SYSTEMATICS AND SPECIES DELIMITATION IN *PESTALOTIA* AND *PESTALOTIOPSIS* S.L. (AMPHISPHAERIALES, ASCOMYCOTA)

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1 Abstract

The fungal genus *Pestalotiopsis* s.l. contains approximately 300 described species and is globally distributed. The monotypic genus *Pestalotia* is considered the closest relative of *Pestalotiopsis* s.l. This study aims to investigate the diversity and systematics within *Pestalotiopsis* s.l. and its relation to *Pestalotia*. Therefore, an integrative approach is used considering molecular phylogeny methods as well as examination of morphological characters.

Recently, *Pestalotiopsis* s.l. was split into three genera with the addition of the newly erected *Neopestalotiopsis* and *Pseudopestalotiopsis*. The species of these genera are usually saprotrophic, phytoparasitic, or endophytic, and have been isolated from soil, air, and many kinds of anorganic material. The asexual fruiting bodies appear on infected plant material as black acervuli that release conidia. The conidia are important to examine for morphological taxon recognition. The number of conidial cells is the feature that distinguishes *Pestalotiopsis* s.l. spp. with five celled conidia, from *Pestalotia pezizoides* with six celled conidia. However, the significance of morphological characters is controversially discussed among mycologists. In recent years, 55 new species were described based on minor genetic distances and marginal or no morphological differences. Thus, the value of certain morphological characters and genetic markers need to be reconsidered.

In this study, 102 herbarium specimens of 26 described species, with an emphasis on plant pathogenic species from North America, have been morphologically examined and documented through drawings and photographs. Morphological examination was complemented with a comprehensive molecular dataset obtained from 191 cultures representing the genera *Neopestalotiopsis*, *Pestalotia*, *Pestalotiopsis*, *Pseudopestalotiopsis*, and *Truncatella*. One novelty of this work is that, besides the well-established markers ITS, *TEF1*, and *ß-tubulin*, the protein-coding genes *MCM7* and *TSR1* were successfully sequenced and included in the analyses. Phylogenies using Maximum Likelihood and Bayesian inference methods of single loci and the combined dataset were calculated. By comparison of these phylogenies, *MCM7* was identified as the most powerful one in terms of phylogenetic resolution and statistical support of nodes and is proposed as an additional barcoding marker in *Pestalotiopsis* s.l.

In *Pestalotiopsis*, species delimitation was tested using the Baysian Phylogenetics and Phylogeography (BP&P) program that tests an existing species scenario against

Bayesian inference methods under a multispecies coalescent model. The program supported only ten species out of the predetermined 19 species scenario. Measurements of conidia for species detected by BP&P were explored using a TukeyHSD-Test in the program R to find means that are significantly different from each other. This test revealed that combinations of morphological characters are required to distinguish between the ten species found by BP&P.

Another purpose of this work was to clarify the status of *Pestalotia* with regard to *Pestalotiopsis* s.l. Therefore, fresh epitypic material of *Pestalotia pezizoides*, was collected, isolated, and cultivated. The molecular analysis of a combined dataset of the gene regions ITS and LSU for species of Amphisphaeriales nested *P. pezizoides* in the genus *Seiridium.* Thus, synonymy of *Pestalotia* with *Seiridium* is proposed here. This is supported by morphology of the conidia. Further, an epitype is proposed for the type species of *Pestalotiopsis*, *P. maculans*. On the other hand, the recently proposed epitype of *P. adusta* is rejected here as it conflicts with the taxonomic hypothesis obtained in this study and its introduction is inconsistent with the formal requirements for epitypification. A new topotypic specimen is proposed instead. Additionally, several nomenclatural changes become necessary in many species examined. These include three new combinations and six synonyms of species of *Pestalotiopsis* s.l.

The conclusion of this work is that morphological data have potential as a valuable, inexpensive and easy way to recognize species. However, it is not the best method for species discovery and delimitation bearing in mind that in microfungi and many other organisms, individual plasticity and analogous structures are inadequately investigated. By phylogenetic analyses of molecular sequence data, it is possible to compare a great amount of equivalent characters and to delimit species that are morphologically cryptic. This is especially important since species of *Pestalotiopsis* s.l. mostly lack sexual structures that are helpful for morphological species delimitation in other groups of fungi. Thus, the Genealogical Concordance Species Concept (GCSC) finds its application in many fungal taxa. Conflicts in the genealogy between phylogenetic trees of different markers are interpreted as recombination of the genetic material within a linage. Accordingly, the change from conflict to congruence in a set of different phylogenetic trees can be seen as the species limit. It can be expected that increased application of the GCSC will lead to further approximation of described species numbers to the real number of species, especially in complicated groups like asexual microfungi.

2 Zusammenfassung

Die anamorphe Gattung *Pestalotiopsis* s.l. (Pestalotiopsidaceae, Xylariales, Ascomycota, Echte Pilze) ist weltweit verbreitet und umfaßt ungefähr 300 aktuell in ihr beschriebene Arten. Ihr gegenüber steht die monotypische Gattung *Pestalotia* mit der Typusart *P. pezizoides*. In dieser Studie wird die Validität der Gattung *Pestalotia* erstmals mit Hilfe molekularer Daten untersucht. Weiterhin werden morphologisch beschriebene Arten von *Pestalotiopsis* s.l. mittels verschiedenen Ansätzen der molekularen Systematik und Stammbaumrekonstruktion unter Berücksichtigung von Typusmaterial evaluiert. Zudem werden morphologische Daten erstmals im Rahmen einer Varianzanalyse untersucht.

Die Gattung *Pestalotiopsis* s.l. wurde 1949 von Steyaert aufgestellt und vor kurzem basierend auf morphologischen und molekularen Daten in die drei Gattungen *Neopestalotiopsis*, *Pestalotiopsis* und *Pseudopestalotiopsis* unterteilt. *Pestalotiopsis* s.l. umfaßt sowohl saprotroph, pflanzenparasitisch als auch endophytisch lebende Arten. Vertreter dieser Gattung wurden u.a. aus der Luft, dem Boden sowie von anorganischem Material isoliert. Typischerweise bilden Arten der Gattung *Pestalotiopsis* s.l. subepidermale, tellerförmige, schwarz gefärbte asexuelle Fruchtkörper, welche als Acervuli (Einzahl: Acervulus) bezeichnet werden. An der befallenen Wirtspflanze treten Acervuli meist in Gruppen auf. Innerhalb dieser Fruchtkörper entstehen die für diese Gattung morphologisch sehr charakteristischen Konidien. Das auffälligste Merkmal der Konidien von *Pestalotiopsis* s.l. sind die hyalinen Anhängsel an der apikalen Zelle. Die meisten Arten besitzen drei dieser Anhängsel, welche zur Verbreitung der Konidien durch Wind und Wasser beitragen. Weiterhin sind die Konidien von Arten der Gattung *Pestalotiopsis* s.l. morphologisch durch vier transversale Septen, drei dunkel pigmentierten Mittelzellen und jeweils eine basale und apikale hyaline Zelle sowie ein einzelnes Anhängsel an der basalen Zelle gekennzeichnet.

