline germ pore in the center of the conidium. Very rarely a telomorphic phase with globose asci and darkly pigmented 2−celled ascospores was observed together with the anamorph below the same scutellum. The asci were not produced in separate loculi but appeared dispersed and scattered below the scutellum. The anamorph was identified as ***Hemisphaeropsis magnoliae*** Petr., a pycnothyrial fungus with uncertain placement listed in the artificial order ‘Pycnothyriales’ in Sutton`s survey on Coelomycetes (Sutton 1977). Petrak described *H. magnoliae* and observed the telomorphic phase of the fungus, but did not specify a taxon name for the sexual stage (Petrak 1947). The shape of the sporomata and the scutellum texture of *H. magnoliae* is similar to the ascostromata of the teleomorphic fungus *Myriostigmella guatteriae* (G. Arnaud) G. Arnaud (Arnaud 1925), a bitunicate ascomycete formerly included in the Brefeldiellaceae (Müller and Arx 1962). According to Lumbsch and Huhndorf (2007a) and Kirk et al. (2008), *Myriostigmella* is as a teleomorphic genus with uncertain placement in the Dothideomycetes

The morphological characteristsics of *H. magnoliae* and its teleomorph are partly characteristical for three different families of foliicolous bitunicate ascomycetes, the Brefeldiellaceae, Parmulariaceae and the Asterinaceae. *H. magnoliae* forms multilocular sporomata under a scutellum composed of a single layer of cells, lacks a surface mycelium, but posesses expanded hypostromata, forms darkly pigmented, septated conidia developing within pycnothyria from short conidiophores which correspond to the lower part of single scutellum cells, and develops globose asci and darkly pigmented, 2−celled ascospores. Multilocular sporomata and the type of scutellum composition mentioned above are typical features of species of the Brefeldiellaceae. However, the ascospores of species of the type genus *Brefeldiella* are hyaline (Eriksson 1981, Kirk et al. 2001) and Müller and Arx (1962) suspect that *Brefeldiella* spp. are more likely commensals than biotropic pathogens. Many species of Parmulariaceae form multilocular sporomata on hypostromata and darkly pigmented spores. However, species of Parmulariaceae produce ascomata with walls composed of several layers of darkly pigmented cells. And the anamorphs of Parmulariaceae show a differenet type of conidiogenesis and the conidia are hyaline and 1−celled (Inacio 2005). *H. magnoliae* is probably closely related to the Asterinaceae, although species of the familiy are known to produce distinct brown surface mycelia and unilocular sporomata. Most of the species of Asterinaceae have a similar scutellum composition, produce globose asci and darkly pigmented, 2−celled ascospores and some of them are known to form hypostromata. The anamorphs of Asterinaceae are formed in similar pycnothria, the type of conidiogenesis is identical and the conidium morphology and pigmentation is similar in anamorphic stages of Asterinaceae.

The anamorphic species *H. magnoliae* and its teleomorphic stage are described and illustrated in detail below.

***Hemisphaeropsis* Petr.**

Sydowia 1: 24 (1947)

Type species: *Hemisphaeropsis magnoliae* Petr. (1947)

Teleomorph: present, but not named, unknown genus.

Stromata superficial on living leaves. *Surface mycelium* absent. *Hypostromata* epidermal and subepidermal, dark brown. *Sporomata* superficial, dimidiate, multi-locular, develop above hypostromata, irregularly circular to elliptical, dark brown, anamorph locules circular, open with irregular fissures. *Scutellum* radiate, composed of of rows of synchronal and dichotomously branching cells forming a continuous plate of cells, one cell layer thick, cells isodiametrical, cylindrical. *Conidiogenous cells* monoblastic, formed inside the pycnothyrial cavity by single cells of the inner part of the scutellum layer. *Conidia* globose, flat, with truncate hilum, brown, with a central hyaline germpore.

Teleomorph rarely present, asci not in locules but discrete below scutellum, next to anamorph locules or single. *Asci* globose, bitunicate, 8–spored, hyaline, vertical below scutellum, interascal tissue not seen. *Ascospores* 2–celled, brown.

Notes. The monotypic genus *Hemisphaeropsis* was erected by Petrak (1947) as a result of his studies on *Dothidea magnoliae* and its respective synonyms. *D. magnoliae* was described by Cooke (1879) on *Magnolia* sp. (Magnoliaceae) from North America. The ascospores *D. magnoliae* were described as 4−celled and hyaline (Cooke 1879). Saccardo (1883) transferred the species to the genus *Homostegia* due to ascospore morphology, whereas Cooke (1885) placed it in *Phyllachora*, because the fungus forms shiny, darkly pigmented hypostromata in the host, similar to clypei of Phyllachorales. According to Theissen and Sydow (1915), the type material of *D. magnoliae* only contained brown conidia, but no asci or 4−celled ascospores. Therefore, the authors cited *Homostegia magnoliae* as doubtful species and assumed that the anamophic fungus is closely related to the Polystomellaceae (Theissen and Sydow 1915). Petrak observed material of *D. magnoliae* on *Magnolia glauca* (not the type specimen) and established the new anamorph genus *Hemisphaeropsis* which he assigned to the Parmulariaceae.

Hemisphaeropsis magnoliae Petr., Sydowia 1: 25 (1947). Figs. 3.98, 3.99

Type on *Magnolia glauca* (Magnoliaceae). USA, locality and date unknown, *F.S. Earle* s.n. (type n.v.).

= *Dothidea magnoliae* Cooke, Grevillea 7(no. 42): 50 (1878). Type on *Magnolia* sp. (Magnoliaceae). USA, Darien, date and collector unknown *2485* (type n.v.).

≡ *Homostegia magnoliae* (Cooke) Sacc., Syll. Fung. 2: 650 (1883).

≡ *Phyllachora magnoliae* (Cooke) Cooke, Grevillea 13(no. 67): 70 (1885).

[synonymy according to Petrak (1947)]

Teleomorph: present, unknown genus, not treated as distinct species by the author.

Colonies absent, groups of sporomata epiphyllous, more rarely hypophyllous, inconspicuous and irregularly dispersed, fly-speck habit, black. *Surface hyphae* absent. *Appressoria* develop only during germination of mature ascospores or conidia, simple and entire, if developed from conidia unstalked, if developed from ascospores stalked, penetration pore up to 1.5 µm diam., in the center of the appressorium, penetrate cuticle to form bundles of intracellular hyphae in epidermal and subepidermal host cells. *Haustoria* absent. *Hypostroma* epidermal or subepidermal, composed of interwoven, brown hyphae, fill entire cells or parts of cells, can kill infected host cells, sometimes spread completely through the leaf profile, visible on respective abaxial side as brown spots. *Sporomata* multilocular, superficial, develop above intracellular hypostroma, irregularly circular to elliptical, often elongated, dimidiate, single or confluent, with entire margins, (380)456–721(1015)×(350)382–656(1005) µm (*n*=32), brown to dark brown, locules of anamorphic state circular, 200–270 µm diam. (*n*=10), open with irregular central fissures, dark brown to blackish. *Scutellum* radiate, composed of dichotomously branched filaments, isodiametrical to cylindrical, straight in center and at margins, (5)6–10(11)×3–7(8) µm, brown to dark brown. *Conidiogenous cells* monoblastic, formed inside the pycnothyrial cavity by single cells of the inner part of the scutellum layer. *Conidia* very numerous per locule, 2–celled, broadly clavate to broadly pyriform or circular, flat, septum in center or upper third or conidium, not constricted at septum, with a slightly stalked truncate hilum in the basal part of lower cell, (24)26–30(31)×(23)24–28(30) µm (*n*=40), dark brown, lower cell with a central hyaline germpore on front and back side, germinate through one germpore with a simple, unstalked appressorium, conidium collapses after successful penetration of a host cell.

Teleomorph present, rarely observed, next to anamorph locules in multiloculate sporomata or without anamorph locules, asci not in defined locules, discrete below the scutellum. *Asci* few, globose to ovate, bitunicate, (50)53–63(68) µm diam. (*n*=27), (2–)4–8–spored, hyaline, each ascus develops vertical in a single locus beneath scutellum, interascal tissue absent. *Ascospores* few, 2–celled, broadly ellipsoidal, straight, ends broadly rounded, sometimes tapering to one end, constricted at septum, (31)33–36(37) µm long (*n*=22), upper cell (16)18–20(21) µm wide, lower cell (15)16–19 µm wide, brown to dark brown, cell wall up to 1 µm thick, verrucose, germinate at the distal part of the lower cell with a stalked and simple appressorium, ascospores collapse during germination.

Illustrations (anamorph and teleomorph): *H. magnoliae* is illustrated here for the first time.

Hosts (anamorph and teleomorph). Magnoliaceae: *Magnolia glauca* (L.) L., <u>*Magnolia sororum*</u> Seibert. and *Magnolia* sp. *M. sororum* is a new host plant species for *H. magnoliae*.

Known distribution (anamorph and teleomorph). Subtropical and tropical America: Central America (Panama) and North America (USA). *H. magnoliae* is a new record for Central America and Panama and occurs in Western Panama in humid moutain rainforests at approx. 2300 m a.s.l.

Specimens examined (anamorph and teleomorph): PANAMA. Chiriquí Province: Parque International La Amistad (PILA), lower part of path to Cerro Picacho, ca. 2300 m a.s.l., amphigenous on *Magnolia sororum* (det. T.A. Hofmann), 19 Apr. 2006, *T.A. Hofmann & T. Trampe 428* (M-0141094; PMA); same locality and host species, 2 Jul. 2006, *T.A. Hofmann 479* (FR; PMA); same locality and host species, 26 Jan. 2007, leg. *T.A. Hofmann 505* (PMA); same locality and host species, 25 Sep. 2007, *T.A. Hofmann 567* (M-0141095; PMA); same locality and host species, 3 Apr. 2008, *T. Trampe & A. Pfaff 653* (FR; PMA). **USA. Florida:** Sanford, on *Magnolia* sp., Apr. 1928, *S. Rapp 1429* (S F48137).

Notes. When Petrak introduced *Hemisphaeropsis magnoliae*, he stated that the brown conidia were one-celled with a central hyaline germ pore (Petrak 1947). However, examination of typical material of *H. magnoliae* revealed that the conidia are 2−celled and that the germpore is situated in the upper part of the lower cell. The conidia become

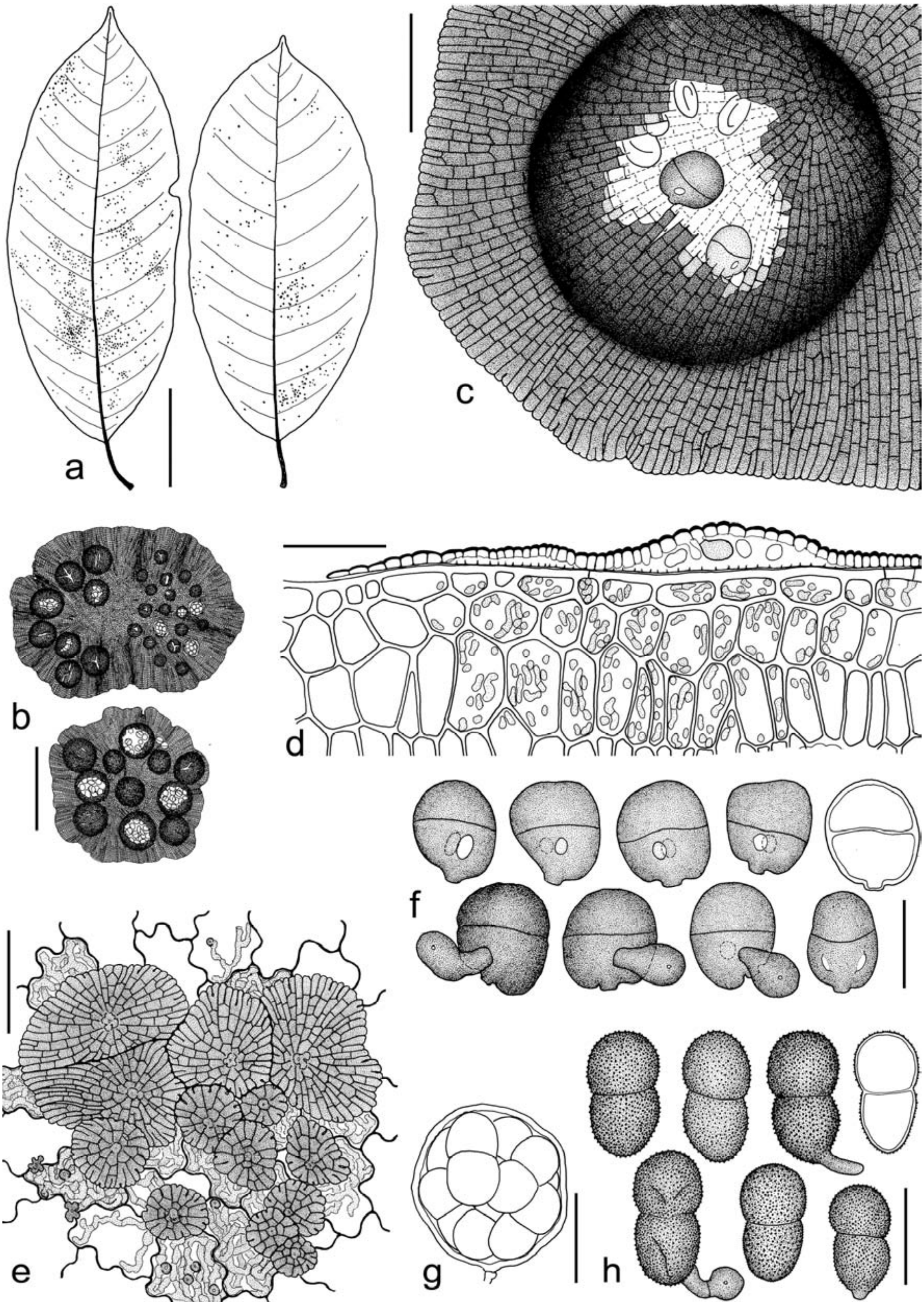

Figure 3.98: ***Hemisphaeropis magnoliae*** **on** ***Magnolia sororum*****. a:** Adaxial side of infected leaves (TH 428). Scale bar = 4 cm. **b:** Two multiloculate sporomata, upper sporoma with loculi of teleomorph and anamorph, lower sporoma with loculi of anamorph (TH 505). Scale bar = 300 µm. **c:** Part of sporomata with a single, mature anamorph locule, remnants of lower cell walls of scutellum cells located at the base of the locule are indicated with dotted lines (TH 505). **d:** Cross section of sporoma with a locule of the anamorph containing immature conidia, below hypostroma within host tissue. Scale bar = 50 µm. **e:** Confluent sporomata initials and intracellular hyphae (TH 505). f: Mature conidia, some of the germinating. Scale bar = 25 µm. **g:** Immature ascus. Scale bar = 25 µm. **h:** Mature, verrucose ascospores, some of them germinating. Scale bar = 25 µm.

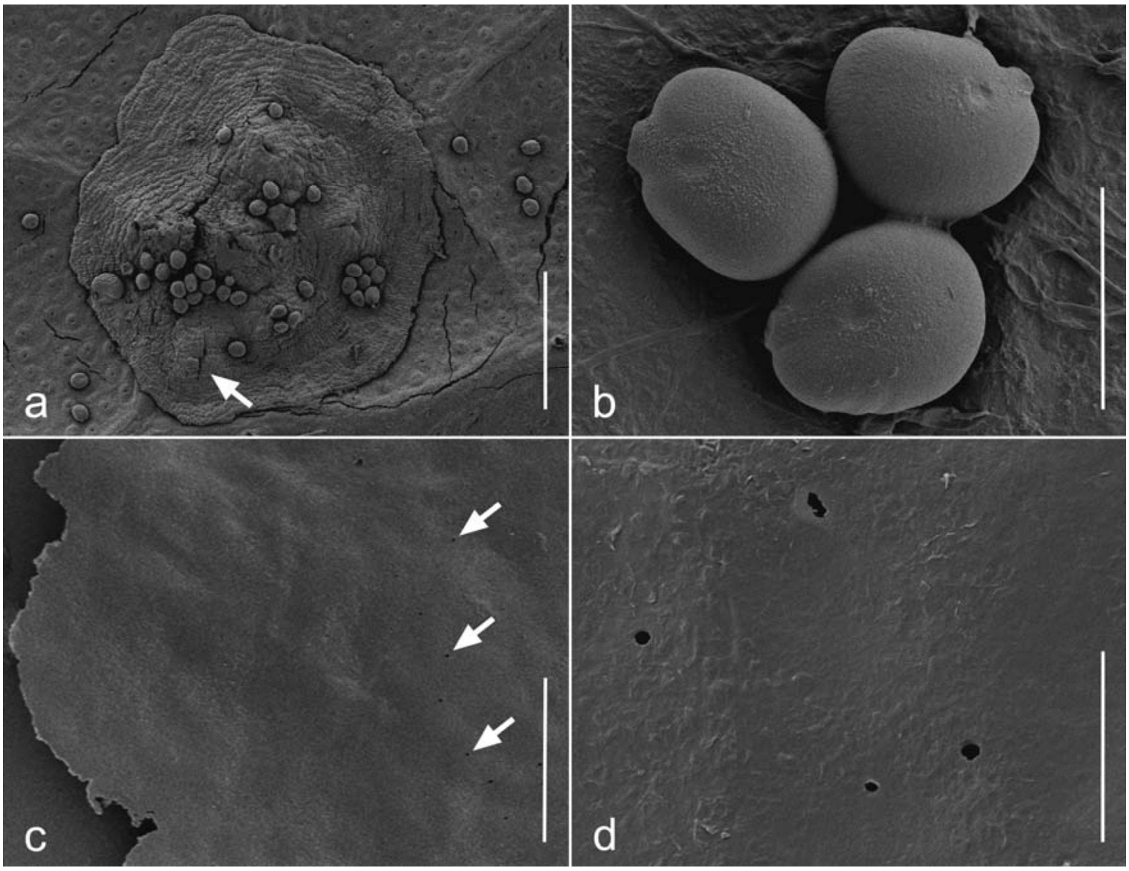

Figure 3.99: SEM photographs of *Hemisphaeropsis magnoliae* on *Magnolia sororum*. a: Multilocular sporoma (one locule indicated with arrow) with liberated conidia (TH 505). Scale bar = 200 µm. **b:** Mature conidia, each with a central germpore and a truncated hilum. (TH 505). Scale bar = 30 µm. **c:** Lower wall of sporoma, arrows indicate infection holes (TH 428). Scale bar = 100 µm. **d:** Penetration pores in lower sporoma wall (TH 428). Scale bar = 20 µm.

dark brown when fully mature and, therefore, the septum sometimes is hardly visible. The conidial stage of *H. magnoliae* dominates on living leaves of *Magnolia sororum* in Panama. The sporomata mostly produce various anamorph locules in which masses of conidia develop. More rarely and only in few larger sporomata asci with ascospores are formed next to anamorph loculi. The asci are not united in locules, but are produced separately below the scutellum layer. When the ascus expands and enlarges during maturity, the scutellum above ruptures and exposes the ascus, which soon releases its mature, brown ascospores. When the superficial sporomata of *H. magnoliae* are detached from the substrate the hyphae from the internal hypostroma can initiate the development of new sporomata by the reverse outgrowth through already existing intracuticular channels. The reverse outgrowth through the intracuticular channel yields to the formation of an irregularly lobed, brown cell at the surface of the host cuticule. The small cell divides radially and leads to the formation of a small, dimidiate sporoma that sometimes fuses laterally fuse with other sporoma initials (Fig. 3.98e).

Thus, the fungus maintains its reproductive capability and virulence by the continuous production of infectious spores.

The sporomata of *Hemispheropsis magnoliae* resemble those of *Myriostigmella guatteriae* (G. Arnaud) G. Arnaud (Arnaud 1925), a bitunicate ascomycete with a yet uncertain placement (Lumbsch and Huhndorf 2007a) which was formerly included in the Brefeldiellaceae (Müller and Arx 1962). Like *H. magnoliae*, *M. guatteriae* forms no free surface mycelium but multilocular sporomata developing from an internal hypostroma (Arnaud 1925). The composition of the scutellum of the sporomata of *M. guatteriae* is similar to the one of *H. magnoliae*. However, *M. guatteriae* forms no conidial stage and the asci develop in groups in more or less elongated loculi (Arnaud 1925).

3.4 Taxonomic changes

Type material of different species of thyriothecioid ascomycetes was analysed during this study. Some of the taxonomic changes concerning species that are not treated in detail in this study are listed below.

Asterina diaphana Syd. & P. Syd., Leafl. Philipp. Bot. 4: 1155 (1911).

Type on *Solanum manucaling* Elmer (Solanaceae). Philippines, Mindanao Island, Davao Region, Davao del Sur Province, Mt. Apo, Todayo, [Sep. 1909, *A.D.E. Elmer 11695*] (type, S F12348!).

≡ *Asterinella diaphana* (Syd. & P. Syd.) Theiss., Brotéria 10: 105 (1912).

≡ *Prilleuxina diaphana* (Syd. & P. Syd.) R.W. Ryan, Ill. Biol. Monogr. 17(2): 79 (1939).

Asterina diaphana was recombined to *Asterinella diaphana* by Theissen (1912) and to *Prillieuxina diaphana* by Ryan (Stevens and Ryan 1939). The type specimen, however, is clearly an *Asterina* due to the brown surface mycelia with lateral appressoria. Therefore, *Asterina diaphana* should be reastablished with the homotyic synonyms *Asterinella diaphana* and *Prillieuxina diaphana.*

Asterolibertia nodulifera (Syd. & P. Syd.). T.A. Hofmannn, **comb. nov.** (Hofmann, in prep.)

Type on *Angelesia splendens* Korth. (Chrysobalanaceae). Philippines, Palawan Province, Taytay, May 1913, *Merill 8901* (lectotype, designated here, BPI 690120!); samel locality, date, host plant and collector (isotype, BPI 690121!).

≡ *Asterina nodulifera* Syd. & P.Syd., Philipp J. Sci. 9(2): 180 (1914).

The type of *Asterina nudulifera* was examined and the species has to recombined to *Asterlibertia nodulifera*, due to the intercalary appressoria of the surface mycelium, the circular ascomata and brown, two-celled ascospores.

Asterina saginata Syd., in Sydow and Sydow, Ann. Mycol. 15(3/4): 241 (1917).

Type on *Polyalthia sp.* (Annonaceae). Philippines, Central Luzon region, Bataan Province, Luzon, Dec. 1915, *M. Ramos 24024* (syntypes, BPI 690393!, 690394!, 690395!).

= *Asterina melanomera* Syd., in Sydow and Sydow, Ann. Mycol. 15(3/4): 241 (1917). Type on *Dasymaschalon clusiflorum* Merr. (Annonaceae). Philippines, Calabarzon region, Laguna Province, Paete, Apr. 1914, *C.F. Baker 3123* (holotype, S F12393!). **syn. nov.**

Examination of the type material of *A. melanomera* and *A. saginata* revealed that both species are identical. *A. saginata* was described from the same country growing on *Polyalthia* sp. (Annonaceae) and was presented in the same publication (Sydow and Sydow 1917, p. 241) directly before the description of *A. melanomera*. *A. melanomera* is a new synonym of *A. saginata*.

Asterolibertia minor T.A. Hofmann nom. nov. et stat. nov. (Hofmann, in prep.)

Type on *Licania* sp. (Chrysobalanaceae). Brazil, Vicinity of Pará, 15. May 1908, *C.F. Baker s.n.* (holotype, S F12536!, labeled as *Seynesia minor*).

≡ *Seynesia licaniae* Rehm, Ann. Mycol. 7:538 (1909).

≡ *Asterina schroeteri* var. *licaniae* (Rehm) Theiss., Abh- Zool.-Bot. Ges. Wien 7(3): 54 (1913).

non *Asterina licaniae* Cooke, Grevillea 12: 85 (1884). Type on *Licania* sp. (Chrysobalanaceae). Brazil, Santa Catarina, San Fransisco, *E. Ule Rabenhorst-Winter Fungi europei 3746* (type, BPI 689922!, labeled as *Asterina inaequalis*).

≡ *Asterolibertia licaniae* (Cooke) Hansf. (1947).

The type specimen of the basionym *Seynesia licaniae* from S was examined. The fungus forms brown surface mycelia with intercalary appressoria and 2–celled brown ascospores and, therefore, clearly belongs to the genus *Asterolibertia*. The fungus is not identical with *Asterolibertia licaniae*, because it forms smaller ascospores. Therefore, a new name *Asterolibertia minor* is proposed.

3.4.1 Excluded species and bad material

During the examination of type material of numerous species of thyriothecioid ascomycetes it became obvious that some type specimens included misinterpreted fungi or did not contain any fungal species at all.

Asterina advenula Syd., Ann. Mycol. 25(1/2): 46 (1927).

Type on *Rondeletia affinis* Hemsl. (Rubiaceae). Costa Rica, Alajuela Province, San Ramón, Mondongo, 3 Feb. 1925, *H. Sydow 192* (syntype, BPI 689209!), same locality and date, *H. Sydow s.n.* (syntypes, BPI 689208!, Exsiccata Reliquiae Petrakianae 2617: BPI 1111982!, PDD 61238 n.v.).

Sydow (1927) assumes that *A. advenula* is no typical species of *Asterina* due to ascospore shape and their significantly smaller size. Investigation of the type material of *A. advenula* revealed that the leaves of *Rondeletia affinis* are parasitized amongst others by mycelia of a *Meliola* species (Meliolales) which again are overgrown by a thyriothecioid ascomycete. The hyperparasite forms numerous confluent thyriothecia above the appressoriate surface mycelium of *Meliola* sp. and Sydow mistakenly assigned the ascocarps to be connected to the mycelia. The thyriothecioid hyperparasite probably belongs to the genus *Cyclotheca* because of the confluent thyriothecia with elongated asci that develop inclined within the ascocarps, the 2-celled ascospores, that stay hyaline or become pale brown and because it lacks a surface mycelium. The leaves of *Rondeletia affinis* are associated with numerous epiphyllous fungi.

Asterina disseminata var. *cleistopholidis* S. Hughes, Mycol. Pap. 48: 11 (1952).

Type on *Cleistopholis patens* (Benth.) Engl. & Diels (Annonaceae). Africa, Ghana [formerly Gold Goast], Nsuaem, 8 May 1949, *S.J. Hughes* s.n. (type, IMI 43584c!).

The type material from IMI 43584c cited by Hughes (1952) was examined and contains a part of a leaf that does not show any fungal infections. No *Asterina* spp. was found to be associated with the leaf.

Asterina uleana Pazschke, Hedwigia 31(3): 104 (1892).

Type on Myrtaceae. Brasil, Santa Catarina, São Francisco, Aug.-Nov. 1884, *E. Ule 165* (syntype,n.v.), *166* (syntype, n.v.), *184* (syntype, n.v.), *281* (syntype, HBG 1683!).

≡ *Asterinella uleana* (Pazschke) Theiss., Brotéria 10: 109 (1912).

≡ *Maublancia uleana* (Pazschke) Arx, Beitr. Kryptgfl. Schweiz 11(2): 524 (1962).

The syntype of *Asterina uleana* from HBG was examined and revealed the presence of another fungus on the leaves of the plant specimen. The fungus is causing black, subcuticular, clypeus-like crusts with multilocular sporomata. The fungus is clearly no species of *Asterina*, *Asterinella* or *Maublancia*, therefore, the syntype from HBG has to be excluded from the protolouge of the basionym *A. uleana*.

3.5 Cultivation experiments

The cultivation of saprotrophic and commensalistic species of thyriothecioid ascomycetes was not successful, even after numerous attemps with different cultivation media. In Panama, the cultivation experiments of commensalistic species of thyriothecioid ascomycetes (mainly Micropeltidaceae) were hindered because no clean and sterile environment could be created in the field laboratory. Unfortunately, the cultures were contaminated rapidly by fast growing opportunistic fungi.

Commensalistic thyriothecioid ascomycetes probably grow very slowly in culture. In Frankfurt, we tried to cultivate saprotrophic species of thyriothecioid ascomycetes presented in Hofmann (2005), but unfortunately the plated ascomata were all contaminated with *Penicillium* spp. even after three or four rinsing events in sterile water.

3.6 Molecular results

For the phylogenetic analysis, separate alignments for SSU (388 bp) and LSU rDNA sequences (495 bp) of species of *Asterina* were created with Mega 4.0 (integrated ClustalW algorithm, default parameters). A combined data set with SSU and LSU rDNA sequences (883 bp) was created and all positions containing gaps and missing data were eliminated from the dataset (complete deletion option). The evolutionary distances were computed using the Maximum Composite Likelihood method (Tamura et al. 2004) and are in the units of the number of base substitutions per site. The final data set contained 822 positions.

The hypothesis derived from SSU and LSU rDNA neighbour-joining analysis supports the monophyly of the Asterinaceae represented by six species of the type genus *Asterina* (and their respective anamorphic stages) within the class Dothideomycetes with a bootstrap value of 100 % (Fig. 3.100). The *Asterina* clade forms a sister relationship with the Venturiaceae with a bootstrap support of 87 %. The Venturiaceae are highly supported as a monophyletic clade with bootstrap values of 100 %. The monophyly of Venturiaceae was also supported in molecular phylogenetic analysis conducted by Kruys et al. (2006) and Winton et al. (2007). Lichenized Arthoniomycetes, represented by members of the Roccellaceae, form a less supported sister group to Venturiaceae and Asterinaceae with a bootstrap value of 49 %. The Roccellaceae form a monophyletic clade with a high bootstrap value of 100 %. According to the conducted BLAST search, the included taxa of both Roccellaceae and Venturiaceae are closely related to sequences of *Asterina* spp.

The combined SSU-LSU rDNA sequence analysis agrees in general with recent multigene-based phylogenies of the Dothideomycetes (Schoch et al. 2006a, Winton et al. 2007). The Dothideomycetes clade is supported with a bootstrap value of 100 %, the monophyly of the subclass Dothideomycetidae is supported with 99 % (Fig. 3.100). The clades of the orders Dothideales and Capnodiales (with Capnodiaceae, Schizothyriaceae and Mycosphaerellaceae) are both supported with high bootstrap values of 100 %. The sister relationship of Schizothyriaceae and Mycosphaerellaceae, first shown by Batzer et al. (2008), was confirmed in the present analysis with a high bootstrap value of 96 %. The clade Pleosporomycetidae is highly supported with a bootstap value of 100 % and confirms the monophyly of the recently introduced subclass (Schoch et al. 2006a). The monophyletic Tubeufiaceae and Botryosphaeriales, both highly supported with bootstrap values of 99 %, are nested with low support in the Dothideomycetes (Fig. 3.100). Similar findings were shown by Schoch et al. (2006a) and Winton et al. (2007).

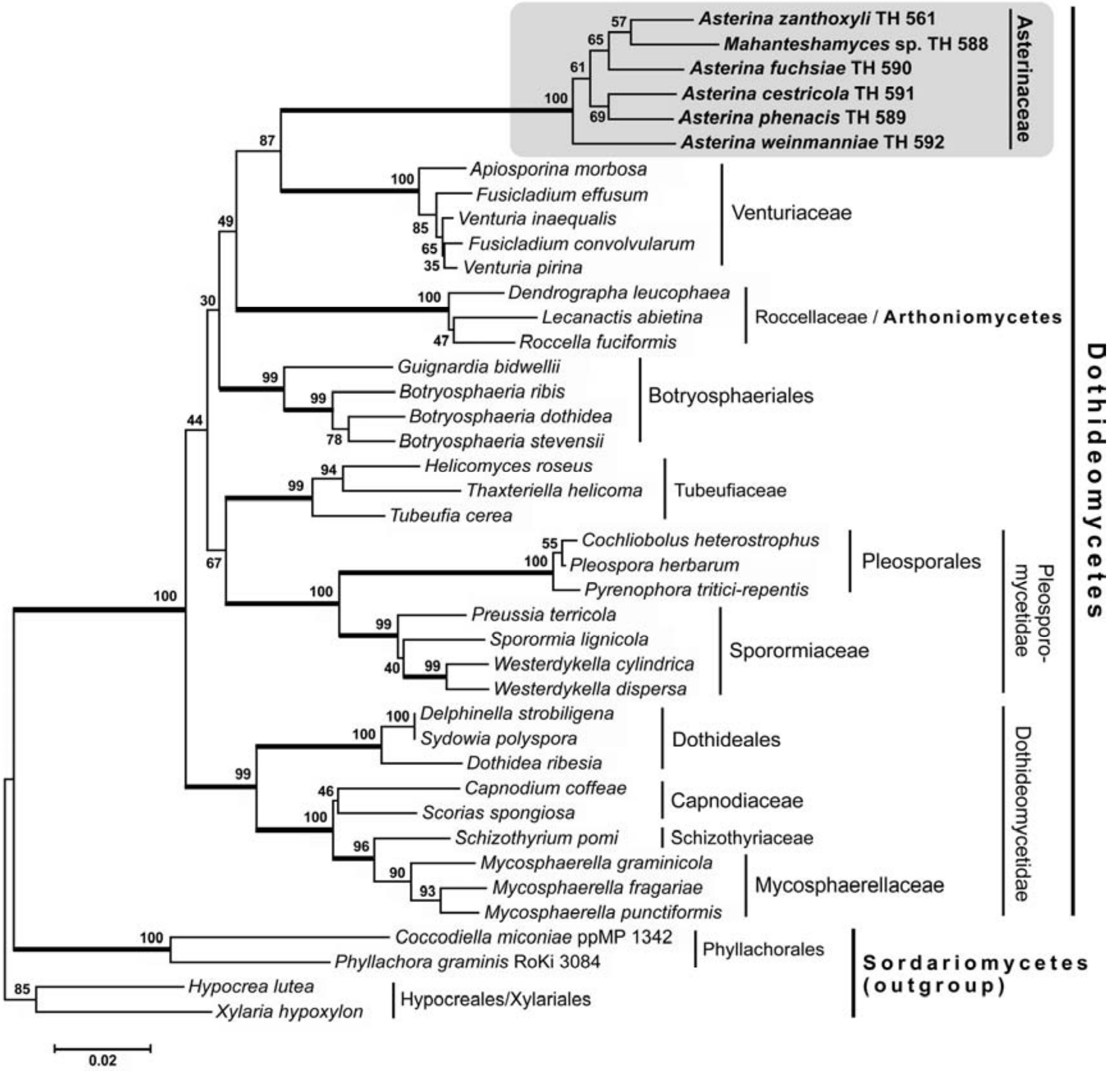

Figure 3.100: Estimated dothideomycete phylogeny including species of *Asterina* inferred from neighbour-joining analysis of SSU and LSU rDNA sequences. The phylogenetic hypothesis was conducted with MEGA version 4.0. The optimal tree with the sum branch length = 1.06455900 is shown and rooted with Hypocreales/Xylariales (Sordariomycetes). Branches with more than 95% bootstrap support (bootstrap test with 2000 replications) are indicated with bold black lines.

3.7 Thyriothecioid ascomycetes in the ppMP project

3.7.1 Collections

In the ppMP project, a total of almost 1300 specimens of plant parasitic microfungi have been collected. The causatives of leaf spots of almost 100 specimens could not be identified, 240 specimens were parasitized by Imperfect Fungi and from the remaining specimens almost 722 were identified as members of Basidiomycota (rust fungi, smut fungi) and Ascomycota (black mildews, tar spot fungi, thyriothecioid ascomycetes and similar families) (Piepenbring et al. in prep.).

The rust fungi (Puccinales) are the most species-rich group of plant parasitic microfungi in Western Panama (data not shown, Piepenbring in prep.). The most species-rich plant parasitic Ascomycota in Western Panama are the black mildews (Meliolales) (data not shown, Piepenbring et al. in prep.).

Plant parasitic thyriothecioid ascomycetes and similar families are represented in the ppMP project with a total of 180 specimens which comprise approx. 97 different species belonging to 6 families and one form group (Fig. 3.101). Plant parasitic thyriothecioid ascomycetes represent about 17 % of the total plant parasitic microfungi collected in investigated areas in Western Panama. The Asterinaceae are the most species-rich familiy of plant parasitic thyriothecioid ascomycetes with approx. 61 species, followed by plant parasitic Microthyriaceae with a total of 12 species,

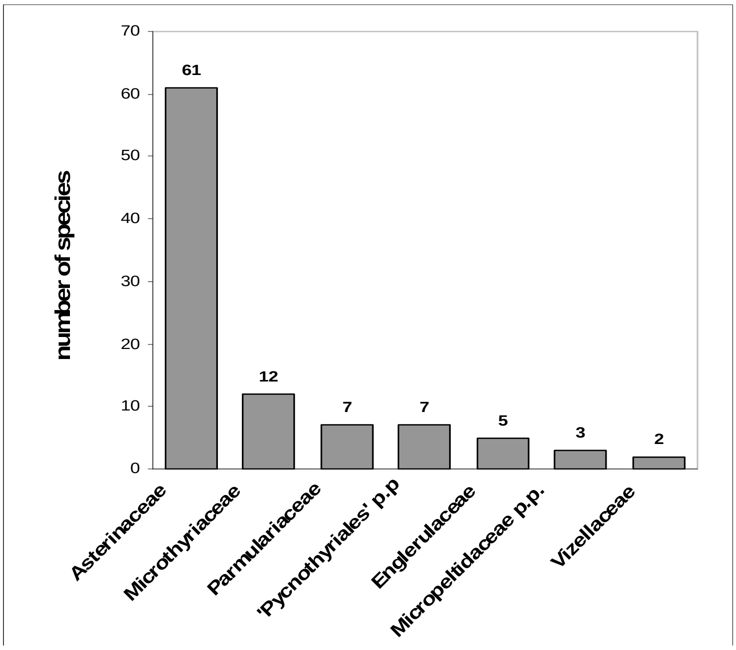

Figure 3.101: Thyriothecioid ascomycetes collected in the ppMP project in Western Panama.

Parmulariaceae and ‘Pycnothyriales’ p.p. with 7 species respectively, Englerulaceae with 5 species, Micropeltidaceae p.p. with 2 species and Vizellaceae with 2 species (Fig. 3.101).

Plant parasitic thyriothecioid ascomycetes are abundant in almost any habitat examined in Western Panama (Fig. 3.102), although their species number is relatively low compared to the overall species number of other plant parasitic microfungi, e.g. Meliolales (data not shown). The only exception was the lowland forest on the slopes of the Chorcha plateau (I) in the Chiriquí Province on the pacific side of the country, where no plant parasitic thyriothecioid ascomycete was collected (Fig. 3.102). In general, the collection area (I) was devoid of plant parasitic microfungi, and instead somehow rich in commensalistic species of thyriothecioid ascomycetes (Micropeltidaceae). Plant parasitic thyriothecioid ascomycetes are most species-rich in the mountain forest of Alto Chiquero (E), the primary cloudforest Cerro Picacho (G) and the lowland gallery forest in Los Algarrobos near the Majagua River (B) (Fig. 3.102). Less than 10 but more that 5 species of plant parasitic thyriothecioid ascomycetes were found in the montane forest (N) and the montane cloud forest (O) on the continenatal divide, in the subalpine subpáramo dwarf forest (M), at the pacific coast in La Barqueta (H) and in the marsh forest in the Changuinola canal at the Atlantic side (J) (Fig. 3.102). Up to 5 species of plant parasitic thyriothecioid ascomycetes were collected at the path to the Majagua River in Los Algarrobos (A), in the secondary forest of a private finca in direction to Piedra Candela (C), in the rural

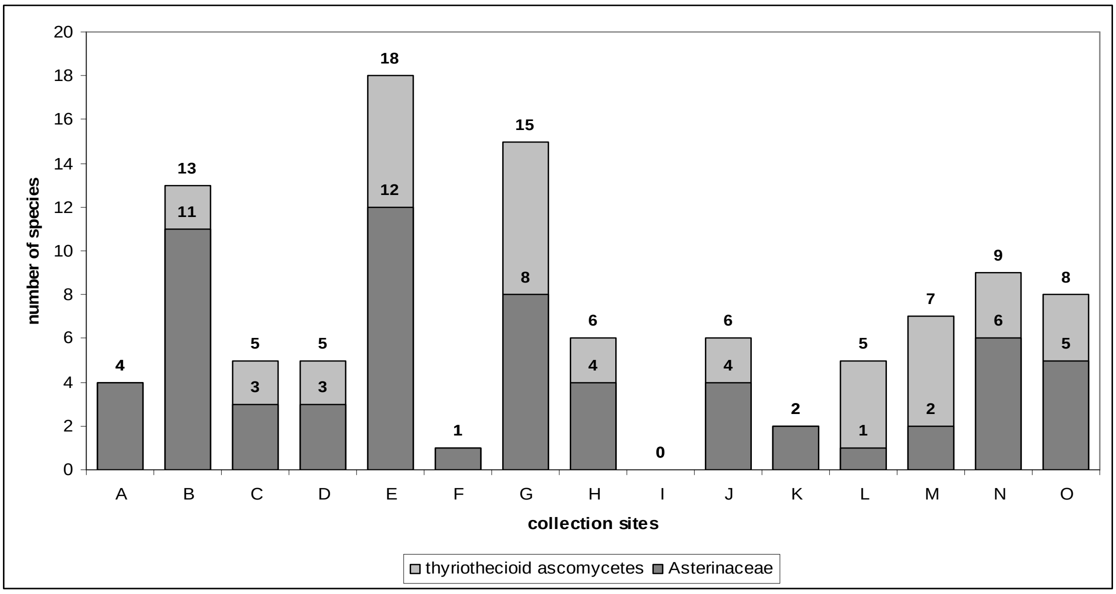

Figure 3.102: Abundance of plant parasitic thyriothecioid ascomycetes and Asterinaceae in the different collection areas of the ppMP project in Western Panama.

vegetation of a roadside in direction to Piedra Candela (D) and in the submontane forest near Finca Celestine at the Atlantic side (L) (Fig. 3.102). The lowest species numbers of thyriothecioid ascomycetes were determined for the collection area of Boquete, Alto Lino with rural vegetation (F) and the lowland forest in Bonjik on the Atlantic side of Western Panama (K) (Fig. 3.102).

3.7.2 The Asterinaceae in the ppMP project

With approx. 124 specimens representing 61 species, the Asterinaceae are the most species-rich family of plant parasitic thyriothecioid ascomycetes in the investigated areas of the ppMP project in Western Panama (Fig. 3.101). The 61 species grow on 58 different host plant species (including 2 species of Pteridophyta, 31 unidentified species) in 55 host plant genera (including 2 Pteridophyte genera and 13 unidentified genera) belonging to 35 host plant families (including 2 Pteridophyte families and 1 unidentified host plant family).

Within the Asterinaceae, *Asterina* is the most common and species-rich genus in Western Panama (Fig. 3.103). About 42 species of *Asterina* (including 2 species exclusively growing as *Asterostomella*-anamorphs) were collected in the areas of the ppMP project (Fig. 3.103). *Lembosia* and *Morenoina* are represented respectively by 5 species, *Asterolibertia* is represented by 3 species, *Prillieuxina* by 2 species and *Cirsosia* and *Halbanin*a by 1 species respectively (Fig. 3.103).

The genus *Asterina* is most species-rich in the mountain rainforest Alto Chiquero (E) with 11 collected species (Fig. 3.104). Five *Asterina* spp. were collected in the gallery forest near the Majagua River in Los Algarrobos (B), 4 different species

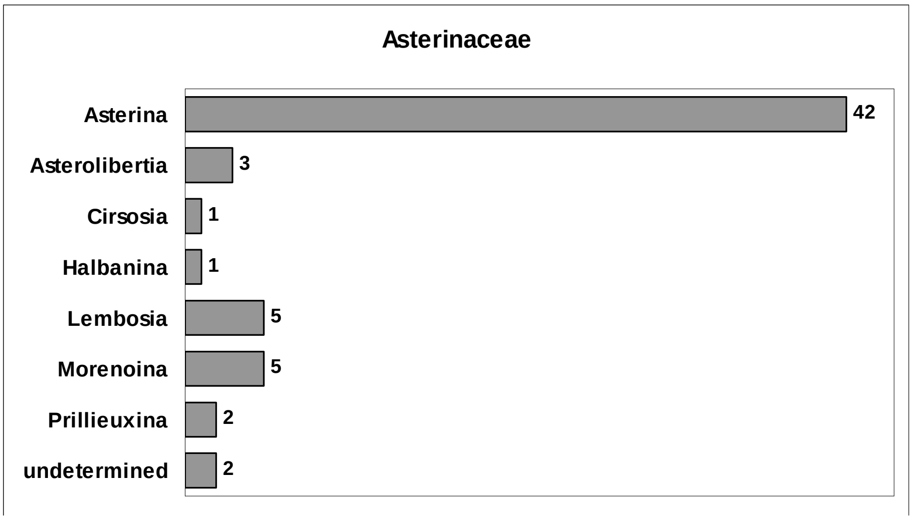

Figure 3.103: Species-richness of genera of Asterinaceae collected during the ppMP project in Western Panama.

of *Asterina* were collected in the montane cloud forest at Cerro Picacho (G) and the montane forest at the continental divide (N) (Fig. 3.104). 3 species of *Asterina* were collected at the path to Majagua River in Algarrobos (A), in rural vegetation at a roadside in direction to Piedra Candela (D), in the marsh forest of the Canal Changuinola at the Atlantic side (J) and the montane cloud forest at the continental divide (O) (Fig. 3.104). Two species of *Asterina* were collected respectively at the pacific coast in La Barqueta (H) and the lowland forest at Bonjik at the Atlantic side (K) (Fig. 3.104). Only one species of *Asterina* was collected in the secondary forest of a private finca in direction to Piedra Candela (C), in Boquete, Alto Lino with rural vegetation (F), in a submontane forest on the Atlantic side of Western Panama (L) and in the subalpine subpáramo dwarf forest at the slopes of the Volcán Barú (M) (Fig. 3.104). *Asterina* is absent in the lowland forest at the slopes of the Chorcha plateau (I) (Fig. 3.104).

Species accumulation curves were calculated only for selected collection sites from which more than 5 species of Asterinaceae were collected and where a maximum of 4 collection events was reached (Fig. 3.105). The curve for the collection site E indicates that the sampling at the understory of the area was at least moderately complete with the used method. Only few additionally species will be expected in the understory at collection site E. The curves for collection sites B, G and H indicate that more sampling almost certainly would add new species (Fig. 3.105).

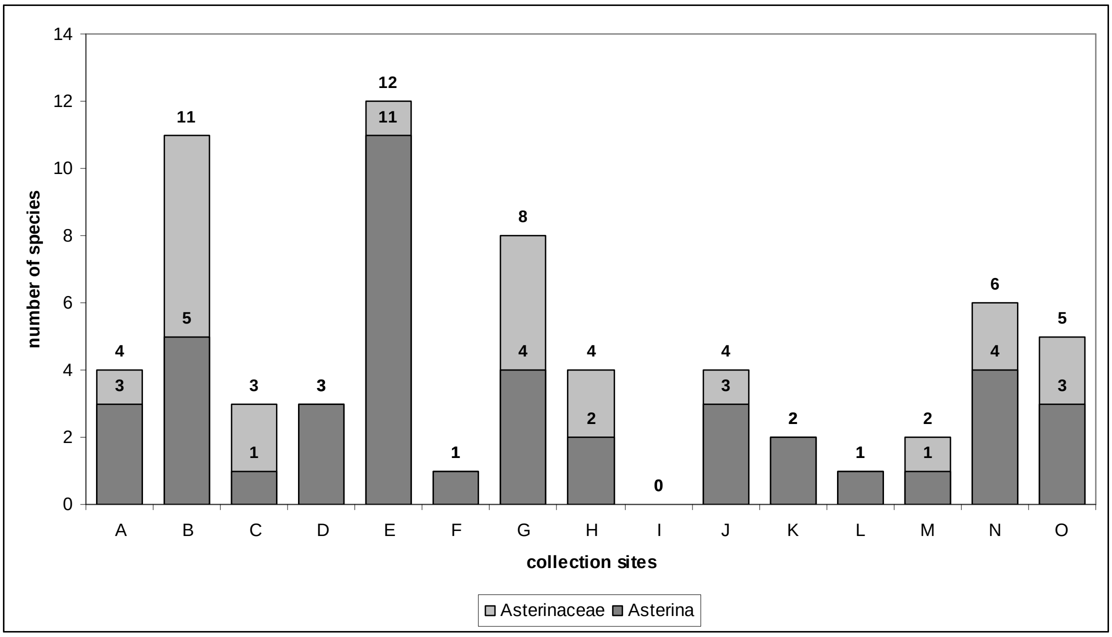

Figure 3.104: Abundance of species of Asterinaceae and *Asterina* in the different collection areas of the ppMP project in Western Panama.

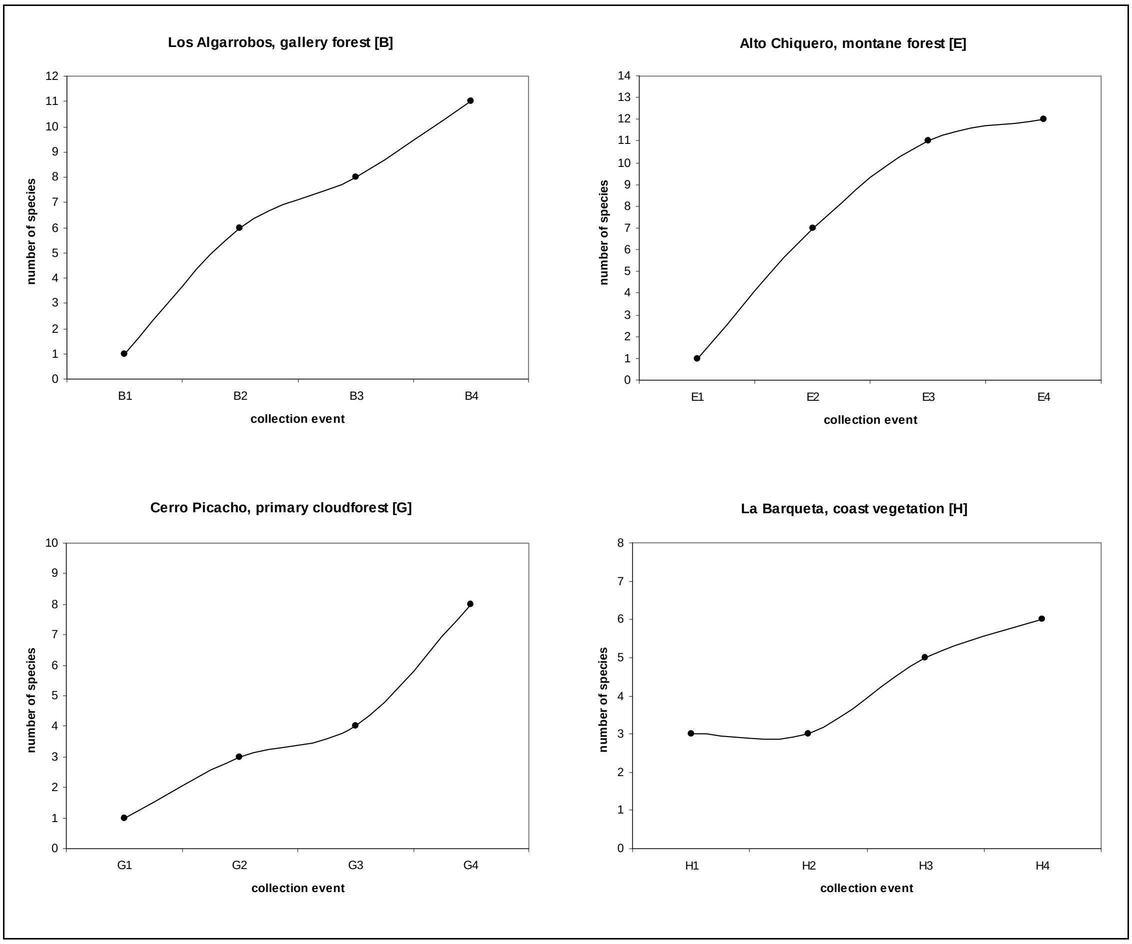

Figure 3.105: Species accumulation curves for Asterinaceae from selected areas of the ppMP project in Western Panama.

3.7.3 Plant diversity and fungal diversity

On average, about 150 plant species are present per collection site (Table 3.8). The collection site with the highest number of estimated plant species was a submontane forest near finca Celestine (L) at the Atlantic site of Western Panama in the Province Bocas del Toro with about 249 plant species (Fig. 3.106). Very rich in plant species, but somehow more heterogeneous in vegetation types was the roadside of the path to the Majagua River in Los Algarrobos (A) with 240 plant species including parts with rural vegetation, secondary forest and pastures (Fig. 3.106). The area with the fewest number of plant species was the subalpine subpáramo dwarf forest Los Fogones (M) near the summit of the Volcán Barú with only 19 plant species.

On average, about 4 % of the total plant species per collection site were infected with a plant parasitic thyriothecioid ascomycete (Table 3.8). The highest number of infected plant species was determined for collection site M (subalpine subpáramo at Los

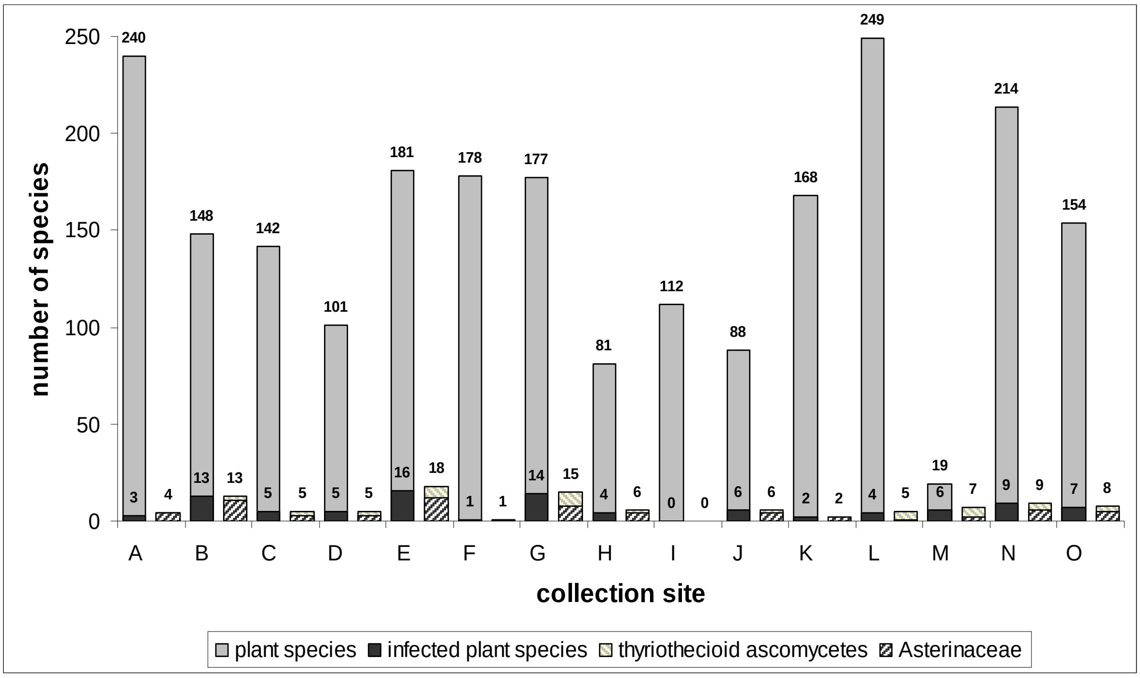

Figure 3.106: Overview to the overall species-richness of plants and plant parasitic thyriothecioid ascomycetes in the collection areas of the ppMP Project in Western Panama.

Fogones, Volcán Barú) with a total of 6 infected host plant species, that correspond to 32 % of the total plant species present in collection area M (Fig. 3.106, Table 3.8). However, the collction site M remains as an exception to the rule, because of the few plant species present in the area and because in the rest of the investigated areas less than 10 % of the total plant species were infected with a plant parasitic thyriothecioid ascomycete. Within the collection site E (Montane forest near Boquete) and B (gallery forest in Los Algarrobos) 9 % of the total plant species were infected with a plant parasitic thyriothecioid ascomycete, in collection site G (cloudforest at Cerro Picacho) 8 % of the plant species were infected. The lowest number of plant species infected with a thyriothecioid ascomycete were found in collection areas A (natural woody vegetation in Los Algarrobos) with 1 %, F (rural vegetation in Boquete) with 1 %, K (lowland forest in Bonyik) with 1 %, and L (submontane forest at Finca Celestine) with 2 % (Fig. 3.106).

Similar results were obtained for plant species infected with species of Asterinaceae. In M, 11 % of the plants species were infected with an asterinaceous fungus, in B and E 7 % and in G 5% of the plant species were infected with a species of Asterinaceae. Areas with the lowest numbers of host plants infected with a species of Asterinaceae were collection sites L with 0.4 % (average), A, F and K with 1 % and C with 2 % (Fig. 3.106). On average, about 3 % of the total plant species per collection site were infected with a member of Asterinaceae (Table 3.8).

Table 3.8: Overview of the ppMP collection sites with informations on determined vegetational and climatic conditions, altitude, areal size, relative light intensity, and estimated plant and fungal diversity. Abbreviations: ppMP acronyms: [A] Los Algarrobos, path to Majagua river; [B] Los Algarrobos, border of Majagua river; [C] Piedra de Candela, forest; [D] Piedra de Candela, road side; [E] Boquete, forest; [F] Boquete, Alto Lino; [G] PILA, path to Cerro Picacho; [H] La Barqueta, pacific coast; [I] Chorcha, forest near path to plateau; [J] Canal Changuinola; [K] Bonyik, Teribe river; [L] Finca Celestine, El Valle; [M] PNVB, Volcán Barú; [N] Fortuna, forest; [O] Fortuna, Quijada de Diablo; abbreviations of groups of thyriothecioid ascomycetes: A = Asterinaceae, Mt = Microthyriaceae, Mp = Micropeltidaceae, E = Englerulaceae, P = Parmulariaceae, Py = 'Pycnothyriales', V = Vizellaceae, Ø = average.