Pestalotia, mit der Typusart *P. pezizoides*, wurde von De Notaris 1839 als heterogene Gattung aufgestellt, die zuerst auch *Pestalotiopsis* s.l. beinhaltete. Das heute angenommene morphologische Hauptunterscheidungsmerkmal zu *Pestalotiopsis* s.l. ist die Anzahl der Konidienzellen. Demnach ist die Art von *Pestalotia* durch sechs konidiale Zellen pro Konidie, Arten von *Pestalotiopsis* s.l. durch fünf konidiale Zellen charakterisiert. Die Verläßlichkeit der morphologischen Merkmale für die Abgrenzung

dieser beiden Gattungen und für die Bestimmung von Arten wird von Wissenschaftlern kontrovers diskutiert. Dies führt seit der Aufstellung von *Pestalotia* und *Pestalotiopsis* s.l. zu Unstimmigkeiten auf taxonomischer Ebene sowie Ungewißheiten in Bezug auf die Artenvielfalt innerhalb dieser Gattungen.

Wissenschaftlich wurde *Pestalotiopsis* s.l. in den letzten Jahren vermehrt Aufmerksamkeit zuteil, da Arten dieser Gattung immer häufiger im Zusammenhang mit verschiedenen Schadbildern und Symptomen an Zier- und Nutzpflanzen gebracht wurden. Allein in den letzten vier Jahren wurden 55 neue Arten beschrieben. Die meisten Neubeschreibungen basieren auf geringen genetischen Distanzen und wenigen bis keinen morphologischen Unterschieden. Für die molekularen Analysen wird meistens eine Kombination aus dem universalen Barcodemarker ITS und den beiden Protein kodierenden Markern *ß-tubulin* und *TEF1* verwendet. Häufig wird auch die Wirtspflanze für die Abgrenzung einer neuen Art benutzt, obwohl eine Wirtsspezifität von *Pestalotiopsis* s.l. Arten stark angezweifelt wird.

Für ein besseres Verständnis des morphologischen Art- und Gattungskonzepts von *Pestalotiopsis* s.l. und nah verwandten Gattungen wurden intensive Literaturrecherchen und lichtmikroskopische Untersuchungen durchgeführt. Insgesamt wurden 102 Herbarbelege von 26 Arten aus fünf Gattungen morphologisch untersucht. Bei der Auswahl der Arten wurde insbesondere berücksichtigt, ob eine Pathogenität bekannt ist, da die genaue taxonomische Einordnung solcher Arten als besonders dringlich ist. Eine tabellarische Übersicht mit den Maßen der gängigen morphologischen Merkmale zur Artabgrenzung wurde angefertigt und kann als Grundlage für zukünftige taxonomische Arbeiten dienen. Teilweise wurden die untersuchten Herbarbelege durch Zeichnungen und/oder lichtmikroskopische Fotografien illustriert. Bei einigen Herbarbelegen waren die fragilen, hyalinen Strukturen zerbrochen oder der gesamte Beleg war stark eingefallen. Daher war es nicht immer möglich alle wichtigen Merkmalsstrukturen zu vermessen. Einige Versuche wurden unternommen Herbarbelege von *Pestalotiopsis* s.l. zu sequenzieren, jedoch blieb ein positives Resultat aus. Die wissenschaftlichen Erstbeschreibungen, insbesondere älterer Arten, sind häufig aus heutiger Sicht unvollständig und erlauben keine sichere Artbestimmung.

Für die Evaluierung bestehender Arten von *Pestalotiopsis* s.l. wurde in dieser Studie ein umfangreicher molekularer Datensatz erstellt. Insgesamt wurden Sequenzen von 191 Kulturen der fünf nah verwandten Gattungen *Neopestalotiopsis* (76 Kulturen), *Pestalotia* (zwei Kulturen), *Pestalotiopsis* (109 Kulturen), *Pseudopestalotiopsis* (drei Kulturen) und *Truncatella* (eine Kultur) generiert. Dabei wurden die fünf Genregionen ITS, *TEF1*, *ß-tubulin, MCM7* und *TSR1* sequenziert. Sequenzen der beiden proteinkodierenden Marker *MCM7* und *TSR1* wurden in dieser Studie zum ersten Mal für diesen Verwandtschaftskreis ermittelt. Aus den generierten Datensätzen wurden sowohl für einzelne Marker, als auch kombiniert mittels Maximum Likelihood (ML) und Bayesianischer Analyse (BS) Dendrogramme errechnet und ausgewertet. Im Vergleich der phylogenetischen Bäume, die auf Einzeldatensätzen basieren, konnte mit *MCM7* die am besten aufgelöste und am besten statistisch unterstützte Phylogenie errechnet werden. Folglich wird in dieser Studie *MCM7* als sekundärer Barcodemarker für die Gattung *Pestalotiopsis* s.l. vorgeschlagen.

Die drei Einzeldatensätze der Marker ITS, *TEF1* und *ß-tubulin* wurden außerdem mit den in GenBank frei verfügbaren Typussequenzen ergänzt, phylogenetisch analysiert und die Baumtopologien auf Kongruenz geprüft. Für die Gattung *Pestalotiopsis* wurde außerdem erstmals eine Artabgrenzungsanalyse mit dem Programm Bayesian Phylogenetics and Phylogeography (BP&P) durchgeführt. BP&P basiert auf verschiedenen Bayesschen Inferenz Methoden und ist speziell für die Artabgrenzung nah verwandter Taxa mittels multi-lokus Datensätzen konzipiert. Die von BP&P ermittelten putativen Arten stützen sich auf ein hypothetisches Arten-Szenario, das vom Anwender vorgegeben wird. Das hier verwendete Arten-Szenario beruht auf monophyletischen Kladen, die im kombinierten Datensatz sowohl in der ML als auch von der BS Analyse statistisch unterstützt wurden. Dieses Ausgangsszenario ging von 19 Arten aus. Durch die Artabgrenzungsanalyse wurde diese Anzahl minimiert, indem eine Reihe von Bayesian Inferenz Methoden unter dem Multiarten Vereinigung Model (multispecies coalescenz model) angewendet wurde. Das Ergebnis der Analyse unterstützt lediglich das Vorhandensein von zehn Arten.

In der vorliegenden Studie wurde weiterhin ein TukeyHSD-Test, ein multipler Vergleichstest, morphologischer Merkmale mittels des Statistikprogramms R durchgeführt. Zu diesem Zweck wurden jeweils fünf morphologische Merkmale der Konidien von je drei Isolaten aus acht der zehn, durch BP&P ermittelten, putativen Arten aufgenommen. Unter Berücksichtigung der gesamten Merkmalskombination unterstützt die statistische Analyse die Existenz der von BP&P vorgeschlagenen Arten auf morphologischer Ebene.

Zu Beginn dieser Arbeit stand von der Typusart der Gattung *Pestalotia*, *P. pezizoides,* weder Kulturmaterial noch Sequenzdaten zur Verfügung. Die Artbestimmung konnte somit lediglich auf die Untersuchung von Herbarmaterial gestützt werden. Ausgehend von frisch gesammeltem Pflanzenmaterial der Wirtspflanze, *Vitis vinifera*, konnte im Rahmen dieser Studie erfolgreich *P. pezizoides* isoliert, kultiviert und epitypifiziert werden. Für die Klärung der Verwandtschaftsverhältnisse von *Pestalotia* zu *Pestalotiopsis* wurden in dieser Studie erstmals die Genregionen ITS und LSU des Epityps sequenziert. Die folgende phylogenetische Untersuchung mittels einer ML Analyse berücksichtigt Vertreter der Ordnung Amphisphaeriales und basiert auf einem kombinierten Datensatz der sequenzierten DNA-Marker. Die Analyse unterstützt die Zugehörigkeit von *P. pezizoides* zur nah verwandten Gattung *Seiridium*, was auf taxonomischer Ebene die Synonymisierung der Gattung *Pestalotia* mit *Seiridium* und die Umkombination von *Pestalotia pezizoides* zu *Seiridium pezizoides* zur Folge hat. Die morphologischen Merkmale, insbesondere der Konidien beider Gattungen, unterstützen diese These.