	Area description	Dry season	Altitude in m a.s.l.	Examined area	Relative light intensity	No. of estimated plant species	No. of species of plant parasitic thyriothecioid ascomycetes							No. of infected plant species (Total = total plant species, A = plant species infected with Asterinaceae)
							A	Mt	Mp	E	P	Py	V	
[A]	roadside, natural woody vegetation, very disturbed	yes	140 m	4000 m^2	26%	240	4	–	–	–	–	–	–	Total/A: 3 (1%)
[B]	lowland gallery forest, disturbed	yes	140 m	1547 m^2	21%	148	11	1	–	–	–	–	1	Total: 13 (9%), A: 11 (7%)
[C]	secondary forest, disturbed		1400 m	1600 m^2	4%	142	3	1	–	–	–	1	–	Total: 5 (4%), A: 3 (2 %)
[D]	road side, rural vegetation, very disturbed	yes	1417 m	1706 m^2	99%	101	3	–	–	1	1	–	–	Total: 5 (5%), A: 3 (3%)
[E]	montane forest, disturbed	–	1750 m	1568 m^2	6%	181	12	2	–	–	3	1	–	Total: 16 (9%), A: 12 (7%)
[F]	roadside, rural vegetation, disturbed	–	1270 m	2050 m^2	54%	178	1	–	–	–	–	–	–	Total/A: 1 (1%)
[G]	primary mountain cloudforest, not disturbed	–	2550 m	1360 m^2	5%	177	8	3	1	1	–	2	–	Total: 14 (8%), A: 8 (5%)
[H]	coast vegetation, not disturbed	yes	5 m	7248 m^2	92%	81	6	–	–	–	–	–	–	Total/A: 4 (5%)
[I]	lowland forest, not disturbed	yes	270 m	1400 m^2	0,3%	112	–	–	–	–	–	–	–	–
[J]	marsh forest, dominated by *Raphia taedigera*, not disturbed	–	19 m	1148 m^2	6%	88	4	1	–	1	–	–	–	Total: 6 (7%), A: 4 (5%)
[K]	lowland forest, disturbed, indigenous influence	–	64 m	2070 m^2	4%	168	2	–	–	–	–	–	–	Total/A: 2 (1%)
[L]	submontane forest, disturbed, indigenous influence	–	600 m	900 m^2	16%	249	1	2	–	–	1	1	–	Total: 4 (2%), A: 1 (0,4%)
[M]	roadside, subalpine subpáramo dwarf forest, disturbed	–	3295 m	3200 m^2	n.n	19	2	1	1	2	1	–	–	Total: 6 (32%), A: 2 (11%)
[N]	montane forest, continental divide, slightly disturbed	–	1240 m	723 m^2	2%	214	6	1	1	–	1	–	–	Total: 9 (4%), A: 6 (3%)
[O]	montane cloudforest, continental divide, not disturbed	–	1278 m	600 m^2	68%	154	5	–	–	–	–	2	1	Total: 7 (5%), A: 5 (3%)
						Ø=150,1$\overline{3}$								Total: Ø = 4,21 (4%), A: Ø = 2,86 (3%)

4 Discussion

4.1 Ecology

Obligate plant parasitic species of Asterinaceae and Microthyriaceae are specialized tropical ascomycetes occupying living leaves as ecological niches. In the tropics, epiphyllous habitats are colonized by numerous microorganisms such as bacteria, archaea, fungi, algae, lichens and liverworts. Epiphyllous organisms compete for space and nutrients resulting in strong selective pressures (Parbery and Emmett 1977). These evolutionary forces yielded to the biotrophic lifestyle, characteristic distribution patterns, host plant preferences and morphological adaptations present in epiphyllous species of Asterinaceae and Microthyriaceae.

4.1.1 Distribution

Asterinaceae and plant parasitic Microthyriaceae are restricted to areas with tropical and subtropical climate (Doidge 1942), whereas saprotrophic and hyperparasitic species of Microthyriaceae are also present in regions with temperate climate (Ellis 1976, 1977). The limited distribution patterns of plant parasitic species may be due to specific abiotic and biotic factors. Arnaud (1918) suspects that ectoparasitic "asterinoid" fungi depend on the high humidity present in tropical zones worldwide. Constant temperatures in the tropics also play a significant role for fungal development and virulence (Parbery and Emmett 1977, Hofmann 2005).

Detailed analyses of global distribution patterns of thyriothecioid ascomycetes are not available so far. The preliminary checklists prepared for species of *Asterina*, *Asterostomella*, *Asterolibertia*, *Cirsosia*, *Halbanina*, *Maublancia*, *Platypeltella*, *Prillieuxina* and *Xenostomella* confirm a tropical and subtropical distribution of these pathogens, whereas the distribution centers are located in the tropics of the southern hemisphere worldwide (Central and South America, Caribbean, tropical Africa, South and Southeast Asia, Tropical East Asia and Oceania). However, most of the species are only known from a single collection site (Theissen 1913a) and from regions with increased collection activities by mycologists. Intense field work in unexplored regions of tropical countries is necessary to obtain more details on distributional patterns of plant parasitic Asterinaceae and Microthyriaceae.

In Western Panama, species of plant parasitic Asterinaceae are present in almost every habitat visited. Asterinaceae are most diverse in lowland gallery forests and rainforests of higher elevations (above 1000 m a.s.l.). Plant parasitic Microthyriaceae, however, are more abundant in rainforests of higher elevations with a constant high humidity throughout the year. Most of the species occur in the Chiriquí Province, only 3 species of *Asterina* are reported from Bocas del Toro Province: *Asterina ekmanii* on *Gonzalagunia rudis* (Rubiaceae), *Asterina* sp. 7 on *Compsoneura sprucei* (Myristicaceae) and *Asterina tonduzii* with its anamorph *Asterostomella tonduzii* on *Xylosma* sp. (Salicaceae).

Most of the presented species of Asterinaceae and Microthyriaceae have a neotropical distribution, but some are pantropical, e.g. *Asterina diplocarpa*, *A. manihotis*, *A. radiofissilis* and *A. sponiae*, *A. tonduzii* and *A. zanthoxyli*. However, *Asterina gaiadendricola* and *A. schlegeliae* are only known from Panama until today and probably represent endemic species.

4.1.2 Host plant families

The distribution of species of Asterinaceae and plant parasitic Microthyriaceae is determined by their specific host preferences. The majority of the species prefer woody host plants like shrubs and trees with hard and leathery leaves, but some species occur also on annual or perennial herbaceous plants. Species-rich groups, e.g. *Asterina* spp. favour hosts from plant families such as Apocynaceae, Euphorbiaceae, Lauraceae, Melastomataceae, Myrtaceae, Rubiaceae, Rutaceae, Salicaceae (formerly Flacourtiaceae) and many others (compare host index *Asterina*, Chapter 7.5).

The presented species of Asterinaceae and Microthyriaceae from Western Panama are associated with hosts from 28 different angiosperm families (see Chapter 7.3). According to the APG classification system (A.P.G. II 2003), the host plant families belong to orders placed in magnoliids, monocots and eudictos, the three superordinal groups of angiosperms. In Panama, members of Asterinaceae (*Asterina*/*Asterostomella* spp., *Asterolibertia* spp., *Cirsosia splendida* with *Homalopeltis chrysobalani* anamorph, *Halbanina* sp., and *Prillieuxina winteriana* with *Leprieurina winteriana* anamorph) prefer hosts from plant families belonging to magnoliids (Magnoliales: Annonaceae and Myristicaceae) and core eudicots with basal Dilleniales (Dilleniaceae), rosids (rosids I with Oxalidales: Cunoniaceae; Malpighiales: Crysobalanaceae, Clusiaceae, Euphorbiaceae and Salicaceae; Fabales: Fabaceae; and Rosales: Cannabaceae and Urticaceae; rosids II with Myrtales: Onagraceae; Sapindales: Rutaceae; Malvales: Malvaceae; and Brassicales: Cleomaceae), Santalales (Chloranthaceae) and asterids (Ericales: Styracaceae; asterids I with Gentianales: Rubiaceae; Lamiales: Acanthaceae, Gesneriaceae and Schlegeliaceae; and Solanales: Solanaceae; and asterids II with Asterales: Campanulaceae) (compare Angiosperm Phylogeny Website). Members of Microthyriaceae (*Maublancia uleana*, *Platypeltella* spp. and *Xenostomella tovarensis*) are asscociated with hosts from plant families belonging to monocots (Liliales: Smilacaceae; and commelinids with Poales: Bromeliaceae) and core eudictos (rosids I with Fabales: Polygalaceae; and rosids II with Myrtales: Myrtaceae). *Hemisphaeropsis magnoliae* (‘Pycnothyriales’) is associated with the host *Magnolia sororum* (Magnoliaceae, Magnoliales), a plant that belongs to the basal magnoliids group (Angiosperm Phylogeny Website). These findings together with the data from the preliminary checklists (see Appendix, Chapters 7.5-7.12) indicate that members of phytopathogenic Asterinaceae, e.g. species of *Asterina*, diversified especially on host families from the core eudicots. Strikingly, *Platypeltella* spp. (Microthyriaceae), show a limited host range and are specialized on host families belonging to monocots (Liliales and commelinids such as Poales: Bromeliaceae and Arecales: Arecaceae) (compare Angiosperm Phylogeny Website, Appendix Table 7.10).

In Panama, members of Annonaceae, Chrysobalanaceae, Dilleniaceae and Solanaceae are associated with more than 2 different species of plant pathogenic Asterinaceae. Interestingly, plants like *Chrysobalanus icaco* (Chrysobalanaceae), *Styrax argenteus* (Styracaceae) and *Trema micrantha* (Cannabaceae) are found to be associated with numerous foliicolous fungi, such as members of Meliolales, Asterinaceae, Englerulaceae, Parmulariaceae and other bitunicate Ascomycetes. This indicates that certain plant species are favoured by fungi that occupy similar ecological niches. Those plants may exhibit specific leaf topologies or weak defense responses that facilitate growth of biotrophic foliicolous ascomycetes. In the case of *C. icaco*, the richness of fungal pathogens can be explained by the lack of other potential perennial hosts in the coastal, savannah-like vegetation of La Barqueta.

4.1.3 Host specificity

As biotrophic pathogens, species of Asterinaceae and Microthyriaceae interact with living cells of plants and, therefore, they are thought to be host-specific. For many authors, the species concept of these pathogens is particularly based on the associated host plant and not exclusively on morphological aspects of the fungus. Undoubtedly, this practice caused a species accumulation over the past 150 years and yielded to an ambiguity of certain species concepts. For example, the morphologically homogeneous genus *Asterina* includes today 709 described species growing on hosts from 120 different plant families (compare Chapter 7.6). Host specificity of *Asterina*, however, is not verified by any experimental approach. It still remains unclear, whether this group of pathogens is truly host-specific and as species-rich as predicted. Similar circumstances are known from other species-rich groups of parasitic foliicolous ascomycetes from the tropics, such as Meliolales (black mildews) and Phyllachorales (tar spot fungi).

However, parasitic relationships between pathogenic fungi and host plants result from complex developmental programs and coordinated signalling processes in both the pathogen and its host (Ebel and Scheel 1997, Hahn and Mendgen 2001). To overcome host plant resistance, plant pathogens evolve diverse structural and chemical compounds and plants elaborate different defensive tools against pathogen attack (Ferreira et al. 2006). This results in a co-evolutionary struggle between pathogens and potential hosts and may explain the host specificity present in biotrophs (Ferreira et al. 2006, Heath 2002). Biotrophic pathogens form stable interactions with their hosts that may last for months (Mendgen and Hahn 2002). During this phase pathogens are able to avoid or suppress host defense and mediate host cell re-programming (Panstruga 2003, Schulze-Lefert and Panstruga 2003). As shown by the few existing model systems, such as *Uromyces* spp. (rust fungi, Basiodiomycota), *Colletotrichum* spp. (anamorphic Ascomycota) and *Magnaporthe grisea* (rice blast fungus, Ascomycota) (Mendgen and Deising 1993, Howard and Valent 1996, Perfect and Green 2001, Mendgen and Hahn 2002), each pathogen–host relationship is different and exhibits a unique set of structural and chemical components dependent on the pathogen and the host involved. Therefore, biotrophic species of Asterinaceae and Microthyriaceae are probably highly specialized on particular host species or groups of closely related host plants and might have evolved together with them in stable one-to-one relationships over long periods of time.

In Western Panama, species of Asterinaceae and Microthyriaceae show narrow host ranges. Almost all species are associated exclusively with one host plant species (Table 3.1). Exceptions are *Asterina diplocarpa* growing on two different species of *Sida* (Malvaceae), *Asterina siphocampyli* on two different species of *Burmeistera* (Campanulaceae) and *Cirsosia splendida* and its anamorph *Homalopeltis chrysobalani* on host plant species from two different genera of Chrysobalanaceae (*Chrysobalanus icaco* and *Hirtella triandra*) (Table 3.1). Most of the presented species are originally described from other hosts plant species than from those collected in Panama (Chapter 7.3). However, most of the host plants of a particular fungal species belong to the same plant genus or plant family. This indicates that species of Asterinaceae and Microthyriaceae are specialized on individual or closely related host plant species. Therefore, we consider species of this group of pathogens at least specific on the level of host plant family (Hofmann and Piepenbring 2008).

4.1.4 Diversity of Asterinaceae and plant parasitic Microthyriaceae in Panama

Plant parasitic species of Asterinaceae and Microthyriaceae are considered to be host specific. Therefore, their diversity is thought to be closely related to the diversity of the hosts. Panama is one of the major biodiversity centers worldwide with more than 9500 known species of vascular plants (Correa et al. 2004). According to Correa et al. (2004), about 8560 (81.96 %) of the species represent angiosperms (Magnoliopsida) which include the most favoured groups of host plants of Asterinaceae and Microthyriaceae. If we assume that these plant pathogens are host specific, and if we consider the high diversity of potential tropical host plants, we can expect that Asterinaceae and Microthyriaceae are very diverse in Panama and in the Neotropis in general. Data obtained from the ppMP project support the theory of an increased diversity of *Asterina* spp. (Asterinaceae) in Western Panama (Fig. 3.103). However, the ppMP data refer to investigations conducted in the understory of primary and secondary vegetation in Western Panama. The canopy of the respective areas might bear a much greater diversity of plant parasitic microfungi.

Some habitats in Western Panama are characterized by a higher diversity of species of Asterinaceae, e.g. a mountain rain forest close to Boquete (E) and a lowland gallery forest in Los Algarrobos (B, Fig. 3.102, 3.104). Interestingly, both forests are exposed to a constantly high degree of human interference, such as understory cutting in the case of the mountain rainforest and cattle breeding, fire clearance and fumigation near the gallery forest. Therefore, species diversity of Asterinaceae is probably also related to the disturbance gradient of the specific habitat and the respective host plants that are adapted to this rapidly changing environment.

4.1.5 Adaptations to the habitat leaf

Leaves are surrounded by the cuticle, an extracellular matrix acting as the major barrier against uncontrolled water loss from plants (Riederer and Schreiber 2001, Gniwotta et al. 2005, Bargel et al. 2006). Additionally, the cuticle protects underlying tissue against harmful radiation, mechanical stress, helps to maintain the physiological integrity and has signalling properties for pathogen/herbivore recognition (Bargel et al. 2006). The cuticle mainly consists of the insoluble polymer cutin and different soluble lipids termed cuticular waxes. Epicuticular waxes cover the upper surface of the cuticle and lead to extreme water repellency and self-cleaning properties of the cuticle (Bargel et al. 2006). Therefore, leaf surfaces are hostile environments where temperature and relative humidity fluctuate rapidly and where nutrient resources are limited (Lindow and Brandl 2003). In the tropics, however, leaves are usually colonized by large numbers of microorganisms (bacteria, fungi, algae, lichens, mosses and sometimes flowering plants). Plant pathogenic Asterinaceae and Microthyriaceae exhibit numerous characteristics to survive in spite of the hostile conditions of leaf surfaces.

Melanization of fungal cells: Light-exposed structures, like surface mycelia, fruiting bodies (scutellum layer), ascospores and conidia of plant parasitic species of Asterinaceae and Microthyriaceae have always darkly pigmented (melanized) cell walls for protection against solar radiation. Melanin pigments are one of the most stable, insoluble and resistant biochemical materials (Jacobson 2000). Melanins are known to induce pathogenic effects like shielding of cell wall components against hydrolytic enzymes, sequestration of host defensive proteins, redox buffering, trapping of single electrons, a role in the osmotic penetration of the plant cell wall by the appressorium and a possible role in other penetrations (Jacobson 2000). Therefore, melanization of fungal structures is a common phenomenon among obligate biotrophic pathogens because it is crucial for spore survival, fungal virulence and pathogenicity (Parbery and

Emmett 1977, Howard and Valent 1996, Jacobson 2000).

Endohyphae: The 2-celled ascospores of *Asterolibertia licaniicola* and conidia of *Homalopeltis chrysobalani* develop the first appressorium from the upper cell, whereas the lower cell collapses during withdraw of its cytoplasm into the upper cell. After successful infection and constant acquisition of nutrients from the first appressorium, an endohypha develops from the upper cell into the cavity of the emptied lower cell. The endohypha grows through the lower cell, penetrates the wall of the collapsed cell and differentiates into an infective surface mycelium (Figs. 3.62f, 3.73g, 3.74e-f). Endohyphae or intrahyphal hyphae are known from many fungi and are thought to enable survival when hostile conditions lead to degeneration of exposed hyphae (Kim et al. 2004). Endohyphae in spores of *A. licaniicola* and *H. chrysobalani* might be a response to drought stress, because both species grow on host plants adapted to temporary dry environments. *A. licanicae* grows on *Licania arborea* (Chrysobalanaceae) and *H. chrysobalani* on *Chrysobalanus icaco* (Chrysobalanaceae). Both host plants have hard and leathery leaves characterized by thick cuticles. *L. arborea* is a lowland tree on the pacific side of Panama and is annually exposed to a harsh dry season. *C. icaco* is a typical shrub of coastal regions throughout the Americas and during the dry season in Western Panama the plant is exposed to extreme dry conditions.

Mucous substances: Scutellum cells, interascal tissue and other internal hyphae of maturing fruitingbodies of many species of Asterinaceae and Microthyriaceae excrete mucus into the thyriothecial/pycnothyrial cavity. Mucous substances are thought to serve in retaining water within ascomata and therewith protection against desiccation of internal hyphae, such as ascogenous hyphae and maturing asci, and may also reveal antimicrobial effects. Additionally, mucilage may also play an important role in the disintegration of central scutellum cells of mature sporomata through the secretion of specific enzymes. Thyriothecia of some *Asterina* spp. open via a slimy dehiscence of central scutellum cells, e.g. *A. ciferriana* and *A. sponiae*. In the past, the type of scutellum dehiscence or disintegration was used to segregate *Asterina*-like fungi with this characteristic in own genera such as *Myxasterina* (Höhnel 1909) or *Englerulaster* (Höhnel 1910). However, numerous authors (Theissen and Sydow 1917, Doidge 1942, Hansford 1946, Müller and Arx 1962) considered the segregation to be artificial and thereupon the genera were united with *Asterina*. Members of the family Englerulaceae, e.g. species of *Schiffnerula*, are morphologically similar to *Asterina* spp. with slimy disintegrating thyriothecia. However, *Schiffnerula* spp. produce globose fruitingbodies with few asci and contain hyphomycetous anamorphs instead of pycnothyrial anamorphs as in species of *Asterina*.

Concentric bodies: As seen by TEM, the cytoplasm of different cells of plant pathogenic species of Asterinaceae and Microthyriaceae contain concentric bodies (Fig. 4.1). Concentric bodies are small circular cell organelles reported from many lichenized and nonlichenized ascomycetes (Tyson and Griffiths 1976, Samuelson and Bezerra

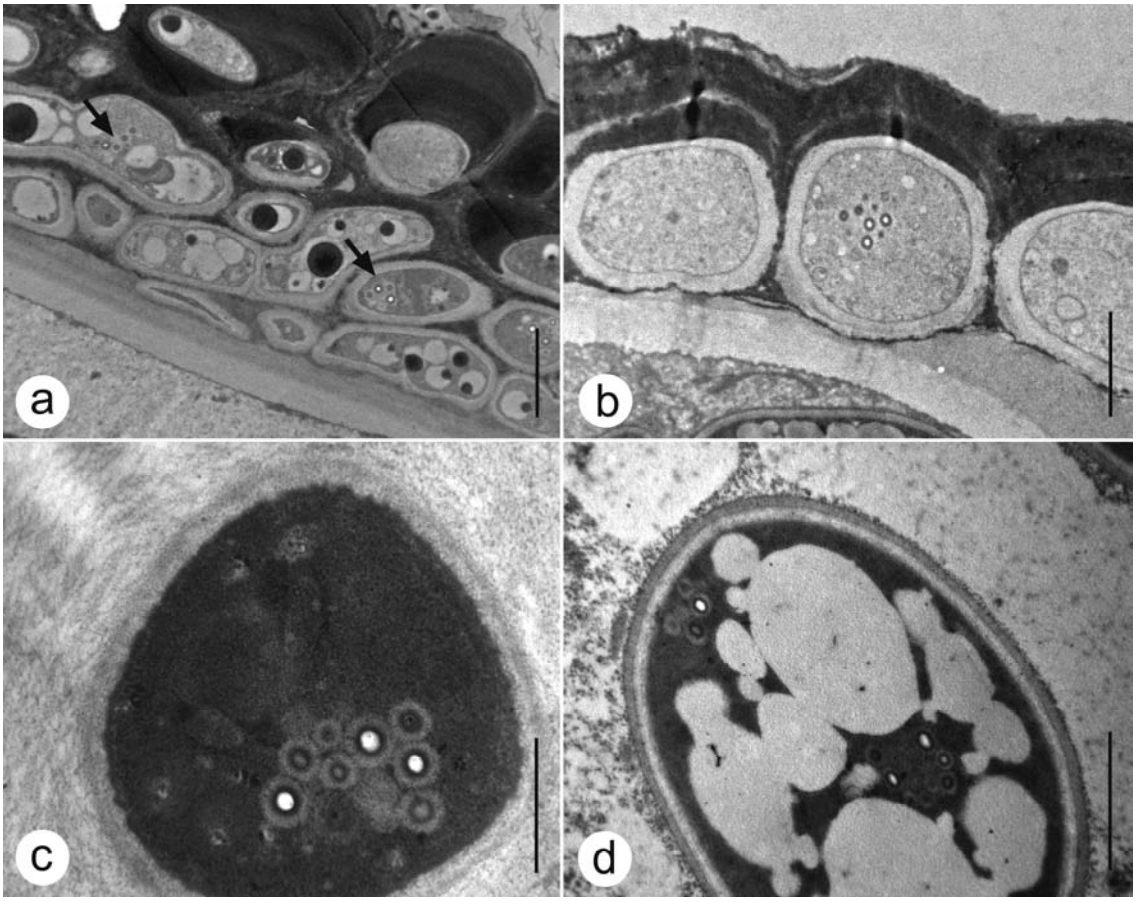

Figure 4.1: TEM photographs of concentric bodies in cells of different species of Microthyriaceae (a-c) and anamorphic Asterinaceae (d). a: Cross section through the scutellum layer of a thyriothecium of *Maublancia uleana* (ppMP 1206), concentric bodies (arrows) are situated in lower scutellum cells, note the numerous cell layers of the scutellum. Scale bar = 2 µm. **b:** Cross section of the one-celled scutellum layer of *Platypeltella smilacis* (ppMP 1346) with scutellum cells containing concentric bodies. Scale bar = 2 µm. **c:** Electron-dense cytoplasm of a partly shown scutellum cell of an undetermined thyriothecioid ascomycete (cf. *Stomiopeltis* sp., TH 414) parasitizing leaves of *Gaultheria erecta* (Ericaceae). Electron transparent zone represents the inner part of the thick cell wall. Concentric bodies are arranged in small groups in the cytoplasm, note the three layered composition with an electron-transparent outer zone, followed by an electron-dense zone and the translucent core. Scale bar = 0.5 µm. **d:** Cross section through a conidium of *Homalopeltis chrysobalani* (ppMP 571) containing groups of concentric bodies and large vacuoles. Scale bar = 1 µm.

1977, Ahmadjian 1993, Classen et al. 2000, Honegger 2001). Concentric bodies consist of three concentric zones, an outermost electron-transparent zone followed by a dark electron-dense zone and a central transparent core (Fig. 4.1, Samuleson and Bezerra 1977). The origin and function of these subcellular organelles is still unknown, but concentric bodies have been found in fungal cells that are known for their relative longevity and desiccation tolerance (Classen et al. 2000, Honegger 2001). According to Honegger (2001), concentric bodies are remains of cytoplasmatic cavitation events due to drought stress. Concentric bodies are present in melanized scutellum cells and conidia (Fig. 4.1) of plant parasitic species of Asterinaceae and Microthyriaceae. These cellular structures are exposed to direct sunlight and temporary dryness.

4.1.6 Hyperparasites

Colonies of Asterinaceae and plant parasitic Microthyriaceae are frequently parasitized by other fungi, mostly Hyphomycetes and Ascomycetes. In the literature, various so-called hyperparasitic fungi are reported from members of Asterinaceae and more rarely from Microthyriaceae, e.g. species of ascomycetous genera like *Chaetodimerina*, *Dimerina*, *Dimerium*, *Phaeophragmeriella*, *Philonectria*, *Nematothecium*, *Saccardomyces*, *Rizalia* (Hansford 1946), *Phaeodimeriella* (Barr 1997, Batista 1962, Hughes 1953), *Calonectria* (Hansford 1946) and species of hyphomycetous genera like *Cephalosporium*, *Cephalosporiopsis*, *Domingoella*, *Helminthosporium*, *Periconia*, *Titaea* (Hansford 1946), *Cincinnobella* (Batista 1962), *Pirozynskiella* (Hughes 2007), *Dendryphion*, *Hansfordiella* and *Tetraposporium* (Hughes 1952).

In Panama, numerous species of plant parasitic Asterinaceae and Microthyriaceae are infected with hyperparasites (Table 4.1). The mycelia of hyperparasitic fungi invade the host mycelium or develop directly within thyriothecia or pycnothyria of their hosts (Fig. 4.2). Hyperparasites are often present on fungal colonies of older leaves that additionally are colonized by numerous other epiphyllous organisms, like lichens, liverworts or mosses. Interestingly, some plant pathogenic thyriothecioid ascomycetes are parasitized by relatives of the same fungal group (Fig. 4.2a-b). Some species of Microthyriaceae are known to grow on other fungi and are characterized by special fruitingbodies, so called cathathecia, with an upper and lower scutellum wall (Spooner and Kirk 1990). Cathathecioid fungi, formerly segregated in an own family Trichothyriaceae, can parasitize members of Meliolales, Asterinaceae and other foliicolous ascomycetes (Müller and Arx 1962, Ellis 1977). In Panama, cathathecioid hyperparasites are present on *Platypeltella irregularis* (Microthyriaceae), *Asterina cestricola*, *Asterina* sp. 1 and *Asterina* sp. 4 (Asterinaceae).

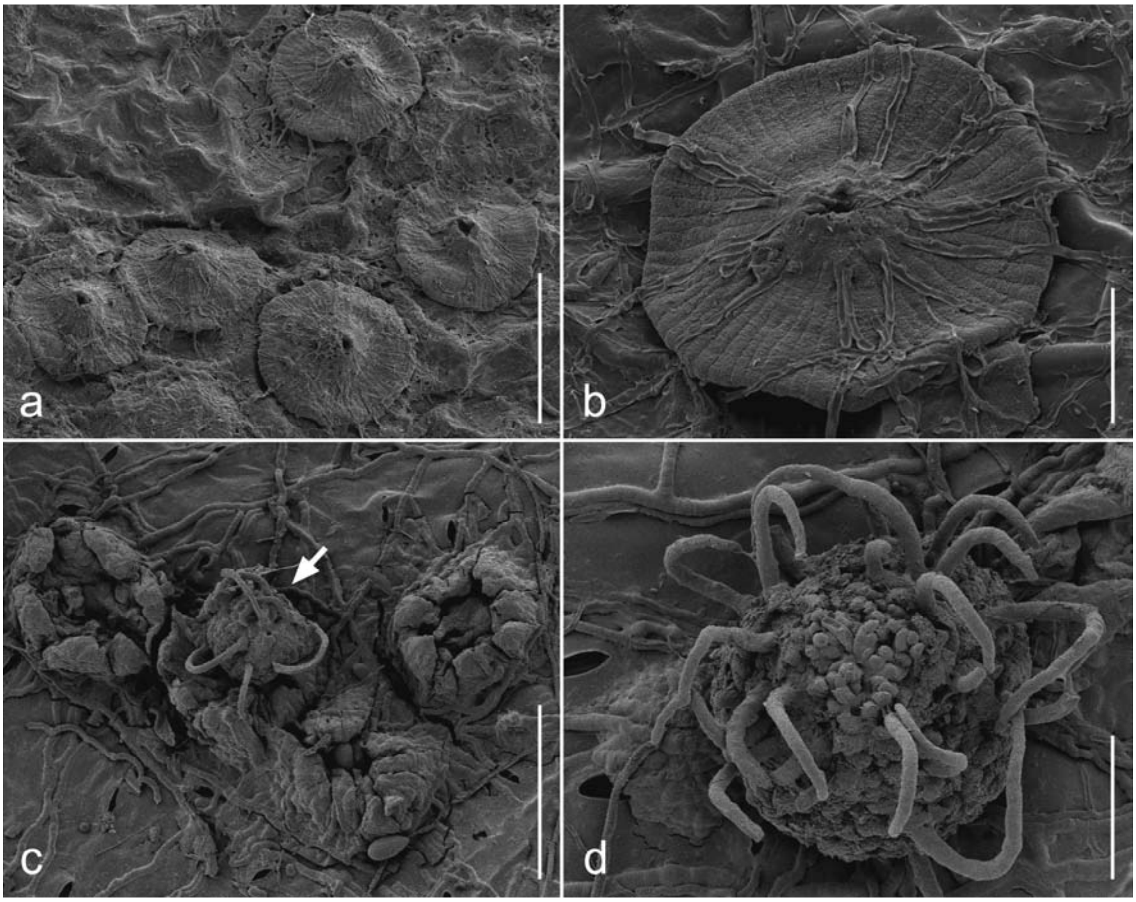

Figure 4.2 SEM photographs of hyperparasitic ascomycetes on species of plant pathogenic Microthyriaceae (a-b) and Asterinaceae (c-d). a: Group of catathecia of cf. *Trichothyrinula petrakii* hyperparasitizing colonies of *Platypeltella irregularis* (ppMP 406). Scale bar = 90 µm. **b:** Single ostiolate catathecium of *T. petrakii*, note the external hyphal elements radiating from the ostiole. Scale bar = 30 µm. **c:** Group of pycnothyria of *Asterostomella stipitipodia* (TH 596-B), hyperparasitized by a young setose ascoma of *Phaeodimeriella guarapiense* (arrow). Scale bar = 80 µm. **d:** Single setose ascomata of *P. guarapiense* with a group of liberated ascospores emerging through the central ostiole. Scale bar = 30 µm.

Table 4.1: Hyperparasitic fungi on species of Asterinaceae and Microthyriaceae collected in Western Panama.

Species	Ascomycetes		Fungi Imperfecti	
	thyriothecioid	perithecioid	Hyphomycetes	Coelomycetes
Asterinaceae				
Asterina cestricola	+	+	–	–
Asterina consobrina	–	–	+	–
Asterina corallopoda	–	+	–	–
Asterina davillae	–	+	+	–
Asterina diplocarpa	–	+	+	–
Asterina fuchsiae	–	+	+	–
Asterina phenacis	–	–	+	–

Asterina radiofissilis	–	+	–	–
Asterina schlegeliae	–	–	+	–
Asterina siphocampyli	–	+	+	–
Asterina stipitipodia	–	+	–	–
Asterina styracina	–	+	+	–
Asterina tonduzii	–	+	–	–
Asterina sp. 1	+	+	+	–
Asterina sp. 2	–	+	–	–
Asterina sp. 4	+	+	–	–
Asterina sp. 6	–	+	–	–
Asterina sp. 7	–	–	+	–
Asterolibertia licaniicola	–	–	+	–
Asterolibertia nodulosa	–	+	+	–
Asterostomella dilleniicola	–	+	–	+
Halbanina sp.	–	–	–	+
Microthyriaceae				
Platypeltella irregularis	+	–	–	–
Platypeltella smilacis	–	–	+	–

4.2 Morphological features

Species of Asterinaceae and Microthyriaceae have diverse morphological characteristics (Fig 4.3). In the past, many authors concentrated on characters of superficial structures such as surface mycelium, appressoria, sporomata and spores (Theissen 1913a, Doidge 1942, Yamamoto 1956, 1957, Kar and Ghosh 1996, Hosagoudar and Abraham 1997, 1998, Hosagoudar and Goos 1996, Song and Li 2002 and many others). Therefore, species descriptions of species of Asterinaceae and Microthyriaceae often lack information about internal features and the type of parasitism (Hansford 1946).

4.2.1 Colony and macroscopical aspects

Colonies of species of Asterinaceae and plant parasitic Microthyriaceae are typically darkly pigmented and grow superficially on living leaves of plants. Colonies can be exclusively epiphyllous e.g. in *Asterina corallopoda*, *Asterina sponiae* and *Asterolibertia licaniicola*, or exclusively hypophyllous, as in *Asterina gaiadendricola*, *Asterina stipitipodia*, *Asterina* sp. 7 and *Halbanina* sp. or amphigenous, as in *Asterina davillae*, *Cirsosia splendens* and *Platypeltella* spp. Hypophyllous growing species of Asterinaceae are often associated with the stomata of the host plant and can from specialized structures to penetrate them, e.g. in *Halbanina* sp., or to infect stomatal guard cells, such as *Asterina gaiadendricola*.

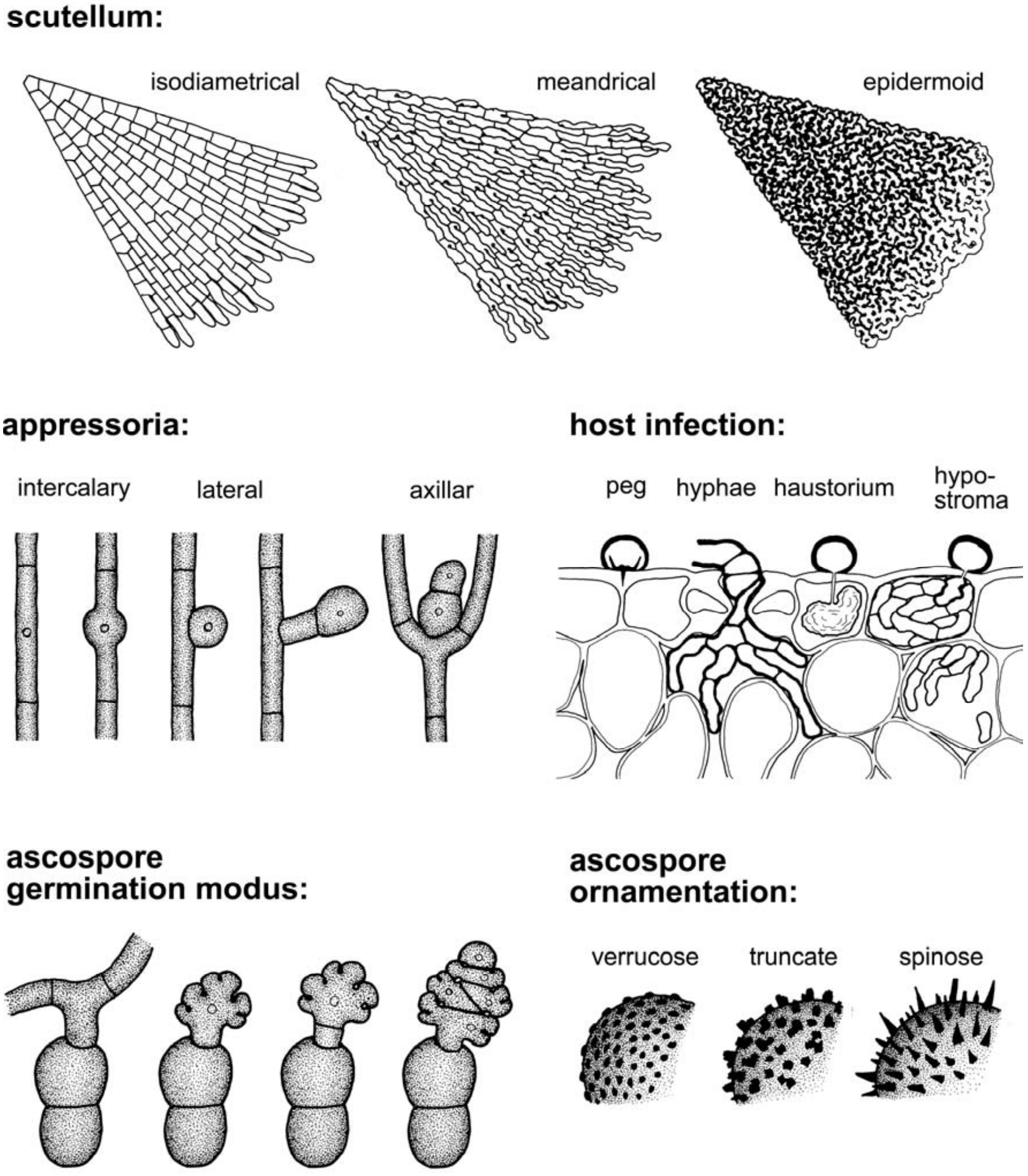

Figure 4.3: Morphological features of plant parasitic species of Asterinaceae and Microthyriaceae collected in Western Panama.

Colony development is initiated with a germinating spore from which one or several surface hyphae emerge on the leaf surface. Radiate growth results in the formation of a more or less circular colony that sometimes becomes confluent with neighbouring colonies of the same fungal species. Confluent colonies can result in the colonization of large leaf parts by a single fungal species.

Colony size, shape and density depend on the respective fungal species and the leaf surface patterns of the specific host plant and therefore, are of minor significance for species delineation. However, features of colony appearance in combination with other morphological characters can facilitate the identification process on species level.

4.2.2 Surface mycelium

Many species of plant parasitic Asterinaceae and Microthyriaceae develop darkly pigmented mycelia to invade the host plant surface and form specialized structures for host infection. Surface mycelia are present in *Asterina/Asterostomella* spp., *Asterolibertia* spp., *Cirsosia* spp., *Maublancia* spp., *Platypeltella* spp. *Prillieuxina* spp. and *Xenostomella* spp. However, some species do not develop surface mycelia such as *Hemisphaeropsis magnoliae* ('Pycnothyriales'). The presence or absence of a conspicuous, dark surface mycelium is an important criterion for delimiting genera of thyriothecioid ascomycetes, at familiy level it is of less significance than previously thought (Theissen, 1913a, Doidge 1942).

Surface mycelia often reveal characteristical progression patterns ranging from straight or linear, e.g. in *Asterina styracina*, *Asterolibertia* spp., *Platpeltella irregularis* and *Prillieuxina winteriana*, to sinuate, as in *Asterina ciferriana*, *Asterina stipitipodia* and *Asterina tonduzii* or zigzag-like, as in *Asterina cestricola*, *Asterina consobrina*, *Asterina diplocarpa*, *Asterina siphocampyli* and *Xenostomella tovarense*. The type of hyphal progression may be species induced, but is more likely determined by the surface patterns of the particular host plant. I observed surface mycelia of *Asterina* sp. 3 on *Desmopsis bibracteata* (Annonaceae) changing their progression patterns from straight to shortly zigzag-like as they reached a thallus of the epiphytic algae *Phycopeltis* sp. (Trentepohliales). Superficially growing hyphae orientate along subsided cell ridges of the epidermis to locate suitable positions for appressorium formation with subsequent host cell penetration. The more deeper or distinct the cell ridges between every epidermal plant cell are, the more sinuate and zig-zag-like is the surface mycelium. However, hyphal progression patterns together with other morphological characteristics are important for species segregation in Asterinaceae and Microthyriaceae.

4.2.3 Structures for host infection

Plant pathogenic species of Asterinaceae and Microthyriaceae develop diverse strategies to invade their hosts (Fig. 4.3, Hansford 1946). Appressoria enable the penetration of the host cuticle, whereas intracellular hyphae or haustoria realize nutrient uptake from the plant cells. Sometimes intracellular hyphae may develop into expanding hypostromata and more rarely intercellular hyphae or intracuticular pegs were observed. The type of host infection is an important criterion for delimiting genera and species of thyriothecioid ascomycetes.

Appressoria: Appressoria are specialized infection structures involved in fungal attachment to host tissues with or without a subsequent penetration of host cells (Kirschner 2009). Appressoria of plant pathogenic Asterinaceae and Microthyriaceae are always characterized by dark pigmented (melanized) cell walls. Melanin is crucial for host plant infection because it lowers the porosity of the appressorial walls, which blocks the efflux of soluble molecules larger than water (Howard and Valent 1996). As shown in appressoria of *Magnaporthe grisea*, this creates a semipermeable barrier within appressoria leading to the formation of elevated tugor pressures up to 80 bar (Howard and Valent 1996, Howard 1997, Jacobson 2000). The large mechanical forces are exposed to a small area of the plant cell wall and pierce a hole through it (Jacobson 2000). Melanin might also play a role in the long-term survival of appressoria (Parbery and Emmett 1977, Howard 1997).

Appressoria are present in almost all species of Asterinaceae and Microthyriaceae included in this study, except *Halbanina* sp. which penetrates the host stomata. Most appressoria are associated with a brown surface mycelium as in species of *Asterina*/*Asterostomella*, *Asterolibertia*, *Cirsosia*/*Homalopeltis*, *Maublancia*, *Platypeltella* and *Xenostomella*. However, *Hemisphaeropsis magnoliae* and *Prillieuxina winteriana* lack appressoriate surface mycelia and the appressoria are exclusively formed by germinating ascospores and conidia or by scutellum cells. In most cases, appressoria realize the penetration of epidermal host cells and initiate the formation of intracellular haustoria or hypostromata. Appressoria of *Platypeltella* species, however, do not penetrate through the entire host plant cuticle but form intraparietal or intracuticular penetration pegs, similar to thumbtacks.

Appressoria are normally one-celled, e.g. in species of *Asterina*/*Asterostomella*, *Asterolibertia licaniicola*, *Asterolibertia* sp., *Cirsosia splendida* with anamorph, *Platypeltella* spp., *Prillieuxina winteriana* and its anamorph, and *Xenostomella tovarense*. However, in *Maulbancia uleana* the axillar appressoria are two-celled, and germinating ascospores of *Asterolibertia nodulosa* form multicellular appressoria (Fig. 4.3). The shape of mycelial appressoria is mostly constant within a single species, whereas primary appressoria of germinating ascospores sometimes differ dramatically, e.g. in *Asterolibertia nodulosa*.

Appressorium shape is an important criterion for species segregation, when used in combination with other morphological characters. Appressorium position is relevant to delineate genera of plant parasitic Asterinaceae and Microthyriaceae.

Haustoria: Haustoria are intracellular structures that are formed upon host-cell penetration and enable the fungus to take up nutrients from the host cell (Panstruga 2003). A haustorium is separated from the host cytoplasm by an invagination of the host plasma membrane, the extrahaustorial membrane (EHM). The space between the invaginated EHM and the fungal cell wall is filled with an amorphous layer termed extracellular matrix (Fig. 3.52b). To transfer nutrients from the host plant into the haustorium, the molecules must pass through the EHM and the extracellular matrix, the haustorial wall and the haustorial plasma membrane (Szabo and Bushnell 2001). In rust fungi, the transport is realized by a proton symport mechanisms involving sugar- and aminoacid transporters and a H^+-ATPase which creates a proton gradient across the haustorial membrane (Szabo and Bushnell 2001, Hahn and Mendgen 2001). According to Voegele et al. (2001), the major nutrient components transferred from the plant cells to rust haustoria are plant derived sugars, such as glucose and fructose, and amino acids. Additionally, haustoria function in signalling, communication and avoidance of recognition by the host (Perfect and Green 2001) and also might play a role in the biosynthesis of fundamental metabolites not available in sufficient amounts by the host (Panstruga 2003). However, haustorium-host interfaces are far from being well understood due to their intriguing structural and functional complexity (Hahn and Mendgen 2001) and the limited amount of suitable techniques to study obligate biotrophs.

In Panama, haustoria-forming thyriothecioid ascomycetes are members of Asterinaceae, e.g. all species of *Asterina*/*Asterostomella*, *Asterolibertia licaniicola* and *Cirsosia splendida* and its anamorph. The haustoria are globose, ellipsoidal or reniform, and are normally present in cells of the upper or lower epidermis of the host plant. Similar as in haustoria of other obligate biotrophs, the haustoria of *Asterina* spp. are surrounded by an extracellular matrix (Fig. 3.52b).

Hypostromata: Hypostromata are composed of bundles of interwoven intracellular hyphae filling plant cells partly or entirely. Hypostromata can be restricted to a single epidermal cell, e.g. in *Asterolibertia* sp., or they expand to neighbouring cells. Extended hypostromata are formed by *Asterolibertia nodulosa*, *Prillieuxina winteriana* and its anamorph *Leprieurina winteriana* (Asterinaceae) and *Hemisphaeropsis magnoliae* (‘Pycnothyriales’). In *A. nodulosa* and *P. winteriana*, the intracellular hyphae spread horizontally to neighbouring epidermal cells resulting in hypostromata restricted to the epidermis of the plant. In *H. magnoliae*, the intracellular hyphae extend vertically to subepidermal plant tissue and sometimes span through the entire leaf profile. Hypostroma formation in *A. nodulosa*, *P. winteriana* and *H. magnoliae* seems to be more invasive because it can lead to the local death of plant cells. For the pathogen, however, hypostromata are advantageous over other infection strategies. Cells of the hypostromata beneath detached parts of colonies or sporomata can grow upwards through the preformed cuticular channels to initiate the formation of new superficial hyphae or sporomata. Therefore, hypostromata can increase the virulence and longevity of epiphyllous pathogens.

Intercellular hyphae: The surface hypae of *Halbanina* sp. penetrate host stomata, form plug-like structures within the stomatal openings and enter the stomatal cavity with intercellular hyphae. The hyphae grow between parechyma cells but do not penetrate them. Intercellular hyphae are known from other dothideomycetous plant pathogens, for example cercosporoid hyphomycetes (species of *Cercospora*, *Passalora* or *Ramularia*) which represent the anamophic stages of members of Mycosphaerellaceae (Kirschner 2009). However, it remains unknown how nutrient uptake is achieved in intercellular hyphae.

Intracuticular pegs: Species of *Platypeltella* form special thumb-tack like penetration pegs that enter the cuticle of the host plant. The pegs evolve from circular, bowl-like discs that are tightly pressed to the host cuticle in the basal part of node-like appressoria. It is still speculative, if the pegs initiate the penetration of deeper host tissue or if they only help to attach the colony to its substrate. The type of infection via intracuticular pegs arising from intercalary appressoria is unique in species of *Platypeltella* and was not observed before in any other epiphyllous ascomycete.

Other infection mechanisms: Species of thyriothecioid ascomycetes are specialized to a broad variety of host plants and, therefore, show diverse strategies for host infection. The excellent illustrations of Hansford (1946) from numerous species of plant parasitic thyriothecioid ascomycetes indicate that. Other infection mechanisms are for example intra- or subcuticular hyphae or hypostromata. Intense studies of the parasitism of tropical species of Asterinaceae and Microthyriaceae based on microscopical and ultrastructural methods might accelerate the discovery of new and unique infection strategies in this group of pathogens.

4.2.4 Thyriothecium

Thyriothecia of Asterinaceae and Microthyriaceae are flattened and typically circular in outline, e.g. *Asteina*/*Asterostomella* spp., *Asterolibertia* spp., *Maublancia* spp., *Platypeltella* spp. and *Prillieuxina* spp., or more rarely elongated, L-, Y- or X-shaped, as in *Cirsosia splendida*. In most species, thyriothecia develop directly below or lateral from a surface hyphae, except in *Hemisphaeropsis magnoliae*, where surface mycelia are absent and where the thyriothecia arise from hypostromata within plant cells.

The development of a thyriothecium is initiated by lateral outgrowths from a surface hypha, termed the generatorhypha (Fig. 4.4). Above and below the outgrowths, septa develop to segregate the ascocarp initial from the generatorhyphae. As the lateral outgrowths expand, further septa are formed perpendicular to the growth direction. A pseudoparenchymatic scutellum is formed by the continuous growth of the peripheral scutellum cells and subsequent circumferential cell divisions. During the expansion of the scutellum at the periphery, single cells in the center of the scutellum grow and divide in anticlinal direction to initiate the development of internal ascocarp hyphae. Thereby, the layer is lifted upwards and a flat cavity is formed between the scutellum layer and the host cuticle. During this process, pigmented scutellum cells might loose parts of their lower melanised cell wall deposits that remain firmly attached to the cuticle. In some species of *Asterina*, these deposits are thick and continuous and, therefore, are easily visible as an exact copy of the cell progress of the upper scutellum layer (Fig. 4.5). In older literature, the melanin deposits were interpreted as a basal cell

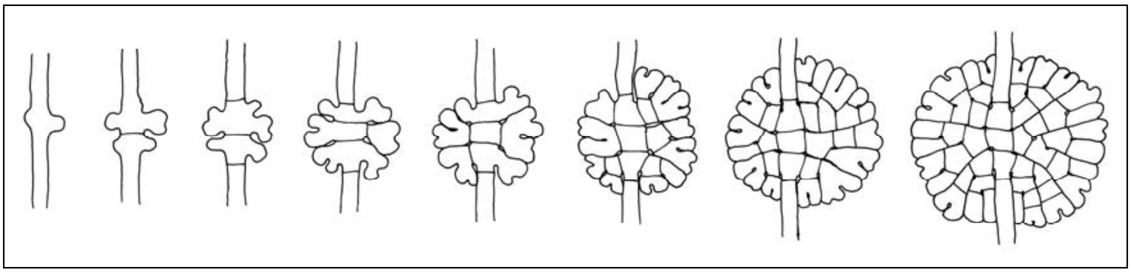

Figure 4.4: Initial stages of thyriothecium development.

layer representing the lower ascoma wall (Theissen 1913a). Species of *Asterina* that developed 'basal cell layers' were segregated in a so-called *Clypeolaster*-section/subgenus (Theissen 1913a, Doidge 1942). However, this segregation seems to be artificial and of no systematic relevance at species level. In Western Panama, we collected some *Asterina* spp. and their respective anamorphic states as well as the anamorphic *Hemisphaeropsis magnoliae* that develop sporomata with distinct basal remnants of melanin deposits, here referred to as basal 'plates' (Table 4.2). Basal 'plates' might play a role in the spatial separation of the sporomatal cavity from the subjacent plant cuticle. Therefore, melanised basal 'plates' probably help to protect fragile hyphae or developing spores from possible cuticle-mediated plant defense responses.

The shape of the thyriothecia is an important criterion to delineate genera of Asterinaceae and Microthyriaceae. The dimidiate type of ascoma probably developed independently in different families of thyriothecioid ascomycetes due to adaptations to epihyllous habitats.

Table 4.2: Presence or absence of basal 'plates' in thyriothecia of species of Asterinaceae and Microthyriaceae examined during this study. Abbreviations: + = present, – = absent.

Species	basal 'plate'	Species	basal 'plate'
Asterinaceae			
Asterina cestricola	+	*Asterina ciferriana*	–
Asterina consobrina	+	*Asterina corallopoda*	+, slightly
Asterina davillae	+	*Asterina diplocarpa*	+, slightly
Asterina diplopoda	–	*Asterina ekmanii*	–
Asterina fuchsiae	–	*Asterina gaiadendricola*	–
Asterina manihotis	–	*Asterina phenacis*	+, slightly
Asterina radiofissilis	+, anamorph	*Asterina schlegeliae*	+, anamorph
Asterina siphocampyli	–	*Asterina sponiae*	–
Asterina stipitipodia	–	*Asterina styracina*	–
Asterina tonduzii	+, anamorph	*Asterina weinmanniae*	–
Asterina zanthoxyli	–	*Asterina* sp. 1	–
Asterina sp. 2	+	*Asterina* sp. 3	+
Asterina sp. 4	+, slightly	*Asterina* sp. 5	–
Asterina sp. 6	+	*Asterina* sp. 7	–
Asterina sp. 8	–	*Asterolibertia licaniicola*	–
Asterolibertia nodulosa	+, slightly	*Asterolibertia* sp.	+
Asterostomella dilleniicola	–	*Cirsosia splendida*	–
Halbanina sp.	–	*Mahanteshamyces* sp.	+, slightly
Prillieuxina winteriana	–		
Microthyriaceae			
Maublancia uleana	–	*Platypeltella irregularis*	–

Platypeltella smilacis	–	*Xenostomella tovarensis*	–
Species	basal ‘plate’	Species	basal ‘plate’
‘Pycnothyriales’			
Hemisphaeropsis magnoliae	+		

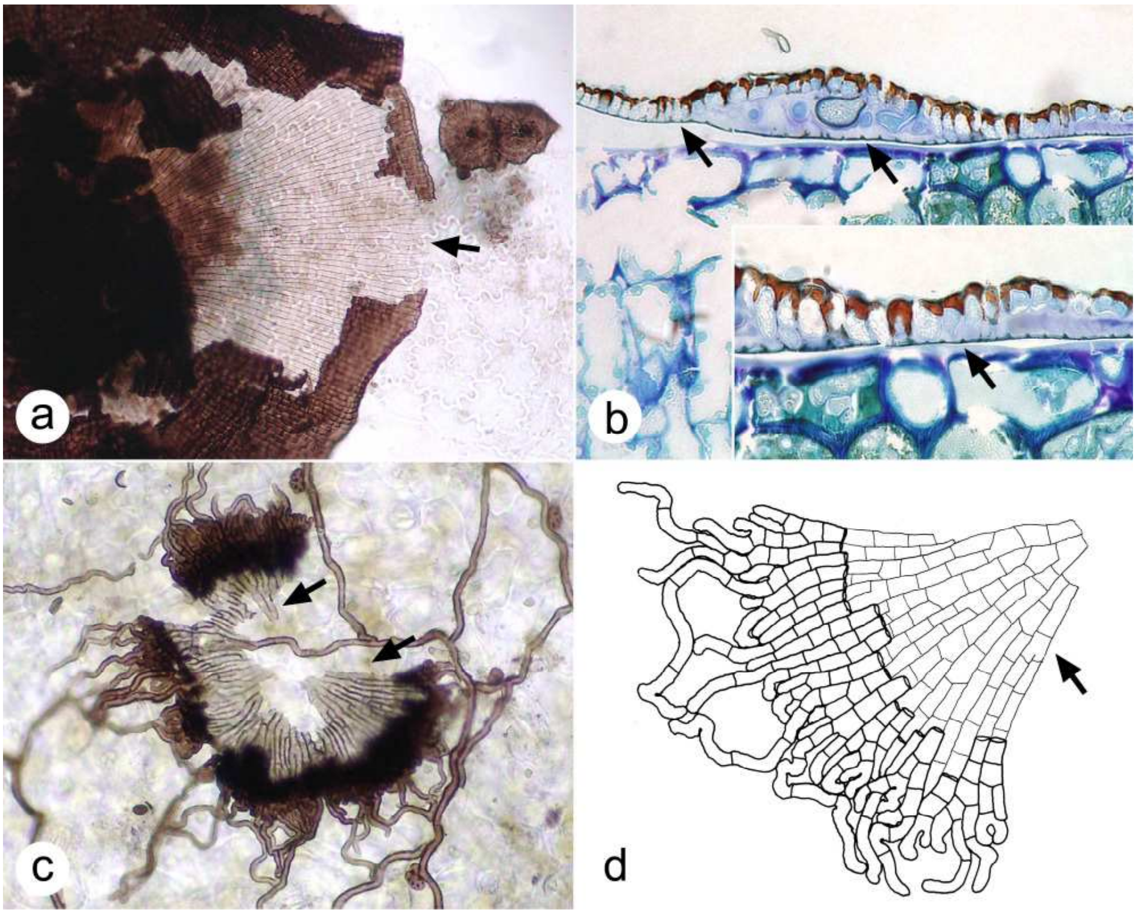

Figure 4.5: Basal ‘plates’ or remnants of melanin deposits of scutelli of *Hemisphaeropsis magnoliae* (‘Pycnothyriales’, TH 505, a-b) and *Asterina* sp. 1 (Asterinaceae, TH 422, c-d). a: Part of a multiloculate sporomata of *H. magnoliae* with a partly detached upper scutellum layer and exposed subjacent basal ‘plate’ (arrow). **b:** Cross section of a sporomata of *H. magnoliae* and subjacent host plant tissue stained in crystal violet, note the thin basal ‘plate’ (arrows) adjacent to the host cuticle. **c:** Emty and partly destroyed thyriothecium of *Asterina* sp. 1 with detached upper scutellum layer and remnants of the subjacent basal ‘plate’ (arrows). **d:** Illustration of a partly shown ascomata *Asterina* sp. 1 with a partly removed upper scutellum layer and the basal ‘plate’ (arrow).

4.2.5 Scutellum

The structure and composition of the scutellum varies significantly among different genera and species of thyriothecioid ascomycetes and therefore, it is an important criterion for the segregation on genus- and even family-level. Scutelli of species of Asterinaceae (*Asterina*, *Asterostomella*/*Mahanteshamyces*, *Asterolibertia*, *Halbanina* and *Prillieuxina*) are composed of rigid, isodiametrical to cylindrical cells that are arranged in radiating rows and form a continuous plate of cells. Species of plant parasitic Microthyriaceae have similar scutelli, as in *Platypeltella* spp., or they are made of meandrical cells (*Maublancia uleana*) or epidermoidal cells as in *Xenostomella* spp. Two morphological scutellum types can be distinguished in transverse sections of thyriothecia. First, the '*Asterina*'-type scutellum is composed of a single layer of scutellum cells and is present in all examined species of Asterinaceae including the genera *Asterina*, *Asterostomella*/*Mahanteshamyces*, *Asterolibertia*, *Halbanina* and *Prillieuxina* and in species of the microthyriaceous genus *Platypeltella*. Second, the '*Maublancia*'-type scutellum is composed of numerous layers of scutellum cells and is present in species of plant parasitic Microthyriaceae from the genera *Maublancia* and *Xenostomella*.

The opening mechanisms of scutelli of mature ascomata are criteria for the segregation of families of thyriothecioid ascomycetes. Scutelli of species of Asterinaceae open with star-shaped fissures due to the break down of lateral cell wall connections in the center of the scutellum. Microthyriaceae are characterized by central ostioles that are formed by the break down of central scutellum cells. However, for anamorphic (pycnothyrial) stages of thyriothecioid ascomycetes opening mechanisms do not always indicate possible relationships to a group of teleomorphs. Elongated thyriothecia of *Cirsosia splendida* (Asterinaceae) open with central slits (Figs. 3.73c, 3.75a), the corresponding anamorph *Homalopeltis chrysobalani*, however, has circular pycnothyria that open with central ostioles (Figs. 3.74b, 3.75d).

Scutellum cells are protected by thick cell walls containing melanin which is normally deposited in thick layers in the upper cell walls on the surface of the sporoma (Fig. 3.79, 3.87, 3.94c-d). Melanin is thought to protect fungal cells against UV radiation and chemical substances (Jacobson 2000). Scutellum cells often contain concentric bodies (Fig. 4.1) suggesting that the cells survive relatively long and tolerate desiccation (Honegger 2001). In young developmental stages of sporomata, scutellum cells are sometimes able to from penetration hyphae that grow through the sporomatal cavity, penetrate the cuticle and initiate the development of invasive hyphae within epidermal host cells, e.g. in *Prillieuxina winteriana* and its anamorphic stage (Fig. 3.81g). Scutellum cells apparently are multifunctional, by forming spores or spore producing structures, by protecting sporomata with thick, melanized cell walls and by producing invasive hyphae to enable nutrient uptake from the host plant.

4.2.6 Ascocarp center

Within the flat cavity of the shield-shaped ascocarp, hyaline cells are formed that initiate the development of ascogenous hyphae and interascal tissue. Nothing is known about the early development of the ascocarp center in species of thyriothecioid ascomycetes and it is still speculative how dikaryotization occurs, if spermatization plays a role and how ascogonia are formed. In the center of young thyriothecia of species of *Asterina* and *Platypeltella* (treated with KOH and lactic acid with water blue), broad, downwards spiralling, hook-like hyphae were observed. Later, ascogenous hyphae seem to emerge from these hook-like hyphae that probably represent ascogonia. However, those small structures are hard to observe through the dark scutellum layer. In squeezed preparations of young thyriothecia, hooks or spirals could not be observed freely because they seem to be closely connected to the scutellum cells and are destroyed by hard squeezing. More detailed ontogenetic studies are necessary to solve the question of fertilization events in thyriothecia of species of Asterinaceae and Microthyriaceae.

Early ascus development of species of Asterinaceae is known insufficiently and observations on ascus ontology are restricted to few, selected species of *Asterina* (Swart 1969). Swart (1969) illustrated asci of *A. systema-solare* and *A. correicola* that are formed on ascogenous hyphae with proliferating croziers. This type of ascus development could be verified for many species of Asterinaceae collected in Western Panama and is reported for the first time for plant parasitic members of Microthyriaceae (Table 4.3). Ascus ontogeny of species of Microthyriaceae was not investigated in detail before.

Crozier formation is involved in ascus development and is present in almost all lichenized and nonlichenized ascomycetes (Wilson 1952, Gäumann 1964, Esser 2000). A crozier or hook is formed when the uppermost cell of an ascogenous hyphae bents backwards. During this process the two haploid nuclei in the apex of the cell undergo a conjugated mitosis and subsequently walls are formed to separate the recurved, uninucleate apical cell from the binucelate penultimate cell and the uninucleate stalk cell (Wilson 1952, Hung and Wells 1971, Raju 1980). The dikaryotic penultimate cell now differentiates into the ascus initial and the crooked apical cell may fuse with the stalk cell to maintain its dikaryotic state (Raju 1980). The stalk cell sometimes proliferates laterally to form new croziers with ascus initials. Proliferating croziers are reported from ascogenous hyphae of many higher ascomycetes (Wilson 1952, Grube and Lücking 2001) and somehow resemble the clamp connections present in hyphae of Basidiomycetes (Swart 1969). However, both structures are not homologous because of essential developmental differences (Wilson 1952). Clamp connections are present along vegetative hyphae of most Basidiomycetes and function in maintaining the dikaryotic state of all hyphal cells, whereas croziers are exclusively associated with ascogenous hyphae and are absent in vegetative hyphae of Ascomycetes (Esser 2000).

Proliferating croziers are continuously present along ascogenous hyphae of species of Asterinaceae and Microthyriaceae and are not exclusively associated with developing asci. I assume that for this group of fungi proliferating croziers are not just involved in ascus formation, but play also a significant role in the maintenance of the dikaryotic condition of the ascogenous hyphae. Ascogenous hyphae with continuous proliferating croziers were found among numerous species of *Asterina*, all *Asterolibertia* spp., *Cirsosia splendida*, *Halbanin*a sp., *Prillieuxina winteriana*, *Maublancia uleana*, *Platypeltella* ssp. and *Xenostomella tovarensis* (Table 4.3). Some species of *Asterina*, however, form very indistinct ascogenous hyphae, that are difficult to observe with the light microscope (Table 4.3). This can be due to the diffuse and slimy disintegration of internal ascoma structures, as in *A. ciferriana*, or because of the relatively small size of ascogenous hyphae and young asci, e.g. in *A. phenacis*. Species of *Platypeltella* show a slightly modified ascus development where ascus initials are formed on proliferating ascogenous hyphae by means of a defined sequence of two contrariously orientated hooks and four consecutive septation events (Fig. 3.92). Ascus initials of *Platypeltella* spp. are attached at three points with the originating ascogenous hyphae, whereas species of other genera of Asterinaceae and Microthyriaceae are attached only at two points with the originating hyphae.

Crozier formation may vary among different genera and species of thyriothecioid ascomycetes and, therefore, can be important for the segregation at species- and genus-level and probably even at higher systematic ranks.

4.2.7 Asci

The bitunicate asci of members of Asterinaceae and Microthyriaceae can be segregated morphologically in two main categories with which both families can be recognized easily. Typical for species of Asterinaceae are spherical to broadly clavate asci that are positioned vertical in the thyriothecium, whereas species of Microthyriaceae produce elongated and cylindrical asci which develop inclined within the dimidiate ascoma (Fig. 1.3). In both families, the ascus shape is relatively constant within genera and species. Asci of Asterinaceae and plant parasitic Microthyriaceae have a distinctly thickened endotunica in the apical part of the ascus, except the asci of *Halbanina* sp., which have a uniformly thick endotunica. In the apical part of many asci, small papilla-like protuberances, so called ocular chambers, are formed. Ocular chambers are typical for many examined species of *Asterina* (except in *A. schlegeliae*, *A. styracina* and *A. tonduzii*), *Cirsosia splendida*, *Maublancia uleana*, *Prillieuxina winteriana* and *Xenostomella tovarensis* (Table 4.3). Ocular chambers are absent in species of *Asterolibertia*, *Platypeltella* and in *Halbanina* sp. (Table 4.3). When treated with Melzers's reagent or Lugol's solution, asci of members of Asterinaceae sometimes show a slight and temporary blue reaction at the outer ascus wall, visible as a small blue halo at the surface of the ascus (Table 4.3). Similar reactions to iodine were observed for asci of Englerulaceae (Eriksson 1981). However, a positive reaction to iodine is normally absent or very inconspicuous in asci of most asterinaceous species and in all examined plant parasitic species of Microthyriaceae (Table 4.3). The type of iodine reaction and the presence or absence of ocular chambers in asci may help to segregate species of Asterinaceae and is probably of systematic value at family level.

In general, thyriothecia are filled with numerous asci, which are densely packed together or dispersed within a pseudoparaphysate hamathecium. *Asterina* sp. 7, however, only forms two or rarely three large asci per ascoma. The reduction of internal structures may be due to a lower supply of nutrients from the specific host plant. In most cases, the asci of species of Asterinaceae and Microthyriaceae contain 8 ascospores per ascus, more rarely 4 or 6 spores. Ascus sizes of members of Asterinaceae range from 15–75 µm diam., the smallest asci are formed by *Asterina radiofissilis* and *A. davillae*, the largest asci were found in *Asterina styracina*, *Asterina* sp. 7 and *Halbanina* sp. However, most of the species form asci between 20–40 µm diam. Asci of species of Microthyriaceae are larger and sometimes reach more than 100 µm in length, as in *Maublancia uleana*. The asci of *Xenostomella tovarensis* are the smallest with less than 70 µm longitude. Ascus dehiscence of species of Asterinaceae and Microthyriaceae seems to be fissitunicate under the light microscope, however, intense morphological studies with specific staining dyes and ultrastructural analysis of mature asci were not performed during this study. It is possible that ascus dehiscence of Asterinaceae may correspond to the rostrate type rather than the fissitunicate type as hypothesized by Reynolds (1987, 1989).

Ascus size, reactions to iodine and the presence or absence of ocular chambers and the presence/absence of interascal tissue are criteria for the segregation on species-level. Ascus-shape and the position within the thyriothecium are important morphological criteria to delineate families of plant parasitic thyriothecioid ascomycetes.

Table 4.3: Overview to ascus and hamathecium characteristics of examined plant parasitic species of Asterinaceae and Microthyriaceae in Western Panama. I = iodine.

Species	Ascogenous hyphae	Interascal tissue	Ocular chamber	Iodine reaction
Asterinaceae				
Asterina cestricola	proliferating croziers	–	+	I–
Asterina ciferriana	indistinct, slimy	–	+	I–
Asterina consobrina	proliferating croziers	+, evanescent	+	I+, ascus wall
Asterina corallopoda	proliferating croziers	–	+	I+, ascus wall
Asterina davillae	proliferating croziers	+, evanescent	+	I–
Asterina diplocarpa	proliferating croziers	–	+	I–
Asterina diplopoda	indistinct, slimy	–	+	I+, ascus wall
Asterina ekmanii	indistinct, slimy	+, evanescent	+	I+, ascus wall
Asterina fuchsiae	proliferating croziers	–	+	I–
Asterina gaiadendricola	proliferating croziers	+	+	I–
Asterina manihotis	indistinct, asci terminal?	–	+	I–
Asterina phenacis	indistinct, asci terminal?	–	+	I–
Asterina radiofissilis	indistinct	–	+	I–
Asterina schlegeliae	proliferating croziers	–	–	I–
Asterina siphocampyli	proliferating croziers	–	+	I–
Asterina sponiae	proliferating croziers	+	+	I+, ascus wall
Asterina stipitipodia	proliferating croziers	–	+	I–
Asterina styracina	proliferating croziers	+, evanescent	–	I–
Asterina tonduzii	indistinct	–	–	I–
Asterina weinmanniae	proliferating croziers	+	+	I–
Asterina zanthoxyli	proliferating croziers	+	+	I–
Asterina sp. 1	proliferating croziers	+	+	I–
Asterina sp. 2	proliferating croziers	–	+	I–
Asterina sp. 3	proliferating croziers	–	+	I–
Asterina sp. 4	indistinct, evanescent	+, evanescent	+	I–
Asterina sp. 5	indistinct, slimy	+, evanescent	+	I+, ascus wall
Asterina sp. 6	indistinct, asci terminal?	+	+	I–
Asterina sp. 7	indistinct	–	+	I+, ascus wall
Asterina sp. 8	indistinct, slimy	+	+	I+, ascus wall
Asterolibertia licaniicola	proliferating croziers	–	–	I+, ascus wall
Asterolibertia nodulosa	proliferating croziers	+	–	I–
Asterolibertia sp.	proliferating croziers	–	–	I–
Cirsosia splendida	proliferating croziers	–	+	I+, ascus wall
Halbanina sp.	proliferating croziers	+	–	I–
Prillieuxina winteriana	proliferating croziers	+	+	I–

Species	Ascogenous hyphae	Interascal tissue	Ocular chamber	Iodine reaction
Microthyriaceae				
Maublancia uleana	proliferating croziers	+	+, broad	I–
Platypeltella irregularis	proliferating croziers	+	–	I–
Platypeltella smilacis	proliferating croziers	–	+	I–
Xenostomella tovarensis	proliferating croziers	+	+	I–

4.2.8 Hamathecium

Hamathecial elements within thyriothecia of plant parasitic Asterinaceae and Microthyriaceae are difficult to study, because the fine structures are often short living and dissolve irregularly during ascocarp maduration. In the traditional literature, conflictive opinions exist concerning the composition of the interascal tissue of thyriothecoid ascomycetes. Theissen (1913a), Arnaud (1918), Doidge (1942), Hansford (1946) and Arx and Müller (1975) describe the sterile hyphae as paraphyses, Müller and Arx (1962) as paraphysoids, and Luttrell (1973), Barr (1987) and Sierra López (2006) as pseudoparaphyses. Ontogenetic studies of early thyriothecium development in Asterinaceae and Microthyriaceae are still missing and it remains speculative from where the sterile hyphae originate exactly in the first place. Luttrell (1944) and Tyson and Griffiths (1976) studied ascoma development in two members of Microthyriaceae, but the earliest stages of dikaryotization and the origin of the interascal tissue were not analyzed in detail by the autors.

In this study, interascal tissue was observed in thyriothecia of some species of *Asterina*, *Asterolibertia nodulosa*, *Halbanina* sp. and *Prillieuxina winteriana* (Asterinaceae), as well as in *Maublancia uleana* and *Platypeltella irregularis* (Microthyriaceae, Table 4.3). The origin of the sterile elements in ascomata of Asterinaceae is difficult to assign, but in *Halbanina* sp. the sterile hyphae seem to originate from ascogenous hyphae. Thyriothecia of *M. uleana* contain sterile, anastomising hypae which probably represent pseudoparaphyses. *P. irregularis* forms a central column of filamentous elements originating from the bottom of the ascomata and, therefore, probably represent paraphyses. However, conclusive results cannot be taken from these fragmentary observations and further studies, preferable on the basis of fixed material, are necessary to clarify aspects of hamathecium composition and early thyriothecium development.

The presence or absence of interascal tissue in mature thyriothecia is not considered of generic importance because numerous species of the larger genera of

Asterinaceae and Microthyriaceae show significant variation in these aspects (Hansford 1949. Müller and Arx 1962).

4.2.9 Ascospores

The ascospores of species of Asterinaceae and plant parasitic Microthyriaceae are almost uniformly two-celled with one transversal septum in the central part or upper third of the spore, as in species of *Asterina*, *Asterolibertia*, *Cirsosia*, *Halbanina*, *Maublancia*, *Prillieuxina*, *Xenostomella* and many more asterinaceous and microthyriaceous genera. Species of *Platypeltella* are an exception because they produce 2-5-celled ascospores. At the region of the septum, the spores can be more or less constricted and the apices are mostly rounded or slightly acuminate. In general, ascospores of Asterinaceae and plant parasitic Microthyriaceae are relatively small and never reach more than 50 µm in length. The ascospores are almost always ellipsoidal with equal cells or with the upper cell slightly longer and broader. Ascospore size is significant at species level, in combination with other morphological characteristics.

The pigmentation of ascospores is a constant characteristic but it can vary in mature ascospores from pale brown (e.g. species of *Platypeltella*), brown (most of the species of *Asterina*) to dark brown (e.g. *Asterolibertia nodulosa* and *Asterina* sp. 7). Ascospore pigmentation mostly becomes darker with age. Ascospores of species of Asterinaceae are often more or less distinctly ornamented. The ornamentation pattern varies from warty or verrucose (e.g. *Asterina davillae*, *Asterolibertia* spp., *Cirsosia splendida*, *Halbanina* sp.), truncate (*Asterina corallopoda*) to aculeate or spiny (*Asterina* sp. 7). Within a single species the ornamentation pattern of ascospores may vary slightly in different developmental stages. Smooth-walled ascospores are present in some species of *Asterina*, as in *A. ciferriana*, and in plant parasitic species of Microthyriaceae, e.g. in *Maublancia uleana*, *Platypeltella* spp. and *Xenostomella tovarensis*. The absence or presence of ornamented ascospores is an important criterion to separate species of plant parasitic thyriothecioid ascomycetes, e.g in the genus *Asterina*.

Mature ascospores germinate primarily from one or both cells with unstalked or stalked appressoria (e.g. many species of *Asterina*, *Asterolibertia*, Maublancia, *Platypeltella*, *Prillieuxina*, *Xenostomella*) or directly with an invasive mycelium (e.g. *Halbanina* sp.). Those spores that germinate with primary appressoria may germinate again nearby with a surface mycelium as in *Asterina diplocarpa* and *Asterina* *siphocampyli*. Some ascospores collapse partly (e.g. *Asterolibertia* spp., *Maublancia uleana*) or entirely (e.g. *Platypeltella* spp., *Xenostomella tovarensis*) during the germination process. I observed that ascospore germination is constant and uniform among ascospores of a single species, e.g. in many *Asterina* spp. and *Asterolibertia* spp. Therefore, the germination modus of ascospores is an important character for species segregation of plant parasitic thyriothecioid ascomycetes.

Characteristics like ascospore shape, cell number and colour are constant in Asterinaceae and Microthyriaceae and, therefore, should not be used as criteria for the delineation of species and genera. Especially ascospore colour should not be overestimated because in some species ascospore pigmentation may not become evident until late during spore development. For example, species of *Asterella* were separated in former times from *Asterina*, because of the absence of pigmented ascospores (Saccardo 1891). The type species of *Asterella, A. megalospora* Berk & M.A. Curtis, however, had to be transferred to *Asterina* because the species forms brown ascospores when fully mature (Theissen 1912b, Müller and Arx 1962). A direct evidence for the presence of pigmented ascospores is almost always provided when the fungus is characterized by a pigmented surface mycelium. However, important criteria for species delimitation within a genus of Asterinaceae and Microthyriaceae are ascospore size, ornamentation pattern and germination modus of mature ascospores.

4.3 Teleomorph-anamorph connections

Pycnothyria of *Homalopeltis chrysobalani* open with small central ostioles (Fig. 3.73b, 3.74d), although the anamorph is closely related to a member of Asterinaceae. This indicates that opening mechanisms of sporomata of ‘Pycnothyriales’ do not always provide evidence of the possible relationship with a group of teleomorphic fungi such as Asterinaceae and Microthyriaceae.

4.3.1 *Asterina-Asterostomella/Mahanteshamyces*

Many species of *Asterina* produce anamorphic *Asterostomella*-states (Theissen 1913a, Doidge 1942, Hughes 1952, Müller and Arx 1962, Sivanesan 1984, Hosagoudar and Abraham 2000, Hofmann and Piepenbring 2008). Both anamorphic and teleomorphic stages are plant parasitic and develop together or independently from each other on living leaves. *In planta*, the anamorph-teleomorph connection can be observed regularly, but until today the connection is not corroborated by cultural studies (Sivanesan 1984). The obligate biotrophic life cycle of *Asterina* and its *Asterostomella*-state is illustrated in Fig. 1.4.

The genus *Mahanteshamyces* is morphologically similar to *Asterostomella* - it differs only by angular conidia (Hosagoudar 2004). However, many species of *Asterostomella* produce more or less angular conidia as shown by Hofmann and Piepenbring (2008). Therefore, the genus concept of *Mahanteshamyces* seems to be artificial and the maintenance of the genus should be reconsidered (Hofmann and Piepenbring 2008). Molecular data support this, because *Mahanteshamyces* sp. clusters within species of *Asterina* (Fig. 3.100).

4.3.2 *Cirsosia-Homalopeltis*

For the first time, the connection of the teleomorphic genus *Cirsosia* and the anamorphic genus *Homalopeltis* was observed on fresh leaf material of *Chrysobalanus icaco* and *Hirtella triandra* in Western Panama. *Homalopeltis* is a monotypic genus with only one species, *H. chrysobalani* (Batista and Valle 1961). *Cirsosia* contains about 12 species (Table 7.6) for which anamophic stages were not reported so far. It is possible, that more pycnothyrial anamorphs will be discovered for species of *Cirsosia* and closely related genera such as *Asterolibertia*.

4.3.3 *Hemisphaeropsis*-unnamed teleomorph

Hemisphaeropsis is a monotypic genus within the anamorphic ‘Pycnothyriales’ (Sutton 1977). The only species *H. magnoliae* includes a teleomorphic stage that occurs occasionally together with the anamorph. *H. magnoliae* forms thallus-like sporomata with numerous pycnothyrial locules in which masses of conidia develop. Sometimes, globose asci are formed separately from each other beneath parts of the thallus that are not occupied by locules of the anamophic state. At ascus maturity, the scutellum above ruptures and large brown ascospores are released. *H. magnoliae* and its teleomorph probably belong to the Asterinaceae, because of the 2-celled, brown ascospores, globose asci, 1-layered scutelli with cylindrical cells, pycnothyrial loculi, monoblastic conidiogenesis and brown conidia. But unlike Asterinaceae, *H. magnoliae* develops sporomata from an internal hypostroma, whereas surface mycelia with appressoria are completely absent.

The presence of the teleomorph was recognized by Petrak (1947) who described

H. magnoliae. However, the sexual stage was not named separately as it is not well developed in the type specimen (Petrak 1947) and the material collected in Panama.

4.4 Phylogeny of Asterinaceae

Phylogenetic hypothesis concerning members of thyriothecioid ascomycetes are scarce and restricted to economically important members such as *Schizothyrium pomi* and its *Zygophiala*-anamorphs (Schizothyriaceae), the agents of the flyspeck disease on apples (Batzer et al. 2005, 2008, Crous et al. 2007a). According to rDNA sequence data, *S. pomi* and *Zygophiala* spp. form a sisterclade with Mycosphaerellaceae within the Capnodiales (Batzer el al. 2008). The results of Batzer and coworkers were adopted for Asterinaceae by mycological reference systems such as the Index Fungorum (www.indexfungorum.org) and the Dictionary of Fungi (Kirk et al. 2008), although molecular data are lacking for members of Asterinaceae.

Nucleotide- or protein-sequences of *Asterina* (non *Asterina* Nardo (1843), Asteroidea, Metazoa) or of other genera of Asterinaceae have not yet been deposited in GenBank (www.ncbi.nlm.nih.gov). For the first time, I isolated nuclear DNA from fresh fungal material of *Asterina* spp. and other selected thyriothecioid ascomycetes from Panama and analysed SSU and LSU rDNA sequences of *Asterina* spp. in the laboratory in Frankfurt. The combined SSU and LSU rDNA phylogenetic analysis shows, that species of *Asterina* and its anamorphs form a well supported clade within the Dothideomycetes (Fig. 3.100). These results might suggest the reestablishment of the order Asterinales as proposed by Barr (1976, 1979, 1983) and Barr and Huhndorf (2001). The Asterinales according to Barr and Huhndorf (2001), include biotrophs that grow superficially on or erumpent from the substrate and tend to be tropical or subtropical in distribution. Within the ascomata short wide asci are formed without a hamathecium or with apically free paraphyses. The ascoma wall is narrow and opens with slits between rows of cells or disintegration of ascoma cells, or occasionally with a lysigenous pore. Ascospores are typically 2-celled and brown when fully mature. Superficial hyphae with appressoria are often present. The order includes three families: the Asterinaceae, Englerulaceae and Parmulariaceae (Barr and Huhndorf 2001). Molecular data are still missing for members of Englerulaceae and Parmulariaceae. Therefore, a broader taxon sampling of thyriothecioid ascomycetes from different families and advanced molecular analyses are urgently needed. The presented molecular phylogenetic analysis provides only very preliminary conclusions and is regarded as a first step towards a molecular classification of Asterinaceae and closely related families of thyriothecioid ascomycetes.

The Asterinaceae-clade forms a sister group to the plant pathogenic Venturiaceae (Dothideomycetes) and the lichen family Roccellaceae (Arthoniomycetes, bitunicate Ascomycetes). Members of Venturiaceae are host specific plant pathogens on vascular plants (Müller and Arx 1962, Beck et al. 2005) and are distributed in temperate and tropical regions worldwide. Species of Venturiaceae form pyriform pseudothecia that develop in very different positions in the host substratum, such as completely or partly immersed, erumpent, superficially or innate with a foot-like hypostroma (Arx (1952). The fruitingbodies are often setose and open with a lysogenous pore. The bitunicate asci are cylindrical and develop between pseudoparaphyses, whereas ascospores are two-celled and always become pigmented during maturity (Arx 1952). Venturiaceae form cladosporoid anamorphs belonging to the genera *Fusicladium* (incl. *Pollaccia* and *Spilocaea*) and *Pseudocladosporium* (Beck et al. 2005). Commonly the mycelia of anamorphic stages overwinter in fallen leaves, fruits and stems and the sexual stages are formed in the following spring (Beck et al. 2005). In the present molecular phylogenetic analyses, the Venturiaceae form a monophyletic clade within the Dothideomycetes (Fig. 3.100). However, the ordinal placement of Venturiaceae remains unresolved. These results are consistent whith multi-gene based phylogenies accomplished by Kruys et al. (2006), Winton et al. (2007) and Schoch et al. (2009, supplemental figure 6b).

Roccellaceae are a group of lichenized ascomycetes (Arthoniomycetes) with mostly fruticose or more rarely crustose thalli (Grube 1998). Members of Roccellaceae are characterized by usually apothecioid ascomata and fusiform ascospores and are distributed worldwide, predominantly along coasts (Tehler 1990, Tehler and Irestedt 2007). The Roccellaceae are probably not closely related with Asterinaceae, however, the lichen group is included in the presented molecular phylogeny because the BLAST search conducted for rDNA sequences of *Asterina* revealed similarities with sequences of members of Roccellaceae. The lichenized Arthoniomycetes are closely related to Dothideomycetes and both form a monophyletic clade as shown by numerous multi-gene phylogenies (Hibbett et al. 2007, Gueidan et al. 2008, Lumbsch et al. 2004, Lutzoni et al. 2004 and Schoch et al. 2009, supplementary figure 6b, Spatafora et al. 2006). However, Arthoniomycetes and Dothideomycetes appear paraphyletic in the present SSU+LSU rDNA phylogeny (Fig. 3.100). Similar results with two gene analyses were obtained by Lutzoni et al. (2004), whereupon only three- and four-gene analyses supported the monophyly of Arthoniomycetes and Dothideomycetes.

The presented ribosomal DNA based phylogeny corresponds well with the general phylogenetic classification of the Dothideomycetes (Boehm et al. 2009, Schoch et al. 2006a, Winton et al. 2007). Dothideomycetes are separated into two subclasses, Dothideomycetidae (incl. aparaphysate Dothideales, Capnodiales and Myriangiales) and Pleosporomycetidae (incl. paraphysate Pleosporales, Hysteriales and Mytilinidiales) and some orders and families with a yet uncertain placement (Botryosphaeriales, Tubeufiaceae, Venturiaceae and others) (compare Boehm et al. 2009, Schoch et al. 2006a, 2009, supplementary figure 6b). The present phylogenetic analysis does not support a relationship of Asterinaceae with Capnodiales as assumed by the Index Fungorum and the Dictionary of Fungi (Kirk et al. 2008). The data, however, indicate the polyphyly of thyriothecioid ascomycetes. The dimidiate habit of thyriothecia developed independently in different groups of bitunicate ascomycetes due to adaptations to epiphyllous habitats. A broader taxon sampling of biotrophic, as well as saprotrophic, commensalistic and mycoparasitic thyriothecioid ascomycetes will help to improve the understanding of the phylogenetic relationships among these epiphyllous ascomycetes.

4.5 Analysis of the ppMP data focussing on thyriothecioid ascomycetes

Results obtained from ppMP data indicate a constant but low abundance of plant parasitic thyriothecioid ascomycetes in natural plant communities in Western Panama (Fig. 3.102). On average, 4 % of the plants of the examined areas are infected with a plant parasitic thyriothecioid ascomycete, whereas 3 % of these plants are parasitized by a member of Asterinaceae. Asterinaceae are the most diverse and species-rich group (61 spp.) of thyriothecioid ascomycetes in Western Panama. Species of Asterinaceae are present in almost any habitat visited, from the pacific coast and lowland marsh forests at the atlantic side up to over 3000 m a.s.l. at the slopes of Volcán Barú. *Asterina* is the most species-rich genus of Asterinaceae in Western Panama, with 42 collected species (Fig. 3.103). Species of Asterinaceae are most diverse in a lowland gallery forest in Los Algarrobos (B), a mountain rainforest in Boquete (E), and a primary mountain cloud forest in the international park PILA (G, Fig. 3.104). The forests are located at different elevations (B: 1547 m a.s.l, E: 140 m a.s.l., G: 2550 m a.s.l.), show different disturbance gradients (B: very disturbed, E: disturbed, G: not disturbed), have seasonal differences (B: ±5 months dry season, E+G: no dry season, constant rainfalls all year round) and are characterized by varying relative light intensities (B: 21%, E: 6 %, G: 5%) (compare Table 3.8). However, the three forests sites are relatively rich in plant species (B: 148 spp., E: 181 spp., G: 177 spp.) and show tendencies to gap formation (B: expanded gaps mainly due to damage, E: light gaps due to damage, B: light gaps due to tree fall and branch loss). These observations indicate, that species of Asterinaceae favour species-rich forestal habitats with tendencies to gap formation with the associated increased levels of disturbance in the respective plant community. However, the diversity of Asterinaceae in a specific habitat apparently is not linked to abiotic factors such as seasonal changes, light intensity or habitat elevation.

Plant parasitic Microthyriaceae are less common in natural plant communities in Western Panama and are restricted to single collection sites in lowland gallery forests at 140 m a.s.l. and mountain rainforests above 1200 m a.s.l. A total of 12 species of plant parasitic Microthyriaceae were collected during the ppMP project. Habitat preferences of plant parasitic Microthyriaceae cannot be assessed due to their punctual occurrence and the low overall species number in the examined areas of the ppMP project.

The ppMP project covers only a small percentage of the natural plant communities present in Panama. Further collection activities in other regions of the country will certainly increase our knowledge about species diversity and ecology of tropical plant parasitic thyriothecioid ascomycetes.

5 Summaries

5.1 Summary

Plant parasitic species of Asterinaceae and Microthyriaceae (Dothideomycetes, Ascomycota, Fungi) are inconspicuous foliicolous fungi with a mainly tropical distribution. They form black colonies on the surface of living leaves. Members of Asterinaceae and Microthyriaceae are characterized by shield-shaped, flat ascomata (thyriothecia) which grow completely superficially on the leaf cuticle. Microthyriaceae, Asterinaceae and other families of thyriothecia-forming ascomycetes belong to the class Dothideomycetes due to the presence of bitunicate asci. However, until today no consistent taxonomic concept nor molecular phylogenetic studies exist for the families of thyriothecioid ascomycetes.

In the present thesis, 42 species belonging to 13 different anamorphic and teleomorphic genera of Asterinaceae, Microthyriaceae and ‘Pycnothyriales’ recently collected in Western Panama, are identified, described in detail and illustrated with drawings, transmission and scanning electron microscopical photographs. Among the 42 species, 37 species belong to the Asterinaceae, four species to the Microthyriaceae and one species to the from group ‘Pycnothyriales’. Two species of Asterinaceae are new to sience: *Asterina gaiadendricola* with an *Asterostomella* anamorph and *Asterina schlegeliae* with a *Mahanteshamyces* anamorph. Among the remaining species of Asterinaceae, 28 species represent new records for Panama: *Asterina cestricola*, *A. ciferriana*, *A. consobrina*, *A. corallopoda*, *A. davillae* with anamorph, *A. diplocarpa*, *A. diplopoda*, *A. ekmanii*, *A. fuchsiae*, *A. manihotis*, *A. phenacis*, *A. radiofissilis* with anamorph, *A. siphocampyli*, *A. sponiae*, *A. stipitipodia* with anamorph, *A. styracina*, *A. tonduzii* with anamorph, *A. weinmanniae*, *A. zanthoxyli*, *Asterostomella dilleniicola*, *Asterolibertia licaniicola*, *Asterolibertia nodulosa*, *Cirsosia splendida* with its

Homalopeltis chrysobalani anamorph and *Prillieuxina winteriana* with its *Leprieurina winteriana* anamorph. The remaining 11 species of Asterinaceae probably respresent new species: *Asterina* spp. 1-8, *Asterolibertia* sp., *Halbanina* sp. and *Mahanteshamyce*s sp. The four species of Microthyriaceae are new records for Panama: *Maublanica uleana*, *Platypeltella irregularis*, *Platypeltella smilacis* and *Xenostomella tovarensis*. The species *Hemisphaeropsis magnoliae* in the form group 'Pycnothyriales' is a new record for Panama. During this study, voucher material of 44 additional species of plant parasitic thyriothecioid ascomycetes was examined.

Thereby, the number of species of Asterinaceae known for Panama since 2006 raises from four to 30, for Microthyriaceae respectively from zero to four and for 'Pycnothyriales' from zero to one. 21 of the presented species are new records for Central America and two species are new records for the American Continent.

The presented 42 species parasitize 47 host plant species in 39 genera belonging to 28 plant families. For 23 fungal species, new host plant species are discovered. From those, seven belong to host plant genera not reported before to be parasitized by a member of Asterinaceae and Microthyriaceae: *Burmeistera* (Campanulaceae), *Curatella* and *Davilla* (Dilleniaceae), *Greigia* (Bromeliaceae), *Hirtella* (Chrysobalanaceae), *Oxandra* and *Xylopia* (Annonaceae).

In this study, the first molecular phylogenetic approach in Asterinaceae is provided. For the first time, DNA was isolated from fresh material of *Asterina* spp. and their respective anamorphic stages on leaves in Panama. The hypothesis derived from SSU and LSU rDNA neighbour-joining analysis supports the monophyly of the Asterinaceae and suggests a close relationship to Venturiaceae within the class Dothideomycetes.

The data obtained from the ppMP project (plant parasitic microfungi of Panama) indicate a constant but low abundance of plant parasitic thyriothecioid ascomycetes in natural plant communities in Panama, with Asterinaceae as the most species-rich and diverse family. Further collection activities in tropical regions worldwide will certainly increase our knowledge about species diversity and ecology of tropical plant parasitic thyriothecioid ascomycetes.

5.2 Zusammenfassung

Pflanzenparasitische Arten der Asterinaceae und Microthyriaceae (Dothideomycetes, Ascomycota, Echte Pilze) sind unscheinbare Blattbewohner mit hauptsächlich tropischer Verbreitung. Sie bilden schwarze Kolonien auf der Oberfläche von lebenden Blättern und infizieren das Wirtsgewebe auf vielfältige Weise. Vertreter der Asterinaceae und Microthyriaceae sind durch spezielle, schild-förmig abgeflachte Fruchtkörper charakterisiert, die als Thyriothezien bezeichnet werden und komplett oberflächlich auf der Wirtskutikula wachsen. Die sehr kleinen Ascomata entstehen meist an einem ausgedehnten Oberflächenmyzel, welches ausserdem spezielle Infektionsstrukturen zur Penetration des Wirtsgewebes ausbildet. In den Thyriothezien werden globose oder zylindrische, bitunicate Asci gebildet in denen acht zweizellige Ascosporen (Meiosporen) entstehen. Neben dem sexuellen Entwicklungsgang besitzen viele Vertreter der Asterinaceae auch asexuelle Stadien, welche durch den Thyriothezien morphologisch ähnliche Konidiomata, sogenannte Pyknothyrien, gekennzeichnet sind und in denen Konidien (Mitosporen) gebildet werden. Thyriothecien-bildende Ascomyceten, auch thyriothecioide Ascomyceten genannt, werden mithilfe morphologischer und ökologischer Merkmale unterschiedlichen Familien zugeordnet (Asterinaceae, Aulographaceae, Brefeldiellaceae, Leptopeltidaceae, Micropeltidaceae, Microthyriaceae, Parmulariaceae, Polystomellaceae, Schizothyriaceae und Vizellaceae), deren Verwandtschaftsverhältnisse untereinander sowie innerhalb der bitunicaten Ascomyceten noch nicht aufgeklärt sind.

In Panama sind thyriothecioide Ascomyceten nahezu unbekannt und nur sehr sporadisch untersucht. Dies liegt zum einen an der geringen Größe der Pilze, sowie deren unwesentlicher Bedeutung als Schädlinge auf wirtschaftlich genutzen Pflanzen, aber auch am Fehlen von Spezialisten für die Pilzgruppe. Bis 2006 waren für Panama nur 10 Arten von thyriothecioiden Ascomyceten bekannt. Trotz der relativ geringen Größe Panamas ist die Diversität der vaskulären Pflanzen mit ca. 9500 Arten etwa dreimal so hoch wie in dem etwa fünfmal größeren Deutschland. Da Vertreter der Asterinaceae und Microthyriaceae obligat biotroph sind und dauerhafte, komplexe Interaktionen mit ihrem Wirt eingehen, wird eine Wirtspezifität zumindest auf Pflanzenfamilienebene vermutet. Wenn man die enorme Vielfalt der potentiellen Wirtspflanzen in Panama in Betracht zieht, kann man von einer hohen Diversität dieser Pflanzenpathogene in dem Land ausgehen.

Für diese Studie wurden insgesamt 379 Belege geprüft, die 86 verschiedenen Arten von pflanzenparasitischen Asterinaceae und Microthyriaceae entsprechen. Insgesamt wurden 174 Belege von pflanzenparasitischen thyriothecioiden Ascomyceten im Westen Panamas in den Provinzen Chiriquí und Bocas del Toro gesammelt. Zwischen 2005 und 2007 wurden 86 Belege von der Autorin selbst und 74 Belege im Rahmen des ppMP Projektes (pflanzenparasitische Mikropilze Panamas) von T.A. Hofmann, R. Mangelsdorff, M. Piepenbring und T. Trampe gesammelt. Jeweils 5 Belege wurden zwischen 2000 und 2005 von M. Piepenbring, sowie von T. Trampe 2008 gesammelt. 3 Belege wurden von R. Mangelsdorff zwischen 2004 und 2006 gesammelt, und 1 Beleg wurde 2004 von Boris Koch gesammelt. Zusätzlich wurden insgesamt 205 Belege aus Herbarien konsultiert, 163 Belege aus den U.S. National Fungus Collections (BPI), 25 Belege aus dem Swedish Museum of Natural History (S), 10 Belege aus dem CABI Bioscience UK Centre (formerly International Mycological Institute, IMI), 3 Belege aus der Universidad National de la Plata (LPS), 2 Belege vom Biozentrum Klein-Flottbeck (HBG) and jeweils 1 Beleg aus dem Herbarium Bogoriense (BO) und dem Plant Protection Research Institute (PREM).

In der vorliegenden Arbeit werden 42 Arten von pflanzenparasitischen thyriothecioiden Ascomyceten identifiziert, detailliert beschrieben und durch Zeichungen sowie transmissions- und rasterelektronenmikroskopische Aufnahmen zum großen Teil erstmals illustriert. Die 42 Arten gehören zu 13 unterschiedlichen Anamorph- und Teleomorphgattungen in den zwei Familien Asterinaceae (37 Arten) und Microthyriaceae (vier Arten) sowie der Fromgruppe ‘Pycnothyriales’ (eine Art). Zwei der vorgestellten Arten der Asterinaceae sind neu für die Wissenschaft: *Asterina gaiadendricola* mit *Asterostomella*-Anamorph auf *Gaiadendron punctatum* (Loranthaceae) und *Asterina schlegeliae* mit *Mahanteshamyces*-Anamorph auf *Schlegelia parviflora* (Schegeliaceae). *Asterina gaiadendricola* unterscheidet sich von anderen *Asterina*-Arten auf Loranthaceae durch das hypophylle Wachstum, die besondere Morphologie der Appressorien und deren ausschließliches Vorkommen auf den Schließzellen der Spaltöffungen der Wirtspflanze. *Asterina schlegeliae* ist die einzige bekannte Art von *Asterina*, die auf einem Vertreter der Schlegeliaeceae parasitiert und unterscheidet sich von *Asterina*-Arten auf den nahe verwandten Pflanzenfamilien Scrophulariaceae und Bignoniaceae durch das *Mahanteshamyces*-artige Anamorph mit dreieckigen Konidien. Von den restlichen Arten der Asterinaceae werden 24 Arten bis auf Artebene identifiziert und repräsentieren ausnahmslos

Erstnachweise für das Land Panama: *Asterina cestricola* auf *Cestrum rugulosum* (Solanaceae), *A. ciferriana* auf *Caesalpinia bonduc* (Fabaceae), *A. consobrina* auf *Solanum aphyodendron* (Solanaceae), *A. corallopoda* auf *Solanum trizygum* (Solanaceae), *A. davillae* mit Anamorph auf *Curatella americana* (Dilleniaceae), *A. diplocarpa* auf *Sida acuta* und *Sida rhombifolia* (Malvaceae), *A. diplopoda* auf *Solanum acerifolium* (Solanaceae), *A. ekmanii* auf *Gonzalagunia rudis* (Rubiaceae), *A. fuchsiae* auf *Fuchsia paniculata* (Onagraceae), *A. manihotis* auf *Manihot esculenta* (Euphorbiaceae), *A. phenacis* auf *Phenax mexicanus* (Urticaceae), *A. radiofissilis* mit Anamorph auf *Acalypha arvensis* (Euphorbiaceae), *A. siphocampyli* auf *Burmeistera vulgaris* and *Burmeistera* sp. (Campanulaceae), *A. sponiae* auf *Trema micrantha* (Cannabaceae) und einer nicht identifizierten Tiliaceae, *A. stipitipodia* mit Anamorph auf *Davilla kunthii* (Dilleniaceae), *A. styracina* auf *Styrax argenteus* (Styracaceae), *A. tonduzii* mit Anamorph auf *Xylosma* sp. (Salicaceae), *A. weinmanniae* auf *Weinmannia pinnata* (Cunoniaceae), *A. zanthoxyli* auf *Zanthoxylum scheryi* (Rutaceae), *Asterostomella dilleniicola* auf *Davilla kunthii* (Dilleniaceae), *Asterolibertia licaniicola* auf *Licania arborea* (Chrysobalanaceae), *Asterolibertia nodulosa* auf *Oxandra venezuelana* (Annonaceae), *Cirsosia splendida* mit *Homalopeltis chrysobalani*-Anamorph auf *Chrysobalanus icaco* und *Hirtella triandra* (Chrysobalanceae) und *Prillieuxina winteriana* mit *Leprieurina winteriana*-Anamorph auf *Annona montana* (Annonaceae). Die restlichen 11 Arten der Asterinaceae konnten nicht bis auf Artebene identifiziert werden und sind möglicherweise neue Arten: *Asterina* sp. 1 auf *Hansteinia reflexiflora* (Acanthaceae), *Asterina* sp. 2 auf *Hansteinia ventricosa* (Acanthaceae), *Asterina* sp. 3 auf *Desmopsis bibracteata* (Annonaceae), *Asterina* sp. 4 auf *Cleome* sp. (Cleomaceae), *Asterina* sp. 5 auf *Clusia* sp. (Clusiaceae), *Asterina* sp. 6 auf *Alloplectus ichtyoderma* (Gesnericaceae), *Asterina* sp. 7 auf *Compsoneura sprucei* (Myristicaceae), *Asterina* sp. 8 auf *Casearia commersoniana* (Salicaceae), *Asterolibertia* sp. auf Annonaceae, *Halbanina* sp. auf *Chrysobalanus icaco* (Chrysobalanaceae) und *Mahanteshamyce*s sp. auf *Schlegelia parviflora* (Schlegeliaceae). Die vier vorgestellten, pflanzenparasitischen Arten der Microthyriaceae werden erstmalig für Panama dokumentiert: *Maublanica uleana* auf *Myrcia splendens* (Myrtaceae), *Platypeltella irregularis* auf *Greigia sylvicola* (Bromeliaceae), *Platypeltella smilacis* auf *Smilax* sp. (Smilacaceae) und *Xenostomella tovarensis* auf *Monnina xalapensis* (Polygalaceae). Die Art der Formgruppe “Pycnothyiales”, *Hemisphaeropsis magnoliae* mit Teleomorph

Stadium auf *Magnolia sororum* (Magnoliaceae), ist ein Neunachweis für Panama. Insgesamt 16 der vorgestellten Arten werden erstmals in dieser Studie illustriert.

Weiterhin werden Listen der aus der Literatur bekannten Arten der Gattungen *Asterina*, *Asterostomella*, *Asterolibertia*, *Cirsosia*, *Halbanina*, *Maublancia*, *Prillieuxina*, *Platypeltella* und *Xenostomella* vorgestellt. Neben Wirtsindizes der gültigen Arten werden ebenfalls alle ungültigen und synonymisierten Arten aufgelistet.

Die Zahl der für bis 2006 in Panama bekannten Arten der Asterinaceae erhöht sich mit dieser Arbeit von vier auf 30, für Microthyriaceae respektive von null auf vier und für ‘Pycnothyriales’ von null auf eins. 21 der vorgestellten Arten repräsentieren Neunachweise für Zentralamerika und zwei Arten werden das erste Mal für den Amerikanischen Kontinent dokumentiert.

In dieser Studie werden Infektionsmechanismen von ausgewählten Arten von Asterinaceae und Microthyriaceae auf ultrastrucktureller Ebene untersucht. Erstmals werden für Ascomyceten spezifische Zellorganellen in Arten von Asterinaceae und Microthyriaceae nachgewiesen. Mithilfe lichtmikrokopischer Techniken wird die Ascusentwicklung von *Asterina schlegelia*e, *Asterina* sp. 7., *Asterolibertia nodulosa*, *Cirsosia splendida*, *Halbanina* sp., *Maublancia uleana*, *Prillieuxina winteriana*, *Platypeltella irregularis* und *P. smilacis* erstmalig analysiert und illustriert. Weiterhin werden morphologische und ontogenetische Besonderheiten der Pilzgruppen diskutiert, die für Art-, Gattungs- und Familienkonzepte thyriothecioider Ascomyceten von taxonomischer Bedeutung sein können.

In der vorliegenden Arbeit wird eine neue Teleomorph-Anamorph Verbindung vorgestellt, das Teleomorph *Cirsosia splendida* (Asterinaceae) mit dem Anamorphstadium *Homalopeltis chyrsobalani* auf *Chrysobalanus icaco* und *Hirtella triandra* (Chrysobalanaceae).

Zusätzlich werden in der Studie taxonomische Veränderungen vorgeschlagen. Drei Arten von Asterinaceae werden synonymisiert, *Asterina melanomera* mit *Asterina saginata*, *Asterina myrciae* mit *Maublancia uleana*, und *Leprieurina radiata* mit *Homalopeltis chrysobalani* (Anamorph von *Cirsosia splendida*), eine Art wird umkombiniert, *Asterina nodulifera* zu *Asterolibertia nodulifera*, und eine Art wird neu benannt, *Asterina schroeteri* var. *licaniae* zu *Asterolibertia minor*.

Die 42 vorgestellten Arten parasitieren auf insgesamt 47 Wirtspflanzenarten in 39 Gattungen und 28 unterschiedlichen Pflanzenfamilien. Für 23 der präsentierten Pilzarten werden neue Wirtsarten genannt. Von diesen gehören sieben zu Gattungen, von denen bisher keine Wirtsarten für Asterinaceae und Microthyriaceae bekannt waren: *Burmeistera* (Campanulaceae) für *Asterina siphocampyli*, *Curatella* (Dilleniaceae) für *Asterina davillae* mit *Asterostomella*-Anamorph, *Davilla* (Dilleniaceae) für *Asterina stipitipodia* mit *Asterostomella stipitipodia*-Anamorph sowie für *Asterostomella dilleniicola*, *Greigia* (Bromeliaceae) für *Platypeltella irregularis*, *Hirtella* (Chrysobalanaceae) für *Cirsosia splendida* mit *Homalopeltis chrysobalani*-Anamorph, *Oxandra* und *Xylopia* (Annonaceae) für *Asterolibertia nodulosa*.

In dieser Arbeit wird zum ersten Mal eine molekularphylogenetische Hypothese zur den Verwandschaftsverhältnissen der Asterinaceae mit Gruppen anderer bitunicater Ascomyceten innerhalb der Klasse Dothideomycetes vorgestellt. In Panama konnte erstmals DNA von Frischmaterial von *Asterina* spp. und deren Anamorph-Stadien von Blättern isoliert werden. Die von LSU und SSU rDNA-Sequenzen abgeleitete Neighbour-Joining-Analyse unterstützt die Monophylie der Asterinaceae mit enger Beziehung zu den Venturiaceae innerhalb der Klasse der bitunicaten Ascomyceten, Dothideomycetes. Die vorgestellte phylogenetische Analyse ist jedoch nur als vorläufiges Ergebnis anzusehen. Sequenzendaten von anderen Arten von Asterinaceae und nahe verwandte Familien der thyriothecioiden Ascomyceten sowie erweiterte phylogenetische Untersuchungen sind notwendig, um die Pilzgruppe anhand molekularer Daten klassifizieren zu können.

Die im Rahmen des ppMP Projektes (pflanzenparasitische Mikropilze Panamas) untersuchte Häufigkeitsverteilung von pflanzenparasitischen thyriothecioiden Ascomyceten zeigt die konstante aber geringe Abundanz dieser Pflanzenpathogene in natürlichen Pflanzengesellschaften im Westen Panamas. Dabei stellen die Asterinaceae mit 61 verschiedenen Arten die artenreichste Gruppe dar, *Asterina* ist die am häufigsten gefunden Gattung der Asterinaceae. Faktoren wie jahreszeitliche Schwankungen von Regen- und Trockenzeit, Lichtintensität oder Höhenlage sind nicht für ein vermehrtes Vorkommen von Arten von Asterinaceae in einer bestimmten Pflanzengesellschaft maßgebend. Vielmehr spielen das Vorhandensein von Waldhabitaten mit Tendenz zu Lückenbildung sowie der damit assoziierte erhöhte Störungsgrad der jeweiligen Pflanzengesellschaft eine entscheidende Rolle für die Diversität der Asterinaceae. Verstärkte Sammelaktivitäten in Panama und tropischen Gebieten weltweit werden zur Erweiterung des Kenntnisstandes über die Artenvielfalt und Ökologie tropischer thyriothecioider Ascomyceten beitragen.

5.3 Resumen

Especies de Asterinaceae y Microthyriaceae son hongos parásitos que ocurren especialmente en los trópicos del mundo. Estos pequeños hongos forman colonias negras en la superficie de hojas vivas e infectan el tejido de la planta en diversas formas. Son caracterizados por ascomatas escutiformes llamado thiriothecia que se desarrollan superficialmente sobre la cutícula de la planta. Asterinaceae y Microthyriaceae pertenecen juntos con otras familias de ascomicetos thiriothecioides de la clase Dothideomycetes por la presencia de ascos bitunicados. Hasta ahora los ascomicetos thiriothecioides no tienen un concepto taxonómico uniforme y estudios filogenéticos extensos estan ausentes.

En esta thesis 42 especies de ascomicetos thiriothecioides recientemente colectados en el Oeste de Panamá, se presentan con descripciones detalladas e illustraciones en forma de dibujos e imágenes de microscopío electrónico de barrido y transmisión. Las 42 especies pertenecen a 13 diferentes géneros de las familias Asterinaceae (37 especies), Microthyriaceae (cuatro especies) y ‘Pycnothyriales’ (una especie). Dos especies de Asterinaceae son nuevas para la ciencia: *Asterina gaiadendricola* con *Asterostomella* anamorfo y *Asterina schlegeliae* con *Mahanteshamyces* anamorfo. 28 especies de Asterinaceae se citan por primera vez para Panamá: *Asterina cestricola*, *A. ciferriana*, *A. consobrina*, *A. corallopoda*, *A. davillae* con anamorfo, *A. diplocarpa*, *A. diplopoda*, *A. ekmanii*, *A. fuchsiae*, *A. manihotis*, *A. phenacis*, *A. radiofissilis* con anamorfo, *A. siphocampyli*, *A. sponiae*, *A. stipitipodia* con anamorfo, *A. styracina*, *A. tonduzii* con anamorfo, *A. weinmanniae*, *A. zanthoxyli*, *Asterostomella dilleniicola*, *Asterolibertia licaniicola*, *Asterolibertia nodulosa*, *Cirsosia splendida* con *Homalopeltis chrysobalani* anamorfo y *Prillieuxina winteriana* con *Leprieurina winteriana* anamorfo. Las otras 11 especies de Asterinaceae representan probablemente nuevas especies: *Asterina* spp. 1-8, *Asterolibertia* sp., *Halbanina* sp. y *Mahanteshamyce*s sp. Las cuatros especies de Microthyriaceae son nuevos reportes para Panamá: *Maublanica uleana*, *Platypeltella irregularis*, *Platypeltella smilacis* y *Xenostomella tovarensis*. *Hemisphaeropsis magnoliae* que pertenece al grupo ‘Pycnothyriales’, también representa un nuevo reporte para Panamá.

Así el número de especies de Asterinaceae conocidas en Panamá aumenta de cuatro a 30, para Microthyriaceae de cero a cuatro y para ‘Pycnothyriales’ de cero a una. 21 de las especies presentadas son nuevos reportes para América Central y dos especies están nuevamente reportadas para el continente Américano.

Las 42 especies presentadas crecen en 47 especies de plantas hospederas de 39 géneros que pertenecen a 28 familias de plantas vasculares. Para 23 especies de hongos se descubrieron nuevas especies de plantas hospederas. De estas, siete pertenecen a géneros de plantas desconicidas antes como hospederos de especies de Asterinaceae y Microthyriaceae: *Burmeistera* (Campanulaceae), *Curatella* y *Davilla* (Dilleniaceae), *Greigia* (Bromeliaceae), *Hirtella* (Chrysobalanaceae), *Oxandra* y *Xylopia* (Annonaceae).

En esta tésis se presenta el primer estudio filogenético de la familia Asterinaceae. Por primera vez, el ADN fue aislado en Panamá de material fresco de especies de *Asterina* y sus estados anamorfos. La hipótesis derivada de SSU y LSU rADN neighbour-joining análisis soporta la monofilia de la familia Asterinaceae en la clase Dothideomycetes.

Los datos del proyecto ppMP (microhongos parásitos en plantas de Panamá) indican una constante presencia de ascomicetos thiriothecioides parasitícos en comunidades naturales de plantas en Panamá. En el Oeste de Panamá los Asterinaceae representan el grupo más diverso y rico en especies. Amplias colecciones en las áreas tropicales del mundo seguramente pueden ampliar el conocimiento sobre la diversidad y ecología de ascomicetos thiriothecioides parasitícos.

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Angiosperm phylogeny Website: www.mobot.org/mobot/research/apweb/welcome.html

Index fungorum: www.indexfungorum.org

NCBI BLAST search: www.blast.ncbi.nlm.nih.gov/Blast.cgi

U.S. National Fungus Collections, BPI: http//nt.ars-grin.gov/fungaldatabases

7 Appendix

7.1 The genera of Asterinaceae, Microthyriaceae and similar families

- the taxonomy and systematics of the fungal genera were adopted from Kirk et al. (2001, 2008)
- * indicates an anamorphic genus known to be associated with a teleomorphic genus
- synonymic genera are indicated in regular type with the respective valid genus in italics
- names and years in brakets were added by the autor and differ from Kirk et al. (2001, 2008)

Asterinaceae Hansf. (1946), 46 [49] genera (+ 39 synonyms), 652 species.

Acarella Syd. (1927)*, anamorphic *Morenoina*
Allothyrium Syd. (1939), monotypic
Anariste Syd. (1927), monotypic
Aphanopeltis Syd. (1927)
Asterella (Sacc.) Sacc. (1891) = *Asterina*
Asterina Lév. (1845)
Asterinotheca Bat. & H. Maia (1959), monotypic, = *Asterina*
Asterodothis Theiss. (1912), monotypic
Asterolibertia G. Arnaud (1918)
Asterostomella Speg. (1886)*, anamorphic *Asterina*
Asterostromina Bat. & A.F. Vital (1957)*, monotypic, anamorphic *Asterodothis*
[*Asterostomula* Theiss. (1916)*, anamorphic *Asterinella*]
Asterotexis Arx (1958)
Aulographella Höhn. (1917) = *Morenoina*
Aulographina Arx & E. Müll. (1960)
Balansina G. Arnaud (1918), monotypic, = *Dothidasteromella*
Batistinula Arx (1960), monotypic
Calothyriolum Speg. (1919) = *Asterina*
Cirsosia G. Arnaud (1918)
Cirsosiella G. Arnaud (1918) = *Cirsosia*
Dimerosporium Fuckel (1870) = *Asterina*
Doguetia Bat. & J.A. Lima (1960), monotypic, = *Trichasterina*
Dothiclypeolum Höhn. (1916), monotypic, = *Thyriopsis*
Dothidasteris Clem. & Shear (1931) = *Dothidasteromella*
Dothidasteromella Höhn. (1910)
Echidnodella Theiss. & Syd. (1918)
Echidnodes Theiss. & Syd. (1918)
Englera F. Stevens (1939) = *Asterina*
Englerulaster Höhn. (1910) = *Asterina*
Eupelte Syd. (1924)
Halbania Racib. (1889)
Halbanina G. Arnaud (1918) = *Cirsosia*
Heraldoa Bat. (1959) = *Lembosia*
Hyphaster Henn. (1903)*, monotypic, = *Asterostomella*
Hysterostoma Theiss. (1913) = *Dothidasteromella*
Ishwaramyces Hosag (2004), monotypic
Isipinga Doidge (1921) = *Symphaster*
Lembopodia Bat. (1960), monotypic, = *Cirsosia*
Lembosia Lév. (1845)
Lembosidium Speg. (1924), monotypic, = *Lembosia*
Lembosiellina Bat. & H. Maia (1960) = *Lembosia*
Lembosina Theiss. (1913)
Lembosiodothis Höhn. (1917) = *Echidnodes*
Lembosiopeltis Bat. & J.L. Bezerra (1967) = *Uleothyrium*
Lembosiopsis Theiss. (1918)
[*Leprieurina* G. Arnaud (1918)*, anamorphic *Prillieuxina*]
Leveillella Theiss. & Syd. (1915), monotypic
Macowaniella Doidge (1921)
Mahanteshamyces Hosag. & C.K. Biju (2004)*, monotypic
Maurodothella G. Arnaud (1918) = *Echidnodes*
Maurodothina G. Arnaud ex Piroz. & Shoemaker (1970) = *Eupelte*

Meliolaster Höhn. (1918)
Meliolinopsis Beeli (1920) = *Patouillardina*
Micrographa Müll. Arg. (1890) = *Lembosia*
Micrographomyces Cif. & Tomas (1953), monotypic, = *Micrographa*
Morenoella Speg. (1885) = *Lembosia*
Morenoina Theiss. (1913)
Morqueria Bat. & H. Maia (1963), monotypic, = *Cirsosia*
Myxasterina Höhn. (1909), monotypic, = *Asterina*
Neostomella Syd. (1927)
Oothecium Speg. (1919)* = *Asterostomella*
Opeasterina Speg. (1919) = *Asterina*
Parasterina Theiss. & Syd. (1917) = *Asterina*
Parasterinella Speg. (1924), monotypic
Parasterinopsis Bat. (1960)
Patouillardina G. Arnaud (1917) = *Meliolaster*
Peresiopsis Bat. (1960) = *Yamamotoa*
Petrakina Cif. (1932)
Pirozynskia Subram. (1972)*, anamorphic *Maurodothina*
Placoasterella Sacc. ex Theiss. & Syd. (1915)
Placoasterina Toro (1930), monotypic
Placosoma Syd. (1924)
Polythyrium Syd. (1929) = *Neostomella*
Prillieuxina G. Arnaud (1918)
[*Septothyrella* Höhn. (1911)*, anamorphic *Uleothyrium*]
Shivamyces Hosag. (2004)
Steyaertia Bat. & H. Maia (1960), monotypic, = *Asterolibertia*
Symphaster Theiss. & Syd. (1915)
Thallochaete Theiss. (1913) = *Aphanopeltis*
Thyrinula Petr. & Syd. (1924)*, anamorphic *Aulographina*
Thyriopsis Theiss. & Syd. (1915)
Trichamelia Bat. (1960), monotypic
Trichasterina G. Arnaud (1918)
Trichosia Bat. & R. Garnier (1960), monotypic, = *Trichasterina*
Triposporium Corda (1837)*, anamorphic *Batistinula*
Uleothyrium Petr. (1929)
Viegasia Bat. (1951)
Wardina G. Arnaud (1918) = *Asterolibertia*
Yamamotoa Bat. (1960)

Aulographaceae Luttr ex. P.M. Kirk, P.F. Cannon & J.C. David (2001), 2 genera, 31 species.
Aulographum Lib. (1834)
Polyclypeolina Bat. & I.H. Lima (1959)

Brefeldiellaceae E. Müll. & Arx (1962), 1 genus, 2 species.
Brefeldiella Speg. (1889)

Englerulaceae Henn. (1904), 11 genera (+ 9 synonyms), 106 species.
Anatexis Syd. (1928) = *Englerula*
Capnodiastrum Speg. (1886)*, anamorphic *Rhytidenglerula*
Clypeolella Höhn. (1910) = *Schiffnerula*
Coniosporiella Bat. (1966), monotypic, = *Schiffnerula*
Dialacenium Syd. (1930) = *Rhytidenglerula*
Diathrypton Syd. (1922) = *Schiffnerula*
Englerula Henn. (1904)
Englerulella Hansf. (1946) = *Rhytidenglerula*
Goosia B. Song (2003), monotypic
Linotexis Syd. & P. Syd. (1917) = *Parenglerula*
Mitteriella Syd. (1933)*, anamorphic *Schiffnerula*
Parenglerula Höhn. (1910)
Phaeoschiffnerula Theiss. (1914) = *Schiffnerula*
Questieria G. Arnaud (1918) = *Schiffnerula*
Questieriella G. Arnaud ex S. Hughes (1983)*, anamorphic *Schiffnerula*
Rhizotexis Theiss. & Syd. (1917), monotypic
Rhytidenglerula Höhn. (1918)
Sarcinella Sacc. (1880)*, anamorphic *Schiffnerula*
Schiffnerula Höhn. (1909)
Thrauste Theiss. (1916)

Leptopeltidaceae Höhn. ex Trotter (1928), 6 genera (+ 8 synonyms), 14 species.
Dothiopeltis E. Müll. (1957), monotypic
Dothithyrella Höhn. (1918), monotypic, = *Leptopeltis*
Leptopeltella Höhn. (1917) = *Leptopeltis*
Leptopeltina Petr. (1947) = *Leptopeltinella*
Leptopeltinella Petr. (1951) = *Leptopeltis*
Leptopeltis Höhn. (1917)
Leptopeltopsis Petr. (1947) = *Leptopeltis*
Moesziella Petr. (1927), monotypic, = *Leptopeltis*
Moeszopeltis Petr. (1947), monotypic, = *Leptopeltis*
Nannfeldtia Petr. (1947)
Opegraphellomyces Cif. & Tomas. (1953), monotypic, = *Leptopeltis*
Phacidina Höhn. (1917), monotypic
Ronnigeria Petr. (1947), monotypic
Staibia Bat. & Peres (1966), monotypic

Micropeltidaceae Clem. & Shear (1931), 27 genera (+ 25 synonyms), 186 species.