Ferner wird in der vorliegenden Arbeit ein Epitypus-Beleg für *Pestalotiopsis maculans*, Typusart der Gattung *Pestalotiopsis*, vorgeschlagen. Der frisch gesammelte Epitypus konnte kultiviert und Sequenzen verschiedener Genbereiche generiert werden. Die molekularen Daten wurden in den phylogenetischen Analysen dieser Arbeit berücksichtigt.

Weiterhin wird, gestützt auf den neu gewonnenen Erkenntnissen aus dieser taxonomischen Arbeit, vorgeschlagen, den bereits beschriebenen Epitypus von *Pestalotiopsis adusta* abzulehnen. An seiner Stelle wird ein offizieller, repräsentativer Beleg vorgeschlagen. *Pestalotiopsis adusta* wurde erstmals von *Prunus domestica* aus New Jersey beschrieben und ist heute als Pflanzenparasit verschiedener Nutzpflanzen bekannt. Kürzlich wurde ein Epitypus publiziert, jedoch ist seine Identifizierung nicht konform mit der gängigen Praxis zur Bestimmung von Epitypen. Hingegen wurde der in dieser Arbeit vorgeschlagene, repräsentative Beleg von topotypischem Pflanzenmaterial der Gattung *Prunus* isoliert sowie kultiviert.

Basierend auf den erhobenen Daten werden weitere taxonomische Veränderungen innerhalb der drei Gattungen *Neopestalotiopsis*, *Pestalotiopsis* und *Pseudopestalotiopsis* vorgeschlagen. Vier Arten werden umkombiniert, *Pestalotia caroliniana* zu *Pestalotiopsis caroliniana, Pestalotiopsis casuarinae* zu *Truncatella*

casuarinae, *Pestalotiopsis simitheae* zu *Pseudopestalotiopsis simitheae* und *Pseudopestalotiopsis coffeae-arabicae* zu *Neopestalotiopsis coffeae-arabicae*. Sechs Arten werden synonymisiert, *Pestalotiopsis monochaeta* mit *P. hollandica*, *P. trachicarpicola* mit P. *kenyana*; Für die Art *P. shorea* werden vier neue Synonyme, *P. colombiensis*, *P. diploclisiae*, *P. humus* und *P. papuana*, vorgeschlagen.

Morphologische Merkmale sind verhältnismäßig leicht zu beobachten und bilden bedingt durch ihre Vielseitigkeit, die auf komplexen Genomen beruht, nach wie vor eine gute Grundlage für die Abgrenzung von Taxa. Allerdings kann es auch leicht zu Interpretationsfehlern kommen, wenn lediglich morphologische Merkmale für die Bestimmung eines Individuums herangezogen werden. Beispielsweise kann die Unterscheidung zwischen Homologien und Analogien schwierig sein. Die morphologische Plastizität einer Art ist oft schwierig einzuschätzen und kann zu einer Überschätzung der Diversität führen. Zudem besitzen zahlreiche nahe verwandte Arten kaum unterscheidbare morphologische Merkmale - die Folge ist häufig eine hohe Anzahl kryptischer Arten innerhalb solcher Verwandtschaftskreise. Molekulare Merkmale beruhen hingegen direkt auf der Erbinformation der Organismen und mit ihnen steht eine große Anzahl gleichwertiger Merkmale zur Verfügung. Dadurch können mit Hilfe der molekularen Systematik auch kryptische Arten gut erkannt werden, die sich morphologisch wenig bis gar nicht unterscheiden.

Im Fall asexueller Mikropilze, zu denen auch die Gattung *Pestalotiopsis* s.l. zählt, sind morphologische Merkmale häufig nicht ausreichend, um zweifelsfrei Arten abzugrenzen. Vor diesem Hintergrund wird häufig das *Genealogical Concordance Species Concept* (GCSC) verwendet, welches hauptsächlich für die Erkennung von Pilzarten entwickelt wurde. Das GCSC beruht auf der Idee, daß Rekombination innerhalb einer genetischen Linie zu einem Konflikt zwischen Gen-Bäumen führt und, daß durch den Wechsel von Konflikt zu Kongruenz Artgrenzen identifiziert werden können. Es ist zu erwarten, daß die standartmäßige Anwendung des GCSC zu einer Annäherung der beschriebenen Arten an die wahre Artenanzahl führt, insbesondere in taxonomisch komplizierten Gruppen, zu denen auch die asexuellen Mikropilze zählen. In der Gattung *Pestalotiopsis* s.l. führt dies voraussichtlich zu weiteren Synonymisierungen, wodurch die Artenanzahl deutlich sinkt. In anderen Pilzgruppen kann es durch die Anwendung des GCSC aber auch zu einer Erhöhung der Artenzahl kommen. Weiterhin bietet das GCSC eine gute Möglichkeit den taxonomischen Wert bestimmter Merkmale für die Unterscheidung von Arten zu prüfen.

3 List of abbreviations and symbols

3.1 Abbreviations of herbaria and institutions

ARS	Agricultural Research Service
BIK-F	Biodiversity and Climate Research Centre, Frankfurt, Germany
BPI	U.S. National Fungus Collections, Beltsville, USA
COI	University of Coimbra, Coimbra, Portugal
CUP	Cornell University, New York, USA
JKI	Julius Kühn Institut, Quedlinburg, Germany
LWK	Landwirtschaftskammer Niedersachsen, Oldenburg, Germany
PR	National Museum in Prague, Prague, Czech Republic
USDA	Untied State Department of Agriculture

3.2 General abbreviations

AICc	corrected Akaike Information Criterion
approx.	approximately
BI	Bayesian inference
BLAST	Basic Local Alignment Search Tool
bp	base pairs
BS	bootstrap
ca.	*circa*: about
coll.	collector(s)
CTAB	cetyltrimethylammonium bromide
d	days
det.	determined
ddH_2O	double-distilled water
DNA	Deoxyribonucleic acid

dNTPs	deoxyribose nucleotid triphosphates
dpi	dots per inch
e.g.	*exempli gratia*: for example
EIDs	emerging infectious diseases
et al.	*at alii/ et aliortum*: and others/ and of others
fide	*fide*: according to
g	gram
LA	length of apical appendages
LB	length of basal appendages
leg.	legit
LM	length of the three conidial middle cells
h	hour(s)
m^2	square meter
MCMC	Makov chain Monte Carlo
mg	milligram
min	minute(s)
ml	milliliter
ML	maximum likelihhood
mm	millimeter
mM	millimolar
n	number
N/A	not available
N_AA	number of apical appendages
ng	nanogram
nom. nud.	*nomen nudum*: naked name
n.v.	*non visus*: not seen
PCR	polymerase chain reaction

PP	posterior probability
RNA	Ribonucleic acid
rRNA	ribosomal Ribonucleic acid
sec	second
s.l.	*sensu lato*, in the broad sense
s.n.	*sine numero*, without a number
sp.	species
Tab.	table
TIFF	Tagged Image File Format
tRNA	transfer Ribonucleic acid
U	units
°C	degree Celsius
µl	microliter
µm	micrometer

3.3 Symbols

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

4 Introduction

4.1 Preface

Fungal plant pathogens play a key role in our daily lives as they have a negative influence on food security, international travel and trade, and wildlife (Lane and Kirk 2012). In the last decades, more than half of the world´s plant emerging infectious diseases (EIDs) resulted from the arrival of previously unrecognized pathogens (Bandyopadhyay and Frederiksen 1999; Anderson et al. 2004). Amongst the major pathogens causing plant EIDs, fungi play a primary role. At the same time, fungal EIDs are found to cause plant diseases at an alarming rate. For example, Fisher et al. (2012) report a 13-fold increase of disease alerts for plant-infecting fungi in ProMED (Program for Monitoring Emerging Diseases) between the years 1995 and 2010. To face the challenges posed by those diseases and to adopt strategies for the surveillance and control of fungal plant pathogens, it is important to gather as much knowledge as possible about their diversity and taxonomy. An in-depth knowledge about the systematic relationships reflecting phylogeny may prevent these disease introductions by enhancing the ability to make predictions about the potential pathogenicity of fungi (Rossman and Palm-Hernández 2008).