Akaropeltella M.L. Farr (1972), monotypic
Akaropeltis Bat. & J.L. Bezerra (1961) = *Akaropeltella*
Akaropeltopsis Bat. & Peres (1966), monotypic, = *Stomiopeltis*
Armata W. Yamam. (1958), monotypic
Bonaria Bat. (1959)
Ceratochaetopsis F. Stevens & Weeson (1927), monotypic, = *Chaetothyrina*
Chaetopeltopsis Theiss. (1913), monotypic, = *Chaetothyrina*
Chaetothyrina Theiss. (1913)
Clypeolina Speg. (1923) = *Clypeolopsis*
Clypeolina Theiss. (1918)
Clypeolinopsis Bat. (1959) = *Stomiopeltis*
Clypeolopsis F. Stevens & Manter (1925) = *Stomiopeltis*
Cyclopeltella Petr. (1953)*, monotypic, anamorphic *Cyclopeltis*
Cyclopeltis Petr. (1953)
Dictyopeltella Bat. & I.H. Lima (1959)
Dictyopeltis Theiss. (1913)
Dictyostomiopelta Viégas (1944), monotypic
Dictyothyriella Rehm (1914) = *Micropeltis*
Dictyothyriella Speg. (1924)
Dictyothyrina Theiss. (1913)
Dictyothyrium Theiss. (1912)
Diplocarponella Bat. (1957) = *Stomiopeltis*
Hansfordiopsis Bat. (1959), monotypic
Haplopeltheca Bat., J.L. Bezerra & Cavalc. (1963), monotypic
Hormopeltis Speg. (1912), monotypic, = *Micropeltis*
Leptopeltina Speg. (1924) = *Stomiopeltis*
Mendoziopeltis Bat. (1959)
Micropeltella Syd. & P. Syd. (1913) = *Micropeltis*
Micropeltidium Speg. (1919) = *Micropeltis*
Micropeltis Mont. (1842)
Mitopeltis Speg. (1921), monotypic
Muricopeltis Viégas (1944), monotypic
Ophiopeltis J.V. Almeida & Sousa da Câmara (1903), monotypic, = *Micropeltis*
Parapeltella Speg. (1919) = *Micropeltis*
Phaeostomiopeltis Bat. & Cavalc. (1963), monotypic, = *Haplopeltheca*
Plochmopeltidella J.M. Mend. (1925) = *Chaetothyrina*
Polypedia Bat. & Peres (1959), monotypic
Scolecopeltella Speg. (1923) = *Micropeltis*
Scolecopeltis Speg. (1889) = *Micropeltis*
Scolecopeltopsis Höhn. (1909) = *Micropeltis*
Setopeltis Bat. & A.F. Vital (1959), monotypic, = *Chaetothyrina*
Stigmatodothis Syd. & P. Syd. (1914)
Stigmatophragmia Tehon & G.L. Stout (1929), monotypic
Stomiopeltella Theiss. (1914) = *Stomiopeltis*
Stomiopeltis Theiss. (1914)
Stomiopeltopsis Bat. & Cavalc. (1963)
Stomiotheca Bat. (1959), monotypic
Theciopeltis F. Stevens & Manter (1925) = *Micropeltis*
Thyriodictyella Cif. (1962), monotypic
Verlandea Bat. (1957), monotypic, = *Stomiopeltis*

Microthyriaceae Sacc. (1883), 54 [55] genera (+ 40 synonyms), 278 species.

Actinomyxa Syd. & P. Syd. (1917), monotypic
Actinopeltella Doidge (1924) = *Actinopeltis*
Actinopeltis Höhn. (1907)
Actinosoma Syd. (1930) = *Actinopeltis*
Arnaudiella Petr. (1927)
Asteridiellina Seaver & Toro (1926), monotypic, = *Actinopeltis*
Asterinella Theiss. (1912)
Asterinema Bat. & Gayão (1953)
Asterinopeltis Bat. & H. Maia (1958) = *Platypeltella*
Asteritea Bat. & R. Garnier (1961), monotypic
Asteronia (Sacc.) Henn. (1895)
Byssopeltis Bat., J.L. Bezerra & T.T. Barros (1970), monotypic
Caenothyrium Theiss. & Syd. (1918) = *Actinopeltis*
Calopeltis Syd. (1925) = *Cyclotheca*
Calothyriella Höhn. (1917) = *Microthyrium*
Calothyriopsis Höhn. (1919)
Calothyrium Theiss. (1912) = *Asterinella*
Caribaeomyces Cif. (1962), monotypic
Carlosia G. Arnaud (1954) = *Isthmospora*
Caudella Syd. & P. Syd. (1916)
Caudellopeltis Bat. & H. Maia (1960), monotypic, = *Maublancia*
Chaetothyriopsis F. Stevens & Dorman (1927) = *Actinopeltis*
Cirsosina Bat. & J.L. Bezerra (1960)
Cirsosiopsis Butin & Speer (1979), monotypic
Corynocladus Leidy (1850), monotypic
Cyclotheca Theiss. (1914)
Dasypyrena Speg. (1912) = *Actinopeltis*
Dictyoasterina Hansf. (1947), monotypic
Didymopyrostroma Bat. & Cavalc. (1964), monotypic, = *Lichenopeltella*
Dubujiana D.R. Reynolds & G.S. Gilbert (2005), monotypic
Ellisiodothis Theiss. (1914) = *Muyocopron*
Govindua Bat. & H. Maia (1960), monotypic
Halbaniella Theiss. (1917) = *Actinopeltis*
Hansfordiella S. Hughes (1951)*, anamorphic *Trichothyrium*
Haplopeltis Theiss. (1914) = *Muyocopron*
Hariotula G. Arnaud (1917) = *Cyclotheca*
Helminthopeltis Sousa de Câmara (1950), monotypic
Hidakaea I. Hino & Katum. (1955), monotypic
Hugueninia J.L. Bezerra & T.T. Barros (1970), monotypic
Isthmospora F. Stevens (1918)*, anamorphic *Trichothyrium*
Lembosiella Sacc. (1891), monotypic
Lichenopeltella Höhn. (1919)

Loranthomyces Höhn. (1909) = *Actinopeltis*
Maublancia G. Arnaud (1918)
Micropeltopsis Vain (1921) = *Lichenopeltella*
Microthyrina Bat. (1960) = *Microthyrium*
Microthyris Clem. (1931), monotypic, = *Lichenopeltella*
Microthyrium Desm. (1841)
Monorhizina Theiss. & Syd. (1915), monotypic
Muyocopron Speg. (1881)
Mycolangloisia G. Arnaud (1818) = *Actinopeltis*
Opeasterinella Speg. (1917) = *Asterinella*
Pachythyrium G. Arnaud ex Spooner & P.M. Kirk (1990), monotypic
Palawania Syd. & P. Syd. (1914)
Peltella Syd. & P. Syd. (1917) = *Muyocopron*
Peltopsis Bat. (1960) = *Muyocopron*
Petrakiopeltis Bat., A.F. Vital & Cif. (1957), monotypic
Phaeothyriolum Syd. (1938)
Phragmaspidium Bat. (1960)
Phragmothyrium Höhn. (1912) = *Microthyrium*
Platypeltella Petr. (1929)
Plochmothea Syd. (1939), monotypic, = *Xenostomella*
Polycylinopsis Bat., A.F. Vital & I.H. Lima (1958), monotypic
Polystomellina Bat. & A.F. Vital (1985), monotypic
Ptychopeltis Syd. (1927) = *Calothyriopsis*
Raciborskiella Speg. (1919) = *Trichopeltella*
Resendea Bat. (1961)
Sapucchaka K. Ramakr. (1956), monotypic
Scolecopeltidium F. Stevens & Manter (1925)
Scolecopeltium Clem. & Shear (1931) = *Scolecopeltidium*
Seynesiella G. Arnaud (1918)
Seynesiola Speg. (1919), monotypic, = *Arnaudiella*
Seynesiopeltis F. Stevens & R.W. Ryan (1925), monotypic
Seynesiospora Bat. (1960), monotypic, = *Cyclotheca*
Stegothyrium Höhn. (1918), monotypic
Synostomella Syd. (1927) = *Cyclotheca*
Synpeltis Syd. & P. Syd. (1917) = *Cyclotheca*
Thyrosoma Syd. (1921), monotypic, = *Cyclotheca*
Tothia Bat. (1960), monotypic
Trichopeltella Höhn. (1910), monotypic
Trichopeltina Theiss. (1914)
Trichopeltis Speg. (1889) = *Trichothyrium*
Trichopeltopsis Höhn. (1909), monotypic, = *Trichothyrium*
Trichopeltospora Bat. & Cif. (1958)
Trichopeltula Theiss. (1914) = *Trichothyrium*
Trichopeltum Bat., Cif. & C.A.A. Costa (1957)
Trichothyriella Theiss. (1914), monotypic
Trichothyrina (Petr.) Petr. (1950) = *Lichenopeltella*
Trichothyrinula Petr. (1950)
Trichothyriomyces Bat. & H. Maia (1955), monotypic
Trichothyriopsis Theiss. (1914)
Trichothyrium Speg. (1889)
Trotteria Sacc. (1919) = *Actinopeltis*
Xenogliocladiopsis Crous & W.B. Kendr. (1994)*, monotypic, anamorphic *Arnaudiella*
Xenostomella Syd. (1930)

Parmulariaceae E. Müll. & Arx ex M.E. Barr (1979), 34 genera (+ 24 synonyms), 119 species.

Aldona Racib. (1900)
Aldonata Sivan. & A.R.P. Sinha (1989), monotypic
Apoa Syd. (1931), monotypic, = *Pachypatella*
Aspidothea Syd. (1927), monotypic, = *Inocyclus*
Aulacostroma Syd. & P. Syd. (1914)
Byliana Dippen (1930), monotypic, = *Palawaniella*
Campoa Speg. (1921)
Chaetaspis Syd. & P. Syd. (1917), monotypic, = *Rhagadolobium*
Clypeum Massee (1896), monotypic, = *Parmularia*
Coccodothis Theiss. & Syd. (1914)
Cocconia Sacc. (1889)
Cocconiopsis G. Arnaud (1918), monotypic, = *Cyclostomella*
Cycloschizella Höhn. (1919), monotypic, = *Cycloschizon*
Cycloschizon Henn. (1902)
Cyclostomella Pat. (1896)
Dictyocyclus Sivan., W.H. Hsieh & Chi Y. Chen (1998), monotypic
Dielsiella Henn. (1903) = *Cycloschizon*
Discodothis Höhn. (1909) = *Rhagadolobium*
Dothidasteroma Höhn. (1909)
Dothophaeis Clem. (1931), monotypic, = *Englerodothis*
Ellimonia Syd. (1930), monotypic, = *Inocyclus*
Englerodothis Theiss. & Syd. (1915)
Ferrarisia Sacc. (1919)
Fraserula Syd. (1938) = *Inocyclus*
Hemigrapha Müll. Arg. ex D. Hawksw. (1975)
Hysterostomella Speg. (1885)
Hysterostomina Theiss. & Syd. (1915) = *Hysterostomella*
Inocyclus Theiss. (1915)
Kiehlia Viégas (1944)
Lateropeltis Shanor (1946) = *Kiehlia*
Lauterbachiella Henn. (1898) = *Rhagadolobium*
Maurodothis Sacc., Syd. & P. Syd. ex Syd. & P. Syd. (1904), monotypic, = *Cycloschizon*
Melanoplaca Syd. & P. Syd. (1917), monotypic, = *Dothidasteroma*
Microthyriolum Speg. (1917) = *Ferrarisia*
Mintera Inácio & P.F. Cannon (2003), monotypic
Monorhiza Theiss. & Syd. (1915) = *Rhagadolobium*
Myiocoprella Sacc. (1916), monotypic, = *Rhagadolobium*
Myxostomella Syd. (1931) = *Campoa*
Pachypatella Theiss. & Syd. (1915)
Palawaniella Doidge (1921)

Parmularia Lév. (1846)
Parmulariopsella Sivan. (1970), monotypic
Parmulariopsis Petr. (1954), monotypic
Parmulina Theiss. & Syd. (1914)
Perischizon Syd. & P. Syd. (1914)
Placomelan Cif. (1962), monotypic
Polycyclina Theiss. & Syd. (1915), monotypic
Polycyclus Höhn. (1909)
Protothyrium G. Arnaud (1917)
Pseudolembosia theiss. (1913)
Pycnographa Müll. Arg. (1890), monotypic, = *Parmularia*
Rhagadolobium Henn. & Lindau (1896)
Rhipidocarpon (Theiss.) Theiss. & Syd. (1915), monotypic
Schneepia Speg. (1885) = *Parmularia*
Symphaeophyma Speg. (1912), monotypic
Thallomyces H.J. Swart (1975), monotypic
Viegasella Inácio & C.F. Cannon (2003), monotypic
Xenodiscella Petr. (1954), monotypic, = *Rhagadolobium*

Polystomellaceae Theiss. & P. Syd. (1915), 3 [4] genera (+ 5 synonyms), 9 species.
Apiotrabutia Petr. (1929), monotypic, = *Munkiella*
Coscinopeltis Speg. (1909) = *Munkiella*
Dothidella Speg. (1880)
Hypostigme Syd. (1925), monotypic, = *Parastigmatea*
Marchalia Sacc. (1889)
Munkiella Speg. (1885)
Parastigmatea Doidge (1921)
Pluriporus F. Stevens & R.W. Ryan (1925), monotypic, = *Dothidella*
Polystomella Speg. (1888) = *Dothidella*

Schizothyriaceae Höhn. ex Trotter, Sacc., D. Sacc. & Traverso (1928), 16 genera (+ 28 synonyms), 52 species.
Agyronella Höhn. (1909), monotypic, = *Schizothyrium*
Amazonotheca Bat. & H. Maia (1959) Syd. & P. Syd. (1917), monotypic
Chaetoplaca Syd. P. Syd. (1917), monotypic
Ciferriotheca Bat. & I.H. Lima (1959) = *Metathyriella*
Didymopeltis Bat. & I.H. Lima (1959) = *Schizothyrium*
Didymothyriella Bat. & I.H. Lima (1959) = *Plochmopeltis*
Endocycla Syd. (1927), monotypic, = *Schizothyrium*
Epipeltis Theiss. (1913) = *Schizothyrium*
Eremotheca Theiss. & Syd. (1917) = *Schizothyrium*
Gymnopeltis F. Stevens (1924) = *Lecideopsella*
Gyrothyrium Arx (1950), monotypic, = *Schizothyrium*
Henningsiella Rehm (1895)
Hexagonella F.Stevens & Guba ex F. Stevens (1925), monotypic
Kerniomyces Toro (1939), monotypic
Lecideopsella Höhn. (1909)
Linopeltis I. Hino & Katum. (1961), monotypic
Mendogia Racib. (1900)
Metathyriella Syd. (1927)
Microsticta Desm. (1849) = *Schizothyrium*
Microthyriella Höhn. (1909) = *Schizothyrium*
Mycerema Bat., J.L. Bezerra & Cavalc. (1963)
Myiocopraloa Cif. (1958), monotypic, = *Schizothyrium*
Myriangiella Zimm. (1902)
Neopeltella Petr. (1950), monotypic
Orthobellus A.A. Silva & Cavalc. (1973)
Oswaldoa Bat. & I.H. Lima (1959) = *Myriangiella*
Paraphysotheca Bat. (1961) = *Schizothyrium*
Phragmothyriella Höhn. (1912) = *Myriangiella*
Plectomyriangium C. Moreau & M. Moreau (1950) = *Lecideopsella*
Pleiostomella Syd. & P. Syd. (1917) = *Mendogia*
Plochmopeltis Theiss. (1914)
Polyclypeolum Theiss. (1914) = *Schizothyrium*
Protopeltis Syd. (1927) = *Myriangiella*
Sathropeltis Bat. & Matta (1959), monotypic, = *Myriangiella*
Schizontopeltis Bat. & H. Maia (1962), monotypic, = *Schizothyrium*
Schizopeltis Bat. & I.H. Lima (1959) = *Schizothyrium*
Schizothyrina Bat. I.H. Lima (1959), monotypic, = *Schizothyrium*
Schizothyrium Desm. (1849)
Spegazziniella Bat. & I.H. Lima (1959) = *Myriangiella*
Stomiopeltina Bat. (1963), monotypic, = *Metathyriella*
Sydowiellina Bat. & I.H. Lima (1959) = *Myriangiella*
Uleopeltis Henn. (1904) = *Mendogia*
Vanudenia Bat. & H. Maia (1963), monotypic, = *Schizothyrium*
Zygophiala E.W. Mason (1945)*

Vizellaceae H.J. Swart (1971), 3 [4] genera (+ 10 synonyms), 12 species.
Blasdalea Sacc. & P. Syd. (1902), monotypic
Chrysogloeum Petr. (1959), monotypic
Entopeltis Höhn. (1910) = *Vizella*
Haplopyrenula Müll. Arg. (1883) = *Vizella*
Haplopyrenulomyces Cif. & Tomas. (1953), monotypic, = *Haplopyrenula*

Haplospora Räsänen (1943) = *Haplopyrenula*
Hypocelis Petr. (1929) = *Vizella*
[*Manginula* G. Arnaud (1918)*, anamorphic *Vizella*]
Phacopeltis Ptech (1919) = *Vizella*
Phaeaspis Clem. & Shear (1931) = *Vizella*
Phaeopeltis Petch (1919) = *Phaeaspis*
Singeriella Petr. (1959), monotypic, = *Blasdalea*
Stigmatopeltis Doidge (1927) = *Vizella*
Vizella Sacc. (1883)

7.2 Morphology and ecology of of thyriothecioid ascomycetes

Table 7.1: The families of thyriothecioid ascomycetes. Overview to ecological and morphological characteristics of the families of thyriothecioid ascomycetes according to Kirk et al. (2001).

	Asterinaceae	Aulographaceae	Brefeldiellaceae	Englerulaceae	Leptopeltidaceae	Micropeltidaceae	Microthyriaceae	Parmulariaceae	Polystomellaceae	Schizothyriaceae	Vizellaceae
Ecology											
biotropic	+	–	–	+	–	–	+	+	+	–	+
saprotrophic	–	+	–	–	+	–	+	–	–	+	–
commensalistic	–	–	+	–	–	+	–	–	–	+	–
Surface mycelium											
brown	+	+	–	+	–	–	+	–	–	–	–
hyaline	–	–	–	–	–	+	+	–	–	+	+
Hypostromata	+	–	–	–	+	–	–	+	+	–	–
Ascomata											
superficial	+	+	+	+	–	+	+	+	+	+	–
subcuticular	–	–	–	–	+	–	–	+	+	–	+
circular	+	–	+	+	–	+	+	+	+	+	+
linear	+	+	–	–	+	–	–	+	–	–	–
open with central pores	–	–	+	–	–	+	+	–	+	–	+
open with fissures	+	+	–	+	+	–	–	+	–	+	–
Scutellum											
radiate, isodiametrical	+	–	+	+	+	–	+	+	+	–	–
radiate, meandrical	–	+	+	–	–	–	–	+	–	–	–
nonradiate, epidermoidal	–	–	–	–	–	+	–	–	–	+	+
nonradiate, isodiametrical	–	–	–	–	–	–	–	–	–	+	–
Asci											
vertical within ascoma	+	+	+	+	+	–	–	+	–	+	–
inclined within ascoma	–	–	–	–	–	+	+	–	+	–	+
globose to ovoid	+	+	+	+	+	–	–	+	+	+	–
cylindrical, elongated	–	–	–	–	–	+	+	–	–	–	+
Ascospores											
brown	+	–	–	+	–	–	+	+	+	–	+
hyaline	–	+	+	–	+	+	+	+	+	+	–

7.3 Index of host plants of Asterinaceae and Microthyriaceae presented in this study

The taxonomy and systematics of the host plant families and genera was adopted from Mabberley (2008). Underligned host plants were collected in Panama.

Acanthaceae
- *Hansteinia reflexiflora*
  - *Asterina* sp. 1
- *Hansteinia ventricosa*
  - *Asterina* sp. 2

Annonaceae
- *Annona montana*
  - *Prillieuxina winteriana* with *Leprieurina winteriana* anamorph
- *Annona muricata*
  - *Prillieuxina winteriana* with *Leprieurina winteriana* anamorph
- *Annona* sp.
  - *Prillieuxina winteriana* with *Leprieurina winteriana* anamorph
- *Desmopsis bibracteata*
  - *Asterina* sp. 3
- *Guatteria dolichopoda*
  - *Asterolibertia nodulosa*
- *Guatteria sp.*
  - *Asterolibertia nodulosa*
- *Oxandra venezuelana*
  - *Asterolibertia nodulosa*
- *Rollinia* sp.
  - *Prillieuxina winteriana* with *Leprieurina winteriana* anamorph
- unknown genus
  - *Asterolibertia* sp.
- *Xylopia* sp.
  - *Asterolibertia nodulosa*

Bromeliaceae
- *Greigia sylvicola*
  - *Platypeltella irregularis*
- *Guzmania plumieri*
  - *Platypeltella smilacis*
- *Puya* sp.
  - *Platypeltella irregularis*

Campanulaceae
- *Burmeistera* sp.
  - *Asterina siphocampyli*
- *Burmeistera vulgaris*
  - *Asterina siphocampyli*
- *Siphocampylus campanulatus*
  - *Asterina siphocampyli*

Cannabaceae
- *Sponia virgata*
  - *Asterina sponiae*
- *Trema amboinensis*
  - *Asterina sponiae*
- *Trema aspera*
  - *Asterina sponiae*
- *Trema cannabina*
  - *Asterina sponiae*
- *Trema guineensis*
  - *Asterina sponiae*
- *Trema micrantha*
  - *Asterina sponiae*
- *Trema mollis*
  - *Asterina sponiae*
- *Trema orientalis*
  - *Asterina sponiae*
- *Trema sp.*
  - *Asterina sponiae*

Chrysobalanaceae
- *Chrysobalanus icaco*
  - *Cirsosia splendida* with *Homalopeltis chrysobalani* anamorph
  - *Halbanina* sp.
  - *Maublancia uleana*
- *Hirtella americana*
  - *Cirsosia splendida* with *Homalopeltis chrysobalani* anamorph
- *Hirtella triandra*
  - *Cirsosia splendida* with *Homalopeltis chrysobalani* anamorph
- *Licania arborea*
  - *Asterolibertia licaniicola*
- *Licania sp.*
  - *Asterolibertia licaniicola*

Cleomaceae
- *Cleome* sp.
  - *Asterina* sp. 4

Clusiaceae
- *Clusia gundlachii*
  - *Asterina diplocarpa*
- *Clusia* sp.
  - *Asterina* sp. 5

Cunoniaceae
- *Weinmannia hirtella*
  - *Asterina weinmanniae*
- *Weinmannia macrophylla*
  - *Asterina weinmanniae*
- *Weinmannia pinnata*
  - *Asterina weinmanniae*

Dilleniaceae
- *Curatella americana*
  - *Asterina davillae* with *Asterostomella* anamorph
- *Davilla kunthii*
  - *Asterina stipitipodia* with *Asterostomella stipitipodia* anamorph
  - *Asterostomella dilleniicola*

- *Davilla rugosa*
  - *Asterina davillae* with *Asterostomella* anamorph
- Unknown genus
  - *Asterina stipitipodia* with *Asterostomella stipitipodia* anamorph
  - *Asterostomella dilleniicola*

Euphorbiaceae

- *Acalypha arvensis*
  - *Asterina radiofissilis* with *Asterostomella* anamorph
- *Acalypha capensis*
  - *Asterina radiofissilis* with *Asterostomella* anamorph
- *Acalypha decumbens*
  - *Asterina radiofissilis* with *Asterostomella* anamorph
- *Acalypha nemorum*
  - *Asterina radiofissilis* with *Asterostomella* anamorph
- *Ctenomeria capensis*
  - *Asterina radiofissilis* with *Asterostomella* anamorph
- *Dalechampia capensis*
  - *Asterina radiofissilis* with *Asterostomella* anamorph
- *Erythrococca berberidea*
  - *Asterina radiofissilis* with *Asterostomella* anamorph
- *Manihot esculenta*
  - *Asterina manihotis*
- *Manihot glaziovii*
  - *Asterina manihotis*
- *Manihot* sp.
  - *Asterina manihotis*
- *Manihot utilissima*
  - *Asterina manihotis*

Fabaceae s.l.

- *Caesalpinia crista*
  - *Asterina ciferriana*
- *Caesalpinia bonduc*
  - *Asterina ciferriana*
- *Cassia crista*
  - *Asterina ciferriana*
- *Senna* sp.
  - *Asterina ciferriana*

Gesneriaceae

- *Alloplectus ichtyoderma*
  - *Asterina* sp. 6
- unknown genus
  - *Asterina* sp. 6

Loranthaceae

- *Gaiadendron punctatum*
  - *Asterina gaiadendricola* with *Asterostomella* anamorph

Magnoliaceae

- *Magnolia glauca*
  - *Hemisphaeropsis magnoliae* with unnamed teleomorph
- *Magnolia sororum*
  - *Hemisphaeropsis magnoliae* with unnamed teleomorph
- *Magnolia* sp.
  - *Hemisphaeropsis magnoliae* with unnamed teleomorph

Malvaceae

- *Abutilon* sp.
  - *Asterina diplocarpa*
- *Corchorus hirtus*
  - *Asterina diplocarpa*
- *Sida acuta*
  - *Asterina diplocarpa*
- *Sida carpinifolia*
  - *Asterina diplocarpa*
- *Sida cordifolia*
  - *Asterina diplocarpa*
- *Sida glomerata*
  - *Asterina diplocarpa*
- *Sida humilis*
  - *Asterina diplocarpa*
- *Sida rhombifolia*
  - *Asterina diplocarpa*
- *Sida* sp.
  - *Asterina diplocarpa*
- *Sida stipulata*
  - *Asterina diplocarpa*
- *Sida urens*
  - *Asterina diplocarpa*
- *Triumfetta* sp.
  - *Asterina sponiae*
- Unknown genus
  - *Asterina sponiae*

Myristicaceae

- *Compsoneura sprucei*
  - *Asterina* sp. 7

Myrtaceae

- *Eugenia monticola*
  - *Maublancia uleana*
- *Eugenia* sp.
  - *Maublancia uleana*
- *Myrcia splendens*
  - *Maublancia uleana*

Onagraceae

- *Fuchsia paniculata*
  - *Asterina fuchsiae*
- *Fuchsia scabriuscula*
  - *Asterina fuchsiae*

Polygalaceae

- *Diclidanthera laurifolia*
  - *Asteria styracina*
- *Monnina xalapensis*
  - *Xenostomella tovarensis*

Rubiaceae

- *Gonzalagunia rudis*
  - *Asterina ekmanii*
- *Gonzalagunia spicata*
  - *Asterina ekmanii*

Rutaceae

- *Zanthoxylum cuspidatum*
  - *Asterina zanthoxyli*
- *Zanthoxylum oxyphyllum*
  - *Asterina zanthoxyli*
- *Zanthoxylum scheryi*
  - *Asterina zanthoxyli*
- *Zanthoxyllum setosum*
  - *Asterina zanthoxyli*
- *Zanthoxylum simulans*
  - *Asterina zanthoxyli*

Salicaceae

- *Casearia commersoniana*
  - *Asterina* sp. 8
- *Flacourtia ramontchi*
  - *Asterina tonduzii* with *Asterostomella tonduzii* anamorph
- *Xylosma* sp.
  - *Asterina tonduzii* with *Asterostomella tonduzii* anamorph
- *Xylosma velutina*
  - *Asterina tonduzii* with *Asterostomella tonduzii* anamorph

Schlegeliaceae

- *Schlegelia parviflora*
  - *Asterina schlegeliae* with *Mahanteshamyces* anamorph
  - *Mahanteshamyces* sp.

Smilacaceae

- *Smilax* sp.
  - *Platypeltella smilacis*

Solanaceae

- *Cestrum macrophyllum*
  - *Asterina cestricola*
- *Cestrum rugulosum*
  - *Asterina cestricola*
- *Cestrum* sp.
  - *Asterina cestricola*
- *Lycianthes xylopiifolia*
  - *Xenostomella tovarensis*
- *Solanum acerifolium*
  - *Asterina diplopoda*
- *Solanum aphyodendron*
  - *Asterina consobrina*
- *Solanum callicarpaefolium*
  - *Asterina diplopoda*
- *Solanum* cf. *laurifolium*
  - *Asterina consobrina*
- *Solanum* sp.
  - *Asterina corallopoda*
  - *Asterina diplopoda*
- *Solanum stramoniifolium*
  - *Asterina diplopoda*
- *Solanum trachycyphum*
  - *Asterina corallopoda*
- *Solanum trizygum*
  - *Asterina corallopoda*
- unknown genus
  - *Asterina cestricola*

Styracaceae

- *Styrax argenteus*
  - *Asterina styracina*
- *Styrax polyneurus*
  - *Asterina styracina*

Urticaceae

- *Phenax hirtus*
  - *Asterina phenacis*
- *Phenax mexicanus*
  - *Asterina phenacis*
- unknown genus
  - *Asterina phenacis*

7.4 Sequences used for molecular phylogenetic analysis

Table 7.2: SSU and LSU rDNA sequences of *Asterina* spp. and *Mahanteshamyces sp.* used for molecular phylogenetic analyses.

Asterina cestricola on *Cestrum rugulosum* (Solanaceae) (TH 591)	
SSU	CGTAGTTGAACCTTGGGGCTGGCCGACCGGTCCGCCTCACCGCGTGCACTGGCTCGGCCGGCCCTTTCCTCGCGGGGAACCCCATGCCCTTCGATGGGTGTGGCGGCCATCCGCGACTTTTACTGTGAATAAATCAGACTGTTCAAAGGAGGCCTTTGCTCGAATGTCTTAGCATGGAATAATGGAATAGGACGCGCGTCCCTATTTTGTTGGTTTCTAGGGACGCCGTAATGATTAATAGGGATGGTCGGGGGCATCAGTATTCAATTGTCAGAGGTGAAATTCTTGGATTTATTGAAGACTAACTACTGCGAAAGCATTTGCCAGGGATGTTTTCATTAATCAGTGAACGAAAGTTAGGGGATCGAAGACGATCAGATACCGTCGTAGTCTTAACCGTAAACTATGCCGACTAGGGATCGGGCGATGTTTCATCATGACTCGCTCGGCACCTTGCGAGAAATCAAAGTAAGGTTCTGGGGGGAGTATGGTCGCAAGGCTGAAACTTAAAGAAATTGACGGAAGGGCACCACCAGGAGTGGAGCCTGCGGCTTAATTTGACTCAACACGGG
LSU	AAGCGGAGGAAAAGAAACCAACAGGGATTGCCTCAGTAACGGCGAGTGAAGCGGCAACAGCTCAAATTTGAAATCTGGCCCCCGGGCCCGAGTTGTAATTTGCAGAGGATGCTTCGGGGCGGGCCCCGTCCCGAGTCCCTTGGAACAGGGCGCCGCAGAGGGTGAGGGCCCCGTACACGGCCGGACGCCCGCCCCGTGCGAAGCTCCTTCGACGAGTCGAGCTGTTTGGGAATGCAGCTCCAAACGGGAGGTATATTCCTCCCAAGGCTAAATACCGGCCGGAGACCGATAGCGCACAAGTAGAGTGATCGAAAGGTGAAAAGCACTTTGGAAAGAGAGTTAAAAAGTACGTGAAATTGTTGAAAGGGAAGCGTTTGCGGCCAGACCTGGTGGCGGTTGCTCAGCCGGTCCCTCGGGGCCGGCGCACTCTTCCGCCACCTGGCCAGCATCGGTCCGGGCGGCCGGACAAAGGCCGGGGGAACGTGGCCCCCGCGCGGGGTGTTATAGCCCCCGGCACAATACGGCCAGCCCGGACCGAGGACAGCGT
Asterina fuchsiae on *Fuchsia paniculata* (Onagraceae) (TH 590)	
SSU	CCGGTCCGCCTCACCGCGTGCACTGGCTCGGCCGGCCCTTTCCTCGCGGGGAACCCCATGCCCTTTGTTGGGTGTGCGGGCCATCCGCGACTTTTACTGTGAATAAATCAGACTGTTCAAAGGAGGCCTTTGCTCGGATGTCTTAGCATGGAATAATGGAATAGGACGTGCGTCCCTATTTCGTTGGTTTCTAGGGACGCCGTAATGATTAATAGGGATGGTCGGGGGCATCAGTATTCAATTGTCAGAGGTGAAATTCTTGGATTTATTGAAGACTAACTACTGCGAAAGCATTTGCCAGGGATGTTTTCATTAATCAGTGAACGAAAGTTAGGGGATCGAAGACGATCAGATACCGTCGTAGTCTTAACCGTAAACTATGCCGACTAGGGATCGGGCGATGTTTCTTAATGACTCGCTCGGCACCTTGCGAGAAATCAAAGTAAGGTTC
LSU	TCGATATCMAAAAGCGGAGGAAAAGAAACCAACAGGGATTGCCTCAGTAACCGCGAGTGAAGCGGCAACAGCTCAAATTGAAATCTGGCCCCGGGCCCGAGTTGTAATTTGCAGAGGATGCTTCGGGGCGGCCCCCGGTCCAAGTCCCTTGSAACAGGSCGTCSTAGAGGGAGAGGACCCSGTACACGACCGGRCGTCCGCCCCGTGCGAAKCTCCTTCGACGAGTCGAGTTGTTTGGGAATGCAGCTCCAAACGGGAGGTATATTCCTCCCAAKGCTAAATACCGGCCGGAGACCGATAGCGCACAAGTAGAGTGATCGAAAGATGAAAARCACTTTGGAAARARAGTGAAAAAGTACGTGAAATTATTGAAAGGGAAGCGTCTGCGGCCAGACCTGGTGGCGGTTGCTCAGCCGGTCCTTCGGGGCCGGCGCACTCTTCCGCCACCTGGCCAGCATCGGTTTGGGCGGCCGGACAAAGKCCTCGGGAACGTGGCCCCCTCGCGGGGTGTTATAGCCCTTGGCACAATGCG
Asterina phenacis on *Phenax mexicanus* (Urticaceae) (TH 589)	
SSU	TTAAAAAGcTCGTAGTTGAACCTTGGGGCTGGCCGACCGGTCCGCCTCACCGCGAGCACTGGCCCGGCCGGCCCTTCCCTCGCGGGGAACCCCATGCCCTTTACTGGGTGTGCGGGCGATCCGCGACTTTTACTGTGAATAAATCAGACTGTTCAAAGGAGGCCTTTGCTCGGATGTCTTAGCATGGAATAATGGAATAGGACGCGCGTCCCTATTTTGTTGGTTTCTAGGGACGCCGTAATGATTAATAGGGATGGTCGGGGGCATCAGTATTCAATTGTCAGAGGTGAAATTCTTGGATTTATTGAAGACTAACTACTGCGAAAGCATTTGCCAGGGATGTTTTCATTAATCAGTGAACGAAAGTTAGGGGATCGAAGACGATCAGATACCGTCGTAGTCTTAACCGTAAACCATGCCGACTAGGGATCGGGCGATGTTCCATCATGACTCGCTCGGCACCTTGCGAGAAATCAAAGTAAGGTTCTGGGGGGAGTATGGTCGCAAGGCTGAAACTTAAAGAAATTGACGGAAGGGCACCACCAGGAGTGGAGCCTGCGGCTTAAT

	TTGACTCAACACGGKGAAACTCACCAGGTCCAGACACAATAAGGATTGACAGATTGAGAGA
LSU	AAGCGGAGGAAAAGAAACCAACAGGGATTGCCTCAGTAACGGCGAGTGAAGCGGCAGCAGCTCAAATTTGAAATCTGGCCCCCCGGCCCGAGTTGTAATTTGCAGAGGATGCTTCGGGGCGGGCCCCGGCCCGAGTCCCTTGGAACAGGGCGCCGTAGAGGGTGAGGGCCCCGTACACGGCCGGACGTCCGCCCCGTGCGAAGCTCCTTCGACGAGTCGAGTTGTTTGGGAATGCAGCTCCAAACGGGAGGTATATTCCTCCCAAGGCTAAATACCGGCCGGAGACCGATAGCGCACAAGTAGAGTGATCGAAAGATGAAAAGCACTTTGGAAAGAGAGTTAAAAAGTACGTGAAATTGTTGAAAGGGAAGCGTTTGCGGCCAGACCTGGTGGCGGTTGCTCAGCCGGTCCTTCTGGGCCGGCGCACTCTTCCGCCACCTGGCCAGCATCGGTTCGGGCGGCCGGATAAAGGTTGGGGGAACGTGGCCCCCTCGCGGGGTGTTATAGCCCCCTTCACAATGCGGCCCGCCCGGACCGAGGACAGCGTTCGCTAGGATGCTGGCGTAATGGCAGCCAACGGCCCGTCTTG
Asterina weinmanniae on *Weinmannia pinnata* (Cunoniaceae) (TH 592)	
SSU	GCCTCACCGCGAGTACTGGCTCGGCCGGCCCTTTCCTCGCGGGGAACCCCATGCCCTTCACTGGGTGTGCGGGCCATCCGCGACTTTTACTGTGAATAAATCAGACTGTTCAAAGGAGGCCTTTGCTCGTATGTCTTAGCATGGAATAATGGAATAGGACGCGCGTCCCTATTTTGTTGGTTTCTAGGGACGCCGTAATGATTAATAGGGATGGTCGGGGGCATCAGTATTCAATTGTCAGAGGTGAAATTCTTGGATTTATTGAAGACTAACTACTGCGAAAGCATTTGCCAGGGATGTTTTCATTAATCAGTGAACGAAAGTTAGGGGATCGAAGACGATCAGATACCGTCGTAGTCTTAACCGTAAACCATGCCGACTAGGGATCGGGCGATGTTTCATAATGACTCGCTCGGCACCTTGCGAGAAATCAAAGTAAGGTTCTGGGGGGAGTATGGTCGCAAGGCTGAAACTTAAAGAAATTGACGGAAGGGCACCACCAGGAGTGGAGCCTGCGGCTTAATTTGACTCAACACGGGGAAACTCACCAGGTCCAGACACAATAAGGATTGAcAGATTTGAGAG
LSU	CGGCGAGTGAAGCGGCAACAGCTCAAATTTGAAATCTGGCCCCGGGCCCGAGTTGTAATTTGCAGAGGAAGCTTCGGGGTGGCCCCCGGTCCAAGTCCCTTGGAACAGGGCGTCGTAGAGGGTGAGGATCCCGTACACGGCCGGACGTCCGCCCCGTGCGAAGCTCCTTCGACGAGTCGAGTTGTTTGGGAATGCAGCTCCAAACGGGAGGTATATTCCTCCCAAGGCTAAATATTGGCCGGAGACCGATAGCGCACAAGTAGAGTGATCGAAAGATGAAAAGCACTTTGGAAAGAGAGTTAAACAGTACGTGAAATTGTTGAAAGGGAAGCGTCTGCGGCCAGACCTGGCGACGGCGGCTCAGCCGGCCCCTCGGGACCGGCGCACTCCGCCGTCGCCTGGCCAGCATCGGTTCGGGCGGCTGGACAAAGGCCCGGGGAACGTGGCCTCCTTCGGGAGGTGTTATAGCCCCGGGCACAATGCAGCCCGCCCGGACCGAGGACAGCGTTCGCTAGGATGCTGGCGTAATGGCCGCCGACGGCCCGTCTTGAACCACGGACCA
Asterina zanthoxyli on *Zanthoxylum scheryi* (Rutaceae) (TH 561)	
SSU	GTTAAAAAAAAGCGTAGTTGAACCTTGGGGCTGGCCGTCCGGTCCGCCTCACCGCGTGCACTGGCTCGGCCGGCCCTTTCCTCGCGGGGAACCCCATGCCCTTTGTTGGGCGTGCGGGCCATCCGCGACTTTTACTGTGAATAAATCAGACTGTTCAAAGGAGGCCTTTGCTCGGATGTCTTAGCATGGAATAATGGAATAGGACGCGCGTCCCTATTTTGTTGGTTTCTAGGGACGCCGTAATGATTAATAGGGATGGTCGGGGGCATCAGTATTCAATTGTCAGAGGTGAAATTCTTGGATTTATTGAAGACTAACTACTGCGAAAGCATTTGCCAGGGATGTTTTCATTAATCAGTGAACGAAAGTTAGGGGATCGAAGACGATCAGATACCGTCGTAGTCTTAACCGTAAACTATGCCGACTAGGGATCGGGCGATGTTTCATCATGACTCGCTCGGCACCTTGCGAGAAATCAAAGTAAGGTTCTGGGGGGAGTATGGTCGCAAGGCTGAAACTTAAAGAAATTGACGGAAGGGCACCACCAGGAGTGGAGCCTGCGGCTTAATTTGACTCAACACGGGGAAACTCACCAGGTCCAGACACAATAAGGATTGAcAGATTGAGAG
LSU	GGAGGAAAAGAAACCAACAGGGATTKCCTCAGTAACGGCGAGTGAAGCGGCAACAGCTCAGATTTGAAATCCGGCCCCCAGGCCCGAGTTGTAATCTGCAGAGGATGCTTCGGGGCGGCCCCCGGTCCAAGCCCCTTGGAACAGGGCGTCGTAGAGGGTGAGGATCCCGTCCACGGCCGGGCGGACCGCCCCGTGCGAAGCTCCTTCGACGAGTCGAGTTGTTTGGGAATGCAGCTCCAAACGGGAGGCATATTCCTCCCAAGGCTAAATACCGGCCGGAGACCGATAGCGCACAAGTAGAGTGATCGAAAGATGAAAAGCACTTTGGAAAGAGAGTTAAAAAGTACGTGAAATTGTCGAAAGGGAAGCGTCTGCGGCCAGACCTGGTGGCGGTTGCTCAGCCGGCCCTTCGGGGCCGGCGCACTCTCCCGCCACCTGGCCAGCATCGGTCCGGGCGGCCGGACAAAGGCCCCGGGAACGTGGCCCCCTCGCGGGGTGTTATANCCCGGGGCACAATGCGGCCCGCCCGGACCGAGGACAGCGTCCGCTAGGATGCTGG

Mahanteshamyces sp. on *Schlegelia parviflora* (Schlegeliaceae) (TH 588)	
SSU	TGTTAAAAAGcTCGTAGTTGAACCTTGGGGCTGGCCGACCGGTCCGCCTCACCGCGAGCACTGGCTCGGCCGGCCCTTTCCTCGCGGGGAACCCCATGCCCTTCGCTGGGTGTGGCGGCCATCCGCGACTTTTACTGTGAATAAATCAGACTGTTCAAAGGAGGCCTTTGCTCGGATGTCTTAGCATGGAATAATGGAATAGGACGCGCGTCCCTATTTTGTTGGTTTCTAGGGACGCCGTAATGATTAATAGGGATGGTCGGGGGCATCAGTATTCAATTGTCAGAGGTGAAATTCTTGGATTTATTGAAGACTAACCACTGCGAAAGCATTTGCCAGGGATGTTTTCATTAATCAGTGAACGAAAGTTAGGGGATCGAAGACGATCAGATACCGTCGTAGTCTTAACCGTAAACTATGCCGACTAGGGATCGGGCGATGTTTCATCATGACTCGCTCGGCACCTTGCGAGAAATCAAAGTGAGGTTCTGGGGGGAGTATGGTCGCAAGGCTGAAACTTAAAGAAATTGACGGAAGGGCACCACCAGGAGTGGAGCCTGCGGCTTAATTTGACTCAACACGGGGAAACTCACCAGGTCCAGACACAATAAGGATTGACaGAATTGAGAG
LSU	TGCTTATCAATAAGCGGAGGAAAAGAAACCAACAGGGATTGCCCCAGTAACGGCGAGTGAAGCGGCAACAGCTCAGATTTGAAATCCGGCCCCCCGGGCCCGAGTTGTAACCTGCAGAGGACGCTTCGGGGCGGCCCCCGGCCCAAGTCCCTTGGGACAGGGCGTCGTAGAGGGTGAGGATCCCGTACACGGCCGGGCGCCCGCCCCGTGCGAAGCTCCTTCGACGAGTCGAGTTGTTTGGGAATGCAGCTCCAAGCGGGAGGTATATCCCTCCCAAGGCTAAATACCGGCCGGAGACCGATAGCGCACAAGTAGAGTGATCGAAAGATGAAAAGCACTTTGGAAAGAGAGTTAAAAAGTACGTGAAATTGTTGAAAGGGAAGCGTTTGCGGCCAGACCTGGCGGCGGTGGCTCAGCCGGCCCACCTGGGCCGGCGCACTCCACCGCCGCCTGGCCAGCATCGGCCCGGGCGGCCGGACAAAGGCCCCGGGAACGTGGCCCCCTCGCGGGGTGTTACAGCCCGGGGCACAATGCGGCCCGCCCGGGCCGAGGACAGCGTTCGCTAGGATGCTGCGAATGCAC

7.5 Species of *Asterina*

Table 7.3: A preliminary list of the species of *Asterina* based on literature. Listed are only host plant species that are cited in the protologue of the type collection of the fungus.

No.	Species	Reference	Host plant family	Host plant species	Country	Continent
1.	*A. aburiensis* S. Hughes	Mycol. Pap. 48: 7 (1952)	Loranthaceae	*Loranthus* sp.	Ghana	Africa
2.	*A. acalyphae* Syd.	Ann. Mycol. 23(3/6): 359 (1925)	Euphorbiaceae	*Acalypha macrostachya* var. *hirsutissima*	Costa Rica	Central America
3.	*A. acanthopoda* Speg.	Anal. Soc. Cient. Argent. 26(1): 49 (1888)	Sapotaceae	undetermined	Brazil	South America
4.	*A. achyrospermi* Mibey	in Mibey et al., Nova Hedwigia 62(1-2): 147 (1996)	Lamiaceae	*Achyrospermum schimperi*	Kenya	Africa
5.	*A. acronychiae* Hosag. & Goos	Mycotaxon 59: 150 (1996)	Rutaceae	*Acronychia pedunculata*	India	South Asia
6.	*A. adanostemmatis* [as '*adenostemmae*'] A.K. Kar & S.N. Ghosh	Indian Phytopathol. 39(2): 208 (1987) [1986]	Asteraceae	*Adenostemma viscosum*	India	South Asia
7.	*A. adeniae* Hansf.	Proc. Linn. Soc. London 157: 32 (1945) [1944]	Passifloraceae	*Adenia lobata*	Uganda	Africa
8.	*A. adeniicola* Hosag. & Kamar.	in Hosagoudar, Zoos' Print. J. 21(7): 2303	Passifloraceae	*Adenia hondala*	India	South Asia
9.	*A. aemula* Syd.	Ann. Mycol. 25(1/2): 48 (1927)	Lauraceae	undetermined	Costa Rica	Central America
10.	*A. africana* (Van der Byl) Doidge	Bothalia 4: 310 (1942)	Achariaceae	*Xylotheca kraussiana*	South Africa	Africa
11.	*A. africana* var. *kiggelariae* Doidge	Bothalia 4: 33 (1942)	Achariaceae	*Kiggelaria africana*	South Africa	Africa
12.	*A. afzeliae* Mibey	in Mibey and Hawksworth, Mycol. Pap. 174: 84 (1997)	Fabaceae	*Afzelia quanzensis*	Kenya	Africa
13.	*A. aganosmae* Petr.	in Sydow and Petrak, Ann. Mycol. 29: 238 (1931)	Apocynaceae	*Aganosma acuminate*	Philippines	Southeast Asia
14.	*A. aglaiae* Hosag.	in Hosagoudar et al., J. Mycopathol. Res. 44(1): 5 (2006)	Meliaceae	*Aglaia* sp.	India	South Asia
15.	*A. alchorneae* Syd.	Ann. Mycol. 36(2/3): 168 (1938)	Euphorbiaceae	*Alchornea cordifolia*	Ghana	Africa
16.	*A. alchornea-javanensis* Hansf.	Reinwardtia 3: 128 (1954)	Euphorbiaceae	*Alchornea javensis*	Java, Indonesia	Southeast Asia
17.	*A. alchorneae-rugosae* Hansf.	unknown	unknown	unknown	unknown	unknown
18.	*A. alchorneicola* Hansf.	Proc. Linn. Soc. London 157: 32 (1945) [1944-45]	Euphorbiaceae	*Alchornea cordifolia*	Uganda	Africa
19.	*A. altingiae* B. Song	Mycotaxon 85: 319 (2003)	Hamamelidaceae	*Altingia chinensis*	China	East Asia
20.	*A. amadelpha* Syd.	Ann. Mycol. 27(1/2): 56 (1929)	Melastomataceae	*Conostegia oerstediana*	Costa Rica	Central America
21.	*A. ampullipeda* Speg.	Anal. Soc. Cient. Argent. 26(1): 49 (1888)	Lauraceae	*Nectandra* sp.	Brazil	South America
22.	*A. anacardii* (R.W. Ryan) Hosag. & T.K. Abraham	J. Econ. Taxon. Bot. 24(3): 559 (2000)	Anacardiaceae	*Anacardium excelsum*	Puerto Rico	Caribbean
23.	*A. anamirtae* Hosag.	in Hosagoudar et al., Mycotaxon 59: 176 (1996)	Menispermaceae	*Anamirta cocculus*	India	South Asia
24.	*A. anisoptericola* Hansf.	Proc. Linn. Soc. London 160(2): 149 (1949)	Dipterocarpaceae	*Anispotera thurifera*	Philippines	Southeast Asia
25.	*A. anogeissi* R.C. Rajak	J. Econ. Taxon. Bot. 7(1): 30 (1985)	Combretaceae	*Anogeissus latifolia*	India	South Asia
26.	*A. anomala* Sivan.	Trans. Br. Mycol. Soc. 83(4): 710 (1984)	Malvaceae	*Durio zibethinus*	Malaysia	Southeast Asia
27.	*A. antioquensis* (Toro) Orejuela	Mycologia 36: 445 (1949)	Melastomataceae	*Miconia ciliata*	Colombia	South America
28.	*A. aphanes* Petr.	in Sydow and Petrak, Ann. Mycol 27(1/2): 49 (1929)	Primulaceae	*Rapanea ferruginea*	Costa Rica	Central America
29.	*A. aporusae* Hansf.	Reinwardtia 3: 129 (1954)	Phyllanthaceae	*Aporosa aurita*	Java, Indonesia	Southeast Asia
30.	*A. aporusae* var. *cylindrica* A.K. Kar & S.N. Ghosh	Indian Phytopathol. 39(2): 216 (1987) [1986]	Phyllanthaceae	*Aporosa roxburghii*	India	South Asia

No.	Species	Reference	Host plant family	Host plant species	Country	Continent
31.	*A. aquilariae* Ouyang & B. Song	in Ouyang et al., Acta Mycol. Sin. 14(4): 242 (1995)	Thymelaeaceae	*Aquilaria sinensis*	China	East Asia
32.	*A. araliae* M.S. Patil & A.B. Pawar	Indian Phytopathol. 42(2): 248 (1989)	Araliaceae	*Brassaiopsis actinophylla*	India	South Asia
33.	*A. ardisiae* Hansf.	Reinwardtia 3: 129 (1954)	Primulaceae	*Ardisia colorata*	Java, Indonesia	Southeast Asia
34.	*A. arecacearum* Hosag., T.K. Abraham & C.K. Biju	in Hosagoudar et al., Fung. Div. 6: 70 (2001)	Arecaceae	*Calamus* sp.	India	South Asia
35.	*A. argyreiae* Hansf.	Reinwardtia 3: 130 (1954)	Convolvulaceae	*Argyreia capitata*	Java, Indonesia	Southeast Asia
36.	*A. arnaudii* [as '*arnaudia*'] R.W. Ryan	Mycologia 16(4): 184 (1924)	Passifloraceae	*Passiflora multiflora* (type), *Passiflora sexflora*	Puerto Rico	Caribbean
37.	*A. artabotrydis* Hansf.	in Sydow, Ann. Mycol. 36(2/3): 194 (1938)	Annonaceae	*Artabotrys* sp.	Uganda	Africa
38.	*A. asclepiadis* Hosag. & Goos	Mycotaxon 59: 152 (1996)	Apocynaceae	*Asclepias curassavica*	India	South Asia
39.	*A. aspidii* (Henn.) Theiss.	Abh. Zool.-Bot. Ges. Wien 7(3): 75 (1913)	Dryopteridaceae	*Aspidium falcatum* var. *fortunei*	Japan	East Asia
40.	*A. assimilis* Syd.	Philipp. J. Sci. 21(2): 140 (1922)	Myrtaceae	*Eugenia caryophyllata*	Ambon Island, Indondesia	Southeast Asia
41.	*A. asterophora* Ellis & G. Martin	unknown	unknown	unknown	unknown	unknown
42.	*A. astroniae* H.S. Yates	Philipp. J. Sci. 12: 370 (1917)	Melastomataceae	*Astronia* sp.	Philippines	Southeast Asia
43.	*A. atalantiae* Hosag. & D.K. Agarwal	Indian Phytopathol. 56(1): 98 (2003)	Rutaceae	*Atalantia rotundifolia*	India	South Asia
44.	*A. aterrima* Syd.	Ann. Mycol. 36(2/3): 170 (1938)	Rubiaceae	*Oxyanthus* sp.	Uganda	Africa
45.	*A. atypica* (Bat.) Hosag. & T.K.Abraham	J. Econ. Taxon. Bot. 24(3): 564 (2000)	Chrysobalanaceae	*Moquilea tomentosa*	Brazil	South America
46.	*A. aucubae* Henn.	Englers Bot. Jahrb. 31: 739 (1902)	Garryaceae	*Aucuba japonica*	Japan	East Asia
47.	*A. aulica* Syd.	Ann. Mycol. 36(2/3): 185 (1938)	Apocynaceae	*Oncinotis* sp.	Uganda	Africa
48.	*A. australiensis* Syd.	Ann. Mycol. 35: 35 (1937)	Winteraceae	*Drimys dipetala*	Australia	Oceania
49.	*A. averrhoae* Hosag., Kamar. & K.P. Babu	in Hosagoudar et al., Indian Phytopathol 55(4): 497 (2002)	Oxalidaceae	*Averrhoa carambola*	India	South Asia
50.	*A. azarae* Lév.	Ann. Sci. Nat. 3: 60 (1845)	Salicaceae	*Azara serrata*	Chile	South America
51.	*A. balakrishnanii* Hosag.	in Hosagoudar et al., Mycotaxon 59: 168 (1996)	Solanaceae	*Solanum torvum*	India	South Asia
52.	*A. balansae* (Speg.) Sacc. & Trotter	Syll. Fung. 22: 88 (1913)	Myrtaceae	undetermined	Brazil	South America
53.	*A. balanseana* P. Karst. & Roum.	Rev. Mycol. 12: 76 (1890)	Solanaceae	undetermined	Vietnam	Southeast Asia
54.	*A. bambusella* Speg.	unknown	unknown	unknown	unknown	unknown
55.	*A. banguinensis* H.S. Yates	Philipp. J. Sci. 13: 372 (1918)	Rutaceae	*Glycosmis* sp.	Philippines	Southeast Asia
56.	*A. banisteriae* Syd.	in Sydow and Petrak, Ann. Mycol. 27 (1/2): 50 (1929)	Malpighiaceae	*Banisteria argentea*	Costa Rica	Central America
57.	*A. banksiae* Hansf.	unknown	unknown	unknown	unknown	unknown
58.	*A. banosensis* Hansf.	unknown	unknown	unknown	unknown	unknown
59.	*A. baphiae* S. Hughes	Mycol. Pap. 48: 8 (1952)	Fabaceae	*Baphia nitida*	Ghana	Africa
60.	*A. barteriae* Hansf.	Proc. Linn. Soc. London 157: 32 (1945 [1944-45]	Passifloraceae	*Barteria fistulosa*	Uganda	Africa
61.	*A. bataanensis* Petr.	in Sydow and Petrak, Ann. Mycol. 29: 229 (1931)	Thymelaeaceae	*Phaleria perrottetiana*	Philippines	Southeast Asia
62.	*A. belluciae* Henn.	Hedwigia 43: 374 (1904)	Melastomataceae	*Bellucia* sp.	Brazil	South America
63.	*A. betonicae* Hosag. & Goos	Mycotaxon 59: 153 (1996)	Acanthaceae	*Justicia betonica*	India	South Asia
64.	*A. blanda* Syd.	Ann. Mycol. 36(2/3): 171 (1938)	Apocynaceae	*Motandra* sp.	Uganda	Africa

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65.	*A. blanda* var. *alafia* Bat. & Cif.	unknown	unknown	unknown	unknown	unknown
66.	*A. blumeae* A.K. Kar & S.N. Ghosh	Indian Phytopathol. 39(2): 214 (1987) [1986]	Asteraceae	*Blumea* sp.	India	South Asia
67.	*A. boedjiniana* Hansf.	Reinwardtia 3: 130 (1954)	Capparaceae	*Capparis acuminata*	Java, Indonesia	Southeast Asia
68.	*A. borneensis* Hansf.	Reinwardtia 3: 131 (1954)	Elaeocarpaceae	*Elaeocarpus* sp.	Indonesia	Southeast Asia
69.	*A. bosmanae* Doidge	Bothalia 4: 333 (1942)	Sapotaceae	*Chrysophyllum magalis-montana*	South Africa	Africa
70.	*A. bottomleyae* Doidge	Bothalia 4: 333 (1942)	Aquifoliaceae	*Ilex mitis*	South Africa	Africa
71.	*A. brandisiae* Hansf.	Farlowia 3: 278 (1948)	Paulowniaceae	*Brandisia* sp.	China	East Asia
72.	*A. brasiliana* Speg.	Bol. Acad. Nac. Cien. Córdoba 23(3-4): 504 (1919)	Acanthaceae	undetermined	Paraguay	South America
73.	*A. breyniaecola* Trotter	in Saccardo, Syll. Fung. 24: 452 (1925-1928)	Phyllanthaceae	*Breynia acuminata*	Philippines	Southeast Asia
74.	*A. bruceae* B. Song	Mycotaxon 85: 321 (2003)	Simaroubaceae	*Brucea javanica*	China	East Asia
75.	*A. bukobensis* Hansf.	Proc. Linn. Soc. London 157: 201 (1946) [1944-45]	Myrtaceae	*Eugenia bukobensis*	Uganda	Africa
76.	*A. buttneriae* Theiss.	Abh. Zool.-Bot. Ges. Wien 7(3): 99 (1913)	Malvaceae	*Byttneria australis*	Brazil	South America
77.	*A. byrsonimicola* Henn.	Hedwigia 44: 65 (1905)	Malpighiaceae	*Byrsonima* sp.	Brazil	South America
78.	*A. camariensis* Syd. & P. Syd.	Ann. Mycol 12(6): 556 (1914)	Dipterocarpaceae	*Parashorea plicata*	Philippines	Southeast Asia
79.	*A. cambodiana* Joly	Bull. Trimest. Soc. Mycol. Fr. 81: 273 (1965)	Capparaceae	*Capparis flavicans*	Vietnam	Southeast Asia
80.	*A. cannonii* Hosag. & C.K. Biju	in Hosagoudar, Indian Phytopathol. 58(2): 194 (2005)	Pentaphylacaceae	cf. *Eurya* sp.	India	South Asia
81.	*A. cansjerae* R.W. Ryan	Mem. Dept. Agric. India, Bot. Ser. 15(5): 103 (1928)	Opiliaceae	*Cansjera rheedei*	India	South Asia
82.	*A. cansjericola* Hansf. & Thirum.	Farlowia 3: 304 (1948)	Opiliaceae	*Cansjera rheedei*	India	South Asia
83.	*A. cansjericola* var. *indica* Hosag., N.P. Balakr. & Goos	Mycotaxon 59: 170 (1996)	Opiliaceae	*Cansjera rheedei*	India	South Asia
84.	*A. canthii* H.S. Yates	Philipp. J. Sci. 13: 372 (1918)	Rubiaceae	*Canthium* sp.	Philippines	Southeast Asia
85.	*A. canthii-dicocci* Hosag.	in Hosagoudar et al., J. Mycopathol. Res. 44(1): 6 (2006)	Rubiaceae	*Canthium dicoccum*	India	South Asia
86.	*A. capparicola* [as '*capparidicola*'] Doidge	Bothalia 4: 333 (1942)	Capparaceae	*Capparis zeyheri*	India	South Asia
87.	*A. capparis* [as '*capparidis*'] Syd., P. Syd. & E.J. Butler	Ann. Mycol. 9(4): 390 (1911)	Capparaceae	*Capparis zeylandica*	India	South Asia
88.	*A. carbonacea* Cooke	Grevillea 88(47): 96 (1880)	undetermined	undetermined	India	South Asia
89.	*A. carbonacea* var. *acanthopoda* Theiss.	Abh. Zool.-Bot. Ges. Wien 7(3): 70 (1913)	Sapotaceae	undetermined	Brazil	South America
90.	*A. caricarum* Rehm	Hedwigia 35: 161 (1895)	Caricaceae	*Carica* sp.	Ecuador	South America
91.	*A. caricarum* var. *microspora* Theiss.	Abh. Zool.-Bot. Ges. Wien 7(3): 96 (1913)	Caricaceae	*Carica papaya*	Brazil	South America
92.	*A. caseariae* Hansf.	Proc. Linn. Soc. London 156: 113 (1944) [1943-44]	Salicaceae	*Casearia engleri*	Uganda	Africa
93.	*A. caseariae-esculentae* Hosag. & T.K. Abraham	J. Econ. Taxon. Bot. 24(3): 568 (2000)	Salicaceae	*Casearia esculenta*	India	South Asia
94.	*A. caseariicola* Hansf.	Proc. Linn. Soc. London 159(1): 36 (1947)	Salicaceae	*Casearia esculenta*	Uganda	Africa
95.	*A. cassiae* Syd. & P. Syd.	Philipp. J. Sci. 8: 275 (1913)	Phyllanthaceae	*Glochidion ilenosi*	Philippines	Southeast Asia
96.	*A. cassiae* var. *glochidiae* Bat. & Cif.	unknown	unknown	unknown	unknown	unknown
97.	*A. castanopsis* B. Song & Ouyang	in Song et al., Acta Mycol. Sin. 15(3): 166 (1996)	Fagaceae	*Castanopsis kawakamii*	China	East Asia
98.	*A. celtidicola* Henn.	Hedwigia 44: 64 (1905)	Cannabaceae	*Celtis* sp.	Brazil	South America
99.	*A. celtidicola* var. *microspora* Doidge	Trans. Roy. Soc. South Africa 8(4): 260 (1920)	Capparaceae	*Maerua* sp.	South Africa	Africa

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100.	*A. centroniae* Petr.	Sydowia 4: 454 (1950)	Melastomataceae	*Centronia excelsa*	Ecuador	South America
101.	*A. centropogonis* R.E.D. Baker & W.T. Dale	Mycol. Pap. 33: 40 (1951)	Campanulaceae	*Centropogon cornutus*	Trinidad	Caribbean
102.	*A. cestricola* (R.W. Ryan) Hosag. & T.K. Abraham	J. Econ. Taxon. Bot. 24(3): 583 (2000)	Solanaceae	*Cestrum* sp., *Cestrum macrophyllum*	Puerto Rico	Caribbean
103.	*A. champereiae* Hansf.	Proc. Linn. Soc. London 160(2): 149 (1949)	Opiliaceae	*Champereia cumingiana*	Philippines	Southeast Asia
104.	*A. champeriicola* B. Song & T.H. Li	Mycotaxon 89: 193 (2004)	Opiliaceae	*Champereia manillana*	China	East Asia
105.	*A. chloranthi* Syd.	Ann. Mycol. 29: 227 (1931)	Chloranthaceae	*Chloranthus officinalis*	Philippines	Southeast Asia
106.	*A. chlorophorae* Hansf.	Proc. Linn. Soc. London 157: 202 (1946) [1944-45]	Moraceae	*Chlorophora excelsa*	Uganda	Africa
107.	*A. chrysophylli* Henn.	Hedwigia 48: 12 (1909)	Sapotaceae	*Chrysophyllum* sp.	Brazil	South America
108.	*A. chukrasiae* Hosag.	in Hosagoudar and Biju, J. Mycopathol. Res. 44(1): 40 (2006)	Meliaceae	*Chukrasia tabularis*	India	South Asia
109.	*A. ciferriana* Petr.	Ann. Mycol. 30(3/4): 155 (1932)	Fabaceae	*Caesalpinia crista*	San Domingo	Caribbean
110.	*A. cinnamomi* Syd.	Ann. Mycol. 21: 103 (1923)	Lauraceae	*Cinnamomum* sp.	Philippines	Southeast Asia
111.	*A. cinnamomicola* Hansf.	Proc. Linn. Soc. London 157: 202 (1946) [1944-45]	Lauraceae	*Cinnamomum* sp.	Sri Lanka	South Asia
112.	*A. cipadessae* H.S. Yates	Philipp. J. Sci. 12: 371 (1917)	Meliaceae	*Cipadessa baccifera*	Philippines	Southeast Asia
113.	*A. cipizensis* J.M. Mend.	Philipp. J. Sci. 49(2): 189 (1932)	Urticaceae	undetermined	Philippines	Southeast Asia
114.	*A. circularis* G. Winter	Hedwigia 25: 94 (1886)	undetermined	undetermined	Sao Tomé	Africa
115.	*A. cissi* S. Hughes	Mycol. Pap. 48: 10 (1952)	Vitaceae	*Cissus oreophila*	Ghana	Africa
116.	*A. citriobati* Hansf.	Proc. Linn. Soc. New South Wales 82(2): 210 (1957)	Pittosporaceae	*Citriobatus multiflorus*	Australia	Oceania
117.	*A. clasterosporium* S. Hughes	Mycol. Pap. 50: 5 (1953)	Ebenaceae	*Maba warneckei*	Ghana	Africa
118.	*A. clausenicola* Doidge	Trans. Roy. Soc. South Africa 8(4): 273 (1920)	Rutaceae	*Clausena inaequalis*	South Africa	Africa
119.	*A. claviflori* A.K. Kar & Maity	Trans. Br. Mycol. Soc. 54(3): 441 (1970)	Myrtaceae	*Syzygium claviflorum*	India	South Asia
120.	*A. clematidis* Hansf.	Proc. Linn. Soc. New South Wales 79: 107 (1954)	Ranunculaceae	*Clematis glycinoides*	Australia	Oceania
121.	*A. clemensiae* Petr.	in Sydow and Petrak, Ann. Mycol. 29: 231 (1931)	Annonaceae	*Polyalthia* sp.	Philippines	Southeast Asia
122.	*A. clermontiae* F. Stevens & R.W. Ryan	Bull. Bern. P. Bishop Mus. Bull. 19: 73 (1925)	Campanulaceae	*Clermontia* sp.	Hawaii, USA	Oceania
123.	*A. clerodendricola* Hansf.	in Sydow, Ann. Mycol. 36(2/3): 195 (1938)	Lamiaceae	*Clerodendrum capitatum*	Uganda	Africa
124.	*A. coccolobae* Ferd. & Winge	Bot. Tidsskrift 29: 10 (1909)	Polygonaceae	*Coccoloba* sp.	St. Croix, Virgin Islands	Caribbean
125.	*A. coelocaryi* Hansf.	Publ. Inst. Nat. Étude Agron. Congo Belge 2: 43 (1945)	Myristicaceae	*Coelocaryon kleinei*	DR Congo	Africa
126.	*A. coffeicola* Ellis & Everh.	J. Inst. Jamaica 1: 248 (1893)	Rubiaceae	*Coffea arabica*	Jamaika	Caribbean
127.	*A. colliculosa* Speg.	Bol. Acad. Nac. Cien. Córdoba 11(4): 559 (1889)	Myrtaceae	*Eugenia* sp.	Brazil	South America
128.	*A. colliculosa* var. *macrospora* Theiss.	Abh. Zool.-Bot. Ges. Wien 7(3): 48 (1913)	undetermined	undeterminded	Brazil	South America
129.	*A. columellicola* W. Yamam.	Sci. Rep. Hyogo Univ. Agric., Agric. Biol. Ser. 2(2): 33 (1956)	Columelliaceae	*Columella japonica*	Taiwan	East Asia
130.	*A. combreti* var. *cylindrica* A.K. Kar & S.N. Ghosh	Indian Phytopathol. 39(2): 218 (1987) [1986]	Combretaceae	*Combretum indica*	India	South Asia
131.	*A. combreti* var. *brasiliensis* Theiss.	Abh. Zool.-Bot. Ges Wien 7(3): 64 (1913)	Acanthaceae	undetermined	Paraquay	South America
132.	*A. concinna* Syd.	Ann. Mycol. 28(1/2): 134 (1930)	Apocynaceae	*Macroscepis* sp.	Venezuela	South America
133.	*A. confertissima* Syd. & P. Syd.	Ann. Mycol. 14(1-2): 90 (1916)	Melastomataceae	*Arthrostemma campanulata*	Brazil	South America

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134.	*A. congesta* Cooke	Grevillea 88(47): 95 (1880)	Santalaceae	*Santalum album*	India	South Asia
135.	*A. connectilis* Syd.	Ann. Mycol. 37(3): 227 (1939)	Olacaceae	*Olax subscorpioides*	Ghana	Africa
136.	*A. consimilis* Höhn.	Sber. Akad. Wien Math.-Naturw. Kl., Abt.1, 118: 862 (1909)	undetermined	undetermined	Java, Indonesia	Southeast Asia
137.	*A. consobrina* Syd.	Ann. Mycol. 25(1/2): 49 (1927)	Solanaceae	*Solanum* sp.	Costa Rica	Central America
138.	*A. consociata* G. Winter	in Spegazzini, F.. Guar. 2 (no. 131)	Moraceae	*Maclura mora*	Brazil	South America
139.	*A. consociata* var. *rectangularis* Rehm	Hedwigia 40: 161 (1901)	Euphorbiaceae	undetermined	Brazil	South America
140.	*A. contigua* Syd.	Ann. Mycol. 36(2/3): 187 (1938)	Fabaceae	*Dialium heudeloti*	Sierra Leone	Africa
141.	*A. corallopoda* Syd.	Ann. Mycol. 37(4/5): 384 (1939)	Solanaceae	*Solanum trachycyphum*	Ecuador	South America
142.	*A. cordylines* Syd.	Ann. Mycol. 35: 356 (1937)	Asparagaceae	*Cordyline stricta*	Australia	Oceania
143.	*A. coriacella* Speg.	Bol. Acad. Nac. Cien. Córdoba 11(4): 560 (1889)	Solanaceae	*Cestrum* sp.	Brazil	South America
144.	*A. correicola* [as '*correacola*'] Cooke & Massee	Grevillea 16(77): 5 (1887)	Rutaceae	*Correa lawrenciana*	Australia	Oceania
145.	*A. costaricensis* Syd.	Ann. Mycol. 25(1/2): 51 (1927)	Acanthaceae	*Jacobinia* sp.	Costa Rica	Central America
146.	*A. crebra* Syd.	Ann. Mycol. 11(3): 327 (1913)	Opiliaceae	*Opilia amentacea*	India	South Asia
147.	*A. crotonicola* Pat.	Bull. Soc. Myc. Fr. 8: 127 (1892)	Euphorbiaceae	*Croton* sp. [as indet.]	Ecuador	South America
148.	*A. crotoniensis* (Doidge) R.W. Ryan	in Stevens and Ryan, Ill. Biol. Monogr. 17(2): 52 (1939)	Euphorbiaceae	*Croton rivularis*	South Africa	Africa
149.	*A. crotonis* Syd. & P. Syd.	Ann. Mycol. 14(1-2): 91 (1916)	Euphorbiaceae	*Croton* sp.	Brazil	South America
150.	*A. crustosa* var. *microspora* Pat.	Bull. Soc. Myc. Fr. 11: 221 (1895)	Apocynaceae	undetermined	Ecuador	South America
151.	*A. cryptocariicola* Hosag., C.K. Biju & T.K. Abraham	Indian Phytopathol. 54(1): 137 (2001)	Lauraceae	*Cryptocarya bourdillonii*	India	South Asia
152.	*A. cupaniae* Bat.	An. IV Congr. Soc. Bot. Brazil, p. 162	Sapindaceae	*Cupania revoluta*	Brazil	South America
153.	*A. cupheae* Syd.	Ann. Mycol. 25(1/2): 55 (1927)	Lythraceae	*Cuphea infundibulum*	Costa Rica	Central America
154.	*A. cylindrophora* Syd. & P. Syd.	Ann.Mycol. 15(3/4): 250 (1917)	Salicaceae	*Scolopia* sp.	Philippines	Southeast Asia
155.	*A. cynanchi* Hosag. & Shiburaj	in Hosagoudar, Zoos' Print J. 17(12): 943 (2002)	Apocynaceae	*Cynanchum callialatum*	India	South Asia
156.	*A. cyrtandrae* Hansf.	Reinwardtia 3: 131 (1954)	Gesneriaceae	*Cyrtandra picata*	Java, Indonesia	Southeast Asia
157.	*A. dallasica* Petr.	Sydowia 8: 14 (1954)	Cannabaceae	*Trema* sp.	Borneo, Indonesia	Southeast Asia
158.	*A. daphniphylli* W. Yamam.	Sci. Rep. Hyogo Univ. Agric., Agric. Biol. Ser 2(2): 34 (1956)	Daphniphyllaceae	*Daphniphyllum glaucescens*	Taiwan	East Asia
159.	*A. daphniphyllicola* B. Song	in Song et al. Mycotaxon 90: 29 (2004)	Daphnipyhllaceae	*Daphniphyllum macropodum*	China	East Asia
160.	*A. davillae* J.A. Stev.	Mycologia 35: 631 (1943)	Dilleniaceae	*Davilla rugosa*	Brazil	South America
161.	*A. davillae* var. *major* Bat. & A.F. Vital	An. IV Congr. Soc. Bot. Brazil, p. 164 (1953)	Dilleniaceae	*Davilla rugosa*	Brazil	South America
162.	*A. decipiens* Syd. & P. Syd.	Leafl. Philipp. Bot. 5: 1540 (1912)	Opiliaceae	*Champereia cumingiana*	Philippines	Southeast Asia
163.	*A. decora* Syd.	Ann. Mycol. 35: 355 (1937)	Rutaceae	*Melicope australasica*	Australia	Oceania
164.	*A. decumana* Syd.	Ann. Mycol. 35: 36 (1937)	Myrtaceae	*Tristania laurinea*	Australia	Oceania
165.	*A. deightonii* Syd.	Ann. Mycol. 36(2/3): 172 (1938)	Loranthaceae	*Loranthus leonensis*	Sierra Leone	Africa

No.	Species	Reference	Host plant family	Host plant species	Country	Continent
166.	*A. delicata* Doidge	Trans. Roy. Soc. South Africa 8(4): 274 (1920)	Malvaceae	*Grewia lasiocarpa* (misidentified as *Trimeria alnifolia fide* Doidge 1942)	South Africa	Africa
167.	*A. delicatula* Syd. & Bal.	Ann. Mycol. 19(5-6): 308 (1921)	Rutaceae	*Aegle marmelos*	India	South Asia
168.	*A. delitescens* Ellis & G. Martin	Am. Nat. 17(2): 1284 (1883)	Lauraceae	*Persea palustris*	Florida, USA	North America
169.	*A. dendroidea* W. Yamam.	Sci. Rep. Hyogo Univ. Agric., Agric. Biol. Ser. 2(2): 35 (1956)	Acanthaceae	*Strobilanthes longespicatus*	Taiwan	East Asia
170.	*A. denigrata* Petr.	in Sydow and Petrak, Ann. Mycol. 27(1/2): 57 (1929)	Melastomataceae	*Blakea* sp.	Costa Rica	Central America
171.	*A. densa* Syd. & P. Syd.	Ann. Mycol. 12(6): 557 (1914)	Pittosporaceae	*Pittosporum pentandrum*	Philippines	Southeast Asia
172.	*A. densa* var. *australiensis* Hansf.	Proc. Linn. Soc. New South Wales 79: 108 (1954)	Pittosporaceae	*Pittosporum undulatum*	Australia	Oceania
173.	*A. derridis* Henn.	Hedwigia 47: 260 (1908)	Fabaceae	*Derris uliginosa*	Philippines	Southeast Asia
174.	*A. deviata* Syd.	Ann. Mycol. 37(3): 229 (1939)	Passifloraceae	*Smeathmannia pubescens*	Sierra Leone	Africa
175.	*A. diaphana* Syd. & P. Syd.	Leafl. Philipp. Bot. 4: 1155	Solanaceae	*Solanum manucaling*	Philippines	Southeast Asia
176.	*A. diaphorella* Syd. & P. Syd.	Ann. Mycol. 17(1): 35 (1919)	Sapotaceae	*Sideroxylon ferrugineum*	Philipines	Southeast Asia
177.	*A. dichapetali* Hansf. & Thirum.	Farlowia 3: 305 (1948)	Dichapetalaceae	*Dichapetalum gelonioides*	India	South Asia
178.	*A. diclipterae* W. Yamam.	Sci. Rep. Hyogo Univ. Agric., Agric. Biol. Ser. 2(2): 34 (1956)	Acanthaceae	*Dicliptera chinensis*	Taiwan	East Asia
179.	*A. dictyolomatis* Henn.	Hedwigia 43: 372 (1904)	Rutaceae	*Dictyoloma* sp.	Peru	South America
180.	*A. dilabens* Syd. & P. Syd.	Ann. Mycol. 2: 168 (1904)	Gesneriaceae	*Sarmienta repens*	Chile	South America
181.	*A. dilabens* var. *hilliae* R.W. Ryan	Mycologia 16(4): 187 (1924)	Rubiaceae	*Hillia parasitica*	Puerto Rico	Caribbean
182.	*A. dilleniae* Syd. & P. Syd.	Philipp. J. Sci. 9: 181 (1914)	Dilleniaceae	*Dillenia* sp.	Philippines	Southeast Asia
183.	*A. dinghuensis* B. Song, T.H. Li & Y.H. Shen	in Song et al., Mycotaxon 90: 30 (2004)	Myrtaceae	*Cleistocalyx operculatus*	China	East Asia
184.	*A. diospyri* Hosag. & C.K. Pradeep	in Hosagoudar et al., J. Econ. Taxon. Bot. 25(2): 179 (2001)	Ebenaceae	*Diospyros* sp.	India	South Asia
185.	*A. dipholidis* Petr. & Cif.	Ann. Mycol. 28(5/6): 378 (1930)	Sapotaceae	*Dipholis angustifolia*	San Domingo	Caribbean
186.	*A. diplocarpa* Cooke	Grevillea 10(56): 129 (1882)	Malvaceae	*Sida cordifolia*	South Africa	Africa
187.	*A. diplopoda* Syd.	Ann. Mycol. 25(1/2): 56 (1927)	Solanaceae	*Solanum acerifolium*	Costa Rica	Central America
188.	*A. disciferae* Hosag.	in Hosagoudar et al., Mycotaxon 59: 172 (1996)	Myrtaceae	*Eugenia discifera*	India	South Asia
189.	*A. dispar* Speg.	Anal. Soc. Cient. Argent. 26(1): 47 (1888)	Styracaceae	*Styrax* sp.	Brazil	South America
190.	*A. disseminata* Syd.	Ann. Mycol. 37(3): 230 (1939)	Annonaceae	*Uvaria afzali*	Sierra Leone	Africa
191.	*A. disseminata* var. *cleistopholidis* S. Hughes	Mycol. Pap. 48: 11 (1952)	Annonaceae	*Cleistopholis patens*	Ghana	Africa
192.	*A. dissilens* (Syd.) Doidge	Bothalia 4: 287 (1942)	Celastraceae	*Cassine papillosa*	South Africa	Africa
193.	*A. dissilens* var. *senegalensis* Doidge	Bothalia 4: 334 (1942)	Celastraceae	*Gymnosporia senegalensis*	South Africa	Africa
194.	*A. distyliicola* T. Hino & Katum.	Bull. Fac. Agric. Yamaguti Univ. 7: 257 (1956)	Hamamelidaceae	*Distylium racemosum*	Japan	East Asia
195.	*A. ditissima* Syd. & P. Syd.	Ann. Mycol. 15(3/4): 243 (1917)	Myrtaceae	*Eugenia* sp.	Philippines	Southeast Asia
196.	*A. dorsteniae* Syd.	Ann. Mycol. 25(1/2): 57 (1927)	Moraceae	*Dorstenia contrajerva*	Costa Rica	Central America
197.	*A. doryphorae* Hansf.	Proc. Linn. Soc. New South Wales 79: 109 (1954)	Atherospermataceae	*Doryphora sassafras*	Australia	Oceania
198.	*A. drimidicola* Hansf.	Proc. Linn. Soc. New South Wales 79: 109 (1954)	Winteraceae	*Drimys insipida*	Australia	Oceania
199.	*A. drimycarpi* A.K. Kar & Maity	Trans. Br. Mycol. Soc. 54(3): 435 (1970)	Anacardiaceae	*Drimycarpus racemosus*	India	South Asia

No.	Species	Reference	Host plant family	Host plant species	Country	Continent
200.	*A. drypeticola* Petr. & Cif.	Ann. Mycol. 30(3/4): 157 (1932)	Putranjivaceae	*Drypetes glauca*	San Domingo	Caribbean
201.	*A. drypetis* R.W. Ryan	Mycologia 16(4): 180 (1924)	Putranjivaceae	*Drypetes* sp.	Puerto Rico	Caribbean
202.	*A. durantae* Sawada	in Sawada and Yamamoto, Spec. Publ., Coll. Agric., Nat. Taiwan Univ. 8: 43 (1959)	Verbenaceae	*Duranta repens*	Taiwan	East Asia
203.	*A. echinospora* Höhn.	Sber. Akad. Wiss. Wien Math.-Naturw. Kl., Abt. 1, 119: 440 (1910)	Opiliaceae	*Cansjera rheedii*	Sri Lanka	South Asia
204.	*A. ekmanii* Petr. & Cif.	Ann. Mycol. 30(3/4): 158 (1932)	Rubiaceae	*Gonzalagunia spicata*	San Domingo	Caribbean
205.	*A. elachista* Syd.	Ann. Mycol. 36(2/3): 173 (1938)	Piperaceae	*Piper* sp.	Uganda	Africa
206.	*A. elaeagni* (Syd.) Syd.	Ann. Mycol. 29: 225 (1931)	Elaeagnaceae	*Elaeagnus philippinensis*	Philippines	Southeast Asia
207.	*A. elaeocarpi* Syd. & P. Syd.	Leafl. Philipp. Bot. 4: 1156 (1911)	Elaeocarpaceae	*Elaeocarpus pendula*	Philippines	Southeast Asia
208.	*A. elaeocarpi* var. *ovalis* A.K. Kar & S.N. Ghosh	Indian Phytopathol. 39(2): 218 (1987) [1986]	Elaeocarpaceae	*Elaeocarpus* sp.	India	South Asia
209.	*A. elaeocarpicola* Hansf.	Reinwardtia 3: 131 (1954)	Elaeocarpaceae	*Elaeocarpus punctatus*	Java, Indonesia	Southeast Asia
210.	*A. elaeocarpi-kobanmochii* W. Yamam.	Sci. Rep. Hyogo Univ. Agric., Agric. Biol. Ser. 3(1): 23 (1957)	Elaeocarpaceae	*Elaeocarpus kobanmochi*, *Elaeocarpus lanceaefolius*	Taiwan	East Asia
211.	*A. elatostemae* Hosag. & Goos	Mycotaxon 59: 156 (1996)	Urticaceae	*Elatostema lineolatum*	India	South Asia
212.	*A. elegans* Doidge	Bothalia 4: 334 (1942)	Capparaceae	*Capparis citrifolia*	South Africa	Africa
213.	*A. elmeri* Syd. & P. Syd.	Leafl. Philipp. Bot. 4: 1156 (1911)	Opiliaceae	*Champereia fragilis*	Philippines	Southeast Asia
214.	*A. embeliae* Hansf.	Proc. Linn. Soc. London 156: 113 (1944) [1943-44]	Primulaceae	*Embelia schimperi*	Uganda	Africa
215.	*A. entebbeensis* Hansf.	Proc. Linn. Soc. London 157: 203 (1946) [1844-45]	Lamiaceae	*Clerodendrum* sp.	Uganda	Africa
216.	*A. eocenica* Dilcher	Palaeontographica 116: 17 (1965)	Chrysobalanaceae	*Chrysobalanus* sp.	Tennessee, USA	North America
217.	*A. erebia* Syd.	Ann. Mycol. 25(1/2): 59 (1927)	Rubiaceae	*Palicourea costaricensis*	Costa Rica	Central America
218.	*A. erithalidis* (Ellis & Everh.) Farl.	Bibliogr. Index: 285 (1905)	unknown	unknown	unknown	unknown
219.	*A. erysiphoides* Kalchbr. & Cooke	Grevillea 9(49): 32 (1880)	Oleaceae	*Jasminum tortuosum*	South Africa	Africa
220.	*A. erysiphoides* var. *delicata* Hansf.	Proc. Linn. Soc. London 157: 204 (1946) [1944-45]	Oleaceae	*Jasminum dichotomum*	Uganda	Africa
221.	*A. erysiphoides* var. *indica* Hosag., N.P. Balakr. & Goos	Mycotaxon 59: 175 (1996)	Oleaceae	*Jasminum cordifolium*	India	South Asia
222.	*A. erythropali* Hansf.	Reinwardtia 3: 132 (1954)	Erythropalaceae	*Erythropalum scandens*	Java, Indonesia	Southeast Asia
223.	*A. erythropalicola* Hosag. & Goos	Mycotaxon 59: 156 (1996)	Erythropalaceae	*Erythropalum populifolium*	India	South Asia
224.	*A. escharoides* Syd. & P. Syd.	Leafl. Philipp. Bot. 4: 115 (1911)	Combretaceae	*Quisqualis* sp.	Philippines	Southeast Asia
225.	*A. eugeniae* H.S. Yates	Philipp. J. Sci. 12: 371 (1917)	Myrtaceae	*Eugenia* sp.	Philippines	Southeast Asia
226.	*A. eugeniae-formosanae* W. Yamam.	Sci. Rep. Hyogo Univ. Agric., Agric. Biol. Ser. 3(1): 23 (1957)	Myrtaceae	*Eugenia formosana*	Taiwan	East Asia
227.	*A. euodiae* [as '*evodiae*'] Hansf.	Reinwardtia 3: 132 (1954)	Rutaceae	*Euodia aromatica*	Java, Indonesia	Southeast Asia
228.	*A. euodiicola* [as '*evodiicola*'] W. Yamam.	Sci. Rep. Hyogo Univ. Agric., Agric. Biol. Ser. 2(2): 33 (1956)	Rutaceae	*Euodia pteleaefolia*	Taiwan	East Asia
229.	*A. euonymi* Hosag. & Goos	Mycotaxon 52(2): 467 (1994)	Celastraceae	*Euonymus crenulatus*	India	South Asia
230.	*A. eupatorii* A.K. Kar & S.N. Ghosh	Indian Phytopathol. 39(2): 214 (1987) [1986]	Asteraceae	*Eupatorium glandulosum*	India	South Asia
231.	*A. eupomatiae* (Hen.) Theiss.	Abh. Zool.-Bot. Ges. Wien 7(3): 64 (1913)	Eupomatiaceae	*Eupomatia laurinea*	Australia	Oceania
232.	*A. euryae* B. Song.	in Song et al., Mycotaxon 90: 32 (2004)	Theaceae	*Eurya acuminata*	China	East Asia

No.	Species	Reference	Host plant family	Host plant species	Country	Continent
233.	*A. excoecariae* Doidge	Trans. Roy. Soc. South Africa 8(4): 258 (1920)	Putranjivaceae	*Drypetes arguta* (misidentified as *Exocoecaria* sp.)	South Africa	Africa
234.	*A. excoecariicola* Hosag. & Goos	Mycotaxon 59: 161 (1996)	Euphorbiaceae	*Excoecaria crenulata*	India	South Asia
235.	*A. fagarae* H.S. Yates	Philipp. J. Sci. 13: 373 (1918)	Rutaceae	*Fagara avicennae*	Philippines	Southeast Asia
236.	*A. fallaciosa* Syd. & P. Syd.	Ann. Mycol. 15(3/4): 240 (1917)	Burseraceae	*Canarium* sp.	Philippines	Southeast Asia
237.	*A. fawcettii* R.W. Ryan	Mycologia 16(4): 180 (1924)	Myrtaceae	*Eugenia buxifolia*	Puerto Rico	Caribbean
238.	*A. ferruginosa* Doidge	Trans. Roy. Soc. South Africa 8(4): 254 (1920)	Araliaceae	*Cussonia umbellifera*	South Africa	Africa
239.	*A. fici-globosae* Hansf.	Reinwardtia 3: 134 (1954)	Moraceae	*Ficus globosa*	Java, Indonesia	Southeast Asia
240.	*A. fieldiae* Hansf.	Proc. Linn. Soc. New South Wales 79: 107 (1954)	Gesnericaceae	*Fieldia australis*	Australia	Oceania
241.	*A. flacourtiacearum* Hosag. & K. Ravik.	in Hosagoudar et al., Mycotaxon 59: 176 (1996)	Salicaceae	*Scolopia crenata*	India	South Asia
242.	*A. flacourtiaceicola* B. Song, T.H. Li & Hosag.	Fung. Div. 14: 158 (2003)	Salicaceae	undetermined	China	East Asia
243.	*A. flacourtiae* Petr.	in Sydow and Petrak, Ann. Mycol. 29: 255 (1931)	Salicaceae	*Flacourtia indica*	Philippines	Southeast Asia
244.	*A. fleuryae* Doidge	Bothalia 4: 334 (1942)	Urticaceae	*Fleurya* sp.	South Africa	Africa
245.	*A. formosana* W. Yamam.	Sci. Rep. Hyogo Univ. Agric., Agric. Biol. Ser. 3(1): 23 (1957)	Aquifoliaceae	*Ilex warburgii*, *Ilex formosana*	Taiwan	East Asia
246.	*A. fraseriana* Syd.	Ann. Mycol. 35: 37 (1937)	Euphorbiaceae	*Claoxylon australe*	Australia	Oceania
247.	*A. fuchsiae* Syd.	Ann. Mycol. 37 (4/5): 385 (1939)	Onagraceae	*Fuchsia scabriuscula*	Ecuador	South America
248.	*A. fumagina* Dearn. & Barthol.	Mycologia 9(6): 349 (1917)	Poaceae	*Panicum latifolium*	Puerto Rico	Caribbean
249.	*A. funtumiae* Syd.	Ann. Mycol. 36(2/3): 174 (1938)	Apocynaceae	*Funtumia africana*	Sierra Leone	Africa
250.	*A. gaiadendricola* T.A. Hofmann	Mycol. Prog. 7: 88 (2008)	Loranthaceae	*Gaiadendron punctatum*	Panama	Central America
251.	*A. gamsii* Hosag. & C.K. Biju	in Hosagoudar, Indian Phytopathol. 58(2): 195 (2005)	Elaeocarpaceae	*Elaeocarpus tectorius*	India	South Asia
252.	*A. garciniae* Hansf.	Proc. Linn. Soc. London 157: 204 (1946) [1944-45]	Clusiaceae	*Garcinia mangostana*	India	South Asia
253.	*A. garciniicola* Ouyang & B. Song	in Ouyang et al., Acta Mycol. Sin. 14(4): 244 (1995)	Clusiaceae	*Garcinia multiflora*	China	East Asia
254.	*A. gardoquiae* (Syd.) Hosag. & T. K. Abraham	J. Econ. Taxon. Bot. 24(3): 570 (2000)	Lamiaceae	*Gardoquia multiflora*	Chile	South America
255.	*A. geniopori* (Hansf.) Hansf.	Proc. Linn. Soc. London 153: 46 (1942) [1940-41]	Lamiaceae	*Geniosporium paludosum*	Uganda	Africa
256.	*A. geniostomaticola* Hansf.	Reinwardtia 3: 133 (1954)	Loganiaceae	*Geniostoma arboreum*	Java, Indonesia	Southeast Asia
257.	*A. geniostomatis* Hansf.	Reinwardtia 3: 134 (1954)	Loganiaceae	*Geniostoma arboreum*	Java, Indonesia	Southeast Asia
258.	*A. genipae* R.W. Ryan	Mycologia 16(4): 180 (1924)	Rubiaceae	*Genipa americana*	Puerto Rico	Caribbean
259.	*A. gerbericola* Doidge	Bothalia 1(4): 102 (1924)	Asteraceae	*Gerbera cordata*	South Africa	Africa
260.	*A. girardiniae* Hosag. & C.K. Biju	in Hosagoudar, Indian Phytopathol. 58(2): 196 (2005)	Urticaceae	*Girardinia diversifolia*	India	South Asia
261.	*A. glycosmidis* Hosag. & C.K. Biju	in Hosagoudar, Indian Phytopathol. 58(2): 197 (2005)	Rutaceae	*Glycosmis* sp.	India	South Asia
262.	*A. glyptopetali* Hosag. & C.K. Biju	in Hosagoudar, Indian Phytopathol. 58(2): 198 (2005)	Celastraceae	*Glyptopetalum zeylanicum*	India	South Asia
263.	*A. gmelinae* Sacc.	G. Bot. Ital, n.s. 23(2): 199 (1916)	Lamiaceae	*Gmelina* sp.	Philippines	Southeast Asia
264.	*A. gomphandrae* Hosag. & C. K. Biju	in Hosagoudar, Zoos' Print J. 17(8): 835 (2002)	Stemonuraceae	*Gomphandra* sp.	India	South Asia
265.	*A. gonostegiae* W. Yamam.	Sci. Rep. Hyogo Univ. Agric., Agric. Biol. Ser. 2(2): 35 (1956)	Urticaceae	*Gonostegia hirta*	Taiwan	East Asia
266.	*A. goosii* Hoasg. & N.P. Balakr.	in Hosagoudar et al., Mycotaxon 59: 178 (1996)	Berberidaceae	*Mahonia leschenaulti*	India	South Asia

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267.	*A. gopalkrishnanii* L.N. Nair & V.P. Kaul	Curr. Sci. 56(20): 1071 (1987)	Myrtaceae	*Syzygium cumini*	India	South Asia
268.	*A. gouldiae* F. Stevens & R.W. Ryan	Bull. Bern. P. Bishop Mus. Bull. 19: 73 (1925)	Rubiaceae	*Gouldia coriacea*	Hawaii, USA	Oceania
269.	*A. grammocarpa* Syd. & P. Syd.	Ann. Mycol. 12(6): 557 (1914)	Symplocaceae	*Symplocos* sp.	Philippines	Southeast Asia
270.	*A. grandicarpa* Mibey	in Mibey and Hawksworth, Mycol. Pap. 174: 85 (1997)	Capparaceae	undetermined	Kenya	Africa
271.	*A. granulosa* (Hansf.) Hosag., Balakr. & Goos	Mycotaxon 59: 176 (1996)	Salicaceae	*Scolopia* sp.	Uganda	Africa
272.	*A. grewiae* Cooke	Grevillea 10(56): 130 (1882)	Salicaceae	*Trimeria grandifolia* (misidentified as *Grewia lasiocarpa fide* Doidge 1942)	South Africa	Africa
273.	*A. grewiae* var. *zonata* Doidge	Bothalia 4: 335 (1942)	Salicaceae	*Trimeria trinervis*	South Africa	Africa
274.	*A. grisea* Petr.	Sydowia 4: 455 (1950)	Solanaceae	*Solanum* sp.	Ecuador	South America
275.	*A. guaranitica* Speg.	Anal. Soc. Cient. Argent. 26(1): 52 (1888)	Meliaceae	*Trichilia* sp.	Brazil	South America
276.	*A. guianensis* R.W. Ryan	Mycologia 16(4): 182 (1924)	Melastomataceae	*Miconia guianensis*	Puerto Rico	Caribbean
277.	*A. gymnosporiae* E. Castell.	Nuovo G. Bot. Ital., N.S. 49: 11 (1942)	Celastraceae	*Gymnosporia senegalensis*	Äthiopia	Africa
278.	*A. hainanensis* B. Song	in Song and Li, Mycotaxon 89(1): 195 (2004)	Pandaceae	*Microdesmis caseariifolia*	China	East Asia
279.	*A. hakgalensis* Hansf.	Proc. Linn. Soc. London 158: 45 (1947)	Ericaceae	*Rhododendron arboreum*	Sri Lanka	South Asia
280.	*A. hamata* Syd.	Ann. Mycol. 25(1/2): 61 (1927)	Lauraceae	*Phoebe neurophylla*	Costa Rica	Central America
281.	*A. hamatula* Cif.	Ann. Mycol. 36(2/3): 199 (1938)	Cucurbitaceae	*Fevillea cordifolia*	San Domingo	Caribbean
282.	*A. hansfordii* Syd.	Ann. Mycol. 36(2/3): 175 (1938)	Pittosporaceae	*Pittosporum abyssinicum*	Uganda	Africa
283.	*A. hapala* Syd.	Ann. Mycol. 36(2/3): 176 (1938)	Linaceae	*Hugonia platysepala*	Uganda	Africa
284.	*A. heliciae* W. Yamam.	Sci Rep. Hyogo Agric., Agric. Biol. Ser. 2(2): 34 (1956)	Proteaceae	*Helicia formosana*	Taiwan	East Asia
285.	*A. helicteris* Ouyang & Y.X. Hu	in Ouyang et al., Acta Mycol. Sin. 15(2): 88 (1996)	Malvaceae	*Helicteres angustifolia*	China	East Asia
286.	*A. hemisphaerica* Gaillard	Bull. Soc. Mycol. Fr. 13: 179 (1897)	undetermined	undetermined	Brazil	South America
287.	*A. hendersonii* Doidge	Trans. Roy. Soc. South Africa 8(4): 275 (1920)	Aquifoliaceae	*Ilex mitis* (misidentified as *Ilex capensis*)	South Africa	Africa
288.	*A. henianii* R.C. Verma, M.S. Tripathi & R.K. Chaudhary	Indian Phytopathol. 52(4): 377 (1999)	Myrtaceae	*Syzygium henianum*	India	South Asia
289.	*A. henningsii* Theiss.	Ann. Mycol. 10(1): 6 (1912)	Solanaceae	*Solanum leucodendron*	Brazil	South America
290.	*A. heterostemmatis* [as '*heterostemmae*'] W. Yamam.	Sci. Rep. Hyogo Univ. Agric., Agric. Biol. Ser. 2(2): 36 (1956)	Apocynaceae	*Heterostemma browni*	Taiwan	East Asia
291.	*A. heterotropae* Nakam. {?}	Rep. Tottori Mycol. Inst. 10: 448 (1973)	Aristolochiaceae	*Heterotropa hirsuticepala*	Japan	East Asia
292.	*A. hians* Syd. & P. Syd.	Ann. Mycol. 14(1-2): 91 (1916)	Dioscoreaceae	*Dioscorea* sp.	Peru	South America
293.	*A. hibisci* (Doidge) Hosag.	in Hosagoudar et al., J. Econ. Taxon. Bot. 28(1): 175 (2004)	Malvaceae	*Hibiscus* sp.	India	South Asia
294.	*A. hingensis* Hino & Hiddaka	Botany & Zoology, Tokyo II, p. 1187-1169 (1934)	Poaceae	*Phyllostachys bambusae*	Japan	East Asia
295.	*A. hippeastri* R.W. Ryan	Mycologia 16(4): 188 (1924)	Amaryllidaceae	*Hippeastrum* sp.	Puerto Rico	Caribbean
296.	*A. hippocrateae* R.W. Ryan	Macologia 16(4): 181 (1924)	Celastraceae	*Hippocratea volubilis*	Puerto Rico	Caribbean
297.	*A. hodgsoniae* B. Song & T.H. Li	Mycotaxon 84: 407 (2002)	Cucurbitaceae	*Hodgsonia macrocarpa* var. *capniocarpa*	China	East Asia

No.	Species	Reference	Host plant family	Host plant species	Country	Continent
298.	*A. holarrhenae* R.W. Ryan	Mem. Dept. Agric. India, Bot. Ser. 15(5): 103 (1928)	Apocynaceae	*Holarrhena antidysenterica*	India	South Asia
299.	*A. holocalycis* Speg.	Anal. Mus. Nac. Buenos Aires 23: 81 (1912)	Fabaceae	*Holocalyx balansae*	Argentina	South America
300.	*A. homalii* Syd.	Ann. Mycol. 37(3): 231 (1939)	Salicaceae	*Homalium alnifolium*	Sierra Leone	Africa
301.	*A. homaliicola* S. Hughes	Mycol. Pap. 48: 13 (1952)	Salicaceae	*Homalium dichophyllum*	Ghana	Africa
302.	*A. homalomenae* [as '*homalomeae*'] (J.M. Mend.) Hosag. & T.K. Abraham	J. Econ. Tax. Bot. 24(3): 561 (2000)	Araceae	*Homalomena philippinensis*	Philippines	Southeast Asia
303.	*A. hopeae* Hosag. & Kamar	in Hosagoudar, Zoos' Print J. 17(7): 815 (2002)	Dipterocarpaceae	*Hopea ponga*	India	South Asia
304.	*A. hopeicola* [as '*hopiicola*'] Hosag. & T.K. Abraham	Mycol. Res. 102(2): 184 (1998)	Dipterocarpaceae	*Hopea parviflora*	India	South Asia
305.	*A. horsfieldiae* Hansf.	Reinwardtia 3: 134 (1954)	Myristicaceae	*Horsfieldia irya*	Java, Indonesia	Southeast Asia
306.	*A. horsfieldiicola* B. Song, T.H. Li & Hosag.	Fung. Div. 14: 158 (2003)	Myristicaceae	*Horsfieldia glabra*	China	East Asia
307.	*A. hoveaefolia* Cooke & Massee	Grevillea 22(102): 36 (1893)	Fabaceae	*Hovea longifolia*	Australia	Oceania
308.	*A. huallagensis* (Theiss.) Hosag. & T.K. Abraham	J. Econ. Taxon. Bot. 24(3): 582 (2000)	Sapindaceae	undetermined	Brazil	South America
309.	*A. hughesii* Hosag. & T.K. Abraham	J. Econ. Taxon. Bot. 24(3): 573 (2000)	Melastomataceae	*Miconia racemosa*	Puerto Rico	Caribbean
310.	*A. hydnocarpi* Hosag. & T.K. Abraham	Indian Pyhtopathol. 51(4): 389 (1999) [1998]	Achariaceae	*Hydnocarpus macrocarpa*	India	South Asia
311.	*A. hydrangeae* B. Song. & Ouyang	in Song et al., Acta Mycol. Sin. 15(3): 167 (1996)	Hydrangeaceae	*Hydrangea chinensis*	China	East Asia
312.	*A. hydrocotyles* Hosag. & C.K. Biju	in Hosagoudar, Indian Phytopathol. 58(2): 198 (2005)	Araliaceae	*Hydrocotyle* sp.	India	South Asia
313.	*A. hypophylla* (Schwein.) Berk. ex Theiss.	in Theissen, Ann. Mycol. 10(2): 165 (1912)	Melastomataceae	undetermined	Guatemala	Central America
314.	*A. hyptidicola* Hosag.	in Hosagoudar et al., J. Mycopathol. Res. 44(1): 7 (2006)	Lamiaceae	*Hyptis sauveolense*	India	South Asia
315.	*A. hyptidis* [as '*hyptides*'] (Rehm) Hosag. & T.K. Abraham	J. Econ. Taxon. Bot. 24(3): 570 (2000)	Lamiaceae	*Hyptis* sp.	Brazil	South America
316.	*A. ildefonsiae* (Rehm) Theiss.	Abh. Zool.-Bot. Ges. Wien 7(3): 87 (1913)	Euphorbiaceae	*Claoxylon* sp.	Brazil	South America
317.	*A. ilicicola* W. Yamam.	Sci. Rep. Hyogo Univ. Agric., Agric. Biol. Ser. 3(1): 24 (1957)	Aquifoliaceae	*Ilex pubescens*	Taiwan	East Asia
318.	*A. inaequalis* Mont.	Ann. Sci. Nat. 5: 340 (1856)	Melastomataceae	undetermined	French Guiana	South America
319.	*A. incilis* Syd.	Ann. Mycol. 36(2/3): 178 (1938)	Acanthaceae	*Rungia grandis*	Sierra Leone	Africa
320.	*A. inconspicua* (Doidge) Doidge	Botahlia 4: 199 (1942)	Scrophulariaceae	*Chilianthus arboreus*	South Africa	Africa
321.	*A. indecora* Syd.	Ann. Mycol. 25(1/2): 63 (1927)	Malpighiaceae	*Malpighia glabra*	Costa Rica	Central America
322.	*A. indica* Syd. & P. Syd.	in Sydow and Butler, Ann. Mycol. 9(4): 390 (1911)	Symplocaceae	*Symplocos* sp.	India	South Asia
323.	*A. insignis* P. Karst. & Roum.	Rev. Mycol. 12: 77 (1890)	Lauraceae	undetermined	Vietnam	Southeast Asia
324.	*A. isothea* Syd.	Ann. Mycol. 25(1/2): 64 (1927)	Malvaceae	*Triumfetta bartramia*	Costa Rica	Central America
325.	*A. jacaratiae* Theiss.	Ann. Mycol. 14(5): 269 (1916)	Caricaceae	*Jacaratia dodecaphylla*	Brazil	South America
326.	*A. jahnii* Syd.	Ann. Mycol. 28(1/2): 137 (1930)	Annonaceae	cf. *Guatteria* sp.	Venezuela	South America
327.	*A. jambolanae* A.K. Kar & Maity	Trans. Br. Mycol. Soc. 54(3): 438 (1970)	Myrtaceae	*Eugenia jambolana*	India	South Asia
328.	*A. japonica* Theiss.	Abh. Zool.-Bot. Ges. Wien 7(3): 43 (1913)	Elaeagnaceae	*Elaeagnus pungentis*	Japan	East Asia
329.	*A. jasmini* Hansf.	Farlowia 3: 278 (1948)	Oleaceae	*Jasminum* sp.	China	East Asia
330.	*A. jasmini* var. *indica* Hosag. & C.K. Biju	in Hosagoudar, Indian Phytopathol. 55(2): 199 (2005)	Oleaceae	*Jasminum bignoniacearum*	India	South Asia
331.	*A. jasminicola* H.S. Yates	Philipp. J. Sci. 13: 373 (1918)	Oleaceae	*Jasminum* sp.	Philippines	Southeast Asia

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332.	*A. jasmini-subtrinervis* W. Yamam.	Sci. Rep. Hyogo Univ. Agric., Agric. Biol. Ser. 3(1): 29 (1957)	Oleaceae	*Jasminum subtriplinerve* [as '*subtrinervis*']	Taiwan	East Asia
333.	*A. jaundeae* S. Hughes	Mycol. Pap. 50: 6 (1953)	Connaraceae	*Jaundea pinnata*	Ghana	Africa
334.	*A. kampalensis* Hansf.	Proc. Linn. Soc. London 153: 46 (1941) [1940-41]	Euphorbiaceae	*Alchornea cordifolia*	Uganda	Africa
335.	*A. kauaiensis* F. Stevens & R.W. Ryan	Bull. Bern. P. Bishop Mus. Bull. 19: 73 (1925)	undetermined	undetermined	Hawaii, USA	Oceania
336.	*A. kernii* Toro	Mycologia 17(4): 133 (1925)	Brunelliaceae	*Brunellia comocladifolia*	Puerto Rico	Caribbean
337.	*A. killipii* Dearn. & House	Bull. NY St. Mus. 266: 68 (1925)	Orchidaceae	*Erythrodes killipii*	Panama	Central America
338.	*A. knemae-attenuatae* Hosag., T.K. Abraham & T.S. Nayar	Mycotaxon 67: 487 (1998)	Myristicaceae	*Knema attenuata*	India	South Asia
339.	*A. knysnae* Doidge	Bothalia 4: 335 (1942)	Rubiaceae	*Canthium ciliatum*	South Africa	Africa
340.	*A. knysnae* var. *australiensis* Hansf.	Proc. Linn. Soc. New South Wales 79: 110 (1954)	Rubiaceae	*Canthium coprosmoides*	Australia	Oceania
341.	*A. kosciuskensis* Selkirk	Proc. Linn. Soc. New South Wales 100(1): 73 (1975)	Myrtaceae	undetermined	Australia	Oceania
342.	*A. koshunensis* Sawada	Rep. Gov. Res. Inst. Formosa 87: 5 (1944)	Capparaceae	*Capparis kikuchii*	Taiwan	East Asia
343.	*A. kusukusuensis* W. Yamam.	Sci. Rep. Hyogo Univ. Agric., Agric. Biol. Ser. 3(1): 24 (1957)	Malvaceae	*Sida rhombifolia*	Taiwan	East Asia
344.	*A. lactucina* Syd.	Ann. Mycol. 29: 232 (1931)	Asteraceae	*Lactuca dantata*	Philippines	Southeast Asia
345.	*A. laevipodia* M.L. Farr	Mycologia 79(1): 108 (1987)	Dilleniaceae	undetermined	Brazil	South America
346.	*A. lafoensiae* Bat. & Gayão	An. IV Congr. Soc. Bot. Brazil, p. 166 (1853)	Lythraceae	*Lafoensia glyptocarpa*	Brazil	South America
347.	*A. landolphiae* Hansf.	Proc. Linn. Soc. London 156: 115 (1944) [1943-44]	Apocynaceae	*Landolphia florida*	Uganda	Africa
348.	*A. landolphiicola* Hansf.	Proc. Linn. Soc. London 157: 33 (1945) [1944-45]	Apocynaceae	*Landolphia ugandensis*	Uganda	Africa
349.	*A. lanneae* Hosag. & Manojk.	in Hosagoudar, Zoos' Print J. 18(3): 1037 (2003)	Anacardiaceae	*Lannea coromandelica*	India	South Asia
350.	*A. lauracearum* B. Song, T.H. Li & Y.H. Shen	in Song et al., Mycosystema 22(3): 348 (2003)	Lauraceae	undetermined	China	East Asia
351.	*A. lawsoniae* Henn. & E. Nyman	in Warburg, Monsunia 1: 159 (1900)	Lythraceae	*Lawsonia alba*	Java, Indonesia	Southeast Asia
352.	*A. lawsoniicola* B. Song	in Song and Li, Mycotaxon 84: 409 (2002)	Lythraceae	*Lawsonia inermis*	China	East Asia
353.	*A. laxa* G. Winter	Hedwigia 31: 102 (1892)	undetermined	undetermined	Brazil	South America
354.	*A. laxiuscula* Syd. & P. Syd.	Ann. Mycol. 15(3/4): 244 (1917)	Sapotaceae	*Sideroxylon angustifolium*	Philippines	Southeast Asia
355.	*A. leeae* S. Hughes	Mycol. Pap. 48: 14 (1952)	Vitaceae	*Leea guineensis*	Ghana	Africa
356.	*A. leonensis* Syd.	Ann. Mycol. 36(2/3): 179 (1938)	Apocynaceae	*Marsdenia latifolia*	Sierra Leone	Africa
357.	*A. lepianthis* [as '*lepianthedis*'] (Hosag., M.P. Balakr. & Goos) Hosag.	in Hosagoudar et al., Indian Phytopathol. 55(4): 498 (2002)	Piperaceae	*Lepianthes umbellata*	India	South Asia
358.	*A. lepiniana* Mont.	in Theissen, Abh. Zool.-Bot. Ges. Wien 7(3): 73 (1913)	Rubiaceae	*Pavetta* sp.	Tahiti, French Polynesia	Oceania
359.	*A. leptalea* Syd.	Ann. Mycol. 29: 233 (1931)	Malvaceae	*Helicteres hirsuta*	Philippines	Southeast Asia
360.	*A. leveillei* Pat.	J. Bot. 2: 148 (1888)	Poaceae	undetermined	Chile	South America
361.	*A. libertiae* Syd. & P. Syd.	Ann. Mycol. 2: 167 (1904)	Iridaceae	*Libertia* sp.	Chile	South America
362.	*A. ligustricola* Hosag. & Kamar.	in Hosagoudar, J. Econ. Taxon. Bot. 28(1): 187 (2004)	Oleaceae	*Ligustrum travancorium*	India	South Asia
363.	*A. ligustrinae* (Bat. & Peres) S. Hughes	in Sugiyama (Ed.): Pleomorphic fungi. The diversity and its taxonimic implications (Tokyo), p. 131	Myrtaceae	*Eugenia ligustrina*	Brazil	South America