The species-rich genus *Pestalotiopsis* Steyaert includes numerous plant pathogens as well as endophytes (Maharachchikumbura et al. 2011, 2012; Satini et al. 2013, Zhang et al. 2013), which synthesize a diverse array of bioactive compounds (Gazis et al. 2011; Xu et al. 2010). The biology of most species of *Pestalotiopsis* is still largely unclear. For example, it is not known if they are host-specific, obligate parasites or live on diverse hosts as endophytes without causing any visible symptoms and only become pathogenic once the host is weakened. Recently, one common species, *Pestalotiopsis guepinii* (Desm.) Steyaert, has been identified as an invasive forest pathogen (IFP) (Satini et al. 2013). To date, 299 names of species of *Pestalotiopsis* are listed in the *Index Fungorum* (status March 2016), the global fungal nomenclature database. Despite of this high number of described species, more than 55 additional species were introduced into the genus *Pestalotiopsis* s.l. during the past four years (Geng et al. 2013, Liu et al. 2015; Maharachchikumbura et al. 2012, 2013a,b, 2014; Song et al. 2014a,b; Zhang et al. 2012b, 2013; Zhao and Zhao 2012). However, many questions remain concerning the taxonomy and systematics of this genus, particularly regarding species recognition and delimitation.

4.2 History of *Pestalotia*, *Pestalotiopsis*, and closely related genera

Since the genus *Pestalotia* De Not. (1839) was first described, the concept of this genus has undergone many changes, resulting in nomenclatural and taxonomical uncertainties. De Notaris (1841) established the genus *Pestalotia* to accommodate a single species, *P. pezizoides* De Not., occurring on *Vitis vinifera* near Milan, north Italy. The important diagnostic characters of the type species are pezizoid, unilocular conidiomata and conidia with five horizontal distosepta resulting in four deeply brown median cells, one basal and one terminal hyaline cell, and simple or branched appendages arising from the top of the conidia. Desmazières (1840) included *P. guepinii* in *Pestalotia*, even though the morphology of the fruiting bodies and conidia of this species differed remarkably from *P. pezizoides. Pestalotia guepinii* produces acervuloid fruiting bodies that are more or less stromatic and 5-celled conidia. In the following years the trend of including species with 5-celled conidia in *Pestalotia* continued and caused taxonomic confusion.

In 1842, there was a dispute about the correct spelling of the genus name, when Corda (1842) suggested changing *Pestalotia* to *Pestalozzia.* However, Guba (1929) determined that the original genus name *Pestalotia* is the correct Latin spelling and most authors including myself agree with this decision.

Based on conidial characters Saccardo (1884) divided *Pestalotia* into three subgenera: *Monochaetia* defined as having an apical cell with one appendage, *Eu-Pestalotia* having an apical cell hyaline with multiple appendages, and *Pestalozzina* having a subhyaline apical cell. Some years later Allescher (1903) proposed the elevation of the subgenus *Monochaetia* to generic rank as *Monochaetia* (Sacc.) Allesch.

Klehbahn (1914) stated that the number of conidial cells should be used as the main morphological character for the definition of species' groups in the genus *Pestalotia*. Based on this, Guba (1929, 1932) defined three sections, namely the Quadriloculatae, Quinqueloculatae, and Sexloculatae. In the Sexloculatae he placed only one species, *P. pezizoides*. Additionally, Guba (1929, 1932) described several new species under the assumption that species are invariably host specific. Later, Guba (1961) published a comprehensive monograph on *Pestalotia* in the broad sense. Therein, he listed *Labridella, Pestalotiopsis*, and *Truncatella* as synonyms of *Pestalotia* and accepted 220 species in this single genus. Until today, this remains the only comprehensive work on the genus.

Steyaert (1949) revised *Pestalotia* and introduced two generic names: *Pestalotiopsis* Steyaert for species with 5-celled conidia based on the type species, *P. guepinii* (Desm.) Steyaert that is found on leaves of *Camellia* sp., and *Truncatella* Steyaert for species with 4-celled conidia based on the type species, *T. truncata* (Lév.) Steyaert that is found on twigs of *Populus fastigiata*. Both type specimens were originally found in France. In his revision, Steyaert (1949) removed all species from the genus *Pestalotia* except *P. pezizoides* on the basis of conidial morphology and the shape of the fruiting body. He further subdivided each of the two new genera into four sections based on the number of apical appendages of the conidia. The sections are Monosetulatae, Bisetulatae, Trisetulatae, and Multisetulae. Steyaert (1949) revised the genus *Monochaetia* and rearranged the respective species in the two genera *Pestalotiopsis* and *Truncatella*, while the 5-celled species of *Monochaetia* were placed in the genus *Pestalotia*. However, Steyaert´s (1949) introduction of *Pestalotiopsis* was rejected by some authors, e.g. Servazzi (1953) and Guba (1955, 1956, 1961). Meanwhile, Steyaert (1955, 1961) published several articles in support of his new genus. In his revisions Steyaert (1949, 1955, 1961) did not study the type material of all of the species considered. Among others he did not examine the type of *P. pezizoides*. Later, Sutton (1961, 1969, 1980) and Sutton and Sellar (1966) examined the type of *P. pezizoides*, reviewed the generic concept of *Pestalotia* and accepted this genus as monotypic with *P. pezizoides* as the only species. However, the discussion about the validity of *Pestalotiopsis* continues until today (Maharachchikumbura et al. 2011).

Griffiths and Swart (1974a, b) and Roberts and Swart (1980) tested the value of conidial wall structure using light and electron microscopy to answer taxonomic questions in the *Monochaetia-Seiridium* and the *Pestalotia-Pestalotiopsis* complexes. Explicitly, the study by Griffiths and Swart (1974b) provides strong evidence in support of Steyaert's (1949) view to treat *Pestalotia* and *Pestalotiopsis* as separate genera.

Nag Raj (1985a) agreed with Sutton (1980) in that there was a need to redispose and redescribe species of *Monochaetia* and *Pestalotia* and published a series of three papers solving several taxonomic problems in *Monochaetia* and *Pestalotia* (Nag Raj 1985a, b, c). An important taxonomic change by Nag Raj (1985a) was to put *P. guepinii*, the type species of *Pestalotiopsis*, into synonymy with *P. maculans* (Corda) NagRaj. Until today most authors accept this change.