No.	Species	Reference	Host plant family	Host plant species	Country	Continent
364.	*A. linderae* Hansf.	Farlowia 3: 279 (1948)	Lauraceae	*Lindera* sp.	China	East Asia
365.	*A. liparidis* Racib.	in Theissen, Abh. Zool.-Bot. Ges. Wien 7(3): 91 (1913)	Orchidaceae	*Liparis* sp.	Java, Indonesia	Southeast Asia
366.	*A. litseae* H.S. Yates	Philipp. J. Sci. 13: 373 (1918)	Lauraceae	*Litsea* sp.	Philippines	Southeast Asia
367.	*A. litseae-ligustrinae* Hoasg., N.P. Balakr. & Goos	Mycotaxon 59: 180 (1996)	Lauraceae	*Litsea ligustrina*	India	South Asia
368.	*A. litseae-verticillatae* B. Song	in Song et al., Mycosystema 22(3): 349 (2002)	Lauraceae	*Litsea verticillata*	China	East Asia
369.	*A. lobata* Syd. & P. Syd.	Leafl. Philipp. Bot. 5: 1541 (1912)	Simaroubaceae	*Picrasma philippinensis*	Philippines	Southeast Asia
370.	*A. lobeliacearum* Hosag. & C.K. Biju	in Hosagoudar et al., Indian Phytopathol. 57(1): 115 (2004)	Campanulaceae	*Lobelia nicotinofolia*	India	South Asia
371.	*A. lobeliae* F. Stevens & R.W. Ryan	Bull. Bern. P. Bishop Mus. Bull. 19: 74 (1925)	Campanulaceae	*Lobelia* sp.	Hawaii, USA	Oceania
372.	*A. lobeliicola* Hosag. & T.K. Abraham	J. Econ. Taxon. Bot. 24(3): 563 (2000)	Campanulaceae	*Lobelia* sp. (cf. *gibberoa*)	DR Congo	Africa
373.	*A. lobulata* W. Yamam.	Sci. Rep. Hyogo Univ. Agric., Agric. Biol. Ser. 3(1): 24 (1957)	Aquifoliaceae	*Ilex ardisioides* [as '*arsidioideis*']	Taiwan	East Asia
374.	*A. lobulifera* Syd. & P. Syd.	Philipp. J. Sci. 9: 181 (1914)	Phyllanthaceae	*Glochidion* sp.	Philippines	Sputheast Asia
375.	*A. loesneriellae* Hosag. & Goos	Mycotaxon 59: 157 (1996)	Celastraceae	*Loesneriella obtusifolia*	India	South Asia
376.	*A. loranthacearum* Rehm	Ann. Mycol. 5: 522 (1907)	Loranthaceae	undetermined	Brazil	South America
377.	*A. loranthacearum* var. *javensis* Höhn.	Sber. Akad. Wiss. Wien. Math.-Nat. Kl., Abt. 1, 129: 140 (1920)	Loranthaceae	undetermined	Java, Indonesia	Southeast Asia
378.	*A. loranthicola* Syd. & P. Syd.	Ann. Mycol. 12(2): 206 (1914)	Loranthaceae	*Loranthus* sp.	Mozambique	Africa
379.	*A. loranthi-rhododendricolae* W. Yamam.	Sci. Rep. Hyogo Univ. Agric., Agric. Biol. Ser. 3(1): 24 (1957)	Loranthaceae	*Loranthus rhododendricola* [as '*rhododendricolus*']	Taiwan	East Asia
380.	*A. loropetali* B. Song	Mycotaxon 85: 321 (2003)	Hamamelidaceae	*Loropetalum chinense*	China	East Asia
381.	*A. lucida* Bat.	An. IV Congr. Soc. Bot. Brasil, p. 168 (1953)	Myrtaceae	*Eugenia lucida*	Brazil	South America
382.	*A. lycianthis* [as 'lycianthedis'] Hosag. & T.K. Abraham	Indian Phytopathol. 50(2): 216 (1997)	Solanaceae	*Lycianthes laevis*	India	South Asia
383.	*A. mabae* M.S. Patil & A.B. Pawar	Indian Phytopathol. 42(2): 249 (1989)	Ebenaceae	*Maba nigrescens*	India	South Asia
384.	*A. macarangae* Hansf.	Proc. Linn. Soc. London 159(1): 38 (1947)	Euphorbiaceae	*Macaranga* sp.	DR Congo	Africa
385.	*A. machili* Katum.	Trans. Mycol. Soc. Japan 20(4): 448 (1979)	Lauraceae	*Machilus thunbergii*	Japan	East Asia
386.	*A. maculiformis* [as '*maculaeformis*'] (Berk.) Cooke	Grevillea 7(42): 66 (1878)	Winteraceae	*Drimys* sp.	Chile	South America
387.	*A. madikeriensis* Hosag.	in Hosagoudar et al., J. Mycopathol. Res. 44(1): 8 (2006)	Melastomataceae	*Memecylon* sp.	India	South Asia
388.	*A. mahoniae* Keissl.	Sber. Akad. Wiss. Wien Math.-Naturw. Kl., Abt. 1, 2: 12 (1924)	Berberidaceae	*Mahonia beali*	China	East Asia
389.	*A. malaisiae* Syd.	Ann. Mycol. 29: 228 (1931)	Moraceae	*Malaisia scandens*	Philippines	Southeast Asia
390.	*A. malleae* Hansf.	Sydowia 9: 80 (1955)	Meliaceae	*Cipadessa fructicosa*	Sri Lanka	South Asia
391.	*A. malloti* Sawada & W. Yamam.	Speg. Publ., Coll. Agric., Nat. Taiwan Univ. 8: 44 (1959)	Euphorbiaceae	*Mallotus philippinensis*	Taiwan	East Asia
392.	*A. malloti-apeltae* [as '*malloti-apelti*'] B. Song.	in Song and Li, Mycotaxon 89(1): 196 (2004)	Euphorbiaceae	*Mallotus apelta*	China	East Asia
393.	*A. malloticola* Hosag., Kamar. & G. Rajkumar	in Hosagoudar and Agarwal, Indian Phytopathol. 56(1): 99 (2003)	Euphorbiaceae	*Mallotus philippensis*	India	South Asia
394.	*A. mandaquinensis* Henn.	Hedwigia 48: 12 (1909)	Myrtaceae	*Eugenia uniflora*	Brazil	South America
395.	*A. manglietiae* B. Song & Ouyang	in Song et al., Mycosystema 20(4): 461 (2001)	Magnoliaceae	*Manglietia moto*	China	East Asia
396.	*A. manihotis* Syd.	Ann. Mycol. 37(3): 233 (1939)	Euphorbiaceae	*Manihot glaziovii*	Sierra Leone	Africa

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397.	*A. mappiae* Petr. & Cif.	Ann. Mycol. 28(5/6): 379 (1930)	Icacinaceae	*Mappia racemosa*	San Domingo	Caribbean
398.	*A. marginalis* Petr.	in Sydow and Petrak, Ann. Mycol. 29: 240 (1931)	Euphorbiaceae	*Claoxylon* sp.	Philippines	Southeast Asia
399.	*A.markhamiae* Hansf.	Sydowia 9: 79 (1955)	Bignoniaceae	*Markhamia platycalyx*	Tanganjika	Africa
400.	*A. marmellensis* (Henn.) Theiss.	Öst. Bot. Z. 63: 123 (1913)	Fabaceae	*Sweetia nitens*	Brazil	South America
401.	*A. mascagniae* Petr.	Sydowia 1: 290 (1947)	Malpighiaceae	*Mascagnia chlorocarpa* var. *paradoxa*	Brazil	South America
402.	*A. maublancii* (G. Arnaud) Maubl.	Bull. Soc. Myc. Fr. 36: 38 (1920)	Melastomataceae	undetermined	Brazil	South America
403.	*A. megalosperma* Speg.	Rev. Mus. La Plata 15(2): 27 (1908)	Myrtaceae	undetermined	Brazil	South America
404.	*A. megalospora* Berk. & M.A. Curtis	in Berkeley, J. Linn. Soc. 10: 373 (1868)	Passifloraceae	*Passiflora* sp.	Cuba	Caribbean
405.	*A. melanotes* Syd.	in Sydow and Petrak, Ann. Mycol. 27(1/2): 59 (1929)	Melastomataceae	*Blakea* sp.	Costa Rica	Central America
406.	*A. melastomataceae* var. *microspora* Theiss.	Abh. Zool.-Bot. Ges. Wien 7(3): 47 (1913)	Melastomataceae	undetermined	Brazil	South America
407.	*A. melastomataceae* (Henn.) Theiss.	Abh. Zool.-Bot. Ges. Wien 7(3): 46 (1913)	Melastomataceae	undetermined	Brazil	South America
408.	*A. melastomatacearum* R.W. Ryan	Mycologia 16(4): 186 (1924)	Melastomataceae	*Miconia racemosa*, *Miconia impetiolaris*	Puerto Rico	Caribbean
409.	*A. melastomaticola* Hansf.	Reinwardtia 3: 134 (1954)	Melastomataceae	*Melastoma malabathricum*	Java, Indonesia	Southeast Asia
410.	*A. melastomatis* Lév.	Ann. Sci. Nat. 3: 59 (1845)	Melastomataceae	*Miconia* sp.	Brazil	South America
411.	*A. melastomatis* var. *verrucospora* M.L. Farr	Can. J. Bot. 47: 373 (1969)	Melastomataceae	*Miconia coriacea*	Dominica	Caribbean
412.	*A. melastomatis-candidi* [as '*melastomae-candidi*'] W. Yamam.	Sci. Rep. Hyogo Univ. Agric., Agric. Biol. Ser. 3(1): 25 (1957)	Melastomataceae	*Melastoma candidum*	Taiwan	East Asia
413.	*A. melicopicola* [as '*melicopecola*'] Hosag. & T.K. Abraham	Indian Phytopathol. 50(2): 216 (1997)	Rutaceae	*Melicope lunuankanda*	India	South Asia
414.	*A. meliosmae* W. Yamam.	Sci. Rep. Hyogo Univ. Agric., Agric. Biol. Ser. 2(2): 34 (1956)	Sabiaceae	*Meliosma rhoifolia*	Taiwan	East Asia
415.	*A. meliosmicola* [as '*meliosmaticola*'] Petr. & Cif.	Ann. Mycol. 30(3/4): 155 (1932)	Sabiaceae	*Meliosma herbertii*	San Domingo	Caribbean
416.	*A. memecyloniae* R.W. Ryan	Mem. Dept. Agric. India, Bot. Ser. 15(5): 104 (1928)	Melastomataceae	*Memecylon edule*	India	South Asia
417.	*A. memorae* Henn.	Hedwigia 43: 373 (1904)	Bignoniaceae	*Memora* sp.	Peru	South America
418.	*A. menispermacearum* Petr.	Sydowia 12: 474 (1959) [1958]	Menispermaceae	undetermined	Philippines	Southeast Asia
419.	*A. micheliae* Hansf.	Proc. Linn. Soc. London 158: 46 (1947)	Magnoliaceae	*Michelia nilagirica*	Sri Lanka	South Asia
420.	*A. micheliicola* B. Song, T.H. Li & Y.H. Shen	in Song et al., Mycosystema 20(4): 462 (2001)	Magnoliaceae	*Michelia maudiae*	China	East Asia
421.	*A. miconiae* Theiss.	Ann. Mycol. 11(5): 440 (1913)	Melastomataceae	*Miconia* sp.	Brazil	South America
422.	*A. miconiicola* [as '*miconicola*'] R.W. Ryan	Mycologia 16(4): 182 (1924)	Melastomataceae	*Miconia racemosa*	Puerto Rica	Caribbean
423.	*A. microchita* Syd.	Ann. Mycol. 37(4/5): 386 (1939)	Saliaceae	*Banara regia*	Ecuador	South America
424.	*A. microcosi* B. Song	in Song et al., Mycotaxon 87: 417 (2003)	Malvaceae	*Microcos paniculata*	China	East Asia
425.	*A. microspora* W. Yamam.	Sci. Rep. Hyogo Univ. Agric., Agric. Biol. Ser. 2(2): 33 (1956)	Asteraceae	*Adenostemma lavenia*	Taiwan	East Asia
426.	*A. microtropidicola* Hosag., C.K. Biju & D.K. Agarwal	in Hosagoudar et al., Indian Phytopathol. 55(4): 499 (2002)	Celastraceae	*Microtropis latifolia*	India	South Asia
427.	*A. microtropidis* Hosag., N.P. Balakr. & Goos	Mycotaxon 59: 181 (1996)	Celastraceae	*Microtropis ovalifolia*	India	South Asia
428.	*A. miliusiae* Hosag. & C.K. Biju	in Hosagoudar et al., J. Econ. Taxon. Bot. 28(1): 177 (2004)	Annonaceae	*Miliusa* sp.	India	South Asia
429.	*A. mimusopis* [as '*mimusopsidis*'] Hansf.	Sydowia 10, Beih. 1: 121 (1957) [1956]	Sapotaceae	*Mimusops welwitschii*	Congo	Africa

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430.	*A. minor* (E. Fisch.) Hosag.	J. Econ. Taxon. Bot. 24(3): 579 (2000)	Proteaceae	*Banksia* sp.	Australia	Oceania
431.	*A. mischocarpi* Puyang & Y.X. Hu	in Ouyang et al., Acta Mycol. Sin. 15(2): 90 (1996)	Sapindaceae	*Mischocarpus hainanensis*	China	East Asia
432.	*A. mitrariae* Syd.	in Petrak and Ciferri, Ann. Mycol. 30: 86 (1932)	Gesneriaceae	*Mitraria coccinia*	Australia	Oceania
433.	*A. mitteriana* Syd.	Ann. Mycol. 35: 232 (1937)	Aquifoliaceae	cf. *Ilex wightiana*	India	South Asia
434.	*A. momordicae* H.S. Yates	Philipp. J. Sci. 12: 371 (1918)	Cucurbitaceae	*Momordica* sp.	Philippines	Southeast Asia
435.	*A. monanthotaxis* [as '*monanthotaxiae*'] Mibey	in Mibey and Hawksworth, Mycol. Pap. 174: 87 (1997)	Annonaceae	*Monanthotaxis fornicata*	Kenya	Africa
436.	*A. monimiacearum* Bat. & J.L. Bezerra	unknown	unknown	unknown	unknown	unknown
437.	*A. morellae* Hosag., C.K. Biju & T.K. Abraham	Indian Phytopathol. 54 (1): 137 (2001)	Clusiaceae	*Garcinia morella*	India	South Asia
438.	*A. mulleri* J.A. Stev.	Mycologia 35: 631 (1943)	Passifloraceae	*Passiflora speciosa*	Brazil	South America
439.	*A. murrayae* Hansf.	Proc. Lonn. Soc. London 158: 45 (1947)	Rutaceae	*Murraya exotica*	Sri Lanka	South Asia
440.	*A. myriantha* Syd.	Ann. Mycol. 33: 376 (1935)	Elaeocarpaceae	*Crinodendron patagua*	Chile	South America
441.	*A. myrsinacearum* B. Song	in Song et al., Mycotaxon 90: 32 (2004)	Primulaceae	undetermined	China	East Asia
442.	*A. myrsines* A.K. Kar & Maity	Trans. Br. Mycol. Soc. 54(3): 438 (1970)	Primulaceae	*Myrsine semiserrata* var. *subspinosa*	India	South Asia
443.	*A. mysorensis* Hansf. & Thirum.	Farlowia 3: 307 (1948)	Moraceae	*Ficus* sp.	India	South Asia
444.	*A. naraveliae* Hosag, C.K. Biju & D.K. Agarwal	in Hosagoudar et al., Indian Phytopathol. 55(4): 499 (2002)	Ranunculaceae	*Naravelia zeylanica*	india	South Asia
445.	*A. natalitia* Doidge	Bothalia 4: 335 (1942)	Myrtaceae	*Eugenia natalitia*	South Africa	Africa
446.	*A. natsiati* A.K. Kar & Maity	Trans. Br. Mycol. Soc. 54(3): 440 (1970)	Icacinaceae	*Natsiatum herpecticum*	India	South Asia
447.	*A. negeriana* Syd. & P. Syd.	Ann. Mycol. 2: 167 (1904)	Escalloniaceae	*Escallonia pulverulenta*	Chile	South America
448.	*A. neolitseae* H.S. Yates	Ann. Mycol. 20: 72 (1922)	Lauraceae	*Neolitsea* sp.	Philippines	Southeast Asia
449.	*A. neolitsiicola* Hosag., C.K. Biju & T.K. Abraham	Indian Phytopathol. 54(1): 138 (2001)	Lauraceae	*Neolitsea* sp.	India	South Asia
450.	*A. nodosa* Doidge	Bothalia 4: 336 (1942)	Aquifoliaceae	*Ilex mitis*	South Africa	Africa
451.	*A. nodosaria* Dilcher	Palaeontographica 116: 17 (1965)	Chrysobalanaceae	*Chrysobalanus* sp.	Tenessee, USA	North America
452.	*A. nothopegiae* R.W. Ryan	Mem. Dept. Agric. India, Bot. Ser. 16(5): 104 (1928)	Anacardiaceae	*Nothopegia colebrookiana*	India	South Asia
453.	*A. nyanzae* Hansf.	Ann. Mycol. 36(2/3): 195 (1938)	Malvaceae	cf. *Grewia nyanza*	Uganda	Africa
454.	*A. nycticaliae* H.S. Yates	Philipp. J. Sci. 12: 371 (1917)	Bignoniaceae	*Nyctocalos cuspidatum*	Philippines	Southeast Asia
455.	*A. obtusispora* Speg.	Bol. Acad. Nac. Córdoba 11(4): 564	undetermined	undetermined	Brazil	South America
456.	*A. ocotearum* Petr. & Cif.	Ann. Mycol. 30(3/4): 162 (1932)	Lauraceae	*Ocotea cuneata*	San Domingo	Caribbean
457.	*A. olacicola* Hansf.	Proc. Linn. Sco. London 158: 46 (1947)	Olacaceae	*Olax wightiana*	India	South Asia
458.	*A. olacis* B. Song	in Song et al., Mycotaxon 87: 419 (2003)	Olacaceae	*Olax wightiana*	China	East Asia
459.	*A. oligocarpa* Syd. & P. Syd.	Ann. Mycol. 12(6): 558 (1914)	Olacaceae	*Olax imbricata*	Philippines	Southeast Asia
460.	*A. oligopoda* Syd.	Ann. Mycol. 28(1/2): 139 (1930)	Rubiaceae	*Gonzalea cornifolia*	Venezuela	South America
461.	*A. omphaleae* Petr.	Sydowia 2: 319 (1948)	Euphorbiaceae	*Omphalea* sp.	Ecuador	South America
462.	*A. oncinotidis* Doidge	Bothalia 4: 282 (1942)	Apocynaceae	*Oncinotis inandensis*	South Africa	Africa
463.	*A. opaca* Syd. & P. Syd.	Ann. Mycol. 10(1): 38 (1912)	Sapotaceae	*Chrysophyllum natalense*	South Africa	Africa
464.	*A. opiliae* Mibey	in Mibey and Hawksworth, Mycol. Pap. 174: 88 (1997)	Opiliaceae	*Opilia* sp.	Kenya	Africa

No.	Species	Reference	Host plant family	Host plant species	Country	Continent
465.	*A. opposita* Syd. & P. Syd.	Leafl. Philipp. Bot. 6: 1926 (1913)	Meliaceae	undetermined	Philippines	Southeast Asia
466.	*A. oppositipodia* Rahayu & I.H. Parbery	Mycol. Res. 95(6): 733 (1991)	Winteraceae	*Bubbia semecarpoides* var. *whiteana*	Australia	Oceania
467.	*A. orbicularis* var. *interrupta* Thüm.	unknown	unknown	unknown	unknown	unknown
468.	*A. oreocnidecola* Hosag., N.P. Balakr. & Goos	Mycotaxon 59: 183 (1996)	Urticaceae	*Oreocnide integrifolia*	India	South Asia
469.	*A. oreocnidegena* Hosag.	in Hosagoudar and Biju, J. Mycopathol. 44(1): 42 (2006)	Urticaceae	*Oreocnide integrifolia*	India	South Asia
470.	*A. oritis* Hansf.	Proc. Linn. Soc. New South Wales 79: 110 (1954)	Proteaceae	*Orites excelsa*	Australia	Oceania
471.	*A. orthosticha* Syd.	Ann. Mycol. 28(1/2): 140 (1930)	Dilleniaceae	*Doliocarpus dentatus*	Venezuela	South America
472.	*A. oxyanthi* Doidge	Bothalia 4: 284 (1942)	Rubiaceae	*Oxyanthus gerrardi*	South Africa	Africa
473.	*A. pachynema* Syd.	Ann. Mycol. 37(4/5): 386 (1939)	Campanulaceae	*Centropogon aurantiacum*	Ecuador	South America
474.	*A. palaquii* Hosag. & Goos	Mycotaxon 59: 158 (1996)	Sapotaceae	*Palaquium ellipticum*	india	South Asia
475.	*A. pandae* Hansf.	Publ. Inst. Nat. Étude. Agron. Congo Belge 2: 44 (1945)	Pandaceae	*Panda oleosa*	DR Congo	Africa
476.	*A. pandicola* Hansf.	Publ. Inst. Nat. Étude. Agron. Congo Belge 2: 45 (1945)	Pandaceae	*Panda oleosa*	DR Congo	Africa
477.	*A. papillata* Syd.	Ann. Mycol. 14(1-2): 92 (1916)	Capparaceae	*Capparis* sp.	Peru	South America
478.	*A. papuensis* Hansf.	Proc. Linn. Soc. New South Wales 82(2): 211 (1957)	Proteaceae	*Banksia dentata*	Papua New Guinea	Oceania
479.	*A. paraguayensis* Speg.	Anal. Soc. Cient. Argent. 19(6): 257 (1885)	Sapotaceae	undetermined	Brazil	South America
480.	*A. paramacrolobii* Mibey	in Mibey and Hawksworth, Mycol. Pap. 174 (1997)	Fabaceae	*Paramacolobium coeruleum*	Kenya	Africa
481.	*A. paraphysata* G. Winter	Hedwigia 31: 103 (1892)	undetermined	undetermined	Brazil	South America
482.	*A. parsonsiae* Hosg.	in Hosagoudar et al., J. Mycopathol. Res. 44(1): 9 (2006)	Apocynaceae	*Parsonsia alboflavescens*	India	South Asia
483.	*A. passifloricola* R.W. Ryan	Mycologia 16(4): 183 (1924)	Passifloraceae	*Passiflora rubra*	Puerto Rica	Caribbean
484.	*A. pauper* Roum. & P. Karst.	in Karsten and Roumeguère, Rev. Mycol. 12: 79 (1890)	Garryaceae	*Aucuba* sp.	Vietnam	Southeast Asia
485.	*A. pavoniae* Werderm.	Feddes Repert. Spec. Nov. Regni. Veg. 19: 50 (1923)	Malvaceae	*Sida hislopii* (misidentified as *Pavonia* sp.)	South Africa	Africa
486.	*A. peglerae* Doidge	Trans. Roy. Soc. South Africa 8(4): 276 (1920)	Capparaceae	*Maerua* sp. (misidentified as *Rhus* sp.)	South Africa	Africa
487.	*A. pellioniae* Katum.	Trans. Mycol. Soc. Japan 21(1): 3 (1986)	Urticaceae	*Pellionia minima*	Japan	East Asia
488.	*A. pemphidioides* Cooke	Grevillea 5(33): 16 (1876)	Myrtaceae	*Eugenia jambolana*	India	South Asia
489.	*A. pentaphylacis* B. Song	in Song and Li, Mycotaxon 84: 409 (2002)	Pentaphylacaceae	*Pentaphylax eryoides*	China	East Asia
490.	*A. perae* Bat.	An. IV Congr. Cos. Brazil, p. 169 (1953)	Euphorbiaceae	*Pera ferruginea*	Brazil	South America
491.	*A. peraffinis* Speg.	Bol. Acad. Nac. Cien. Córdoba 11(4): 565 (1889)	Apocynaceae	*Tylophora fanagani*	Brazil	South America
492.	*A. perconferta* Trotter	in Saccardo, Syll. Fung. 24: 466 (1926)	Passifloraceae	*Passiflora* sp.	Costa Rica	Central America
493.	*A. perpusilla* Syd. & P. Syd.	Ann. Mycol. 14(5): 366 (1916)	Cornaceae	*Alangium bezoniaefolium*	Philippines	Southeast Asia
494.	*A. phaleriae* J.M. Mend.	Philipp. J. Sci. 49(2): 188 (1932)	Thymelaeaceae	*Phaleria perrottetiana*	Philippines	Southeast Asia
495.	*A. phenacis* Syd.	Ann. Mycol. 25(1/2): 66 (1927)	Urticaceae	*Phenax hirtus*	Costa Rica	Central America

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496.	*A. phlogacanthi* [as '*phlogantae*'] A.K. Kar & S.N. Ghosh	Indian Phytopathol. 39(2): 211 (1987) [1986]	Acanthaceae	*Phlogacanthus curviflorus*	India	South Asia
497.	*A. phoebeicola* [as '*phoebicola*']	Fung. Div. 14: 160 (2003)	Lauraceae	*Phoebe lanceolata*	China	East Asia
498.	*A. phoebes* Syd.	Ann. Mycol. 25(1/2): 68 (1927)	Lauraceae	*Phoebe costaricana*	Costa Rica	Central America
499.	*A. phoradendricola* F. Stevens & Pollack	Mycologia 38(5): 525 (1946)	Santalaceae	*Phoradendron flavescens*	Florida, USA	North America
500.	*A. phyllanthicola* Suj. Singh	Trans. Br. Mycol. Soc. 74(1): 204 (1980)	Phyllanthaceae	*Phyllanthus reticulatus*	India	South Asia
501.	*A. phyllanthigena* Hosag.	Zoos' Print J. 19(7): 1522 (2004)	Phyllanthaceae	*Phyllanthus* sp.	India	South Asia
502.	*A. phyllostegiae* F. Stevens & R.W. Ryan	Bull. Bern. P. Bishop Mus. Bull. 19: 73 (1925)	Lamiaceae	*Phyllostegia* sp.	Hawaii, USA	Oceania
503.	*A. piperina* Syd. & P. Syd.	Ann. Mycol. 15(3/4): 243 (1917)	Piperaceae	*Piper* sp.	Philippines	Southeast Asia
504.	*A. pipturi* Syd. & P. Syd.	Ann. Mycol. 14(5): 366 (1916)	Urticaceae	*Pipturus arborescens*	Philippines	Southeast Asia
505.	*A. pittospori* Hansf.	Reinwardtia 3: 135 (1954)	Pittosporaceae	*Pittosporum ferrugineum*	Java, Indonesia	Southeast Asia
506.	*A. planchonellae* Hansf.	Reinwardtia 3: 135 (1954)	Sapotaceae	*Planchonella nitida*	Java, Indonesia	Southeast Asia
507.	*A. platasca* Berk. & M.A. Curtis	in Berkeley, J. Linn. Soc. 10: 373 (1868)	Passifloraceae	*Passiflora* sp.	Cuba	Caribbean
508.	*A. platypoda* Syd. & P. Syd.	Ann. Mycol. 15(3/4): 241 (1917)	Rubiaceae	*Urophyllum banahaense*	Philippines	Southeast Asia
509.	*A. platystoma* Cooke & Massee	Grevillea 18(85): 6 (1889)	Fabaceae	*Castanospermum* sp.	Australia	Oceania
510.	*A. plectranthi* Hosag., Manojk. & H. Biju	in Hosagoudar, Indian Phytopathol. 55(2): 200 (2005)	Lamiaceae	*Plectranthus* sp.	India	South Asia
511.	*A. plectroniae* J.M. Mend.	Philipp. J. Sci. 49(2): 186 (1932)	Oliniaceae	*Plectronia cumingii*	Philippines	Southeast Asia
512.	*A. plectroniaecola* J.M. Mend.	Philipp. J. Sci. 49(2): 187 (1932)	Oliniaceae	*Plectronia gynochthodes*	Philippines	Southeast Asia
513.	*A. pleioceratis* S. Hughes	Mycol. Pap. 50: 7 (1953)	Apocynaceae	*Pleioceras barteri*	Ghana	Africa
514.	*A. pliniae* Cif.	Sydowia 10: 141 (1957) [1956]	Myrtaceae	*Plinia* sp.	Dominican Republic	Caribbean
515.	*A. pluripora* R.W. Ryan	Mem. Dept. Agric. India, Bot. Ser. 15(5): 104 (1928)	Dipterocarpaceae	*Shorea talura*	India	South Asia
516.	*A. pogostemonis* Petr.	Sydowia 12: 476 (1959) [1958]	Lamiaceae	*Pogostemon velatus*	Philippines	Southeast Asia
517.	*A. poliothea* (Syd.) F. Stevens	in Stven and Ryan, Ill. Biol. Monogr. 17(2): 64 (1939)	Lauraceae	*Phoebe neurophylla*	Costa Rica	Central America
518.	*A. polyloba* Syd.	Ann. Mycol. 35: 38 (1937)	Bignoniaceae	*Tecoma australis*	Australia	Oceania
519.	*A. polysomae* Hosag. & T.K. Abraham	J. Econ. Taxon. Bot. 24(3): 583 (2000)	Escalloniaceae	*Polysoma brachyantha*	Ambon Island, Indonesia	Southeast Asia
520.	*A. polythyria* Doidge	Trans. Roy. Soc. South Africa 8(4): 276 (1920)	Santalaceae	*Osyridicarpos natalensis*	South Africa	Africa
521.	*A. pongalaparensis* Hosag., C.K. Biju & T.K. Abraham	Indian Phytopathol. 54(1): 138 (2001)	Oleaceae	*Jasminum* sp.	India	South Asia
522.	*A. porriginosa* Syd. & P. Syd.	Leafl. Philipp. Bot. 5: 1541 (1912)	Aquifoliaceae	*Ilex cymosa*	Philippines	Southeast Asia
523.	*A. portoricensis* R.W. Ryan	Mycologia 16(4): 185 (1924)	Solanaceae	*Solanum* sp.	Puerto Rico	Caribbean
524.	*A. pouteriae* B. Song	Mycotaxon 85: 323 (2003)	Sapotaceae	*Pouteria grandifolia*	China	East Asia
525.	*A. pouzolziae* Petr.	Sydowia 8: 15 (1954)	Urticaceae	*Pouzolzia* sp.	Bornea	Southeast Asia
526.	*A. pouzolziicola* Hosag. & T.K. Abraham	J. Econ. Taxon. Bot. 24(3): 585 (2000)	Urticaceae	*Pouzolzia zeylanica*	Java, Indonesia	Southeast Asia
527.	*A. pseudopelliculosa* Speg.	Bol. Acad. Nac. Cien. Córdoba 11(4): 566 (1889)	Convolvulaceae	*Ipomoea* sp.	Brazil	South America
528.	*A. psidii* R.W. Ryan	Mycologia 16(4): 185 (1924)	Myrtaceae	*Psidium guajava*	Puerto Rica	Caribbean
529.	*A. psychotriae* R.W. Ryan	Mycologia 16(4): 185 (1924)	Rubiaceae	*Psychotria pubescens*	Puerto Rico	Caribbean

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530.	*A. pterygopodii* Hansf.	Publ. Inst. Nat. Étude Agron. Congo Belge 2: 46 (1945)	Fabaceae	*Pterigopodium* sp.	DR Congo	Africa
531.	*A. puellaris* Syd.	Ann. Mycol. 35: 38 (1937)	Apocynaceae	*Melodinus australe*	Australia	Oceania
532.	*A. pulchella* Petr.	in Sydow and Petrak, Ann. Mycol. 27(1/2): 52 (1929)	undetermined	undetermined	Costa Rica	Central America
533.	*A. pulla* Lév.	Ann. Sci. Nat. 3: 60 (1845)	Melastomataceae	undetermined	Bolivia	South America
534.	*A. punctiformis* Lév.	Ann. Sci. Nat. 5: 267 (1846)	Euphorbiaceae	*Conceveiba javanensis*	Java, Indonesia	Southeast Asia
535.	*A. punctiformis* var. *fimbriata* (Kalchbr. & Cooke) Theiss.	Abh. Zool.-Bot. Ges. Wien 7(3): 67 (1913)	Acanthaceae	*Sclerochiton harveyanus*	South Africa	Africa
536.	*A. pusilla* Syd. & P. Syd.	Philipp. J. Sci. 8: 488 (1913)	Lamiaceae	*Premna nauseosa*	Philippines	Southeast Asia
537.	*A. pycnanthi* Hansf.	in Sydow, Ann. Mycol. 36(2/3): 196 (1938)	Myristicaceae	*Pycnanthus schweinfurthii*	Uganda	Africa
538.	*A. quarta* Racib.	in Theissen, Abh. Zool.-Bot. Ges. Wien 7(3): 77 (1913)	Myrtaceae	*Syzygium jambolana*	Java, Indonesia	Southeast Asia
539.	*A. queenslandica* Rahayu & I.H. Parbery	Mycol. Res. 95(6): 735 (1991)	Winteraceae	*Bubbia semecarpoides*	Australia	Oceania
540.	*A. racemosae* R.W. Ryan	Mycologia 16(4): 182 (1924)	Melastomataceae	*Miconia racemosa*, *M. sintensii*, *M. impetiolaris*	Puerto Rico	Caribbean
541.	*A. radiofissilis* (Sacc.) Theiss.	Ann. MYcol. 10(1): 22 (1912)	Euphorbiaceae	*Erythrococca berberida* (misidentified as *Kraussia coriacea*)	São Thome and Príncipe	Africa
542.	*A. ramonensis* Syd.	Ann. Mycol. 25(1/2): 69 (1927)	undetermined	undetermined	Costa Rica	Central America
543.	*A. ramosiana* Hosag. & T. K. Abraham	J. Econ. Taxon. Bot. 24(3): 576 (2000)	Myrtaceae	*Eugenia* sp.	Philippines	Southeast Asia
544.	*A. ramosii* H.S. Yates	Philipp. J. Sci. 13: 375 (1918)	Dilleniaceae	*Dillenia* sp.	Philippines	Southeast Asia
545.	*A. ramuligera* (Syd. & P. Syd.) Petr.	Medd. Göteborgs Bot. 17: 131 (1947)	Pandaceae	*Microdesmis caseariifolia*	Philippines	Southeast Asia
546.	*A. randiae-bethamianae* [as '*randiae-benthami*'] Hansf.	Proc. Linn. Soc. New South Wales 82(2): 211 (1957)	Rubiaceae	*Randia benthamiana* [as '*benthami*']	Australia	Oceania
547.	*A. raripoda* Doidge	Trans. Roy. Soc. South Africa 8(4): 254 (1920)	Orchidaceae	*Ansellia africana*	South Africa	Africa
548.	*A. recisa* Syd.	Ann. Mycol. 35: 39 (1937)	Pittosporaceae	*Pittosporum undulatum*	Australia	Oceania
549.	*A. reclinata* Syd.	Ann. Mycol. 35: 40 (1937)	Solanaceae	*Solanum stelligerum*	Australia	Oceania
550.	*A. reticulata* Kalchbr. & Cooke	Grevillea 9(49): 33 (1880)	Oliniaceae	*Olinia cymosa*	South Africa	Africa
551.	*A. rhabdodendri* Syd. & P. Syd.	Ann. Mycol. 14(1-2): 92 (1916)	Rhabdodendraceae	*Rhabdodendron crassipes*	Brazil	South America
552.	*A. rhabdodendri* var. *lavibus* M.S. Patil & A.B. Pawar	Indian Phytopathol. 42(2): 251 (1989)	Rutaceae	*Acronychia laurifolia*	India	South Asia
553.	*A. rhamni* [as '*rhamnii*'] A.K. Kar & S.N. Ghosh	Indian Phytopathol. 39(2): 206 (1987) [1986]	Rhamnaceae	*Rhamnus* sp.	India	South Asia
554.	*A. rhodomyrti* Hosag., H. Biju & Manojk.	Zoos' Print J. 21(8): 2335 (2006)	Myrtaceae	*Rhodomyrtus tomentosa*	India	South Asia
555.	*A. rickii* Theiss.	Abh. Zool.-Bot. Ges. Wien 7(3): 69 (1913)	Myrtaceae	undetermined	Brazil	South America
556.	*A. rinoreae* Doidge	Bothalia 3: 335 (1942)	Violaceae	*Rinorea natalensis*	South Africa	Africa
557.	*A. rizalensis* Hansf.	Proc. Linn. Soc. London 160(2): 147 (1949)	Dipterocarpaceae	*Anispotera thurifera*	Philippines	Southeast Asia
558.	*A. rizalica* Petr.	Sydowia 12: 478 (1959) [1958]	Celastraceae	*Salacia* sp.	Philippines	Southeast Asia
559.	*A. robusta* Doidge	Trans. Roy. Soc. South Africa 8(4): 256 (1920)	Sapotaceae	*Sideroxylon inerme* (misidentified as *Pittosporum viridilorum*)	South Africa	Africa
560.	*A. rogergoosii* B. Song	in Song and Li , Mycotaxon 84: 410 (2002)	Staphyleaceae	*Turpinia pomifera*	China	East Asia

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561.	*A. sabiacearum* Hosag. & Goos	Mycotaxon 52(2): 469 (1994)	Sabiaceae	*Meliosma simplicifolia* subsp. *pungens*	India	South Asia
562.	*A. sabiana* A.K. Kar & S.N. Ghosh	Indian Phytopathol. 39(2): 204 (1987) [1986]	Sabiaceae	*Sabia* sp.	India	South Asia
563.	*A. saccardoana* Theiss.	Abh. Zool.-Bot. Ges. Wien 7(3): 45 (1913)	Sapotaceae	*Sideroxylon* sp.	Australia	Oceania
564.	*A. saccopetali* Tilak & U.K. Kulk.	Indian Phytopathol., Suppl. Issue 29(2): 169 (1977) [1976]	Annonaceae	*Saccopetalum tomentosum*	India	South Asia
565.	*A. saginata* Syd. & P. Syd.	Ann. Mycol. 15(3/4): 241 (1917)	Annonaceae	*Polyalthia* sp.	Philippines	Southeast Asia
566.	*A. salaciae* Allesch.	Hedwigia 35: 105 (1896)	Celastraceae	*Salacia* sp.	Brazil	South America
567.	*A. samaderae* Hosag. & Manojk.	in Hosagoudar, Zoos' Print J. 18(3): 1038 (2003)	Simaroubaceae	*Samadera indica*	india	South Asia
568.	*A. samanensis* Cif.	Ann. Mycol. 36(2/3): 200 (1938)	Schoepfiaceae	*Schoepfia* sp.	San Domingo	Caribbean
569.	*A. samoensis* (Henn.) Theiss.	Verh. Zool.-Bot. Ges. Wien 69: 18 (1919)	Menispermaceae	undetermined	Samoa	Oceania
570.	*A. sandowayensis* Thaung	Trans. Br. Mycol. Soc. 67(3): 438 (1976)	Loganiaceae	*Strychnos* cf. *nux-blanda*	Burma, Myanmar	Southeast Asia
571.	*A. saniculae* Doidge	Bothalia 4: 336 (1942)	Apiaceae	*Sanicula europaea*	South Africa	Africa
572.	*A. saniculicola* Hansf.	Reinwardtia 3: 136 (1954)	Apiaceae	*Sanicula europaea*	Java, Indonesia	Southeast Asia
573.	*A. sapotacearum* Speg.	Anal. Soc. Cent. Argent. 26(1): 50 (1888)	Sapotaceae	undetermined	Brazil	South America
574.	*A. saracae* Hosag., T.K. Abraham & J.L. Crane	Mycotaxon 68: 19 (1998)	Fabaceae	*Saraca asoca*	India	South Asia
575.	*A. sarcandrae* Hosag. & Kamar.	in Hosagoudar, Zoos' Print J. 21(7): 2305 (2006)	Chloranthaceae	*Sarcandra chloranthoides*	India	South Asia
576.	*A. sawadai* B. Song	in Song and Li, Mycotaxon 89(1): 196 (2004)	Capparaceae	*Capparis kikuchii*	China	East Asia
577.	*A. scaberrima* Syd.	Ann. Mycol. 36(2/3): 181 (1938)	Euphorbiaceae	*Mareya spicata*	Sierra Leone	Africa
578.	*A. schlechteriana* Syd.	Ann. Mycol. 25(1/2): 71 (1927)	Melastomataceae	*Clidemia dentata*	Costa Rica	Central America
579.	*A. schlegeliae* T.A. Hofmann	Mycol. Prog. 7: 90 (2008)	Schlegeliaceae	*Schlegelia parviflora*	Panama	Central America
580.	*A. schmideliae* Gaillard	Bull. Soc. Mycol. Fr. 13: 181 (1897)	Sapindaceae	*Schmidelia* sp.	Brazil	South America
581.	*A. schroeteri* var. *licaniae* (Rehm) Theiss.	Abh. Zool.-Bot. Ges. Wien 7(3): 54 (1913)	Chrysobalanaceae	*Licania* sp.	Brazil	South America
582.	*A. scitula* Syd.	Ann. Mycol. 36(2/3): 183 (1938)	Fabaceae	*Crotaliaria mespontica*	Uganda	Africa
583.	*A. scolopiae* Doidge	Bothalia 1(2): 77 (1922)	Salicaceae	*Scolopia zeyheri*	South Africa	Africa
584.	*A. scrobiculata* W. Yamam.	Sci. Rep. Hyogo Univ. Agric., Agric. Biol. Ser. 3(1): 25 (1957)	Aquifoliaceae	*Ilex ardisioides* [as '*arsidioideis*'], *I. rotunda* [as '*rotundata*']	Taiwan	East Asia
585.	*A. scruposa* Syd.	Ann. Mycol. 36(2/3): 184 (1983)	Dilleniaceae	*Tetracera potatoria* [as '*alnifolia*']	Uganda and Sierra Leone	Africa
586.	*A. scruposa* var. *longipoda* S. Hughes	Mycol. Pap. 48: 15 (1952)	Dilleniaceae	*Tetracera alnifolia*	Ghana	Africa
587.	*A. secamonicola* Doidge	Bothalia 2(1a): 233 (1927)	Apocynaceae	*Secamone alpinus*	South Africa	Africa
588.	*A. shimbaensis* Mibey	in Mibey and Hawksworth, Mycol. Pap. 174: 92 (1997)	Combretaceae	*Combretum* sp.	Kenya	Africa
589.	*A. shoreana* Sacc.	Notae Mycol. 23: 61 (1917)	Dipterocarpaceae	*Parashorea plicata*	Philippines	Southeast Asia
590.	*A. sideroxyli* Hansf.	Reinwardtia 3: 136 (1954)	Sapotaceae	*Sideroxylon* sp.	Philippines	Southeast Asia
591.	*A. sidicola* R.W. Ryan	Mycolgia 16(4): 181 (1924)	Malvaceae	undetermined, *Sida* sp., *S. carpinifolia*, *Corchorus hirtus* and *Abutilon* sp.	Puerto Rico	Caribbean

No.	Species	Reference	Host plant family	Host plant species	Country	Continent
592.	*A. silvatica* Speg.	Bol. Acad. Nac. Cien. Córdoba 11(4): 568 (1889)	Meliaceae	*Trichilia* sp.	Brazil	South America
593.	*A. simillima* Syd. & P. Syd.	Ann. Mycol. 15(3/4): 242 (1917)	Cucurbitaceae	*Luffa cylindrica*	Philippines	Southeast Asia
594.	*A. singaporensis* Syd. & P. Syd.	Ann. Mycol. 18(4-6): 159 (1920)	Fabaceae	*Derris sinuata*	Singapore	Southeast Asia
595.	*A. sinsuieiensis* W. Yamam.	Sci. Rep. Hyogo Univ. Agric., Agric. Biol. Ser. 3(1): 25 (1957)	Melastomataceae	*Barthea formosana*	Taiwan	East Asia
596.	*A. siphocampyli* Syd.	Ann. Mycol. 37(4/5): 387 (1939)	Campanulaceae	*Siphocampylus campanulatus*	Ecuador	South America
597.	*A. sodalis* Syd.	Ann. Mycol. 26(1/2): 95 (1928)	Symplocaceae	*Symplocos nigricans*	Borneo	Southeast Asia
598.	*A. solanacearum*Orejuela	Mycologia 36: 448 (1944)	Solanaceae	*Solanum* sp.	Columbia	South America
599.	*A. solanicola* Berk. & M.A. Curtis	in Berkeley, J. Linn. Soc. 10: 374 (1868)	Solanaceae	*Solanum* sp.	Cuba	Caribbean
600.	*A. solanicola* var. *cristata* (Speg.) Theiss.	Abh. Zool.-Bot. Ges. Wien 7(3): 105 (1913)	Apocynaceae	undetermined	Brazil	South America
601.	*A. solanicoloides* Rehm	Hedwigia 35: 150 (1896)	Solanaceae	*Solanum* sp.	Ecuador	South America
602.	*A. solidaginis* Cooke	Grevillea 14(70): 40 (1885)	Asteraceae	*Solidago elliptica*	United Kingdom	Europe
603.	*A. spathodeae* Hansf.	Proc. Linn. Soc. London 158: 47 (1947)	Bignoniaceae	*Spathodea nilotica*	Uganda	Africa
604.	*A. spathulata* Seaver & Chardón	Scient. Surv. Porto Rico Virg. Isl. 8: 20 (1926)	Melastomataceae	*Miconia* sp.	Puerto Rico	Caribbean
605.	*A. spectabilis* Syd.	Philipp. J. Sci. 21(2): 149 (1922)	Salicaceae	*Flacourtia inermis*	Ambon Island, Indonesia	Southeast Asia
606.	*A. sphaerelloides* Speg.	Bull. Torr. Cl. 24: 126 (1897)	Aquifoliaceae	*Ilex* sp.	Brazil	South Asia
607.	*A. sphaeropoda* Syd. & P. Syd.	Ann. Mycol. 15 (3/4): 242 (1917)	Euphorbiaceae	*Ostodes* sp.	Philippines	Southeast Asia
608.	*A. sphaerotheca* P. Karst. & Roum.	Rev. Mycol. 12: 76 (1890)	Lamiaceae	*Vitex* sp.	Vietnam	Southeast Asia
609.	*A. sphaerotheca* var. *prodiga* Theiss.	Abh. Zool.-Bot. Ges. Wien 7(3): 59 (1913)	undetermiend	undetermined	Brazil	South America
610.	*A. sphenispora* Ellis & Everh.	J. Inst. Jamaica 1: 248 (1893)	undetermined	undetermined	Jamaica	Caribbean
611.	*A. spinosa* (J.M. Mend.) Hosag. & T.K. Abraham	J. Econ. Taxon. Bot. 24(3): 586 (2000)	Vitaceae	*Cissus* sp.	Phillipines	Southeast Asia
612.	*A. spissa* Syd. & P. Syd.	Ann. Mycol. 9(4): 392 (1911)	Oleaceae	*Jasminum* sp.	Bangladesh	South Asia
613.	*A. sponiae* Racib.	Parasit. Algen und Pilze Javas 3: 34 (1900)	Cannabaceae	*Sponia virgata*	Java, Indonesia	Southeast Asia
614.	*A. stauntoniae* W. Yamam.	Sci. Rep. Hyogo Univ. Agric., Agric. Biol. Ser. 3(1): 27 (1957)	Lardizabalaceae	*Stauntonia hexaphylla*	Taiwan	East Asia
615.	*A. stipitipodia* M.L. Farr	Mycologia 79(1): 108 (1987)	Dilleniaceae	undetermined	Brazil	South America
616.	*A. stixis* B. Song., T.H. Li & Hosag.	Fung. Div. 14: 161 (2003)	Capparaceae	*Stixis suaveolens*	China	East Asia
617.	*A. streptocarpi* Doidge	Bothalia 2(4): 203 (1924)	Gesnericaceae	*Streptocarpus rexi*	South Africa	Africa
618.	*A. strophanthi* Henn.	Englers Bot. Jahrb. 38: 125 (1907)	Apocynaceae	*Strophanthus hispidus*	Togo	Africa
619.	*A. strychni* Höhn.	Sber. Akad. Wiss. Wien Math.-Naturw. Kl., Abt. 1, 118: 868 (1909)	Loganiaceae	*Strychnos* sp.	Java, Indonesia	Southeast Asia
620.	*A. styracina* Syd.	Ann. Mycol. 25(1/2): 72 (1927)	Styracaceae	*Styrax polyneurus*	Costa Rica	Central America
621.	*A. subcylindracea* W. Yamam.	Sci. Rep. Hyogo Univ. Agric., Agric. Biol. Ser. 3(1): 27 (1957)	Rubiaceae	*Diplospora viridiflora*	Taiwan	East Asia
622.	*A. subglobulifera* Höhn.	Sber. Akad. Wiss. Wien Math.-Naturw. Kl., Abt. 1, 129: 141 (1920)	Poaceae	undetermined	Java, Indonesia	Southeast Asia
623.	*A. subinermis* Syd. & P. Syd.	Leafl. Philipp. Bot. 6: 1927 (1913)	undetermined	undetermined	Philippines	Southeast Asia
624.	*A. submegas* (Henn.) Hansf.	Proc. Linn. Soc. London 160(2): 148 (1949)	Meliaceae	*Guarea* sp.	Brazil	South America

No.	Species	Reference	Host plant family	Host plant species	Country	Continent
625.	*A. subreticulata* Speg.	Anal. Soc. Cient. Argent. 26(1): 52 (1888)	Solanaceae	*Solanum* sp., *Cestrum* sp.	Brazil	South America
626.	*A. suttoniae* Stev. & Ryan	in Stevens, Bull. Bern. P. Bishop Mus. 19: 74 (1925)	Primulaceae	*Suttonia* sp.	Hawaii, USA	Oceania
627.	*A. suttonii* Hosag. & C.K. Biju	in Hosagoudar, Biju and Abraham, J. Econ. Taxon Bot. 28(1): 181 (2004)	Symplocaceae	*Symplocos* sp.	India	South Asia
628.	*A. sydowiana* R.W. Ryan	Mycologia 16(4): 184 (1924)	Sapotaceae	*Chrysophyllum* sp.	Puerto Rico	Caribbean
629.	*A. syzygii* Doidge	Bothalia 4: 336 (1942)	Myrtaceae	*Syzygium gerrardi*	South Africa	Africa
630.	*A. syzygii* var. *microspora* Hansf.	Proc. Linn. Soc. London 156: 116 (1944) [1943]	Myrtaceae	*Syzygium cordatum*	Uganda	Africa
631.	*A. syzygiicola* Hansf.	Proc. Linn. Soc. London 156: 115 (1944) [1943]	Myrtaceae	*Syzygium cordatum*	Uganda	Africa
632.	*A. tacsoniae* Petr.	Bull. Soc. Myc. Fr. 40: 147 (1893)	Passifloraceae	*Tacsonia* sp.	Ecuador	South America
633.	*A. tacsoniae* var. *passiflorae* R.W. Ryan	Mycologia 16(4): 183 (1924)	Passifloraceae	*Passiflora* sp., *P. sexflora*	Puerto Rico	Caribbean
634.	*A. talacauveriana* Hosag.	in Hosagoudar et al., J. Mycopathol. Res. 44(1): 11 (2006)	Salicaceae	*Scolopia* sp.	India	South Asia
635.	*A. tantalina* Petr.	Sydowia 7: 383 (1953)	Aquifoliaceae	*Byronia* sp.	Hawaii, USA	Oceania
636.	*A. tarlacensis* Petr.	Sydowia 12: 479 (1959) [1958]	Celastraceae	*Celastrus paniculatus*	Philippines	Southeast Asia
637.	*A. tayabensis* H.S. Yates	Philipp. J. Sci. 12: 372 (1917)	undetermined	undetermined	Philippines	Southeast Asia
638.	*A. tenella* Cooke	Grevillea 13(67): 67 (1885)	Lauraceae	*Persea caroliniensis*	USA	North America
639.	*A. tenuis* G. Winter	Hedwigia 25: 94 (1886)	Euphorbiaceae	*Claoxylon* sp.	South Africa	Africa
640.	*A. tertia* Racib.	in Theissen, Abh. Zool.-Bot. Ges. Wien 7(3): 103 (1913)	Acanthaceae	*Adhatoda* sp. and *Crossandra* sp.	Java, Indondesia	Southeast Asia
641.	*A. tertia* var. *africana* Doidge	Trans. Roy. Soc. South Africa 8(4): 277 (1920)	Acanthaceae	*Dicliptera clinopodia*	South Africa	Africa
642.	*A. tetracerae* Syd.	Ann. Mycol. 29: 277 (1931)	Dilleniaceae	*Tetracera scandens*	Philippines	Southeast Asia
643.	*A. tetracericola* B. Song, T.H. Li & F.W. Xing	Fung. Div. 16: 162 (2004)	Dilleniaceae	*Tetracera asiatica*	China	East Asia
644.	*A. tetrazygiae* R.W. Ryan	Mycologia 16(4): 183 (1924)	Melastomataceae	*Tetrazygia* sp., *T. elaeagnoides*	Puerto Rico	Caribbean
645.	*A. tetrazygiicola* Ahn & J.L. Crane	Can. J. Bot. 82: 1627 (2004)	Melastomataceae	*Tetrazygia bicolour*	USA	North America
646.	*A. theacearum* Hosag., T.K. Abraham, C.K. Biju & Shiburaj	New Botanist 24: 23 (1997)	Pentaphylacaceae	cf. *Eurya* sp.	India	South Asia
647.	*A. theae* W. Yamam.	Sci. Rep. Hyogo Univ. Agric., Agric. Biol. Ser. 3(1): 27 (1957)	Theaceae	*Thea sinensis*	Taiwan	East Asia
648.	*A. theissenii* [as '*theissenia*'] R.W. Ryan	Mycologia 16(4): 187 (1924)	Melastomataceae	undetermined, *Miconia* sp.	Puerto Rico	Caribbean
649.	*A. thotteae* Hosag. & Hanlin	New Botanist 22: 188 (1995)	Aristolochiaceae	*Thottea siliquosa*	India	South Asia
650.	*A. thunbergiicola* Hansf.	Proc. Linn. Soc. London 157: 35 (1945) [1944-45]	Acanthaceae	*Thunbergia chrysops*	Sierra Leone	Africa
651.	*A. thylachii* Mibey	in Mibey and Hawksworth, Mycol. Pap. 174: 93 (1997)	Capparaceae	*Thylachium africanum*	Kenya	Africa
652.	*A. tinosporae* Hansf.	Reinwardtia 3: 137 (1954)	Menispermaceae	*Tinospora coriacea*	Java, Indonesia	Southeast Asia
653.	*A. toddaiae* [as '*toddalae*'] A.K. Kar & S.N. Ghosh	Indian Phytopathol. 39(2): 210 (1987) [1986]	Rutaceae	*Toddalia aculeata*	India	South Asia
654.	*A. tonduzii* [as '*tonduzi*'] (Speg.) Syd.	Ann. Mycol. 25(1/2): 74 (1927)	Salicaceae	*Xylosma velutinum*	Costa Rica	Central America
655.	*A. toroi* Hosag. & T.K. Abraham	J. Econ. Taxon. Bot. 24(3): 585 (2000)	Urticaceae	*Boehmeria ramiflora*	Venezuela	South America
656.	*A. torulosa* Berk.	F. Nov.-Zel. 2: 208 (1859)	Piperaceae	*Piper excelsum*	New Zealand	Oceania
657.	*A. toxocarpi* Hosag. & C.K. Biju	in Hosagoudar, Indian Phytopythol. 55(2): 200 (2005)	Apocynaceae	*Toxocarpus* sp.	India	South Asia

No.	Species	Reference	Host plant family	Host plant species	Country	Continent
658.	*A. trachycarpa* Syd. & P. Syd.	Leafl. Philipp. Bot. 5: 1542 (1912)	Fabaceae	*Derris atro-violacea*	Philippines	Southeast Asia
659.	*A. tragiae* S. Hughes	Mycol. Pap. 48: 17 (1952)	Euphorbiaceae	*Tragia spathulata*	Ghana	Africa
660.	*A. transiens* Theiss.	Abh. Zool.-Bot. Ges. Wien 7(3): 42 (1913)	Melastomataceae	*Miconia candolleana*	Brazil	South America
661.	*A. travancorensis* Syd. & P. Syd.	Ann. Mycol. 13(1): 38 (1915)	Apocynaceae	*Marsdenia* sp.	India	South Asia
662.	*A. trichiliae* Doidge	Trans. Roy. Soc. South Africa 8(4): 253 (1920)	Meliaceae	*Trichilia emetica*	South Africa	Africa
663.	*A. trichocladi* Doidge	Bothalia 4: 336 (1942)	Hamamelidaceae	*Trichocladus crinitus*	South Africa	Africa
664.	*A. trichosanthis* B. Song & Ouyang	Mycosystema 22(1): 14 (2003)	Cucurbitaceae	*Trichosanthes mushaensis*	China	East Asia
665.	*A. triloba* Earle	Bull. NY Bot. Gard. 3: 310 (1904)	Euphorbiaceae	*Croton discolor*	Puerto Rico	Caribbean
666.	*A. triumfettae* (G. Arnaud) F. Stevens	in Stevens and Ryan, Ill. Biol. Monogr. 17(2): 54 (1939)	Malvaceae	*Triumfetta* sp.	Brazil	South America
667.	*A. triumfetticola* W. Yamam.	Sci. Rep. Hyogo Univ. Agric., Agric. Biol. Ser. 3(1): 29 (1957)	Malvaceae	*Triumfetta bartramia*	Taiwan	East Asia
668.	*A. tropicalis* Speg.	Bol. Acad. Nac. Cien. Córdoba 23(3-4): 573 (1919)	Clusiaceae	*Rheedia dulcis*	Costa Rica	Central America
669.	*A. tubocapsici* Sawada & W. Yamam.	Spec. Publ., Coll. Agric., Nat. Taiwan Univ. 8: 44 (1959)	Solanaceae	*Tubocapsicum anomalum*	Taiwan	East Asia
670.	*A. turneracearum* Cif.	Sydowia 8(1-6): 247 (1954)	Passifloraceae	*Turnera ulmifolia*	San Domingo	Caribbean
671.	*A. turnerae* Henn.	Hedwigia 43: 372 (1904)	Passifloraceae	*Turnera ulmifolia*	Peru	South America
672.	*A. turraeae* Hansf.	Proc. Linn. Soc. London 156: 116 (1944) [1943-44]	Meliaceae	*Turraea floribunda*	Uganda	Africa
673.	*A. tylophorae-indicae* Hosag., H. Biju & Manojk.	Zoos' Print J. 21(8): 2336 (2006)	Apocynaceae	*Tylophora indica*	India	South Asia
674.	*A. ugandensis* Syd.	Ann. Mycol. 35: 274 (1937)	Meliaceae	*Turraea vogelii*	Uganda	Africa
675.	*A. uncinata* Doidge	Trans. Roy. Soc. South Africa 8(4): 278 (1920)	Salicaceae	*Scolopia mundtii* (misidentified as *Rhamnus prinoides*)	South Africa	Africa
676.	*A. undulata* Doidge	Trans. Roy. Soc. South Africa 8(4): 278 (1920)	Violaceae	*Viola abyssinica*	South Africa	Africa
677.	*A. urerae* Hansf.	Proc. Linn. Soc. London 157: 34 (1945) [1944-45]	Urticaceae	*Urera hypselodendron* [as '*hypselodendronis*']	Uganda	Africa
678.	*A. uribei* Toro	in Chárdon and Toro, J. Dept. Agric. Puerto Rico 14: 231 (1930)	Melastomataceae	*Miconia toroi*	Colombia	South America
679.	*A. uvariae* Hansf.	Proc. Linn. Soc. London 157: 205 (1946) [1944-45]	Annonaceae	*Uvaria bukobensis*	Uganda	Africa
680.	*A. uvariae-microcarpae* B. Song, T.H. Li & J.Q. Liang	Mycosystema 21(1): 15 (2002)	Annonaceae	*Uvaria microcarpa*	China	East Asia
681.	*A. uvariicola* Hansf.	Proc. Linn. Soc. London 157: 34 (1945) [1944-45]	Annonaceae	*Uvaria welwitschii*	Uganda	Africa
682.	*A. vagans* Speg.	Anal. Soc. Cient. Argent. 26(1): 48 (1888)	Solanaceae	*Solanum boerhaaviifolium*	Brazil	South America
683.	*A. vanderbijlii* Werderm.	Feddes Repert Spec. Nov. Regni. Veg. 19: 49 (1923)	Myrtaceae	*Heteropyxis natalensis*	Africa	Africa
684.	*A. venezuela* Syd.	Ann. Mycol. 28(1/2): 144 (1930)	Melastomataceae	*Clidemia bonplandii*	Venezuela	South America
685.	*A. venustula* Syd.	Philipp. J. Sci. 21(2): 140 (1922)	Oxalidaceae	*Averrhoa bilimbi*	Ambon Island, Indonesia	Southeast Asia
686.	*A. vepridis* Doidge	Bothalia 4: 337 (1942)	Rutaceae	*Vepris lanceolata*	South Africa	Africa
687.	*A. verae-crucis* Theiss.	in Saccardo, Ann. Mycol. 12: 300 (1914)	Lauraceae	*Litsea* sp.	Mexico	Central America
688.	*A. veronicae* (Lib.) Cooke	Grevillea 5(35): 122 (1877)	Plantaginaceae	*Veronica officinalis*	Germany, Austria, Switzerland, Belgia, England	Europe

No.	Species	Reference	Host plant family	Host plant species	Country	Continent
689.	*A. versipoda* R.W. Ryan	Mycologia 16(4): 188 (1924)	undetermined	undetermined	Puerto Rico	Caribbean
690.	*A. viburni* Pat.	J. Bot. 2: 149 (1888)	Adoxaceae	*Viburnum* sp.	China	East Asia
691.	*A. violae* Henn.	Hedwigia 40: 63 (1902)	Violaceae	*Viola sylvestris* var. *grypocerates*	Japan	East Asia
692.	*A. visci* Hosag.	Zoos' Print. J. 17(9): 863 (2002)	Santalaceae	*Viscum* sp.	India	South Asia
693.	*A. viticola* A.K. Kar & S.N. Ghosh	Indian Phytopathol. 39(2): 207 (1987) [1986]	Vitaceae	*Vitis japonica*	India	South Asia
694.	*A. weinmannia*e Syd.	Ann. Mycol. 37(4/5): 388 (1939)	Cunoniaceae	*Weinmannia hirtella*, *W. macrophylla*	Ecuador	South America
695.	*A. wingfieldii* Hosag., N.P. Balakr. & Goos	Mycotaxon 59: 184 (1996)	Malvaceae	*Grewia* sp.	India	South Asia
696.	*A. woodfordiae* V.P. Sahni	Mycopathologia 23(4): 330 (1964)	Lythraceae	*Woodfordia fructicosa*	India	South Asia
697.	*A. woodiana* (Doidge) Doidge	Bothalia 4: 297 (1942)	Lauraceae	*Cryptocarya woodii*	Africa	Africa
698.	*A. woodii* Doidge	Bothalia 4: 337 (1942)	Capparaceae	*Capparis gueinzii*	South Africa	Africa
699.	*A. wrightiae* Syd.	in Sydow and Petrak, Ann. Mycol. 29: 236 (1931)	Apocynaceae	*Wrightia lanata*	Philippines	Southeast Asia
700.	*A. xanthogloea* Syd.	Ann. Mycol. 36(2/3): 304 (1938)	Lauraceae	*Litsea dealbata*	Australia	Oceania
701.	*A. xumenensis* Doidge	Bothalia 4: 337 (1942)	Campanulaceae	*Lobelia stellarioides*	South Africa	Africa
702.	*A. xylosmae* J.M. Mend.	Philipp. J. Sci. 49(2): 185 (1932)	Salicaceae	*Xylosma* sp.	Philippines	Southeast Asia
703.	*A. xymalodicola* Hansf.	Publ. Inst. Nat. Étude Agron. Congo Belge 2: 47 (1945)	Monimiaceae	*Xymalos* sp.	DR Congo	Africa
704.	*A. xymalodis* Hansf.	Publ. Inst. Nat. Étude Agron. Congo Belge 2: 48 (1945)	Monimiaceae	*Xymalos* sp.	DR Congo	Africa
705.	*A. yakusimensis* Katum.	Bull. Fac. Agric. Yamaguti Univ. 26: 81 (1975)	Pittosporaceae	*Pittosporum tobira*	Japan	East Asia
706.	*A. yamamotoicola* Hosag. & T.K. Abraham	J. Econ. Taxon. Bot. 24(3): 569 (2000)	Salicaceae	*Casearia merilli*	Taiwan	East Asia
707.	*A. yoshinoi* Katum.	Bull. Fac. Agric. Yamaguti Univ. 26: 82 (1975)	Aquifoliaceae	*Ilex chinensis*	Japan	East Asia
708.	*A. zanthoxyli* W. Yamam.	Sci. Rep. Hyogo Univ. Agric., Agric. Biol. Ser. 3(1): 28 (1957)	Rutaceae	*Zanthoxylum setosum*	Taiwan	East Asia
709.	*A. zeyheri* Doidge	Bothalia 4: 337 (1942)	Myrtaceae	*Eugenia zeyheri*	South Africa	Africa

Excluded species of *Asterina*:

A. acanthopoda var. *hyptidis* Rehm, Hedwigia 40: 160 (1901) [basionym of *Asterina hyptidis* (Rehm) Hosag. & T.K. Abraham (2000)].
A. advenula Syd., Ann. Mycol. 25(1/2): 46 (1927) [invalid species, type collection contains mycelia of a member of Meliolales hyperparasitized by a thyriothecioid ascomycete, compare Chapter 3.3.7].
A. aesculi Desm., Bull. Soc. Bot. Fr. 4: 914 (1856) [basionym of *Carlia aesculi* (Desm.) Höhn. (1930)].
A. agaves Ellis & Everh., Bull. Torr. Bot. Cl. 27: 571 (1900) [basionym of *Stomatogene agaves* (Ellis & Everh.) Theiss. (1918)].
A. aliena Ellis & L.D. Galloway, in Ellis and Everhart, The North American Pyrenomycetes, p. 36 (1892) [dubious species due to hyaline, 1-celled ascospores].
A. alpina Racib., Parasit. Algen und Pilze Javas 3: 34 (1900) [basionym of *Englera alpinus* (Racib.) F. Stevens (1939)].
A. alsophilae Cooke & Massee, Grevillea 18(88): 81(1890) [heterotypic synonym of *Polystomella pulcherrima* (Speg.) Theiss. (1912a)].
A. ammophilae Durieu & Mont., Fl. Alg. 1: 548 (1849) [basionym of *Davidiella ammophilae* (Durieu & Mont.) Aptroot [as '*ammophila*'] (2006)].
A. angulata Desm., Bull. Soc. Bot. Fr. 4: 914 (1857) [dubious species due to temperate collection area].
A. anisopterae Syd. & P. Syd., Ann. Mycol. 12(6): 556 (1914) [basionym of *Asterolibertia anisopterae* (Syd. & P. Syd.) Hansf. (1949)].
A. annonicola Henn [as '*anonicola*'], Hedwigia 41: 107 (1902) [heterotypic synonym of *Prillieuxina winteriana* (Pazschke) G. Arnaud (1918)].
A. anomala Cooke & Harkn., Grevillea 9(51): 87 (1881) [basionym of *Limacinula anomala* (Cooke & Harkn.) D.R. Reynolds (1971)].