With the availability of molecular data and advanced possibilities for phylogenetic analyses, Jeewon et al. (2003b) showed, on the basis of the generally accepted barcoding marker for fungi, the internal transcribed spacer (ITS), that *Pestalotiopsis* comprises three deep divergent lineages. This finding was integratively confirmed by Maharachchikumbura et al. (2011, 2012, 2013a, 2014) by comparison of morphological data and a multigene analysis including ribosomal and nuclear markers. They suggest splitting the large genus *Pestalotiopsis* into three genera that include, besides *Pestalotiopsis*, the two newly introduced genera *Neopestalotiopsis* Maharachch., K.D. Hyde & Crous and *Pseudopestalotiopsis* Maharachch., K.D. Hyde & Crous based on the type specimens *N. protearum* (Crous & L. Swart) Maharachch., K.D. Hyde & Crous and *Ps. theae* (Sawada) Maharachch., K.D. Hyde & Crous. In particular, *Neopestalotiopsis* differs from *Pestalotiopsis* and *Pseudopestalotiopsis* with respect to conidia pigmentation in having versicolourous median cells. In contrast, both *Pestalotiopsis* and *Pseudopestalotiopsis* have conidia with concolorous median cells but they can be distinguished from each other, besides by sequence data and by the morphology of the conidiophore. In general, in the genus *Pseudopestalotiopsis* the conidial middle cells are dark colored and conidiophores are indistinct, often reduced to conidiogenous cells. In the comprehensive study by Maharachchikumbura et al. (2014), 37 new species of the *Pestalotiopsis* complex are introduced (11 *Neopestalotiopsis*, 24 *Pestalotiopsis*, and two *Pseudopestalotiopsis*). Until today, new species continue to be described (e.g. Liu et al. 2015).

4.3 *Pestalotiopsis* s.l.

Hereinafter, the term *Pestalotiopsis* s.l. will refer to the three anamorph genera *Neopestalotiopsis, Pestalotiopsis*, and *Pseudopestalotiopsis*.

The term *pestalotiopsis*-like is used for asexual taxa with conidia that have at least two transversal septa, colored middle cells, hyaline end cells, the apical cell bearing one to many, branched or unbranched appendages and the basal cell with or without an appendage.

4.3.1 Systematic position

To date, about 1,500 genera and almost 30,000 species of anamorphic fungi are described, and the number of species is still increasing (Kendrick 2001). In the 19th century, the anamorphic fungi formerly called Fungi Imperfecti (Deuteromycotina), had been divided into three classes the Hyphomycetes, Coelomycetes, and Agonomycetes. This classification is based mainly on morphology, using conidia development as the principle distinguishing feature. Three main types of conidial development are distinguished: production of conidia inside of fruiting bodies (Coelomycetes) or lack of such enclosure (Hyphomycetes) or no production of any type of spores (Agonomycetes, Mycelia Sterilia).

Grove (1919) used the term Coelomycetes for the first time as a collective term for the three genera *Phloeospora, Phomopsis*, and *Phyllosticta*. Later, Grove (1935) redefined the concept of the Coelomycetes and included all anamorphic fungi forming their conidia and conidiogenous cells within a cavity lined by fungal or fungal/host tissue. The entire conidia-bearing structure is called a conidioma, pl. conidiomata. Conidiomata usually develop just beneath the surface of their host substrate. Based on shape and position of the conidiomata in relation to the host tissue, Kirk et al. (2008) distinguished between pycnidial, pycnothyrial, acervular, cupulate, and stromatic conidiomata. Furthermore, several intermediate forms between pycnidia and acervuli are recognized (Nag Raj 1993). According to Kirk et al. (2008) the Coelomycetes comprise about 1000 genera (plus 500 synonyms) and 7000 species. Nowadays, it is well known that the Coelomycetes comprise taxa of different evolutionary origins sharing certain morphological features. Thus, this class has no longer a formal taxonomic rank. However, the term coelomycetes is still used on species lists, because many important fungal phytopathogenic genera belong to this group, e.g. *Colletotrichum*, *Pestalotiopsis*, *Phoma*, *Phomopsis*, and *Phyllosticta*.

Based on molecular data, Jeewon et al. (2003a) demonstrated that members of *Pestalotiopsis* s.l. belong to the family Amphisphaeriaceae within the order Xylariales (Ascomycota). The family Amphisphaeriaceae was established by Winter (1887).

Recently, Senanayake et al. (2015) introduced the family Pestalotiopsidaceae Maharachch. & K.D. Hyde to accommodate seven anamorphic genera, *Ciliochorella*, *Lepteutypa*, *Monochaetia*, *Neopestalotiopsis*, *Pestalotiopsis*, *Pseudopestalotiopsis*, and *Seiridium,* that posses *pestalotiopsis*-like conidia and resurrected the order

Amphisphaeriales based on morphological and molecular data. The fungal order Amphisphaeriales was established by Eriksson and Hawksworth (1986) to accommodate the four families Amphisphaeriaceae, Cainiaceae, Clypeosphaeriaceae, and Hyponectriaceae. One year later the same authors synonymized the Amphisphaeriales with the order Xylariales (Eriksson and Hawksworth 1987), which was accepted by various authors in subsequent years (Jeewon et al. 2003a, Lumbsch and Huhndorf 2007, Maharachchikumbura 2015). Following the latest taxonomic concept proposed by Senanayake et al. (2015) the Amphisphaeriales are represented by the six families Amphisphaeriaceae, Bartaliniaceae, Clypeosphaeriaceae, Discosiaceae, Pestalotiopsidaceae, and Phlogicylindriaceae. The anamorphic state of species included in the families of the Amphisphaeriales *sensu* Senanayake et al. (2015) produce conidia that are aseptate to transeuseptate, variously colored, and often bear appendages.

4.3.2 Morphology

In the following dissertation, the morphological characters of the *Pestalotiopsis* s.l. are introduced on the basis of the original description by Steyaert (1949), as well as further explanations by Guba (1961), Kirk et al. (2008), Nag Raj (1993), Sutton (1980), and Webster and Weber (2007). *Pestalotiopsis* is distinguished from other anamorphic genera in the family Pestalotiopsidaceae by the following combination of characters: 5-celled, fusiform conidia, with three-colored median cells, hyaline basal cells, and one or more apical appendages. Figure 1 shows the morphological characters of *Pestalotiopsis* s.l.

The following structures have been used as distinctive features in the past and play a more or less important role in species recognition:

Conidiomata

Conidiomata are commonly irregularly distributed over the host tissue and form scattered to confluent colonies, which are sometimes densely aggregated. The position of the conidiomata can be epidermal to subepidermal, immersed or erumpent. The conidiomatal type varies in shape from acervuloid to pycnidioid. In general the conidiomata are unilocular and glabrous. Mostly, the conidiomata are dark-brown to black pigmented. On the lower regions, the conidiomata are composed of thick, dark-brown pigmented wall tissue, while having thinner and paler wall tissue in the upper part. When very mature, the conidiomata dehisce by irregular fissures. The wall tissue type mostly corresponds to textura angularis.

Conidiophores

A conidiophore is a specialized hypha, simple or branched, on which conidia are formed (Kendrick 2001). In *Pestalotiopsis* s.l. conidiophores develop in all parts of the inner surface of the wall of the conidiomata, but most commonly in the lower regions of the cavity. Usually, the conidiophores are reduced to conidiogenous cells. The species of *Pestalotiopsis* s.l. develop branched, septate, cylindrical or lageniform, hyaline conidiophores.

Conidiogenous cell

Cells producing conidia are referred to as conidiogenous cells. The species of *Pestalotiopsis* s.l. possess discrete or integrated conidiogenous cells, which can vary in shape from cylindrical, ampulliform to lageniform. The conidiogenous cells are hyaline and smooth. Transverse bands mark the distal ends of the conidiogenous cells, which are termed annellations. In *Pestalotiopsis* s.l. the conidiogenesis is holoblastic.