A. antidesmatis Petr., Sydowia 12: 472 (1959) [basionym of *Asteridiella antidesmatis* (Hansf.) Hansf. (1957)].
A. appendiculosa (Mont. & Berk.) Mont., Syll. Crypt., p. 256 (1856) [homotypic synonym of *Hypocelis appendiculosa* (Mont. & Berk.) Petr. (1954)].
A. asperata (Schwein.) Berk. & M. Curtis, J. Acad. Nat. Sci. Phil. 2: 291 (1853) [excluded species *fide* Theissen (1913a)].
A. aspersa Berk., Syll. Fung. 1: 476 (1882) [basionym of *Stomiopeltis aspersa* (Berk.) Theiss. (1914)].
A. asperulispora Gaillard, bull. Soc. Myc. Fr. 13: 180 (1897) [basionym of *Englera asperulispora* (Gaillard) F. Stevens (1939)].
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A. silvatica Rehm, in Rick [heterotypic synonym of *Trichasterina styracis* (Theiss.) G. Arnaud (1918) *fide* Müller and Arx (1962)].
A. similis Cooke, Grevillea 10(56): 130 (1882) [heterotypic synonym of *Asterina diplocarpa* Cooke (1882)].
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Host Index of *Asterina* spp.:

Acanthaceae
- *Adhatoda* sp.
  - *Asterina tertia*
- *Crossandra* sp.
  - *Asterina tertia*
- *Dicliptera chinensis*
  - *Asterina diclipterae*
- *Dicliptera clinopodia*
  - *Asterina tertia* var. *africana*
- *Jacobinia* sp.
  - *Asterina costaricensis*
- *Justicia betonica*
  - *Asterina betonicae*
- *Phlogacanthus curviflorus*
  - *Asterina phlogacanthi*
- *Rungia grandis*
  - *Asterina incilis*
- *Sclerochiton harveyanus*
  - *Asterina punctiformis* var. *fimbriata*
- *Strobilanthes longespicatus*
  - *Asterina dendroidea*
- *Thunbergia chrysops*
  - *Asterina thunbergiicola*
- Unknown genus
  - *Asterina brasiliana*
  - *Asterina combreti* var. *brasiliensis*

Achariaceae
- *Kiggelaria africana*
  - *Asterina africana* var. *kiggelariae*
- *Hydnocarpus macrocarpa*
  - *Asterina hydnocarpi*
- *Xylotheca kraussiana*
  - *Asterina africana*

Adoxaceae
- *Viburnum* sp.
  - *Asterina viburni*

Amaryllidaceae
- *Hippeastrum* sp.
  - *Asterina hippeastri*

Anacardiaceae
- *Anacardium excelsum*
  - *Asterina anacardii*
- *Drimycarpus racemosus*
  - *Asterina drimycarpi*
- *Lannea coromandelica*
  - *Asterina lanneae*
- *Nothopegia colebrookiana*
  - *Asterina nothopegiae*

Annonaceae
- *Artabotrys* sp.
  - *Asterina artabotrydis*
- *Cleistopholis patens*
  - *Asterina disseminata* var. *cleistopholidis*
- *Dasymaschalon clusiflorus*
  - *Asterina saginata*
- cf. *Guatteria* sp.
  - *Asterina jahnii*
- *Miliusa* sp.
  - *Asterina miliusiae*
- *Monanthotaxis fornicata*
  - *Asterina monanthotaxis*
- *Polyalthia* sp.
  - *Asterina clemensiae*
  - *Asterina saginata*
- *Saccopetalum tomentosum*
  - *Asterina saccopetali*
- *Uvaria afzali*
  - *Asterina disseminata*
- *Uvaria bukobensis*
  - *Asterina uvariae*
- *Uvaria microcarpa*
  - *Asterina uvariae-microcarpae*
- *Uvaria welwitschii*
  - *Asterina uvariicola*

Apiaceae
- *Sanicula europaea*
  - *Asterina saniculae*
  - *Asterina saniculicola*

Apocynaceae
- *Aganosma acuminata*
  - *Asterina aganosmae*
- *Asclepias curassavica*
  - *Asterina asclepiadis*
- *Cynanchum callialatum*
  - *Asterina cynanchi*
- *Funtumia africana*
  - *Asterina funtumiae*
- *Heterostemma browni*
  - *Asterina heterostemmatis*
- *Holarrhena antidysenterica*
  - *Asterina holarrhenae*
- *Landolphia florida*
  - *Asterina landolphiae*
- *Landolphia ugandensis*
  - *Asterina landolphiicola*
- *Macroscepis* sp.
  - *Asterina concinna*
- *Marsdenia latifolia*
  - *Asterina leonensis*
- *Marsdenia* sp.
  - *Asterina travancorensis*
- *Melodinus australe*
  - *Asterina puellaris*
- *Motandra* sp.
  - *Asterina blanda*
- *Oncinotis inandensis*
  - *Asterina oncinotidis*
- *Oncinotis* sp.
  - *Asterina aulica*
- *Parsonsia alboflavescens*
  - *Asterina parsonisae*
- *Pleioceras barteri*
  - *Asterina pleioceratis*
- *Secamone alpinus*
  - *Asterina secamonicola*
- *Strophanthus hispidus*
  - *Asterina strophanthi*
- *Toxocarpus* sp.
  - *Asterina toxocarpi*
- *Tylophora fanagani*
  - *Asterina peraffinis*
- *Tylophora indica*
  - *Asterina tylophorae-indicae*
- Unknown genus
  - *Asterina crustosa* var. *microspora*
  - *Asterina solanicola* var. *cristata*
- *Wrightia lanata*
  - *Asterina wrightiae*

Aquifoliaceae
- *Byronia* sp.
  - *Asterina tantalina*
- *Ilex ardisioides*
  - *Asterina lobulata*
  - *Asterina scrobiculata*
- *Ilex chinensis*
  - *Asterina yoshinoi*
- *Ilex cymosa*
  - *Asterina porriginosa*
- *Ilex formosana*
  - *Asterina formosana*
- *Ilex mitis*
  - *Asterina bottomleyae*
  - *Asterina hendersonii*
  - *Asterina nodosa*
- *Ilex pubescens*
  - *Asterina ilicicola*
- *Ilex* sp.
  - *Asterina sphaerelloides*
- *Ilex warburgii*
  - *Asterina formosana*
- cf. *Ilex wightiana*
  - *Asterina mitteriana*

Araceae
- *Homalomena philippinensis*
  - *Asterina homalomenae*

Araliaceae
- *Brassaiopsis actinophylla*
  - *Asterina araliae*
- *Cussonia umbellifera*
  - *Asterina ferruginosa*
- *Hydrocotyle* sp.
  - *Asterina hydrocotyles*

Arecaceae
- *Calamus* sp.
  - *Asterina arecacearum*

Aristolochiaceae
- *Heterotropa hirsuticepala*
  - *Asterina heterotropae*

- *Thottea siliquosa*
  - *Asterina thotteae*

Asparagaceae
- *Cordyline stricta*
  - *Asterina cordylines*

Asteraceae
- *Adenostemma lavenia*
  - *Asterina microspora*
- *Adenostemma viscosum*
  - *Asterina adanostemmatis*
- *Blumea* sp.
  - *Asterina blumeae*
- *Eupatorium glandulosum*
  - *Asterina eupatorii*
- *Gerbera cordata*
  - *Asterina gerbericola*
- *Lactuca dantata*
  - *Asterina lactucina*
- *Solidago elliptica*
  - *Asterina solidaginis*

Atherospermataceae
- *Doryphora sassafras*
  - *Asterina doryphorae*

Berberidaceae
- *Mahonia beali*
  - *Asterina mahoniae*
- *Mahonia leschenaulti*
  - *Asterina goosii*

Bignoniaceae
- *Markhamia platycalyx*
  - *Asterina markhamiae*
- *Memora* sp.
  - *Asterina memorae*
- *Nyctocalos cuspidatum*
  - *Asterina nycticaliae*
- *Spathodea nilotica*
  - *Asterina spathodeae*
- *Tecoma australis*
  - *Asterina polyloba*

Brunelliaceae
- *Brunellia comocladifolia*
  - *Asterina kernii*

Burseraceae
- *Canarium* sp.
  - *Asterina fallaciosa*

Campanulaceae
- *Centropogon aurantiacum*
  - *Asterina pachynema*
- *Centropogon cornutus*
  - *Asterina centropogonis*
- *Clermontia* sp.
  - *Asterina clermontiae*
- *Lobelia nicotinofolia*
  - *Asterina lobeliacearum*
- *Lobelia* sp.
  - *Asterina lobeliae*
  - *Asterina lobeliicola*
- *Lobelia stellarioides*
  - *Asterina xumenensis*
- *Siphocampylus campanulatus*
  - *Asterina siphocampyli*

Cannabaceae
- *Celtis* sp.
  - *Asterina celtidicola*
- *Sponia virgata*
  - *Asterina sponiae*
- *Trema* sp.
  - *Asterina dallasica*

Capparaceae
- *Capparis acuminata*
  - *Asterina boedjiniana*
- *Capparis citrifolia*
  - *Asterina elegans*
- *Capparis flavicans*
  - *Asterina cambodiana*
- *Capparis gueinzii*
  - *Asterina woodii*
- *Capparis kikuchii*
  - *Asterina koshunensis*
  - *Asterina sawadai*
- *Capparis* sp.
  - *Asterina papillata*
- *Capparis zeyheri*
  - *Asterina capparicola*
- *Capparis zeylandica*
  - *Asterina capparis*
- *Maerua* sp.
  - *Asterina celtidicola* var. *microspora*
  - *Asterina peglerae*
- *Stixis suaveolens*
  - *Asterina stixis*
- *Thylachium africanum*
  - *Asterina thylachii*
- Unknown genus
  - *Asterina grandicarpa*

Caricaceae
- *Carica papaya*
  - *Asterina caricarum* var. *microspora*
- *Carica* sp.
  - *Asterina caricarum*
- *Jacaratia dodecaphylla*
  - *Asterina jacaratiae*

Celastraceae
- *Cassine papillosa*
  - *Asterina dissilens*
- *Celastrus paniculatus*
  - *Asterina tarlacensis*
- *Euonymus crenulatus*
  - *Asterina euonymi*
- *Glyptopetalum zeylanicum*
  - *Asterina glyptopetali*
- *Gymnosporia senegalensis*
  - *Asterina dissilens* var. *senegalensis*
  - *Asterina gymnosporiae*
- *Hippocratea volubilis*
  - *Asterina hippocrateae*
- *Loesneriella obtusifolia*
  - *Asterina loesenerieliae*
- *Microtropis latifolia*
  - *Asterina mircotropidicola*
- *Microtropis ovalifolia*
  - *Asterina microtropidis*
- *Salacia* sp.
  - *Asterina rizalica*
  - *Asterina salaciae*

Chloranthaceae
- *Chloranthus officinalis*
  - *Asterina chloranthi*
- *Sarcandra chloranthoides*
  - *Asterina sarcandrae*

Chrysobalanaceae
- *Chrysobalanus* sp.
  - *Asterina eocenica*
  - *Asterina nodosaria*
- *Licania* sp.
  - *Asterina schroeteri* var. *licaniae*
- *Moquilea tomentosa*
  - *Asterina atypica*

Clusiaceae
- *Garcinia mangostana*
  - *Asterina garciniae*
- *Garcinia morella*
  - *Asterina morellae*
- *Garcinia multiflora*
  - *Asterina garciniicola*
- *Rheedia dulcis*
  - *Asterina tropicalis*

Columelliaceae
- *Columella japonica*
  - *Asterina columellicola*

Combretaceae
- *Anogeissus latifolia*
  - *Asterina anogeissi*
- *Combretum indica*
  - *Asterina combreti* var. *cylindrica*
- *Combretum* sp.
  - *Asterina shimbaensis*
- *Quisqualis* sp.
  - *Asterina escharoides*

Connaraceae
- *Jaundea pinnata*
  - *Asterina jaundeae*

Convolvulaceae
- *Argyreia capitata*
  - *Asterina argyreiae*
- *Ipomoea* sp.
  - *Asterina pseudopelliculosa*

Cornaceae
- *Alangium bezoniaefolium*
  - *Asterina perpusilla*

Cucurbitaceae
- *Fevillea cordifolia*
  - *Asterina hamatula*

- *Hodgsonia macrocarpa* var. *capniocarpa*
  - *Asterina hodgsoniae*
- *Luffa cylindrica*
  - *Asterina simillima*
- *Momordica* sp.
  - *Asterina momordica*
- *Trichosanthes mushaensis*
  - *Asterina trichosanthis*

Cunoniaceae

- *Weinmannia hirtella*
  - *Asterina weinmanniae*
- *Weinmannia macrophylla*
  - *Asterina weinmanniae*

Daphniphyllaceae

- *Daphniphyllum glaucescens*
  - *Asterina daphniphylli*
- *Daphniphyllum macropodum*
  - *Asterina daphniphyllicola*

Dichapetalaceae

- *Dichapetalum gelonioides*
  - *Asterina dichapetali*

Dilleniaceae

- *Davilla rugosa*
  - *Asterina davillae*
  - *Asterina davillae* var. *major*
- *Dillenia* sp.
  - *Asterina dilleniae*
  - *Asterina ramosii*
- *Doliocarpus dentatus*
  - *Asterina orthosticha*
- *Tetracera alnifolia*
  - *Asterina scruposa* var. *longipoda*
- *Tetracera asiatica*
  - *Asterina tetracericola*
- *Tetracera potatoria*
  - *Asterina scruposa*
- *Tetracera scandens*
  - *Asterina tetracerae*
- Unknown genus
  - *Asterina laevipodia*
  - *Asterina stipitipodia*

Dioscoreaceae

- *Dioscorea* sp.
  - *Asterina hians*

Dipterocarpaceae

- *Anisoptera thurifera*
  - *Asterina anisoptericola*
  - *Asterina rizalensis*
- *Hopea parviflora*
  - *Asterina hopeicola*
- *Hopea ponga*
  - *Asterina hopeae*
- *Parashorea plicata*
  - *Asterina camariensis*
  - *Asterina shoreana*
- *Shorea talura*
  - *Asterina pluripora*

Dryopteridaceae

- *Aspidium falcatum* var. *fortunei*
  - *Asterina aspidii*

Ebenaceae

- *Maba nigrescens*
  - *Asterina mabae*
- *Maba warneckei*
  - *Asterina clasterosporium*
- *Diospyros* sp.
  - *Asterina diospyri*

Elaeagnaceae

- *Elaeagnus philippinensis*
  - *Asterina elaeagni*
- *Elaeagnus pungentis*
  - *Asterina japonica*

Elaeocarpaceae

- *Crinodendron patagua*
  - *Asterina myriantha*
- *Elaeocarpus kobanmochi*
  - *Asterina elaeocarpi-kobanmochii*
- *Elaeocarpus lanceoefolius*
  - *Asterina elaeocarpi-kobanmochii*
- *Elaeocarpus pendula*
  - *Asterina elaeocarpi*
- *Elaeocarpus punctatus*
  - *Asterina elaeocarpicola*
- *Elaeocarpus* sp.
  - *Asterina borneensis*
  - *Asterina elaeocarpi* var. *ovalis*
- *Elaeocarpus tectorius*
  - *Asterina gamsii*

Ericaceae

- *Rhododendron arboreum*
  - *Asterina hakgalensis*

Erythropalaceae

- *Erythropalum populifolium*
  - *Asterina erythropalicola*
- *Erythropalum scandens*
  - *Asterina erythropali*

Escalloniaceae

- *Escallonia pulverulenta*
  - *Asterina negeriana*
- *Polysoma brachyantha*
  - *Asterina polysomae*

Euphorbiaceae

- *Acalypha macrostachya* var. *hirsutissima*
  - *Asterina acalyphae*
- *Alchornea cordifolia*
  - *Asterina alchorneae*
  - *Asterina alchorneicola*
  - *Asterina kampalensis*
- *Alchornea javensis*
  - *Asterina alchorneae-javensis*
- *Claoxylon australe*
  - *Asterina fraseriana*
- *Claoxylon* sp.
  - *Asterina ildefonsiae*
  - *Asterina marginalis*
  - *Asterina tenuis*
- *Conceveiba javanensis*
  - *Asterina punctiformis*
- *Croton discolor*
  - *Asterina triloba*
  - *Croton rivularis*
  - *Asterina crotoniensis*
- *Croton* sp.
  - *Asterina crotonicola*
  - *Asterina crotonis*
- *Erythrococca berberida*
  - *Asterina radiofissilis*
- *Excoecaria crenulata*
  - *Asterina excoecariicola*
- *Macaranga* sp.
  - *Asterina macarangae*
- *Mallotus apelta*
  - *Asterina malloti-apeltae*
- *Mallotus philippinensis*
  - *Asterina malloti*
  - *Asterina malloticola*
- *Manihot glaziovii*
  - *Asterina manihotis*
- *Mareya spicata*
  - *Asterina scaberrima*
- *Omphalea* sp.
  - *Asterina omphaleae*
- *Ostodes* sp.
  - *Asterina sphaeropoda*
- *Pera ferruginea*
  - *Asterina perae*
- *Tragia spathulata*
  - *Asterina tragiae*
- Unknown genus
  - *Asterina consociata* var. *rectangularis*

Eupomatiaceae

- *Eupomatia laurinea*
  - *Asterina eupomatiae*

Fabaceae s.l.

- *Afzelia quanzensis*
  - *Asterina afzeliae*
- *Baphia nitida*
  - *Asterina baphiae*
- *Caesalpinia crista*
  - *Asterina ciferriana*
- *Castanospermum* sp.
  - *Asterina platystoma*
- *Crotalaria mespontica*
  - *Asterina scitula*
- *Derris atro-violacea*
  - *Asterina trachycarpa*
- *Derris sinuata*
  - *Asterina singaporensis*
- *Derris uliginosa*
  - *Asterina derridis*

- *Dialium heudeloti*
  - *Asterina contigua*
- *Holocalyx balansae*
  - *Asterina holocalycis*
- *Hovea longifolia*
  - *Asterina hoveaefolia*
- *Paramacrolobium coeruleum*
  - *Asterina paramacrolobii*
- *Pterigopodium* sp.
  - *Asterina pterygopodii*
- *Saraca asoca*
  - *Asterina saracae*
- *Sweetia nitens*
  - *Asterina marmellensis*

Fagaceae
- *Castanopsis kawakamii*
  - *Asterina castanopsis*

Garryaceae
- *Aucuba japonica*
  - *Asterina aucubae*
- *Aucuba* sp.
  - *Asterina pauper*

Gesneriaceae
- *Cyrtandra picata*
  - *Asterina cyrtandrae*
- *Fieldia australis*
  - *Asterina fieldiae*
- *Mitraria coccinia*
  - *Asterina mitrariae*
- *Sarmienta repens*
  - *Asterina dilabens*
- *Streptocarpus rexi*
  - *Asterina streptocarpi*

Hamamelidaceae
- *Altingia chinensis*
  - *Asterina altingiae*
- *Distylium racemosum*
  - *Asterina distyliicola*
- *Loropetalum chinense*
  - *Asterina loropetali*
- *Trichocladus crinitus*
  - *Asterina trichocladi*

Hydrangeaceae
- *Hydrangea chinensis*
  - *Asterina hydrangeae*

Icacinaceae
- *Mappia racemosa*
  - *Asterina mappiae*
- *Natsiatum herpecticum*
  - *Asterina natsiati*

Iridaceae
- *Libertia* sp.
  - *Asterina libertiae*

Lamiaceae
- *Achyrospermum schimperi*
  - *Asterina achyrospermi*
- *Clerodendrum capitatum*
  - *Asterina clerodendricola*
- *Clerodendrum* sp.
  - *Asterina entebbeensis*
- *Gardoquia multiflora*
  - *Asterina gardoquiae*
- *Geniosporium paludosum*
  - *Asterina geniospori*
- *Gmelina* sp.
  - *Asterina gmelinae*
- *Hyptis sauveolense*
  - *Asterina hyptidicola*
- *Hyptis* sp.
  - *Asterina hyptidis*
- *Phyllostegia* sp.
  - *Asterina phyllostegiae*
- *Plectranthus* sp.
  - *Asterina plectranthi*
- *Pogostemon velatus*
  - *Asterina pogostemonis*
- *Premna nauseosa*
  - *Asterina pusilla*
- *Pterygopodium* sp.
  - *Asterina pterygopodii*
- *Vitex* sp.
  - *Asterina sphaerotheca*

Lardizabalaceae
- *Stauntonia hexaphylla*
  - *Asterina stauntoniae*

Lauraceae
- *Cinnamomum* sp.
  - *Asterina cinnamomi*
  - *Asterina cinnamomicola*
- *Cryptocarya bourdillonii*
  - *Asterina cryptocariicola*
- *Cryptocarya woodii*
  - *Asterina woodiana*
- *Lindera* sp.
  - *Asterina linderae*
- *Litsea dealbata*
  - *Asterina xanthogloea*
- *Litsea ligustrina*
  - *Asterina litseae-ligustrinae*
- *Litsea* sp.
  - *Asterina litseae*
  - *Asterina verae-crucis*
- *Litsea verticillata*
  - *Asterina litseae-verticillatae*
- *Machilus thunbergii*
  - *Asterina machili*
- *Nectandra* sp.
  - *Asterina ampullipeda*
- *Neolitsea* sp.
  - *Asterina neolitseae*
  - *Asterina neolitsiicola*
- *Ocotea cuneata*
  - *Asterina ocotearum*
- *Persea caroliniensis*
  - *Asterina tenella*
- *Persea palustris*
  - *Asterina delitescens*
- *Phoebe costaricana*
  - *Asterina phoebes*
- *Phoebe lanceolata*
  - *Asterina phoebeicola*
- *Phoebe neurophylla*
  - *Asterina hamata*
  - *Asterina poliothea*
- Unknown genus
  - *Asterina aemula*
  - *Asterina insignis*
  - *Asterina lauracearum*

Linaceae
- *Hugonia platysepala*
  - *Asterina hapala*

Loganiaceae
- *Geniostoma arboreum*
  - *Asterina geniostomaticola*
  - *Asterina geniostomatis*
- *Strychnos* cf. *nux-blanda*
  - *Asterina sandowayensis*
- *Strychnos* sp.
  - *Asterina strychni*

Loranthaceae
- *Gaiadendron punctatum*
  - *Asterina gaiadendricola*
- *Loranthus leonensis*
  - *Asterina deightonii*
- *Loranthus rhododendricola*
  - *Asterina loranthi-rhododendricolae*
- *Loranthus* sp.
  - *Asterina aburiensis*
  - *Asterina loranthicola*
- Unknown genus
  - *Asterina loranthacearum*
  - *Asterina loranthacearum* var. *javensis*

Lythraceae
- *Cuphea infundibulum*
  - *Asterina cupheae*
- *Lafoensia glyptocarpa*
  - *Asterina lafoensiae*
- *Lawsonia alba*
  - *Asterina lawsoniae*
- *Lawsonia inermis*
  - *Asterina lawsoniicola*
- *Woodfordia fructicosa*
  - *Asterina woodfordiae*

Magnoliaceae
- *Manglietia moto*
  - *Asterina manglietiae*
- *Michelia maudiae*
  - *Asterina micheliicola*
- *Michelia nilagirica*
  - *Asterina micheliae*

Malpighiaceae

- *Banisteria argentea*
  - *Asterina banisteriae*
- *Byrsonima* sp.
  - *Asterina byrsonimicola*
- *Malpighia glabra*
  - *Asterina indecora*
- *Mascagnia chlorocarpa* var. *paradoxa*
  - *Asterina mascagniae*

Malvaceae

- *Abutilon* sp.
  - *Asterina sidicola*
- *Byttneria australis*
  - *Asterina buttneriae*
- *Corchorus hirtus*
  - *Asterina sidicola*
- *Duria zibethinus*
  - *Asterina anomala*
- *Grewia lasiocarpa*
  - *Asterina delicata*
- *Grewia nyanzae*
  - *Asterina nyanzae*
- *Grewia* sp.
  - *Asterina wingfieldii*
- *Helicteres angustifolia*
  - *Asterina helicteris*
- *Helicteres hirsua*
  - *Asterina leptalea*
- *Hibiscus* sp.
  - *Asterina hibisci*
- *Microcos paniculata*
  - *Asterina microcosi*
- *Sida carpinifolia*
  - *Asterina sidicola*
- *Sida cordifolia*
  - *Asterina diplocarpa*
- *Sida hislopii*
  - *Asterina pavoniae*
- *Sida rhombifolia*
  - *Asterina kusukusuensis*
- *Sida* sp.
  - *Asterina sidicola*
- *Triumfetta bartramia*
  - *Asterina isothea*
  - *Asterina triumfetticola*
- *Triumfetta* sp.
  - *Asterina triumfettae*
- Unknown genus
  - *Asterina sidicola*

Melastomataceae

- *Arthrostemma campanulata*
  - *Asterina confertissima*
- *Astronia* sp.
  - *Asterina astroniae*
- *Barthea formosana*
  - *Asterina sinsuieiensis*
- *Bellucia* sp.
  - *Asterina belluciae*
- *Blakea* sp.
  - *Asterina denigrata*
  - *Asterina melanotes*
- *Centronia excelsa*
  - *Asterina centroniae*
- *Clidemia bonplandii*
  - *Asterina venezuela*
- *Clidemia dentata*
  - *Asterina schlechteriana*
- *Conostegia oerstediana*
  - *Asterina amadelpha*
- *Melastoma candidum*
  - *Asterina melastomatis-candidi*
- *Melastoma malabathricum*
  - *Asterina melastomaticola*
- *Memecylon edule*
  - *Asterina memecyloniae*
- *Memecylon* sp.
  - *Asterina madikeriensis*
- *Miconia candolleana*
  - *Asterina transiens*
- *Miconia ciliata*
  - *Asterina antioquensis*
- *Miconia coriacea*
  - *Asterina melastomatis* var. *verrucospora*
- *Miconia guianensis*
  - *Asterina guianensis*
- *Miconia impetiolaris*
  - *Asterina melastomatacearum*
  - *Asterina racemosae*
- *Miconia racemosa*
  - *Asterina hughesii*
  - *Asterina melastomatacearum*
  - *Asterina miconiicola*
  - *Asterina racemosae*
- *Miconia sintensii*
  - *Asterina racemosae*
- *Miconia* sp.
  - *Asterina melastomatis*
  - *Asterina miconiae*
  - *Asterina spathulata*
  - *Asterina theissenii*
- *Miconia toroi*
  - *Asterina uribei*
- *Tetrazygia elaeagnoides*
  - *Asterina tetrazygiae*
- *Tetrazygia bicolour*
  - *Asterina tetrazygiicola*
- *Tetrazygia* sp.
  - *Asterina tetrazygiae*
- Unknown genus
  - *Asterina hypophylla*
  - *Asterina inaequalis*
  - *Asterina maublancii*
  - *Asterina melastomataceae* var. *microspora*
  - *Asterina melastomataceae*
  - *Asterina pulla*
  - *Asterina theissenii*

Meliaceae

- *Aglaia* sp.
  - *Asterina aglaiae*
- *Chukrasia tabularis*
  - *Asterina chukrasiae*
- *Cippadessa baccifera*
  - *Asterina cipadessae*
- *Cippadessa fructicosa*
  - *Asterina malleae*
- *Guarea* sp.
  - *Asterina submegas*
- *Trichilia emetica*
  - *Asterina trichiliae*
- *Trichilia* sp.
  - *Asterina guaranitica*
  - *Asterina silvatica*
- *Turraea floribunda*
  - *Asterina turraeae*
- *Turraea vogelii*
  - *Asterina ugandensis*
- Unknown genus
  - *Asterina opposita*

Menispermaceae

- *Anamirta cocculus*
  - *Asterina anamirtae*
- *Tinospora coriacea*
  - *Asterina tinosporae*
- Unknown genus
  - *Asterina menispermacearum*
  - *Asterina samoensis*

Monimiaceae

- *Xymalos* sp.
  - *Asterina xymalodicola*
  - *Asterina xymalodis*

Moraceae

- *Chlorophora excelsa*
  - *Asterina chlorophorae*
- *Dorstenia contrajerva*
  - *Asterina dorsteniae*
- *Ficus globosa*
  - *Asterina fici-globosae*
- *Ficus* sp.
  - *Asterina mysorensis*
- *Maclura mora*
  - *Asterina consociata*
- *Malaisia scandens*
  - *Asterina malaisiae*

Myristicaceae

- *Coelocaryon kleinei*
  - *Asterina coelocaryi*
- *Horsfieldia glabra*
  - *Asterina horsfieldiicola*
- *Horsfieldia irya*
  - *Asterina horsfieldiae*

- *Knema attenuata*
  - *Asterina knemae-attenuatae*
- *Pycnanthus schweinfurthii*
  - *Asterina pycnanthi*

Myrtaceae

- *Cleistocalyx operculatus*
  - *Asterina dinghuensis*
- *Eugenia buxifolia*
  - *Asterina fawcettii*
- *Eugenia caryophyllata*
  - *Asterina assimilis*
- *Eugenia bukobensis*
  - *Asterina bukobensis*
- *Eugenia discifera*
  - *Asterina disciferae*
- *Eugenia formosana*
  - *Asterina eugeniae-formosanae*
- *Eugenia jambolana*
  - *Asterina jambolanae*
  - *Asterina pemphidioides*
- *Eugenia ligustrina*
  - *Asterina ligustrinae*
- *Eugenia lucida*
  - *Asterina lucida*
- *Eugenia natalitia*
  - *Asterina natalitia*
- *Eugenia* sp.
  - *Asterina colliculosa*
  - *Asterina ditissima*
  - *Asterina eugeniae*
  - *Asterina ramosiana*
- *Eugenia uniflora*
  - *Asterina mandaquinensis*
- *Eugenia zeyheri*
  - *Asterina zeyheri*
- *Heteropyxis natalensis*
  - *Asterina vanderbijlii*
- *Plinia* sp.
  - *Asterina pliniae*
- *Psidium guajava*
  - *Asterina psidii*
- *Rhodomyrtus tomentosa*
  - *Asterina rhodomyrti*
- *Syzygium claviflorum*
  - *Asterina claviflori*
- *Syzygium cordatum*
  - *Asterina syzygii* var. *microspora*
  - *Asterina syzygiicola*
- *Syzygium cumini*
  - *Asterina gopalkrishnanii*
- *Syzygium gerrardi*
  - *Asterina syzygii*
- *Syzygium henianum*
  - *Asterina henianii*
- *Syzygium jambolana*
  - *Asterina quarta*
- *Tristania laurinea*
  - *Asterina decumana*
- Unknown genus
  - *Asterina balansae*
  - *Asterina kosciuskensis*
  - *Asterina megalosperma*
  - *Asterina rickii*

Olacaceae

- *Olax imbricata*
  - *Asterina oligocarpa*
- *Olax subscorpioides*
  - *Asterina connectilis*
- *Olax wightiana*
  - *Asterina olacicola*
  - *Asterina olacis*

Oleaceae

- *Jasminum bignoniacearum*
  - *Asterina jasmine* var. *indica*
- *Jasminum cordifolium*
  - *Asterina erysiphoides* var. *indica*
- *Jasminum dichotomum*
  - *Asterina erysiphoides* var. *delicata*
- *Jasminum* sp.
  - *Asterina jasmini*
  - *Asterina jasminicola*
  - *Asterina pongalaparensis*
  - *Asterina spissa*
- *Jasminum subtriplinerve*
  - *Asterina jasmini-subtrinervis*
- *Jasminum tortuosum*
  - *Asterina erysiphoides*
- *Ligustrum travancorium*
  - *Asterina ligustricola*

Oliniaceae

- *Olinia cymosa*
  - *Asterina reticulata*
- *Plectronia cumingii*
  - *Asterina plectroniae*
- *Plectronia gynochthodes*
  - *Asterina plectroniaecola*

Onagraceae

- *Fuchsia scabriuscula*
  - *Asterina fuchsiae*

Opiliaceae

- *Cansjera rheedei*
  - *Asterina cansjerae*
  - *Asterina cansjericola*
  - *Asterina cansjericola* var. *indica*
  - *Asterina echinospora*
- *Champereia cumingiana*
  - *Asterina champereiae*
  - *Asterina decipiens*
- *Champereia fragilis*
  - *Asterina elmeri*
- *Champereia manillana*
  - *Asterina champeriicola*
- *Opilia amentacea*
  - *Asterina crebra*
- *Opilia* sp.
  - *Asterina opiliae*

Orchidaceae

- *Ansellia africana*
  - *Asterina raripoda*
- *Erythrodes killipii*
  - *Asterina killipii*
- *Liparis* sp.
  - *Asterina liparidis*

Oxalidaceae

- *Averrhoa bilimbi*
  - *Asterina venustula*
- *Averrhoa carambola*
  - *Asterina averrhoae*

Pandaceae

- *Microdesmis caseariifolia*
  - *Asterina hainanensis*
  - *Asterina ramuligera*
- *Panda oleosa*
  - *Asterina pandae*
  - *Asterina pandicola*

Paulowniaceae

- *Brandisia* sp.
  - *Asterina brandisiae*

Passifloraceae

- *Adenia hondala*
  - *Asterina adeniicola*
- *Adenia lobata*
  - *Asterina adeniae*
- *Barteria fistulosa*
  - *Asterina barteriae*
- *Passiflora multiflora*
  - *Asterina arnaudii*
- *Passiflora rubra*
  - *Asterina passifloricola*
- *Passiflora sexflora*
  - *Asterina arnaudii*
  - *Asterina tacsoniae* var. *passiflorae*
- *Passiflora* sp.
  - *Asterina megalospora*
  - *Asterina perconferta*
  - *Asterina platasca*
  - *Asterina tacsoniae* var. *passiflorae*
- *Passiflora speciosa*
  - *Asterina mulleri*
- *Smeathmannia pubescens*
  - *Asterina deviata*
- *Tacsonia* sp.
  - *Asterina tacsoniae*
- *Turnera ulmifolia*
  - *Asterina turneracearum*
  - *Asterina turnerae*

Pentaphylacaceae

- *Euyra acuminata*
  - *Asterina euryae*
- cf. *Eurya* sp.
  - *Asterina cannonii*
  - *Asterina theacearum*
- *Pentaphylax eryoides*
  - *Asterina pentaphylacis*

Phyllanthaceae
- *Aporosa aurita*
  - *Asterina aporusae*
- *Aporosa roxburghii*
  - *Asterina aporusae* var. *cylindrica*
- *Breynia acuminata*
  - *Asterina breyniaecola*
- *Glochidion ilenosi*
  - *Asterina cassiae*
- *Glochidion* sp.
  - *Asterina lobulifera*
- *Phyllanthus reticulatus*
  - *Asterina phyllanthicola*
- *Phyllanthus* sp.
  - *Asterina phyllanthigena*

Piperaceae
- *Lepianthes umbellata*
  - *Asterina lepianthis*
- *Piper excelsum*
  - *Asterina torulosa*
- *Piper* sp.
  - *Asterina elachista*
  - *Asterina piperina*

Pittosporaceae
- *Citriobatus multiflorus*
  - *Asterina citriobati*
- *Pittosporum abyssinicum*
  - *Asterina hansfordii*
- *Pittosporum ferrugineum*
  - *Asterina pittospori*
- *Pittosporum pentandrum*
  - *Asterina densa*
- *Pittosporum tobira*
  - *Asterina yakusimensis*
- *Pittosporum undulatum*
  - *Asterina densa* var. *australiensis*
  - *Asterina recisa*

Plantaginaceae
- *Veronica officinalis*
  - *Asterina veronicae*

Poaceae
- *Panicum latifolium*
  - *Asterina fumagina*
- *Phyllostachys bambusae*
  - *Asterina hingensis*
- Unknown genus
  - *Asterina leveillei*
  - *Asterina subglobulifera*

Polygonaceae
- *Coccoloba* sp.
  - *Asterina coccolobae*

Primulaceae
- *Ardisia colorata*
  - *Asterina ardisiae*
- *Embelia schimperi*
  - *Asterina embeliae*
- *Myrsine semiserrata* var. *subspinosa*
  - *Asterina myrsines*
- *Rapanea ferruginea*
  - *Asterina aphanes*
- *Suttonia* sp.
  - *Asterina suttoniae*
- Unkown genus
  - *Asterina myrsinacearum*

Proteaceae
- *Banksia dentata*
  - *Asterina papuensis*
- *Banksia* sp.
  - *Asterina minor*
- *Helicia formosana*
  - *Asterina heliciae*
- *Orites excelsa*
  - *Asterina oritis*

Putranjivaceae
- *Drypetes arguta*
  - *Asterina excoecariae*
- *Drypetes glauca*
  - *Asterina drypeticola*
- *Drypetes* sp.
  - *Asterina drypetis*

Ranunculaceae
- *Clematis glycinoides*
  - *Asterina clematidis*
- *Naravelia zeylanica*
  - *Asterina naraveliae*

Rhabdodendraceae
- *Rhabdodendron crassipes*
  - *Asterina rhabdodendri*

Rhamnaceae
- *Rhamnus* sp.
  - *Asterina rhamni*

Rubiaceae
- *Canthium ciliatum*
  - *Asterina knysnae*
- *Canthium coprosmoides*
  - *Asterina knysnae* var. *australiensis*
- *Canthium dicoccum*
  - *Asterina canthii-dicocci*
- *Canthium* sp.
  - *Asterina canthii*
- *Coffea arabica*
  - *Asterina coffeicola*
- *Diplospora viridiflora*
  - *Asterina subcylindracea*
- *Genipa americana*
  - *Asterina genipae*
- *Gouldia coriacea*
  - *Asterina gouldiae*
- *Gonzalagunia spicata*
  - *Asterina ekmanii*
- *Gonzalea cornifolia*
  - *Asterina oligopoda*
- *Hillia parasitica*
  - *Asterina dilabens* var. *hilliae*
- *Oxyantus gerrardi*
  - *Asterina oxyanthi*
- *Oxyanthus* sp.
  - *Asterina aterrima*
- *Palicourea costaricensis*
  - *Asterina erebia*
- *Pavetta* sp.
  - *Asterina lepiniana*
- *Psychotria pubescens*
  - *Asterina psychotriae*
- *Randia benthamiana*
  - *Asterina randiae-bethamianae*
- *Urophyllum banahaense*
  - *Asterina platypoda*

Rutaceae
- *Acronychia laurifolia*
  - *Asterina rhabdodendri* var. *lavibus*
- *Acronychia pedunculata*
  - *Asterina acronychiae*
- *Aegle marmelos*
  - *Asterina delicatula*
- *Atalantia rotundifolia*
  - *Asterina atalantiae*
- *Clausena inaequalis*
  - *Asterina clausenicola*
- *Correa lawrensiana*
  - *Asterina correicola*
- *Euodia aromatica*
  - *Asterina euodiae*
- *Euodia pteleaefolia*
  - *Asterina euodiicola*
- *Fagara avicennae*
  - *Asterina fagarae*
- *Dictyoloma* sp.
  - *Asterina dictyolomatis*
- *Glycosmis* sp.
  - *Asterina banguinensis*
  - *Asterina glycosmidis*
- *Melicope australasica*
  - *Asterina decora*
- *Melicope lunuankanda*
  - *Asterina melicopicola*
- *Murraya exotica*
  - *Asterina murrayae*
- *Toddalia aculeate*
  - *Asterina toddaiae*
- *Vepris lanceolata*
  - *Asterina vepridis*
- *Zanthoxylum setosum*
  - *Asterina zanthoxyli*

Sabiaceae
- *Meliosma herbertii*
  - *Asterina meliosmicola*
- *Meliosma rhoifolia*
  - *Asterina meliosmae*
- *Meliosma simplicifolia* subsp. *pungens*
  - *Asterina sabiacearum*

- *Sabia* sp.
  - *Asterina sabiana*

Salicaceae

- *Azara serrata*
  - *Asterina azarae*
- *Banara regia*
  - *Asterina microchita*
- *Casearia engleri*
  - *Asterina caseariae*
- *Casearia esculenta*
  - *Asterina caseariae-esculentae*
  - *Asterina caseariicola*
- *Casearia merilli*
  - *Asterina yamamotoicola*
- *Flacourtia indica*
  - *Asterina flacourtiae*
- *Flacourtia inermis*
  - *Asterina spectabilis*
- *Homalium alnifolium*
  - *Asterina homalii*
- *Homalium dichophyllum*
  - *Asterina homaliicola*
- *Scolopia crenata*
  - *Asterina flacourtiacearum*
- *Scolopia mundtii*
  - *Asterina uncinata*
- *Scolopia* sp.
  - *Asterina cylindrophora*
  - *Asterina granulosa*
  - *Asterina talacauveriana*
- *Scolopia zeyheri*
  - *Asterina scolopiae*
- *Trimeria grandifolia*
  - *Asterina grewiae*
- *Trimeria trinervis*
  - *Asterina grewiae* var. *zonata*
- Unknown genus
  - *Asterina flacourtiaceicola*
- *Xylosma* sp.
  - *Asterina xylosmae*
- *Xylosma velutinum*
  - *Asterina tonduzii*

Santalaceae

- *Osyridicarpos natalensis*
  - *Asterina polythyria*
- *Phoradendron flavescens*
  - *Asterina phoradendricola*
- *Santalum album*
  - *Asterina congesta*
- *Viscum* sp.
  - *Asterina visci*

Sapindaceae

- *Cupania revoluta*
  - *Asterina cupaniae*
- *Mischocarpus hainanensis*
  - *Asterina mischocarpi*
- *Schmidelia* sp.
  - *Asterina schmideliae*
- Unknown genus
  - *Asterina huallagensis*

Sapotaceae

- *Chrysophyllum magalis-montana*
  - *Asterina bosmanae*
- *Chrysophyllum natalense*
  - *Asterina opaca*
- *Chrysophyllum* sp.
  - *Asterina chrysophylli*
  - *Asterina sydowiana*
- *Dipholis angustifolia*
  - *Asterina dipholidis*
- *Mimusops welwitschii*
  - *Asterina mimusopis*
- *Palaquium ellipticum*
  - *Asterina palaquii*
- *Planchonella nitida*
  - *Asterina planchonellae*
- *Pouteria grandifolia*
  - *Asterina pouteriae*
- *Sideroxylon angustifolium*
  - *Asterina laxiuscula*
- *Sideroxylon ferrugineum*
  - *Asterina diaphorella*
- *Sideroxylon inerme*
  - *Asterina robusta*
- *Sideroxylon* sp.
  - *Asterina saccardoana*
  - *Asterina sideroxyli*
- Unknown genus
  - *Asterina acanthopoda*
  - *Asterina carbonacea* var. *acanthopoda*
  - *Asterina paraguayensis*
  - *Asterina sapotacearum*

Schlegeliaceae

- *Schlegelia parviflora*
  - *Asterina schlegeliae*

Schoepfiaceae

- *Schoepfia* sp.
  - *Asterina samanensis*

Scrophulariaceae

- *Chilianthus arboreus*
  - *Asterina inconspicua*

Simaroubaceae

- *Brucea javanica*
  - *Asterina bruceae*
- *Picrasma philippinensis*
  - *Asterina lobata*
- *Samadera indica*
  - *Asterina samaderae*

Solanaceae

- *Cestrum macrophyllum*
  - *Asterina cestricola*
- *Cestrum* sp.
  - *Asterina cestricola*
  - *Asterina coriacella*
  - *Asterina subreticulata*
- *Lycianthes laevis*
  - *Asterina lycianthis*
- *Solanum acerifolium*
  - *Asterina diplopoda*
- *Solanum boehaaviifolium*
  - *Asterina vagans*
- *Solanum leucodendron*
  - *Asterina henningsii*
- *Solanum manucaling*
  - *Asterina diaphana*
- *Solanum* sp.
  - *Asterina consobrina*
  - *Asterina grisea*
  - *Asterina portoricensis*
  - *Asterina solanacearum*
  - *Asterina solanicola*
  - *Asterina solanicoloides*
  - *Asterina subreticulata*
- *Solanum stelligerum*
  - *Asterina reclinata*
- *Solanum torvum*
  - *Asterina balakrishnanii*
- *Solanum trachycyphum*
  - *Asterina corallopoda*
- *Tubocapsicum anomalum*
  - *Asterina tubocapsici*
- Unknown genus
  - *Asterina balanseana*

Staphyleaceae

- *Turpinia pomifera*
  - *Asterina rogergoosii*

Stemonuraceae

- *Gomphandra* sp.
  - *Asterina gomphandrae*

Styracaceae

- *Styrax polyneurus*
  - *Asterina styracina*
- *Styrax* sp.
  - *Asterina dispar*

Symplocaceae

- *Symplocos nigricans*
  - *Asterina sodalis*
- *Symplocos* sp.
  - *Asterina grammocarpa*
  - *Asterina indica*
  - *Asterina suttonii*

Theaceae

- *Thea sinensis*
  - *Asterina theae*

Thymelaeaceae

- *Aquilaria sinensis*
  - *Asterina aquilariae*
- *Phaleria perrottetiana*
  - *Asterina bataanensis*
  - *Asterina phaleriae*

Unknown plant
- *Asterina alchoneae-rugosae*
- *Asterina asterophora*
- *Asterina bambusella*
- *Asterina banksiae*
- *Asterina banosensis*
- *Asterina blanda var. alafia*
- *Asterina carbonacea*
- *Asterina cassiae var. glochidiae*
- *Asterina circularis*
- *Asterina colliculosa* var. *macrospora*
- *Asterina consimilis*
- *Asterina erithalidis*
- *Asterina hemisphaerica*
- *Asterina kauaiensis*
- *Asterina laxa*
- *Asterina monimiacearum*
- *Asterina obtusispora*
- *Asterina orbicularis* var. *interrupta*
- *Asterina paraphysata*
- *Asterina pulchella*
- *Asterina ramonensis*
- *Asterina sphaerotheca* var. *prodiga*
- *Asterina sphenispora*
- *Asterina subinermis*
- *Asterina tayabensis*
- *Asterina versipoda*

Urticaceae
- *Boehmeria ramiflora*
  - *Asterina toroi*
- *Elatostema lineolatum*
  - *Asterina elatostemae*
- *Fleurya* sp.
  - *Asterina fleuryae*
- *Girardinia diversifolia*
  - *Asterina girardiniae*
- *Gonostegia hirta*
  - *Asterina gonostegiae*
- *Oreocnide integrifolia*
  - *Asterina oreocnidecola*
  - *Asterina oreocnidegena*
- *Pellionia mirima*
  - *Asterina pellioniae*
- *Phenax hirtus*
  - *Asterina phenacis*
- *Pipturus arborescens*
  - *Asterina pipturi*
- *Pouzolzia* sp.
  - *Asterina pouzolziae*
- *Pouzolzia zeylanica*
  - *Asterina pouzolziicola*
- Unknown genus
  - *Asterina cipizensis*
- *Urera hypselodendron*
  - *Asterina urerae*

Verbenaceae
- *Duranta repens*
  - *Asterina durantae*

Violaceae
- *Rinorea natalensis*
  - *Asterina rinoreae*
- *Viola abyssinica*
  - *Asterina undulata*
- *Viola sylvestris* var. *grypocerates*
  - *Asterina violae*

Vitaceae
- *Cissus oreophila*
  - *Asterina cissi*
- *Cissus* sp.
  - *Asterina spinosa*
- *Leea guineensis*
  - *Asterina leeae*
- *Vitis japonica*
  - *Asterina viticola*

Winteraceae
- *Bubbia semecarpoides*
  - *Asterina queenslandica*
- *Bubbia semecarpoides* var. *whiteana*
  - *Asterina oppositipodia*
- *Drimys dipetala*
  - *Asterina australiensis*
- *Drimys insipida*
  - *Asterina drimidicola*
- *Drimys* sp.
  - *Asterina maculiformis*

7.6 Species of *Asterostomella* (anamorphic *Asterina*)

Table 7.4: A preliminary list of *Asterostomella* (anamorphic *Asterina*) based on literature. Listed are only host plant species that are cited in the protologue of the type collection of the fungus. Species of *Asterostomell*a indicated with asterisks have a validly described teleomorphic *Asterina*-stage.

No.	Species	Reference	Host plant family	Host plant species	Country	Continent
1.	*A. aberiae* Petch	Ann. Roy. Bot. Gard. Peradenya 7: 314 (1922)	Salicaceae s.l.	*Aberia gardernii*	Sri Lanka	South Asia
2.	*A. acalyphae* Syd.*	Ann. Mycol. 23(3/6): 415 (1925)	Euphorbiaceae	*Acalypha macrostachya* var. *hirsutissima*	Costa Rica	Central America
3.	*A. africana* Syd.	Englers Bot. Jahrb. 45: 264 (1910)	Capparaceae	*Thilachium africanum*	Kenya	Africa
4.	*A. alangii* Hosag. & M. Mohanan	Indian J. For. 19(4): 371 (1996)	Cornaceae	*Alangium salviifolium*	India	South Asia
5.	*A. alchorneae* Petr.	Sydowia 12: 484 (1959) [1958]	Euphorbiaceae	*Alchornea sicca*	Philippines	Southeast Asia
6.	*A. balanseana* (P. Karst. & Roum.) Theiss.*	Ann. Mycol. 10(2): 182 (1912)	Solanaceae	undetermined	Vietnam	Southeast Asia
7.	*A. banisteriae* Syd.*	in Sydow and Petrak, Ann. Mycol. 27(1/2): 78 (1929)	Malpighiaceae	*Banisteria argentea*	Costa Rica	Central America
8.	*A. boehmeriae* Hosag., M.P. Balakr. & Goos	Mycotaxon 58: 491 (1996)	Urticaceae	*Boehmeria glomerulifera*	India	South Asia
9.	*A. caperoniae* Speg.	Anal. Mus. Nac. Buenos Aires 20(13): 396 (1910)	Euphorbiaceae	*Caperonia palustris*	Argentina	South America
10.	*A. capparis* [as '*capparidis*'] Petr.	in Sydow and Petrak, Ann. Mycol. 27(5/6): 396 (1929)	Capparaceae	*Capparis micrantha*	Philippines	Southeast Asia
11.	*A. caricae* Henn.	Hedwigia 43: 391 (1904)	Caricaceae	*Carica papaya*	Peru	South America
12.	*A. ceropegiae* Hosag., H. Biju & Manojk.	Zoos' Print J. 21(8): 2337 (2006)	Apocynaceae	*Ceropegia* sp.	India	South Asia
13.	*A. cingulata* Speg.	Rev. Argent. Hist. Nat. 1(6): 144 (no. 152) (1891)	Euphorbiaceae	cf. *Sebastiania* sp.	Brazil	South America
14.	*A. combreti* Bat. & Cif.	IMUR 109: 2 (1959)	Combretaceae	*Combretum racemosum*	Uganda	Africa
15.	*A. concinna* Syd.*	Ann. Mycol. 28(1/2): 196 (1930)	Apocynaceae	*Macroscepis* sp.	Venezuela	South America
16.	*A. cristata* Speg.	Anal. Mus. Nac. Buenos Aires 20(13): 396 (1910)	Rutaceae	undetermined	Brazil	South America
17.	*A. cupaniae* Bat. & Cif*	Mycopath. Mycol. Appl. 11(1-2): 48 (1959)	Sapindaceae	*Cupania revoluta*	Brazil	South America
18.	*A. daphniphylli* Hosag. & K. Ravik.	Mycotaxon 52(2): 471 (1994)	Daphniphyllaceae	*Daphniphyllum neilgherrense*	India	South Asia
19.	*A. dilleniacearum* Hosag., T.K. Abraham & C.K. Biju	New Botanist 19: 19 (1997)	Dilleniaceae	*Dillenia pentagyna*	India	South Asia
20.	*A. dilleniicola* M.L. Farr.	Mycologia 78(2): 271 (1986)	Dilleniaceae	cf. *Doliocarpus* sp.	Brazil	South America
21.	*A. diplocarpa* M.L. Farr.*	Can. J. Bot. 47: 379 (1969)	Malvaceae	*Sida* sp.	Dominica	Caribbean
22.	*A. dispar* Speg.	Anal. Mus. Nac. Buenos Aires 20(13): 397 (1910)	Styracaceae	*Styrax leprosum*	Argentina	South America
23.	*A. dorsteniae* Syd.*	Ann. Mycol. 25(1/2): 134 (1927)	Moraceae	*Dorstenia contrajerva*	Costa Rica	Central America
24.	*A. drymariae* Syd.	unknown	unknown	unknown	unknown	unknwon
25.	*A. elaeocarpi-serrati* Hosag.	in Hosagoudar et al., J. Mycopathol. Res. 44(1): 13 (2006)	Elaeocarpaceae	*Elaeocarpus serratus*	India	South Asia
26.	*A. erysiphoides* (Kalchbr. & Cooke) Bat. & Cif.*	Mycopath. Mycol. Appl. 11(1-2): 49 (1959)	Oleaceae	*Jasminum tortuosum*	South Africa	Africa
27.	*A. eugenicola* Doidge	Bothalia 4: 338 (1942)	Myrtaceae	*Eugenia natalitia*	South Africa	Africa
28.	*A. excoecariicola* Hosag. & Goos*	Mycotaxon 59: 161 (1996)	Euphorbiaceae	*Excoecaria crenulata*	India	South Asia

No.	Species	Reference	Host plant family	Host plant species	Country	Continent
29.	*A. flacourtiarum* Petr.	Sydowia 13: 230 (1959)	Salicaceae s.l.	*Flacourtia ramontchi*	Tanganyika	Africa
30.	*A. forsteroniae* (Henn.) Maubl.	Ann. l`École Nat. Agric. Montp. 16: 215 (1918)	Apocynaceae	*Forsteronia* sp.	Brazil	South America
31.	*A. fusca* Bat.	Bol. Sec. Agr. Pern. 13: 55 (1946)	Annonaceae	*Rollinia silvatica*	Brazil	South America
32.	*A. gregariella* Petr. & Cif.	Ann. Mycol. 28(5/6): 406 (1930)	Passifloraceae	*Passiflora* sp.	San Domingo	Caribbean
33.	*A. grewiae* Petr.	Sydowia 12: 485 (1959) [1958]	Malvaceae	*Grewia multiflora*	Philippines	Southeast Asia
34.	*A. hamulata* Cif.*	Ann. Mycol. 36(2/3): 230 (1938)	Cucurbitaceae	*Fevillea cordifolia*	San Domingo	Caribbean
35.	*A. helicteris* [as ‘*helicteridis*’] Hosag., M.P. Balakr. & Goos	Mycotaxon 58: 492 (1996)	Malvaceae	*Helicteres isora*	India	South Asia
36.	*A. heteropteridis* (Henn.) G. Arnaud	Ann. l`École Nat. Agric. Montp. 16: 213 (1918)	Polypodiaceae	*Heteropteris* sp.	Brazil	South America
37.	*A. horrida* Bat. & H. Maia	in Batista and Ciferri, Mycopath. Mycol. Appl. 11(1-2): 49 (1959)	Capparaceae	*Capparis horrida*	Philippines	Southeast Asia
38.	*A. indecora* Syd.*	Ann. Mycol. 25(1/2): 135 (1927)	Malpighiaceae	*Malpighia glabra*	Costa Rica	Central America
39.	*A. indica* V.G. Rao & Anahosur	Indian J. Myc. Plant Pathol. 2(1): 33 (1972)	Elaeocarpaceae	*Elaeocarpus oblongatus*	India	South Asia
40.	*A. isonandrae* Hosag. & Goos	Mycotaxon 52(2): 470 (1994)	Sapotaceae	*Isonandra lanceolata*	India	South Asia
41.	*A. isothea* Syd.*	Ann. Mycol. 25(1/2): 135 (1927)	Malvaceae	*Triumfetta semitriloba*	Costa Rica	Central America
42.	*A. kushinagarensis* R.C. Verma, M.S. & R.K. Chaudhary	Indian Phytopathol. 52(4): 378 (1999)	Euphorbiaceae	*Croton roxburghii*	India	South Asia
43.	*A. kutuensis* (Henn.) Bat. & Cif.	Mycopath. Mycol. Appl. 11(1-2): 51 (1959)	Combretaceae	*Combretum* sp.	Africa	Africa
44.	*A. lauracearum* Bat. & J.L. Bezerra	An. XIV Congr. Soc. Bot. Brazil, p. 104 (1964) [1963]	Lauraceae	undetermined	Brazil	South America
45.	*A. lepianthis* [as ‘*lepianthedis*’] Hosag., M.P. Balakr. & Goos*	Mycotaxon 58: 492 (1996)	Piperaceae	*Lepianthes umbellata*	India	South Asia
46.	*A. ligustri* Hosag., M.P. Balakr. & Goos	Mycotaxon 58: 493 (1996)	Oleaceae	*Ligustrum gamblei*	India	South Asia
47.	*A. lismorensis* Syd.	Ann. Mycol. 35: 49 (1937)	Euphorbiaceae	*Alchornea ilicifolia*	Australia	Oceania
48.	*A. lunaniae* Cif.	Atti Ist. Bot. Univ. Pavia 19: 92 (1962)	Salicaceae s.l.	*Lunania* sp.	Dominican Republic	Caribbean
49.	*A. maculosa* (Sacc.) S.Hughes	Can. J. Bot. 36: 738 (1958)	Urticaceae	*Conocephalus* sp.	Philippines	Southeast Asia
50.	*A. meliosmae* Bat. & J.L. Bezerra	IMUR 340: 5 (1961)	Salicaceae s.l.	*Meliosma impressa*	Brazil	South America
51.	*A. meliosmicola* [as ‘*meliosmaticola*’] Hosag., M.P. Balakr. & Goos	Mycotaxon 58: 495 (1996)	Sabiaceae	*Meliosma simplicifolia*	India	South Asia
52.	*A. micheliae* Hosag. & Goos*	Mycotaxon 59: 162 (1996)	Magnoliaceae	*Michelia nilagirica*	India	South Asia
53.	*A. miliusiae* A.K. Singh, Kamal. & S.K. Singh	Curr. Sci. 51(16): 787 (1982)	Annonaceae	*Miliusa tomentosa*	India	South Asia
54.	*A. minuta* G. Arnaud	Ann. l`École Nat. Agric. Montp. 16: 215 (1918)	undetermined	undetermined	Brazil	South America
55.	*A. ornata* Cif.	Sydowia 8(1-6): 248 (1954)	Cucurbitaceae	*Fevillea cordifolia*	Dominican Republic	Caribbean
56.	*A. orthosticha* Syd.*	Ann. Mycol. 28(1/2): 196 (1930)	Dilleniaceae	*Doliocarpus dentatus*	Venezuela	South America
57.	*A. paraguayensis* Speg.*	Anal. Soc. Cient. Argent. 22(4): 198 (1886)	Solanaceae	*Cestrum* sp.	Paraguay	South America
58.	*A. parameriae* Petr.	unknown	unknown	unknown	unknown	unknown
59.	*A. pelladensis* Henn.	Hedwigia 48: 15 (1909)	Malpighiaceae	undetermined	Brazil	South America
60.	*A. peraffinis* Speg.*	Bol. Acad. Nac. Cien. Córdoba 11(4): 604 (1889)	*Apocynaceae*	*undetermined*	Brazil	South America

No.	Species	Reference	Host plant family	Host plant species	Country	Continent
61.	*A. pinatubensis* Syd.	Leafl. Philipp. Bot. 9: 125 (1934)	Aquifoliaceae	*Ilex brunnea*	Philippines	Southeast Asia
62.	*A. polystigma* Syd.	Philipp. J. Sci. 21(2): 145 (1922)	Acanthaceae	*Hemigraphis* sp.	Philippines	Southeast Asia
63.	*A. pongamiae* K.V. Rao, K. Gopal & Manohar.	Asian J. Pl. Sci 1: 93 (1989)	Fabaceae s.l.	*Pongamia glabra*	India	South Asia
64.	*A. pseudospondiadis* Bat. & Cif.	IMUR 109: 3 (1959)	Anacardiaceae	*Pseudospondias microcarpa*	Uganda	Africa
65.	*A. radermacherae* Hosag., M.P. Balakr. & Goos	Mycotaxon 58: 495 (1996)	Bignoniaceae	*Radermachera xylocarpa*	India	South Asia
66.	*A. rhaphiostylidis* Hansf.	Proc. Linn. Soc. London 156: 118 (1944) [1943]	Icancinaceae	*Rhaphiostylis beninensis*	Uganda	Africa
67.	*A. roureae* Petr.	Sydowia 12: 485 (1959)	Connaraceae	*Rourea erecta*	Philippines	Southeast Asia
68.	*A. scolopiae-crenatae* Hosag. & T.K. Abraham	New Botanist 24: 111 (1997)	Sabiaceae s.l.	*Scolopia crenata*	India	South Asia
69.	*A. stipitipodia* M.L. Farr*	Mycologia 79(1): 109 (1987)	Dilleniaceae	undetermined	Brazil	South America
70.	*A. strophanthi* Henn.	Englers Bot. Jahrb. 38: 125 (1907)	Apocynaceae	*Strophanthus hispidus*	Togo	Africa
71.	*A. subreticulata* Speg.*	Rev. Argent. Hist. Nat. 1(6), no. 143 (1891)	Solanaceae	*Cestrum pubescens*	Brazil	South America
72.	*A. subreticulata* var. *microspora* Speg.	Rev. Argent. Hist. Nat. 1(6), no. 143 (1891)	Solanaceae	*Cestrum* sp.	Brazil	South America
73.	*A. terminaliae* Hosag., M.P. Balakr. & Goos	Mycotaxon 58: 496 (1996)	Combretaceae	*Terminalia paniculata*	India	South Asia
74.	*A. tonduzii* [as '*tonduzi*'] Syd.*	Ann. Mycol. 25(1/2): 136 (1927)	Salicaceae s.l.	*Xylosma velutina*	Costa Rica	Central America
75.	*A. tosaensis* I. Hino & Katum.	J. Jap. Bot. 38: 27 (1963)	Salicaceae s.l.	*Meliosma rigida*	Japan	East Asia
76.	*A. tremae* Speg.	Anal. Mus. Nac. Buenos Aires 20(13): 397 (1910)	Cannabaceae	*Trema micrantha*	Argentina	South America
77.	*A. veronicae* (Desm.) G. Arnaud	Ann. l`École Nat. Agric. Montp. 16: 174 (1918)	Plantaginaceae	*Veronica derwentia*	Australia	Oceania
78.	*A. visci* Doidge	Bothalia 4: 338 (1942)	Santalaceae	*Viscum obscurum*	South Africa	Africa
79.	*A. vismae* Bat., J.L. Bezerra & Peres	An XIV Congr. Soc. Bot. Brazil, p. 105 (1964) [1963]	Hypericaceae	*Vismia cearensis*	Brazil	South America
80.	*A. walleniae* Petr. & Cif.	Ann. Mycol. 30(3/4): 265 (1932)	Primulaceae	*Wallenia laurifolia*	San Domingo	Caribbean

Excluded species of *Asterostomella*:
A. epiphylla var. *gallica* Bourdot & Galzin, Bull. Trimest. Soc. Mycol. Fr. 27(2): 265 (1911) [dubious species due to temperate collection site in Northern Europe and the untypical host plant].
A. meliosmae I. Hino & Katum., J. Jap. Bot. 36(11): 379 (1961) [basionym of *Asterostomella tosaensis* I. Hino & Katum., J. Jap. Bot. 38: 27 (1963)].

Host Index of *Asterostomella* spp.:

Acanthaceae
 Hemigraphis sp.
  Asterostomella polystigma
Anacardiaceae
 Pseudospondias microcarpa
  Asterostomella pseudospondiadis
Annonaceae
 Miliusa tomentosa
  Asterostomella miliusiae
 Rollinia silvatica
  Asterostomella fusca
Apocynaceae
 Ceropegia sp.
  Asterostomella ceropegiae
 Forsteronia sp.
  Asterostomella forsteroniae
 Macroscepis sp.
  Asterostomella concinna
 Strophanthus hispidus
  Asterostomella strophanthi
 Unknown genus
  Asterostomella peraffinis
Aquifoliaceae
 Ilex brunnea
  Asterostomella pinatubensis
Bignoniaceae
 Radermachera xylocarpa
  Asterostomella radermacherae
Cannabaceae
 Trema micrantha
  Asterostomella tremae
Capparaceae
 Capparis horrida
  Asterostomella horrida
 Capparis micrantha
  Asterostomella capparis
 Thilachium africanum
  Asterostomella africana
Caricaceae
 Carica papaya

Asterostomella caricae
Combretaceae
Combretum racemosum
Asterostomella combreti
Combretum sp.
Asterostomella kutuensis
Terminalia paniculata
Asterostomella terminaliae
Connaraceae
Rourea erecta
Asterostomella roureae
Cornaceae
Alangium salviifolium
Asterostomella alangii
Cucurbitaceae
Feveillea cordifolia
Asterostomella hamulata
Asterostomella ornata
Daphniphyllaceae
Daphniphyllum neilgherrense
Asterostomella daphniphylli
Dilleniaceae
Dillenia pentagyna
Asterostomella dilleniacearum
cf. *Doliocarpus* sp.
Asterostomella dilleniicola
Doliocarpus dentatus
Asterostomella orthosticha
Unknown genus
Asterostomella stipitipodia
Elaeocarpaceae
Elaeocarpus oblongatus
Asterostomella indica
Elaeocarpus serratus
Asterostomella elaeocarpi-serrati
Euphorbiaceae
Acalypha macrostachya var. *hirsutissima*
Asterostomella acalyphae
cf. *Sebastiania* sp.
Asterostomella cingulata
Alchornea ilicifolia
Asterostomella lismorensis
Alchornea sicca
Asterostomella alchorneae
Caperonia palustris
Asterostomella caperoniae
Croton roxburghii
Asterostomella kushinagarensis

Excoecaria crenulata
Asterostomella excoecariicola
Fabaceae s.l.
Pongamia glabra
Asterostomella pongamiae
Lauraceae
Unknown genus
Asterostomella lauracearum
Hypericaceae
Vismia cearensis
Asterostomella vismae
Icacinaceae
Raphiostylis beninensis
Asterostomella raphiostylidis
Magnoliaceae
Michelia nilagirica
Asterostomella micheliae
Malpighiaceae
Banisteria argentea
Asterostomella banisteriae
Malpighia glabra
Asterostomella indecora
Unknown genus
Asterostomella pelladensis
Malvaceae
Grewia multiflora
Asterostomella grewiae
Helicteres isora
Asterostomella helicteris
Triumfetta semitrilobata
Asterostomella isothea
Sida sp.
Asterostomella diplocarpa
Moraceae
Dorstenia contrajerva
Asterostomella dorsteniae
Myrtaceae
Eugenia natalitia
Asterostomella eugenicola
Oleacaea
Jasminum tortuosum
Asterostomella erysiphoides

Ligustrum gamblei
Asterostomella ligustri
Passifloraceae
Passiflora sp.
Asterostomella gregariella
Piperaceae
Lepianthes umbellata
Asterostomella lepianthis
Plantaginaceae
Veronica derwentia
Asterostomella veronicae
Polypodiaceae
Heteropteris sp.
Asterostomella heteropteridis
Primulaceae
Wallenia laurifolia
Asterostomella walleniae
Rutaceae
Unknown genus
Asterostomella cristata
Salicaceae s.l.
Aberia gardernii
Asterostomella aberiae
Flacourtia ramontchi
Asterostomella flacourtiarum
Lunania sp.
Asterostomella lunaniae
Meliosma impressa
Asterostomella meliosmae
Meliosma rigida
Asterostomella tosaensis
Meliosma simplicifolia
Asterostomella meliosmicola
Scolopia crenata
Asterostomella scolopiae-crenatae
Xylosma velutina
Asterostomella tonduzii
Santalaceae
Viscum obscurum
Asterostomella visci
Sapindaceae
Cupania revoluta
Asterostomella cupaniae
Sapotaceae
Isonandra lanceolata
Asterostomella isonandrae
Solanaceae
Cestrum pubescens
Asterostomella subreticulata
Cestrum sp.
Asterostomella paraguayensis
Asterostomella subreticulata var. *microspora*
Unknown genus
Asterostomella balanseana
Styracaceae
Styrax leprosum
Asterostomella dispar
Unknown plant
Asterostomella drymariae
Asterostomella minuta
Asterostomella parameriae
Urticaceae
Boehmeria glomerulifera
Asterostomella boehmeriae
Conocephalus sp.
Asterostomella maculosa

7.7 Species of *Asterolibertia*

Table 7.5: A preliminary list of species of *Asterolibertia* based on literature. Listed are only host plant species that are cited in the protologue of the type collection of the fungus.

No.	Species	Reference	Host plant family	Host plant species	Country	Continent
1.	*A. anispoterae* (Syd. & P. Syd.) Hansf.	Proc. Linn. Soc. London 160: 139 (1949)	Dipterocarpaceae	*Anisoptera thurifera*	Philippines	Southeast Asia
2.	*A. bakeri* (Syd. & P.Syd.) Hansf.	Proc. Linn. Soc. London 160: 139 (1949)	Arecaceae	*Calamus* sp.	Philippines	Southeast Asia
3.	*A. bredemeyerae* (Rehm) Arx	in Müller and Arx, Beitr. Kryptfl. Schweiz 11(2): 98 (1962)	Polygalaceae	*Bredemeyera kunthiana*	Brazil	South America
4.	*A. burchelliae* (Doidge) Doidge	Bothalia 4: 315 (1942)	Rubiaceae	*Burchellia capensis*	South Africa	Africa
5.	*A. couepiae* (Henn.) G. Arnaud	Ann. École Nat. Agric. Montp., Sér. 2, 16: 165 (1918)	Chrysobalanaceae	*Couepia ovalifolia*	Brazil	South America
6.	*A. crustacea* (Ellis & Everh.) Hansf.	Sydowia 9: 80 (1955)	Myrtaceae	*Psidium guajava*	Dom. Republic	Caribbean
7.	*A. cryptocaryae* (Cooke) Hansf.	Proc. Linn. Soc. New South Wales 79: 106 (1955)	Lauraceae	*Cryptocarya meissneri*	Australia	Oceania
8.	*A. cryptocaryae* var. *nodulifera* Hansf.	Proc. Linn. Soc. New South Wales 79: 106 (1955)	Lauraceae	*Cryptocarya rigida*	Australia	Oceania
9.	*A. flabellariae* Hansf.	Proc. Linn. Soc. London 158(1): 44 (1947)	Malpighiaceae	*Flabellaria paniculata*	Sierra Leone	Africa
10.	*A. gibbosa* (Gaillard) Hansf.	Proc. Linn. Soc. London 160: 141 (1949)	Rubiaceae	cf. *Randia* sp.	Brazil	South America
11.	*A. hiiranensis* (W. Yamam.) W. Yamam.	Sci. Rep. Hyogo Univ. Agric., Agric Biol. Ser. 3(1): 29 (1957)	Styracaceae	*Styrax hayataianus*	Taiwan	East Asia
12.	*A. hydnocarpi* Hosag. & T.K. Abraham	J. Mycopathol. Res. 35(1): 55 (1997)	Achariaceae	*Hydnocarpus macrocarpa*	India	South Asia
13.	*A. inaequalis* (Mont.) Toro	Bol. Soc. Españ. Hist. Nat. Madrid 33: 198 (1933)	Melastomataceae	undetermined	French Guiana	South America
14.	*A. licaniae* (Cooke) Hansf.	Proc. Linn. Soc. London 160: 140 (1949)	Chrysobalanaceae	*Licania* sp.	Brazil	South America
15.	*A. licaniicola* Hansf.	Proc. Linn. Soc. London 160: 140 (1949)	Chrysobalanaceae	*Licania* sp.	Brazil	South America
16.	*A. malphighii* Bat. & H. Maia	IMUR 226: 17 (1960)	Malpighiaceae	undetermined	Brazil	South America
17.	*A. mangiferae* Hansf. & Thirum.	Farlowia 3: 303 (1948)	Anacardiaceae	*Mangifera indica*	India	South Asia
18.	*A. megathyria* (Doidge) Doidge	Bothalia 4: 314 (1942)	Rubiaceae	*Tricalysia lanceolata*	South Africa	Africa
19.	*A. megathyria* var. *randiae* Doidge	Bothalia 4: 315 (1942)	Rubiaceae	*Randia dumetorum*	South Africa	Africa
20.	*A. nodulosa* (Speg.) Hansf.	Proc. Linn. Soc. London 160: 141 (1949)	Annonaceae	*Guatteria dolichopodia*	Costa Rica	Central America
21.	*A. nothopegiae* Hosag. & T.K. Abraham	New Botanist 24: 109 (1997)	Anacardiaceae	*Nothopegia aureo-fulva*	India	South Asia
22.	*A. parinarii* (Syd.) Hansf.	Proc. Linn. Soc. London 159: 36 (1947)	Chrysobalnaceae	*Parinari subcordata*	DR Congo	Africa
23.	*A. peruviana* Hansf.	Sydowia 9: 81 (1955)	Bignoniaceae	undetermined	Peru	South America
24.	*A. pogonophorae* Bat. & H. Maia	Broteria, sér. bot. 30(1-2): 44 (1961)	Euphorbiaceae	*Pogonophora schomburgkiana*	Brazil	South America
25.	*A. randiae* (Doidge) Arx	Beitr. Kryptogfl. Schweiz 11(2): 99 (1962)	Rubiaceae	*Randia dumetorum*	South Africa	Africa
26.	*A. santiriae* (Syd. & P. Syd.) Hansf.	Reinwardtia 3: 126 (1954)	Burseraceae	*Santiria* sp.	Philippines	Southeast Asia
27.	*A. schroeteri* (Rehm) Arx	in Müller and Arx, Beitr. Kryptfl. Schweiz 11(2): 98 (1962)	Chrysobalanaceae	*Chrysobalanus* sp.	Brazil	South America
28.	*A. spatholobi* Hansf.	Reinwardtia 3: 127 (1954)	Fabaceae s.l.	*Spatholobus ferrugineus*	Java, Indonesia	Southeast Asia
29.	*A. sporoboli* E. Castell. & Graniti	Nuovo G. bot. ital., N.S. 57: 250 (1950)	Poaceae	*Sporobolus ruspolianus*	Ethiopia	Africa
30.	*A. thaxteri* Hansf.	Sydowia 11: 63 (1958)	undetermined	undetermined	Grenada	Caribbean
31.	*A. ulei* Hansf.	Proc. Linn. Soc. London 160: 142 (1949)	Malpighiaceae	undetermined	Brazil	South America
32.	*A. vateriae* Hosag.	in Hosagoudar et al., J. Mycopathol. Res. 44(1): 12 (2006)	Dipterocarpaceae	*Vateria indica*	India	South Asia

Excluded species of *Asterolibertia*:

A. gibbosa Bat. & Peres, IMUR 226: 15 (1960) [heterotypic synonym of *Asterolibertia gibbosa* (Gaillard) Hansf. (Song et al. 2003)].
A. myocoproides (Sacc. & Berl.) Arx, in Müller and Arx, Beitr. Kryptfl. Schweiz 11(2): 100 (1962) [heterotypic synonym of *Platypeltella smilacis* Petr.].

Host Index of *Asterolibertia* spp.:

Achariaceae
- *Hydnocarpus macrocarpa*
  - *Asterolibertia hydnocarpi*

Anacardiaceae
- *Mangifera indica*
  - *Asterolibertia mangiferae*
- *Nothopegia aureo-fulva*
  - *Asterolibertia nothopegiae*

Annonaceae
- *Guatteria dolichopodia*
  - *Asterolibertia nodulosa*

Arecaceae
- *Calamus* sp.
  - *Asterolibertia bakeri*

Bignoniaceae
- Unknown genus
  - *Asterolibertia peruviana*

Burseraceae
- *Santiria* sp.
  - *Asterolibertia santiriae*

Chrysobalanaceae
- *Chrysobalanus* sp.
  - *Asterolibertia schroeteri*
- *Couepia ovalifolia*
  - *Asterolibertia couepiae*
- *Licania* sp.
  - *Asterolibertia licaniae*
  - *Asterolibertia licaniicola*
- *Parinari subcrodata*
  - *Asterolibertia parinarii*

Dipterocarpaceae
- *Anisoptera thurifera*
  - *Asterolibertia anisopterae*
- *Vateria indica*
  - *Asterolibertia vateriae*

Euphorbiaceae
- *Pogonophora schomburgkiana*
  - *Asterolibertia pogonophorae*

Fabaceae s.l.
- *Spatholobus ferrugineus*
  - *Asterolibertia spatholobi*

Lauraceae
- *Cryptocarya meissneri*
  - *Asterolibertia cryptocaryae*
- *Cryptocarya rigida*
  - *Asterolibertia cryptocaryae* var. *nodulifera*

Malpighiaceae
- *Flabellaria paniculata*
  - *Asterolibertia flabellariae*
- Unknown genus
  - *Asterolibertia malpighii*
  - *Asterolibertia ulei*

Melastomataceae
- Undetermined
  - *Asterolibertia inaequalis*

Myrtaceae
- *Psidium guajava*
  - *Asterolibertia crustacea*

Poaceae
- *Sporobolus ruspolianus*
  - *Asterolibertia sporoboli*

Polygalaceae
- *Bredemeyera kunthiana*
  - *Asterolibertia bredemeyerae*

Rubiaceae
- *Burchellia capensis*
  - *Asterolibertia burchelliae*
- *Randia dumentorum*
  - *Asterolibertia megathyria var. randiae*
  - *Asterolibertia randiae*
- cf. *Randia* sp.
  - *Asterolibertia gibbosa*
- *Tricalysia lanceolata*
  - *Asterolibertia megathyria*

Styracaceae
- *Styrax hayataianus*
  - *Asterolibertia hiiranensis*

Unknown plant
  - *Asterolibertia thaxteri*

7.8 Species of *Cirsosia*

Table 7.6: A preliminary list of species of *Cirsosia* based on literature. Listed are only host plant species that are cited in the protologue of the type collection of the fungus.

No.	Species	Reference	Host plant family	Host plant species	Country	Continent
1.	*C. arecacearum* Hosag. & M. Pillai	Mycol. Res. 98(1): 128 (1994)	Arecaceae	*Calamus thwaitesii*	India	South Asia
2.	*C. dipterocarpi* (Henn.) Bat. & H. Maia	Rev. Biol. 2(2): 115 (1960)	Dipterocarpaceae	*Dipterocarpus grandiflorus*	Philippines	Southeast Asia
3.	*C. flabellariae* (Syd.) Bat. & H. Maia	Rev. Biol. 2(2): 117 (1960)	Malpighiaceae	*Flabellaria pedunculata*	Sierra Leone	Africa
4.	*C. globulifera* (Pat.) Arx	in Müller and Arx, Beitr. Kryptfl. Schweiz 11(2): 114 (1962)	Arecaceae	*Calamus* sp.	Vietnam	Southeast Asia
5.	*C. hughesii* Bat. & H. Maia	Rev. Biol. 2(2): 117 (1960)	Arecaceae	*Ancistrophyllum* sp.	Ghana	Africa
6.	*C. irregularis* (Syd.) Arx,	in Müller and Arx, Beitr. Kryptfl. Schweiz 11(2): 115 (1962)	Dipterocarpaceae	*Vatica obtusifolia*	Philippines	Southeast Asia
7.	*C. manaosensis* (Henn.) G. Arnaud	Ann. École Nat. Agric. Montp., Sér.2, 16: 127 (1918)	Malpighiaceae	*Clonodia verrucosa*	Brazil	South America
8.	*C. moquileae* Bat. & H. Maia	Rev. Biol. 2(2): 121 (1960)	Chrysobalanaceae	*Moquilea tomentosa*	Brazil	South America
9.	*C. moulmeinensis* Thaung	Trans. Br. Mycol. Soc. 67(3): 438 (1976)	Dipterocarpaceae	*Dipterocarpus* sp.	Burma	Southeast Asia
10.	*C. santiriae* Bat. & H. Maia	IMUR 226: 22 (1960)	Burseraceae	*Santiria nitida*	Philippines	Southeast Asia
11.	*C. splendida* Bat. & H. Maia	Rev. Biol. 2(2): 125 (1960)	Chrysobalanaceae	*Hirtella americana*	Brazil	South America
12.	*C. transversalis* (Syd.) Deighton	Mycol. Pap. 48: 24 (1952)	Arecaceae	undetermined	Philippines	Southeast Asia

Host Index of *Cirsosia* spp.:

Arecaceae
- *Ancistrophyllum* sp.
    - *Cirsosia hughesii*
- *Calamus* sp.
    - *Cirsosia globulifera*
- *Calamus thwaitesii*
    - *Cirsosia arecacearum*
- Unknown genus
    - *Cirsosia transversalis*

Burseraceae
- *Santiria nitida*
    - *Cirsosia santiriae*

Chrysobalanaceae
- *Hirtella americana*
    - *Cirsosia splendida*
- *Moquilea tomentosa*
    - *Cirsosia moquileae*

Dipterocarpaceae
- *Dipterocarpus grandiflorus*
    - *Cirsosia dipterocarpi*
- *Dipterocarpus* sp.
    - *Cirsosia moulmeinensis*
- *Vatica obtusifolia*
    - *Cirsosia irregularis*

Malpighiaceae
- *Clonodia verrucosa*
    - *Cirsosia manaosensis*
- *Flabellaria pedunculata*
    - *Cirsosia flabellariae*

7.9 Species of *Maublancia*

Table 7.7: A preliminary list of species of *Maublancia* based on literature. Listed are only host plant species that are cited in the protologue of the type collection of the fungus.

No.	Species	Reference	Host plant family	Host plant species	Country	Continent
1.	*M. gaultheriae* E. Müller	in Müller and Dennos, Kew Bull. 19(3): 384 (1965)	Ericaceae	*Gaultheria* sp.	Venezuela	South America
2.	*M. indica* Patw. & A.K. Pande	Sydowia 21: 314 (1968) [1967]	Myrtaceae	*Eugenia jambolana*	India	South Asia
3.	*M. juruana* (Henn.) G. Arnaud	Ann. École Nat. Agric. Montp. 16: 158 (1918)	Salicaceae s.l.	*Casearia* sp.	Brazil	South America
4.	*M. myrtacearum* G. Arnaud	Ann. École Nat. Agric. Montp. 16: 158 (1918)	Myrtaceae	undetermined	Brazil	South America
5.	*M. raripoda* (Doidge) Arx	in Müller and Arx, Beitr. Kryptfl. Schweiz 11(2): 525 (1962)	Orchidaceae	*Ansellia africana*	South Africa	Africa
6.	*M. trichocladii* (Doidge) Arx	in Müller and Arx, Beitr. Kryptfl. Schweiz 11(2): 525 (1962)	Hamamelidaceae	*Trichocladus crinitus*	South Africa	Africa
7.	*M. uleana* (Pazschke) Arx	in Müller and Arx, Beitr. Kryptfl. Schweiz 11(2): 524 (1962)	Myrtaceae	undetermined	Brazil	South America

Host Index of *Maublancia* spp.:

Ericaceae
- *Gaultheria* sp.
  - *Maublancia gaultheriae*

Hamamelidaceae
- *Trichocladus crinitus*
  - *Maublancia trichocladii*

Myrtaceae
- *Eugenia jambolana*
  - *Maublancia indica*
- Unknown genus
  - *Maublancia myrtacearum*
  - *Maublancia uleana*

Orchidaceae
- *Ansellia africana*
  - *Maublancia raripoda*

Salicaceae s.l.
- *Casearia* sp.
  - *Maublancia juruana*

7.10 Species of *Platypeltella*

Table 7.8: A preliminary list of species of *Platypeltella* based on literature. Listed are only host plant species that are cited in the protologue of the type collection of the fungus.

No.	Species	Reference	Host plant family	Host plant species	Country	Continent
1.	*P. angustispora* M.L. Farr & Pollack	Mycologia 61: 191 (1969)	Arecaceae	*Chamaedorea* sp.	Mexico	Central America
2.	*P. irregularis* M.L. Farr	Mycotaxon 15: 448 (1982)	Bromeliaceae	*Puya* sp.	Colombia	South America
3.	*P. smilacis* Petr.	Ann. Mycol. 27(1/2): 62 (1929)	Smilacaceae	*Smilax* sp.	Costa Rica	Central America

Host Index of *Platypeltella* spp.:

Areceae
  Chamaedora sp.
    Platypeltella angustispora
Bromeliaceae
  Puya sp.
    Platypeltella irregularis
Smilacaceae
  Smilax sp.
    Platypeltella smilacis

7.11 Species of *Prillieuxina*

Table 7.9: A preliminary list of species of *Prillieuxina* based on literature. Listed are only host plant species that are cited in the protologue of the type collection of the fungus.

No.	Species	Reference	Host plant family	Host plant species	Country	Continent
1.	*P. acokantherae* (Doidge) R.W. Ryan	in Stevens and Ryan, Ill. Biol. Monogr. 17(2): 77 (1939)	Apocynaceae	*Acokanthera spectabilis*	South Africa	Africa
2.	*P. amazonica* (Syd. & P. Syd.) R.W. Ryan	in Stevens and Ryan, Ill. Biol. Monogr. 17(2): 78 (1939)	Nyctaginaceae	*Ramisia amazonica*	Brazil	South America
3.	*P. amboinensis* Syd.	Philipp. J. Sci. 21: 142 (1922)	Asparagaceae	*Cordyline terminalis*	Philippines	Southeast Asia
4.	*P. anamirtae* (Syd. & P. Syd.) R.W. Ryan	in Stevens and Ryan, Ill. Biol. Monogr. 17(2): 78 (1939)	Menispermaceae	*Anamirta cocculus*	Philippines	Southeast Asia
5.	*P. antioquensis* (Toro) R.W. Ryan	in Stevens and Ryan, Ill. Biol. Monogr. 17(2): 80 (1939)	Melastomataceae	*Miconia ciliata*	Puerto Rico	Caribbean
6.	*P. ardisiae* (Hansf.) Arx	in Müller and Arx, Beitr. Kryptfl. Schweiz 11(2): 135 (1962)	Primulaceae	*Ardisia humilis*	Java, Indonesia	Southeast Asia
7.	*P. asterinoides* (Pat.) R.W. Ryan	in Stevens and Ryan, Ill. Biol. Monogr. 17(2): 80 (1939)	Poaceae	undetermined	Chile	South America
8.	*P. baccharidincola* (Rehm) Petr.	Sydowia 4: 536 (1950)	Asteraceae	*Baccharis* sp.	Brazil	South America
9.	*P. burchelliae* (Doidge) R.W. Ryan	in Stevens and Ryan, Ill. Biol. Monogr. 17(2): 77 (1939)	Rubiaceae	*Burchellia capensis*	South Africa	Africa
10.	*P. calami* (Syd. & P. Syd.) R.W. Ryan	in Stevens and Ryan, Ill. Biol. Monogr. 17(2): 80 (1939)	Arecaceae	*Calamus* sp.	Philippines	Southeast Asia
11.	*P. calotheca* (Pat. & Lagarde) R.W. Ryan	in Stevens and Ryan, Ill. Biol. Monogr. 17(2): 79 (1939)	undetermined	undetermined	Ecuador	South America
12.	*P. capizensis* (J.M. Mend.) R.W. Ryan	in Stevens and Ryan, Ill. Biol. Monogr. 17(2): 78 (1939)	Urticaceae	*Leucosyke capitellata*	Philippines	Southeast Asia
13.	*P. cinchonae* J.A. Stev.	Mycologia 35(6): 632 (1943)	Rubiaceae	*Cinchona pubescens*	Costa Rica	Central America
14.	*P. clavispora* (Rehm) R.W. Ryan	in Stevens and Ryan, Ill. Biol. Monogr. 17(2): 80 (1939)	Apocynaceae	*Alyxia monilifera*	Philippines	Southeast Asia
15.	*P. conocephali* (Hansf.) Arx	in Müller and Arx, Beitr. Kryptfl. Schweiz 11(2): 135 (1962)	Urticaceae	*Conocephalus suaveolens*	Java, Indonesia	Southeast Asia
16.	*P. creberrima* (Hansf. & P. Syd.) Arx	in Müller and Arx, Beitr. Kryptfl. Schweiz 11(2): 135 (1962)	Lamiaceae	*Premna* sp.	Philippines	Southeast Asia
17.	*P. cryptocaryae* (Cooke) R.W. Ryan	in Stevens and Ryan, Ill. Biol. Monogr. 17(2): 79 (1939)	Lauraceae	*Cryptocarya glaucescens*	Australia	Oceania
18.	*P. cylindrotheca* (Speg.) R.W. Ryan	in Stevens and Ryan, Ill. Biol. Monogr. 17(2): 77 (1939)	Myrtaceae	*Eugenia* sp.	Brazil	South America
19.	*P. dipteridis* (Hansf.) Arx	in Müller and Arx, Beitr. Kryptfl. Schweiz 11(2): 135 (1962)	Dipteridaceae	*Dipteris conjugate*	Java, Indonesia	Southeast Asia
20.	*P. dipterocarpi* (Syd. & P. Syd.) R.W. Ryan	in Stevens and Ryan, Ill. Biol. Monogr. 17(2): 78 (1939)	Dipterocarpaceae	*Dipterocarpus vernicifluus*	Philippines	Southeast Asia
21.	*P. dissilens* (Syd.) Arx	in Müller and Arx, Beitr. Kryptfl. Schweiz 11(2): 133 (1962)	Celastraceae	*Elaeodendron croceum*	South Africa	Africa
22.	*P. distinguenda* (Syd. & P. Syd.) R.W. Ryan	in Stevens and Ryan, Ill. Biol. Monogr. 17(2): 77 (1939)	Rubiaceae	*Ixora philippinensis*	Philippines	Southeast Asia
23.	*P. dysoxyli* (Syd.) Arx	in Müller and Arx, Beitr. Kryptfl. Schweiz 11(2): 135 (1962)	Meliaceae	*Dysoxylum cumingianum*	Philippines	Southeast Asia
24.	*P. elaeagni* [as '*elaegni*'] Hosag. & C.K. Biju	in Hosagoudar et al., Indian Phytopathol. 57(1): 115 (2004)	Elaeagnaceae	*Elaeagnus kologa*	India	South Asia
25.	*P. flexuosa* (G. Winter) R.W. Ryan	in Stevens and Ryan, Ill. Biol. Monogr. 17(2): 77 (1939)	Fabaceae s.l.	*Calliandra* sp.	Brazil	South America
26.	*P. garciniae* Hosag.	J. Econ. Taxon. Bot. 28(1): 191 (2004)	Clusiaceae	*Garcinia imberti*	India	South Asia
27.	*P. gracilis* (Syd. & P. Syd.) Arx	in Müller and Arx, Beitr. Kryptfl. Schweiz 11(2): 135 (1962)	Fabaceae s.l.	*Derris diadelpha*	Philippines	Southeast Asia
28.	*P. hippeastri* (R.W. Ryan) Arx	in Müller and Arx, Beitr. Kryptfl. Schweiz 11(2): 133 (1962)	Amaryllidaceae	*Hippeastrum* sp.	Puerto Rico	Caribbean
29.	*P. hiugensis* Katum.	Bull. Fac. Agric., Yamag. Univ. 26: 89 (1975)	Aquifoliaceae	*Ilex latifolia*	Japan	East Asia
30.	*P. humiriae* (Henn.) R.W. Ryan	in Stevens and Ryan, Ill. Biol. Monogr. 17(2): 79 (1939)	Humiriaceae	*Humiria floribunda*	Brazil	South America
31.	*P. hydnocarpi* (H.S. Yates) Arx	in Müller and Arx, Beitr. Kryptfl. Schweiz 11(2): 136 (1962)	Achariaceae	*Hydnocarpus falcatus*	Philippines	Southeast Asia
32.	*P. ilicicola* (Hansf.) Arx	in Müller and Arx, Beitr. Kryptfl. Schweiz 11(2): 135 (1962)	Aquifoliaceae	*Ilex odorata*	Java, Indonesia	Southeast Asia
33.	*P. inconspicua* (Doidge) Arx	in Müller and Arx, Beitr. Kryptfl. Schweiz 11(2): 133 (1962)	Scrophulariaceae	*Chilianthus arboreus*	South Africa	Africa

No.	Species	Reference	Host plant family	Host plant species	Country	Continent
34.	*P. intense* (Cooke & Massee) R.W. Ryan	in Stevens and Ryan, Ill. Biol. Monogr. 17(2): 78 (1939)	Nyctaginaceae	*Pisonia* sp.	New Zealand	Oceania
35.	*P. ixorae* (R.W. Ryan) R.W. Ryan	in Stevens and Ryan, Ill. Biol. Monogr. 17(2): 79 (1939)	Rubiaceae	*Ixora ferrea*	Puerto Rico	Caribbean
36.	*P. ixoricola* (S. Hughes) Arx	in Müller and Arx, Betr. Kryptfl. Schweiz 11(2): 134 (1962)	Rubiaceae	*Ixora* sp.	Ghana	Africa
37.	*P. lepidotricha* (Theiss.) R. W. Ryan	in Stevens and Ryan, Ill. Biol. Monogr. 17(2): 77 (1939)	Undetermined	undetermined	Philippines	Southeast Asia
38.	*P. loranthi* (Syd. & P. Syd.) Syd.	Philipp. J. Sci. 21: 141 (1922)	Loranthaceae	*Loranthus leytensis*	Philippines	Southeast Asia
39.	*P. luzonensis* (Syd. & P. Syd.) R.W. Ryan	in Stevens and Ryan, Ill. Biol. Monogr. 17(2): 80 (1939)	Dipterocarpaceae	*Shorea polysperma*	Philippines	Southeast Asia
40.	*P. mabae* (F. Stevens & R.W. Ryan) R.W. Ryan	in Stevens and Ryan, Ill. Biol. Monogr. 17(2): 77 (1939)	Ebenaceae	*Maba sandwichensis*	Hawaii, USA	Oceania
41.	*P. malabarensis* (Syd. & P. Syd.) R.W. Ryan	in Stevens and Ryan, Ill. Biol. Monogr. 17(2): 80 (1939)	Araceae	*Pothos scandens*	India	South Asia
42.	*P. manaosensis* (Henn.) R.W. Ryan	in Stevens and Ryan, Ill. Biol. Monogr. 17(2): 77 (1939)	Annonaceae	undetermined	Brazil	South America
43.	*P. melastomatacearum* (R.W. Ryan) R.W. Ryan	in Stevens and Ryan, Ill. Biol. Monogr. 17(2): 80 (1939)	Melastomataceae	undetermined	Puerto Rico	Caribbean
44.	*P. microchita* (Syd.) Arx	in Müller and Arx, Beitr. Kryptfl. Schweiz 11(2): 135 (1962)	Lauraceae	*Nothaphoebe pyriformis*	Borneo, Indoesia	Southeast Asia
45.	*P. mimusopis* [as '*mimusopsidis*'] (Doidge) R.W. Ryan	in Stevens and Ryan, Ill. Biol. Monogr. 17(2): 81 (1939)	Sapotaceae	*Mimusops welwitschii*	DR Congo	Africa
46.	*P. multilobata* (G. Winter) R.W. Ryan	in Stevens and Ryan, Ill. Biol. Monogr. 17(2): 79 (1939)	Malpighiaceae	undetermined	Brazil	South America
47.	*P. obesa* (Syd. & P. Syd.) Arx	in Müller and Arx, Beitr. Kryptfl. Schweiz 11(2): 136 (1962)	Burseraceae	*Canarium villosum*	Philippines	Southeast Asia
48.	*P. parameriae* (Petr.) Arx	in Müller and Arx, Beitr. Kryptfl. Schweiz 11(2): 135 (1962)	Apocynaceae	*Parameria barbata*	Philippines	Southeast Asia
49.	*P. phoradendri* (R.W. Ryan) R.W. Ryan	in Stevens and Ryan, Ill. Biol. Monogr. 17(2): 80 (1939)	Santalaceae	*Phoradendron* sp.	Puerto Rico	Caribbean
50.	*P. polyalthiae* Hosag & T.K. Abraham	Indian Phytopathol. 51(4): 391 (1999)	Annonaceae	*Polyalthia longifolia*	India	South Asia
51.	*P. pterocelastri* (Doidge) R.W. Ryan	in Stevens and Ryan, Ill. Biol. Monogr. 17(2): 80 (1939)	Celastraceae	*Pterocelastrus variabilis*	South Africa	Africa
52.	*P. pumila* Syd.	Leafl. Philipp. Bot. 9: 3128 (1925)	Myristicaceae	*Horsfieldia gigantifolia*	Philippines	Southeast Asia
53.	*P. quinta* (Racib.) R.W. Ryan	in Stevens and Ryan, Ill. Biol. Monogr. 17(2): 78 (1939)	Myrtaceae	*Syzygium jambolanum*	Java, Indonesia	Southeast Asia
54.	*P. ramuligera* (Syd. & P. Syd.) R.W. Ryan	in Stevens and Ryan, Ill. Biol. Monogr. 17(2): 78 (1939)	Pandaceae	*Microdesmis caseariifolia*	Philippines	Southeast Asia
55.	*P. rhaphiostylidis* (S. Hughes) Arx	in Müller and Arx, Beitr. Kryptfl. Schweiz 11(2): 134 (1962)	Icacinaceae	*Rhaphiostylis beninensis*	Togo	Africa
56.	*P. saginata* (Syd. & P. Syd.) R.W. Ryan	in Stevens and Ryan, Ill. Biol. Monogr. 17(2): 80 (1939)	Arecaceae	*Pinanga elmerii*	Philippines	Southeast Asia
57.	*P. santiriae* (Syd. & P. Syd.) R.W. Ryan	in Stevens and Ryan, Ill. Biol. Monogr. 17(2): 80 (1939)	Burseraceae	*Santiria nitida*	Philippines	Southeast Asia
58.	*P. sinensis* Petr.	Sydowia 1: 351 (1947)	Sabiaceae	*Sabia gracilis*	China	East Asia
59.	*P. stuhlmanii* (Henn.) Arx	in Müller and Arx, Beitr. Kryptfl. Schweiz 11(2): 134 (1962)	Bromeliaceae	*Ananas* sp.	Tansania	Africa
60.	*P. systema-solare* (Massee) R. W. Ryan	in Stevens and Ryan, Ill. Biol. Monogr. 17(2): 78 (1939)	Proteaceae	*Banksia marginata*	Tasmania, Australia	Oceania
61.	*P. tecleae* (Doidge) Arx	in Müller and Arx, Beitr. Kryptfl. Schweiz 11(2): 134 (1962)	Rutaceae	*Teclea natalensis*	South Africa	Africa
62.	*P. tetracerae* (Hansf.) Arx	in Müller and Arx, Beitr. Kryptfl. Schweiz 11(2): 136 (1962)	Dilleniaceae	*Tetracera indica*	Java, Indonesia	Southeast Asia
63.	*P. tjibodensis* (Höhn.) R.W. Ryan	in Stevens and Ryan, Ill. Biol. Monogr. 17(2): 79 (1939)	Undetermined	undetermined	Java, Indonesia	Southeast Asia
64.	*P. venusta* (Syd. & P. Syd.) R.W. Ryan	in Stevens and Ryan, Ill. Biol. Monogr. 17(2): 78 (1939)	Annonaceae	*Anaxagorea luzonensis*	Philippines	Southeast Asia
65.	*P. winteriana* (Pazschke) G. Arnaud	Ann. École. Nat. Agric. Montp. 16: 161 (1918)	Annonaceae	*Rollinia* sp.	Brazil	South America
66.	*P. woodiana* (Doidge) R.W. Ryan	in Stevens and Ryan, Ill. Biol. Monogr. 17(2): 78 (1939)	Lauraceae	*Cryptocarya woodii*	South Africa	Africa

Excluded species of *Prillieuxina*:
P. diaphana (Syd. & P. Syd.) R.W. Ryan, in Stevens and Ryan, Ill. Biol. Monogr. 17(2): 79 (1939) [homotypic synonym of *Asterina diaphana* Syd. & P. Syd. (Hofmann ined.)].
P. microspila Syd., Philipp. J. Sci. 21: 141 (1922) [basionym of *Trichasterina microspila* (Syd.) Hansf., Reinwardtia 3: 126 (1954)].

Host Index of *Prillieuxina* spp.:

Achariaceae
- *Hydnocarpus falcatus*
  - *Prillieuxina hydnocarpi*

Amaryllidaceae
- *Hippeastrum* sp.
  - *Prillieuxina hippeastri*

Annonaceae
- *Anaxagorea luzonensis*
  - *Prillieuxina venusta*
- *Polyalthia longifolia*
  - *Prillieuxina polyalthiae*
- *Rollinia* sp.
  - *Prillieuxina winteriana*
- Unknown genus
  - *Prillieuxina manaosensis*

Apocynaceae
- *Acokanthera spectabilis*
  - *Prillieuxina acokantherae*
- *Alyxia monilifera*
  - *Prillieuxina clavispora*
- *Parameria barbata*
  - *Prillieuxina parameriae*

Aquifoliaceae
- *Ilex latifolia*
  - *Prillieuxina hiugensis*
- *Ilex odorata*
  - *Prillieuxina ilicicola*

Araceae
- *Pothos scandens*
  - *Prillieuxina malabarensis*

Arecaceae
- *Calamus* sp.
  - *Prillieuxina calami*
- *Pinanga elmerii*
  - *Prillieuxina saginata*

Asparagaceae
- *Cordyline terminalis*
  - *Prillieuxina amboinensis*

Asteraceae
- *Baccharis* sp.
  - *Prillieuxina baccharidincola*

Celastraceae
- *Elaeodendron croceum*
  - *Prillieuxina dissilens*
- *Pterocelastrus variabilis*
  - *Prillieuxina pterocelastri*

Clusiaceae
- *Garcinia imberti*
  - *Prillieuxina garciniae*

Bromeliaceae
- *Ananas* sp.
  - *Prillieuxina stuhlmanii*

Burseraceae
- *Canarium villosum*
  - *Prillieuxina obesa*
- *Santiria nitida*
  - *Prillieuxina santiriae*

Dilleniaceae
- *Tetracera indica*
  - *Prillieuxina tetracerae*

Dipteridaceae
- *Dipteris conjugate*
  - *Prillieuxina dipteridis*

Dipterocarpaceae
- *Dipterocarpus vernicifluus*
  - *Prillieuxina dipterocarpi*
- *Shorea polysperma*
  - *Prillieuxina luzonensis*

Ebenaceae
- *Maba sandwichensis*
  - *Prillieuxina mabae*

Elaeagnaceae
- *Elaeagnus kologa*
  - *Prillieuxina elaeagni*

Fabaceae
- *Calliandra* sp.
  - *Prillieuxina flexuosa*
- *Derris diadelpha*
  - *Prillieuxina gracilis*

Humiriaceae
- *Humiria floribunda*
  - *Prillieuxina humiriae*

Icacinaceae
- *Rhaphiostylis beninensis*
  - *Prillieuxina rhaphiostylidis*

Lamiaceae
- *Premna* sp.
  - *Prillieuxina creberrima*

Lauraceae
- *Cryptocarya glaucescens*
  - *Prillieuxina cryptocaryae*
- *Cryptocarya woodii*
  - *Prillieuxina woodiana*
- *Nothaphoebe pyriformis*
  - *Prillieuxina microchita*

Loranthaceae
- *Loranthus leytensis*
  - *Prillieuxina loranthi*

Malpighiaceae
- Unknown genus
  - *Prillieuxina multilobata*

Melastomataceae
- *Miconia ciliate*
  - *Prillieuxina antioquensis*
- Unknown genus
  - *Prillieuxina melastomatacearum*

Meliaceae
- *Dysoxylum cumingianum*
  - *Prillieuxina dysoxyli*

Menispermaceae
- *Anamirta cocculus*
  - *Prillieuxina anamirtae*

Myristicaceae
- *Horsfieldia gigantifolia*
  - *Prillieuxina pumila*

Myrtaceae
- *Eugenia* sp.
  - *Prillieuxina cylindrocarpa*
- *Syzygium jambolanum*
  - *Prillieuxina quinta*

Nyctaginaceae
- *Pisonia* sp.
  - *Prillieuxina intense*
- *Ramisia amazonica*
  - *Prillieuxina amazonica*

Pandaceae
- *Microdesmis caseariifolia*
  - *Prillieuxina ramuligera*

Poaceae
- Unknown genus
  - *Prillieuxina asterinoides*

Primulaceae
- *Ardisia humilis*
  - *Prillieuxina ardisiae*

Proteaceae
- *Banksia marginata*
  - *Prillieuxina systema-solare*

Rubiaceae
- *Burchellia capensis*
  - *Prillieuxina burchelliae*
- *Cinchona pubescens*
  - *Prillieuxina cinchonae*
- *Ixora ferrea*
  - *Prillieuxina ixorae*
- *Ixora philippinensis*
  - *Prillieuxina distinguenda*
- *Ixora* sp.
  - *Prillieuxina ixoricola*

Rutaceae
- *Teclea natalensis*
  - *Prillieuxina tecleae*

Scropholariaceae
- *Chilianthus arboreus*
  - *Prillieuxina inconspicua*

Sabiaceae
- *Sabia gracilis*
  - *Prillieuxina sinensis*

Santalaceae
- *Phoradendron* sp.
  - *Prillieuxina phoradendri*

Sapotaceae
- *Mimusops welwitschii*
  - *Prillieuxina mimusopis*

Unknown plant
        Prillieuxina calotheca
        Prillieuxina lepidotricha
        Prillieuxina tjibodensis
Urticaceae
    Conocephalus suaveolens
        Prillieuxina conocephali
    Leucosyke capitellata
        Prillieuxina capizensis

7.12 Species of *Xenostomella*

Table 7.10: A preliminary list of species of *Xenostomella* based on literature. Listed are only host plant species that are cited in the protologue of the type collection of the fungus.

No.	Species	Reference	Host plant family	Host plant species	Country	Continent
1.	*X. meridiensis* Toro	in Chardon and Toro, Monogr. Univ. Puerto Rico, Ser. B 2: 93 (1934)	Melastomataceae	*Miconia* sp.	Venezuela	South America
2.	*X. monninae* (Syd.) Arx	in Müller and Arx, Beitr. Kryptfl. Schweiz 11(2): 526 (1962)	Polygalaceae	*Monnina pilosa*	Ecuador	South America
3.	*X. tovarensis* Syd.	Ann. Mycol. 28 (1/2): 130 (1930)	Solanaceae	*Lycianthes xylopiifolia*	Venezuela	South America

Host Index of *Xenostomella* spp.:
Melastomataceae
Micona sp.
Xenostomella meridiensis
Polygalaceae
Monnina pilosa
Xenostomella monninae
Solanaceae
Lycianthes xylopiifolia
Xenostomella tovarensis

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Curriculum Vitae

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Education:

Sep. 1988 – Jun.1992	Primary school in Burkhardtsdorf, Germany
Sep. 1992 – Jul. 2000	Secondary school, Greifenstein-Gymnasium Thum in Thum/Erzgebirge, Germany
Oct. 2000 – Aug. 2005	Study at the Faculty of Biosciences of the J. W. Goethe-University in Frankfurt am Main, Germany for a Diploma degree, thesis was accomplished under guidance of Prof. Dr. M. Piepenbring at the the Department of Mycology (Botanical Institute) Title: “Fliegendreckpilze von Deutschland und Panama”
since Sep. 2005	PhD candidate of Prof. Dr. M. Piepenbring and PD Dr. R. Kirschner at the Department of Mycology (Institute for Ecology, Evolution and Diversity) at the J.W. Goethe-University in Frankfurt am Main, Germany

Teaching Experience:

Jun. 2005	Tour guide at the Botanical Garden of the J.W. Goethe-University in Frankfurt am Main, Title: “Cryptogams”
Feb. 2007	Workshop “Cientific Illustration (Illustración Científica)” at the Universidad Autónoma de Chirquí (UNACHI) in Panama
Apr. 2008	Tour guide at the Botanical Garden of the J.W. Goethe-University in Frankfurt am Main, Title: “Structure and function of leaves”
Jun. 2008	Lecture Replacement for PD R. Kirschner in the seminar “Morphology, Systematics and Evolution of Plants and Fungi” at the J.W. Goethe-University in Frankfurt am Main, lecture title: “Fungi Imperfecti”
May 2009	Tour guide at the Botanical Garden of the J.W. Goethe-University in Frankfurt am Main, Title: “Symbiosis and Parasitism”

Presentations:

Sep. 2005	Mycological Workshop at the Universidad Autónoma de Chiriqui (UNACHI) in Panama Title: “Microthyriales or fly-speck fungi (caca de mosca)”
Oct. 2006	International Congress of the German Mycological Society at the Eberhardt Karls University of Tübingen, Germany Title: “Fly-speck fungi (thyriothecioid ascomycetes) from Panama”
Feb. 2007	1st Symposium of Biodiversity in the Occident of Panama at the Universidad Autónoma de Chiriquí (UNACHI) in Panama Title: “Hongos caca de mosca (ascomycetes thyriothecioides) de Panamá”
Aug. 2007	Staff meeting at the U.S. National Fungus Collections (BPI), USA Title: “Fly-speck fungi from Panama”
Oct. 2008	International Congress of the German Mycological Society at the University of Kassel, Germany Title: “The genus *Asterina*”
Feb. 2009	Lectures at the meeting of the Deutsche Dendrologische Gesellschaft at the J.W.Goethe-University Frankfurt am Main, Germany Title: “Lebensraum Blatt (habitat leaf)”

Internet publications:

Hofmann T.A. & Kirschner R. (2008). Pilze im Rhein-Main-Gebiet. *BioFrankfurt, the Network for Biodiversity,* published online (www.biofrankfurt.de)

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Hofmann T.A. & Piepenbring M. (2006). New records and host plants of fly-speck fungi from Panama. *Fungal Diversity* 22:55-70.

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