Conidia

Usually, conidia of species of *Pestalotiopsis* s.l. are characterized by four transversal septa (phragmosporous), with only a few exceptions bearing three transversal septa, e.g., *P. besseyi* and *P. casuarinae* or even five e.g., *P. valdiviana*. The shape is mostly fusiform, straight or slightly curved. The conidia are often slightly constricted at the septa and smooth-walled. The middle cells are mostly doliiform and always pigmented. The pigmentation can be concolorous or versicolourous, brown to olivaceous or umber to fuliginous, and of different intensity. Further, the middle cells have thicker cell walls than the terminal cells and can be minutely verrucous. The basal cell is conic to obconic, with or without a truncate base, hyaline to sub-hyaline, thin-walled, and bears one, mostly unbranched appendage that arises from the center of the basal cell. Occasionally, the basal appendage is missing. The apical cell is conic to hemispherical, hyaline to sub-hyaline, thin-walled, and bears one to many, branched or unbranched, spathulate or espathulate appendages. These apical appendages arise from the center of the cell. In a few species the apical appendages originate from the base of the apical cell, e.g., *P. montellica*.

The ecological function and the taxonomic value of appendages have been widely discussed (e.g. Crous et al. 2012; Jones 2006; Nag Raj 1993). It is commonly accepted that the appendages play a key role in spore dispersal, and during the colonization of new substrates. The appendages increase the surface of the conidia, which has a positive effect on spore dispersal by water and wind (Piepenbring 2015). They also facilitate spore attachment to substrates, which enables the conidium to germinate and infect or colonize the substrate (Nag Raj 1993). Recently, Crous et al. (2012) examined the value of appendages as taxonomic character at the generic level among coelomycetous fungi, using *Dinemasporium* as an example. They found that appendage morphology is not informative at the generic level when used in isolation, whereas appendage morphology (mucilaginous or cellular, endo- or exogenous, simple or branched, as well as their position on the conidium body) appears to be highly informative at the species level.

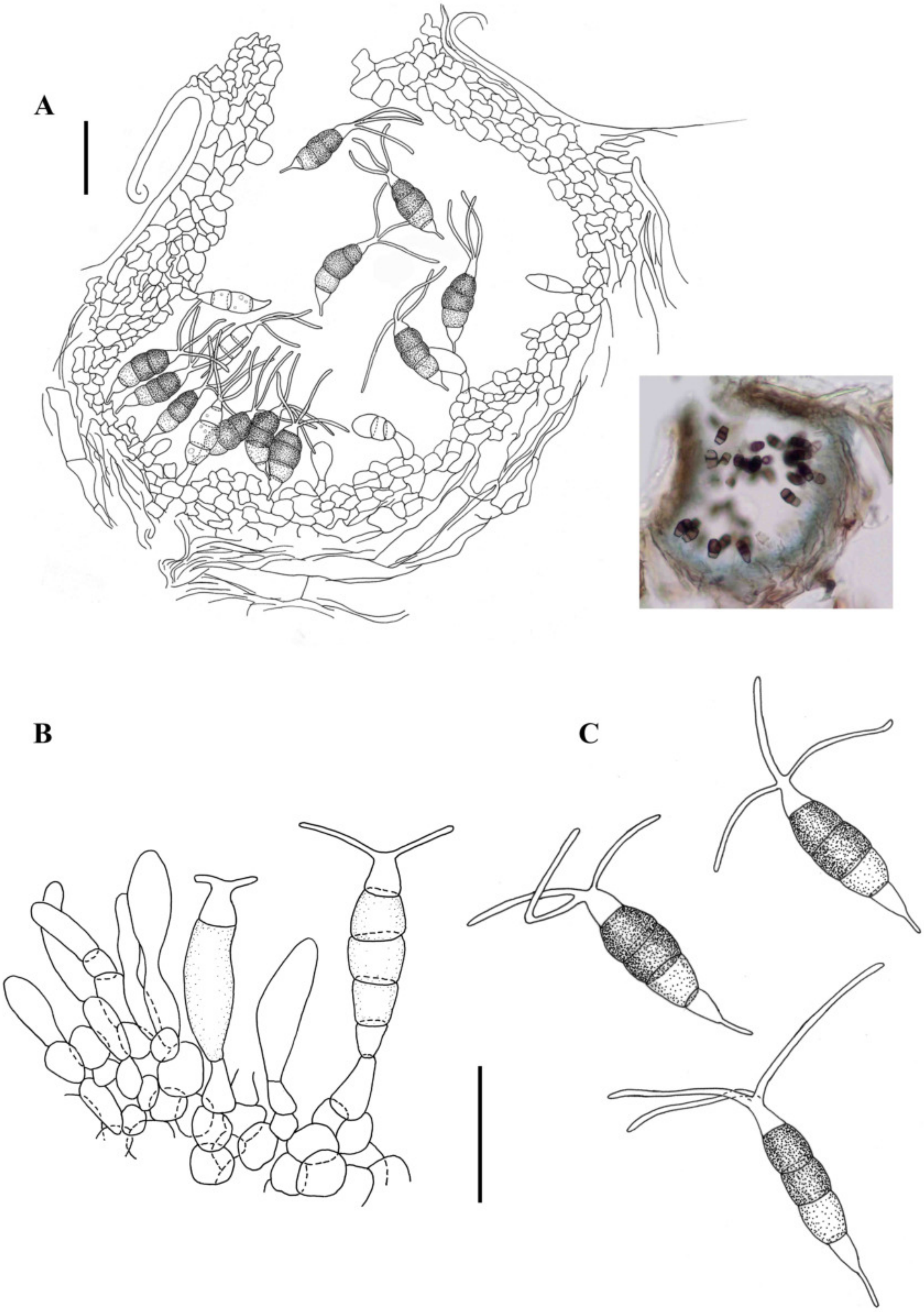


Figure 1: Morphological characters of *Pestalotiopsis* s.l. species **A** Drawing and microscopic photograph of a vertical section of a conidiomata with conidia of different ages on the adaxial side of a leaf of *Erica* x *darleyensis* (CJ 12). **B** Conidiophores, conidiogenous cells with developing conidia (AR 4917). **C** Mature conidia (versicolourous) (CJ 12). Scale bars A–C = 20 µm.

4.3.3 The sexual morph

A sexual morph of *Pestalotiopsis* s.l. species has been observed in only a few species. This is mainly because it rarely develops and is difficult to induce even under laboratory conditions. Barr (1975) studied the teleomorph-anamorph connections in *Pestalotiopsis* s.l. and described the genus *Pestalosphaeria,* based on *P. concentrica*, to accommodate the sexual morph of *Pestalotiopsis guepinii* var. *macrotricha.* In the following years various authors found the sexual morph of certain *Pestalotiopsis* s.l. species (e.g. Metz et al. 2000; Samuels et al. 1987; Shoemaker and Simpson 1981; Zhang et al. 2012a; Zhu et al. 1991) and placed them in the genus *Pestalosphaeria*. However, the asexual morph of *Pestalotiopsis* s.l. is not restricted to the genus *Pestalosphaeria,* but has also been found in the genera *Broomella*, *Khuskia*, and *Neobroomella,* of the Amphisphaeriaceae (Kirk et al. 2008).

4.3.4 Ecology

Members of *Pestalotiopsis* s.l. are distributed worldwide, found to have numerous modes of life, and occur on a broad range of substrates, including plant material, e.g. dead or living plant organs, and synthetic material e.g. plastic (Jeewon et al. 2003b; Maharachchikumbura et al. 2011; Wei et al. 2005). Recently, *Pestalotiopsis* sp. was isolated from a soft coral, *Sarcophyton* sp., in the South China Sea (Jia et al. 2015). Species of *Pestalotiopsis* s.l. are commonly isolated as endophytes (Brown et al. 1998; Liu et al. 2006, 2007; Wei et al. 2005, 2007b), or occur as saprobes in soil, on dead leaves, bark, and twigs (Agarwal and Chauhan 1988; Guba 1961). One species, *P. maculans*, was reported to be a dominant parasymbiont (secondary fungus) in North American lichens (Sun et al. 2002). Several species of *Pestalotiopsis* s.l. have been reported to cause serious plant diseases, such as: *P. dichaeta*, diseases of *Araucaria* spp. and other hosts; *P. funerea*, diseases of conifers; *P. maculans*, diseases of *Camellia* and other hosts; *P. mangiferae* grey leave spots on mango; *P. palmarum*, leaf spot of Arecaceae; *P. psidii*, grey leaf spot and post-harvest fruit canker of guava; and *P. theae*, grey blight of tea (Rossman et al. 1987). Yet, today, the number of plant diseases caused by newly described species of *Pestalotiopsis* s.l. continues to grow. Among recently discovered pathogenic agents are *Neopestalotiopsis iranensis* that causes fruit rot of *Fragaria ananassa* (Ayoubi and Soleimani 2015), *P. samaragensis* that causes fruit rot of *Syzygium samarangense* (Maharachchikumbura et al. 2013b), and *P. versicolor* that causes leave tip blight on *Acacia* (Wei et al. 2007a). Furthermore, some *Pestalotiopsis* s.l. species develop an endophytic and a pathogenic stage in their life cycle (Lee et al.

1995; Maharachchikumbura et al. 2011). Also the production of secondary metabolites with medicinal potential, such as taxol for treating cancer in humans, is another trait of *Pestalotiopsis* s.l. (Li et al. 1996, 1998; Metz et al. 2000; Srinivasan and Muthumary 2009).

The high number of described *Pestalotiopsis* spp. is a result of the concept of naming *Pestalotiopsis* spp. based on host association. For example Guba (1955, 1961) assumed that species of *Pestalotiopsis* s.l. are generally host-specific and his species concept relied primarily on the identification of the host plant from which the species was isolated. However, the concept of host-specificity in *Pestalotiopsis* s.l. has recently been refuted by several authors (Jeewon et al. 2004; Maharachchikumbura et al. 2011). The research by Jeewon et al. (2004) is one of the most comprehensive studies analyzing host association in *Pestalotiopsis* s.l. They used a molecular phylogenetic approach to distinguish between *Pestalotiopsis* spp. isolates with identical morphology from different hosts to determine host specificity in this genus. The result shows that species of *Pestalotiopsis* s.l. are not highly host-specific. However, it is still a common practice to introduce new species based on their host (Maharachchikumbura et al. 2013b, 2014; Song et al. 2013; Zhang et al. 2012b).

4.4 Morphological characters for species recognition of *Pestalotiopsis* s.l.

In the *Pestalotia-Pestalotiopsis* complex a general taxonomic concept is still lacking, because of the ongoing discussion about the basic morphological criteria to be used as distinguishing features at the generic and species level. Traditionally, generic and species concepts have relied on morphological characters and in the last years the value of morphological characters has been re-evaluated. In general, the most important characters used in the taxonomy of the *Pestalotia-Pestalotiopsis* complex are those of conidial morphology. Steyaert (1949) proposed the number of conidial septations as the most important criterion for the delimitation of genera within the *Pestalotia-Pestalotiopsis* complex. Guba (1961) rejected the generic concept of Steyaert (1949) and used conidial septation only for species delimitation. Recently, analyses of molecular data by Maharachchikumbura et al. (2014) gave evidence that the number of conidial septation is a morphological key character to distinguish between genera in the Amphisphaeriaceae inclusive of the Pestalotiopsidaceae. Sutton (1969) proposed that the separation of genera should consider more than a single criterion and introduced conidiomatal wall structure as an additional character. Griffiths and Swart (1974a, 1974b) confirmed and refined the taxonomic value of conidiomatal wall structure. The molecular results of Maharachchikumbura et al. (2014) are not contradictory to the taxonomic concept of Sutton (1969) and Griffiths and Swart (1974a, 1974b). Until today, molecular data for species of the genus *Pestalotia sensu* Sutton (1969, 1980) is still largely lacking. Thus, it remains unclear if the genus *Pestalotiopsis* s.l. is a valid taxon with respect to *Pestalotia sensu* Sutton (1969, 1980) (Maharachchikumbura et al. 2014). Although the two genera can be clearly distinguished by the number of septa in the conidia, species of *Pestalotia sensu* Sutton (1969, 1980) have 5-septated conidia while *Pestalotiopsis* s.l. have 4-septated conidia. Another problem is that the genus *Seiridium,* like *Pestalotia sensu* Sutton (1969, 1980), also possesses 5-septate conidia. Considering conidial septation as a key character to distinguish between genera within the Pestalotiopsidaceae, future molecular analyses will likely confirm the close relationship of *Pestalotia sensu* Sutton (1969, 1980) and *Seiridium*.

Another useful character in the taxonomy of *Pestalotiopsis* s.l. is the variation of pigmentation among the three middle cells. Traditionally, two types of median cell pigmentation could be distinguished: concolorous, e.g., the three middle cells are equally colored, and versicolourous, e.g., three middle cells are differently colored (e.g. Guba 1961; Sutton 1980; Nag Raj 1993). The stability of this character was evaluated using molecular phylogenies (Jeewon 2003a; Watanabe et al. 2012; Liu et al. 2105). According to these studies, middle cell pigmentation is a useful and stable character that correlated with molecularly defined clades, but with certain restrictions. Pigmentation varied among generations, with different hosts, and when cultivated on different media (Purohit and Bilgrami 1968; Satya and Saksena 1984; Hu et al. 2007).

Number and morphology of the apical appendages are also characters that are commonly used in the classical taxonomy of *Pestalotiopsis* (e.g. Guba 1961; Klehbahn 1914; Steyaert 1949; Sutton 1980; Nag Raj 1993). However, number and length of apical appendages have not yet been evaluated against molecular phylogenies. The shape of the tip of the apical appendage, that can be spathulate or espathulate, was compared to molecular phylogenies (Watanabe et al. 2012). Watanabe et al. (2012) found strains with spathulate and espathulate appendage tips in both clades tested. In one clade isolates with spathulate tips formed a monophyletic subclade, while in the other this was not the case. It should therefore be used as a character only in combination with other characters.

Also, conidial length and width has been used for delimitation of species in *Pestalotiopsis* s.l. (Guba 1961; Nag Raj 1993). However, different studies have shown that species with similar conidial dimensions do not necessarily form monophyletic groups (Jeewon et al. 2003b; Maharachchikumbura et al. 2014).

The morphology of conidiomata and conidiogenesis were used for species and genus delimitation in the past (Steyaert 1949; Sutton 1980). However, these features have not been used within the last 30 years.

4.5 Molecular phylogenetic studies of *Pestalotiopsis* s.l.

Species recognition in the *Pestalotia-Pestalotiopsis* complex has been challenging, mainly because of the disagreement about the taxonomic relevance of certain morphological characters and changing species concepts (Guba 1961; NagRaj 1993; Sutton 1980). Advances in molecular biology, which make it easier and cheaper to generate molecular data, have provided great insights into fungal phylogeny. Molecular data are now commonly used to describe new species of fungi (e.g. Liu et al. 2015; Lutzoni et al. 2004; Schmitt et al. 2009; Senanayake et al. 2015; Walker et al. 2012). Initially for the identification of species, one locus, namely the nuclear ribosomal internal transcript spacer (ITS) region of the rDNA, was used. Nowadays, this locus is regarded as a barcode marker for identification and has been used in *Pestalotiopsis* s.l. and other fungi (e.g. Jeewon et al. 2003b, 2004; Maharachchikumbura et al. 2011). More recently, an ongoing debate exists about the usefulness of the ITS region alone for unequivocally identifying species not only in *Pestalotiopsis* s.l. but also of other groups of fungi (e.g. Nilsson et al. 2008; Schoch et al. 2012; Seifert 2009; Stielow et al. 2015). Hu et al. (2007) and Liu et al. (2010) pointed out that for the molecular analyses of taxonomic relationships within *Pestalotiopsis* s.l., it is necessary to use at least two loci, *ß-tubulin* and ITS. Similar results have been shown for a variety of other fungal genera, e.g., *Calonectria*, *Colletotrichum*, and *Fusarium* (Maharachchikumbura et al. 2012). Hu et al. (2007) and Liu et al (2010) disagreed about the performance quality of the ITS marker when incorporated to phylogenetic analyses for *Pestalotiopsis* s.l. Liu et al. (2010) mentioned that the inferred phylogeny based on the ITS marker corresponds to different conidial pigmentation types that can be used to distinguish between species based on morphological data and they concluded ITS to be taxonomically informative. Hu et al. (2007), however, could not separate taxa into groups with high statistical support when using ITS alone. Recently, Maharachchikumbura et al. (2012) tested the suitability of ten different loci for species delimitation (LSU, SSU, *Actin*, *GS*, *GPDH*, *RPB1, CAL*, ITS, *TEF1*, and *ß-tubulin*) in *Pestalotiopsis* s.l. They suggested the two loci *TEF1* and *ß-tubulin* to be the best performing genes for species recognition in this fungal group. Furthermore, a combination of three loci ITS, *TEF1*, and *ß-tubulin* successfully resolved *Pestalotiopsis* s.l. strains and yielded the best results. As a secondary barcode marker for *Pestalotiopsis* s.l. species, they suggested the use of *TEF1* in addition to ITS.

Recently, two major publications have influenced the molecular understanding of *Pestalotiopsis* s.l., namely Maharachchikumbura et al. (2012, 2014). In these publications the authors introduced a total of 51 new species. The novelty of the 51 new species was confirmed based on concatenated multi-locus data using the three markers ITS, *TEF1*, and *ß-tubulin* in combination with morphological data. In Maharachchikumbura et al. (2014), the authors analyzed the phylogenetic relationships within the Pestalotiopsidaceae based on partial LSU rDNA sequence data and could demonstrate that *Pestalotiopsis* s.l. has three well-supported clades. This result had already been observed in previous studies (Jeewon et al. 2003b, Liu et al. 2010). Consequently, Maharachchikumbura et al. (2014) segregated two new genera, *Neopestalotiopsis* and *Pseudopestalotiopsis*, from *Pestalotiopsis*.

4.6 Generic concepts in this study

All recent molecular studies (Jeewon et al. 2003a; Maharachchikumbura 2012, 2014, 2015) basically confirm the generic concept introduced by Steyaert (1949) as redefined by Sutton (1969, 1980). Following Sutton (1969, 1980), *Pestalotia* has 6-celled conidia and is monotypic, *Pestalotiopsis* has 5-celled conidia, and species of *Truncatella* are characterized by 4-celled conidia. I therefore follow the generic concept by Sutton (1969, 1980) in this study and take it as a starting point for my own investigation.

4.7 Aims of the study

Species in *Pestalotiopsis* s.l. were described on the basis of marginal morphological, and in recent years also minimal genetic sequence differences, as well as supposed host specificity. This led to a high number of described species in this group. Even the separation of closely related genera remains unclear. For these reasons, there was a need to reevaluate genetic lineages and described species against a taxonomic background and to prove existing morphological generic concepts using integrative methods. The aim of this study is to address the following questions:

1. Are the genera *Seiridium*, *Pestalotia,* and *Pestalotiopsis* distinct and monophyletic?
2. What is the inner generic diversity based on a multi-gene phylogeny using new genetic markers?
3. Which genetic markers or combinations of markers are most suitable to generate phylogenetic trees in *Pestalotiopsis* s.l.?
4. What is the value of common morphological traits used for species delimitation?
5. What is the value of host plant identity for species delimitation?
6. What name should be applied to distinct lineages on a species level?

5 Material and Methods

5.1 Specimen collection

This study is based on specimens that were obtained through collaborations with research institutions throughout the world, as well as own field collection. The majority of strains were provided by the U.S. National Fungus Collections (BPI) in Beltsville, Maryland, USA. Additional strains in culture and infected plants for strain isolation were provided by the National Museum in Prague (PR), Czech Republic, the Julius Kühn Institut (JKI), Germany, and the Landwirtschaftskammer Niedersachsen (LWK), Germany, as well as directly from Alain Gardiennet (France), and James White (USA). Strains isolated by myself are indicated with my initials followed by consecutive numbering. In Appendix 1 all strains with collection details are summarized. An overview of collection sites and spatial information is illustrated in Figure 2. In cases in which no exact spatial information was available, a standardized point in the geographical middle of the named country was visualized.

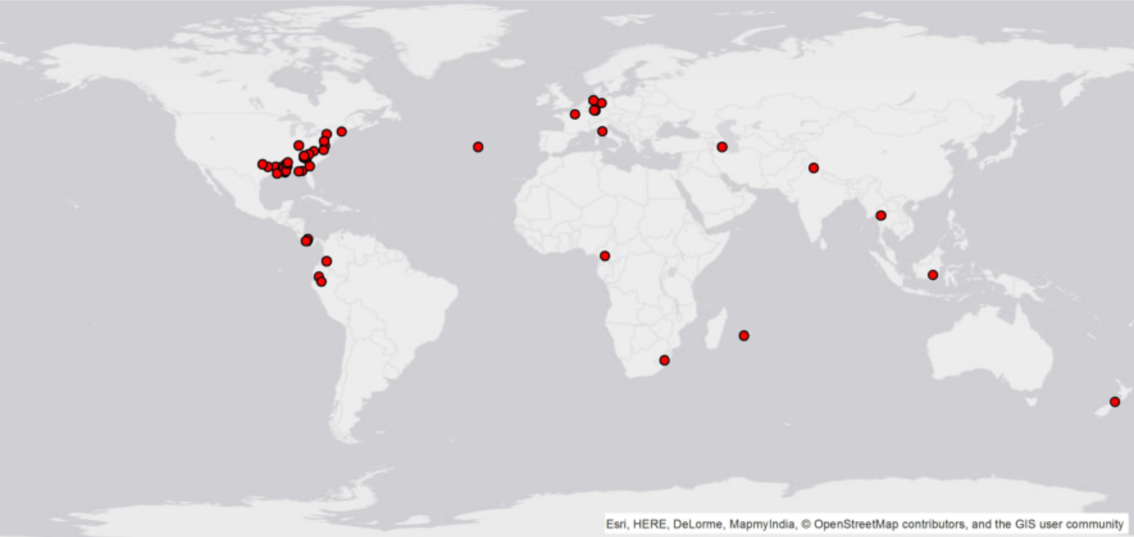


Figure 2: Map showing origin of samples used in this study.

5.2 Selection of herbarium material

The herbarium specimens examined have been chosen with a strong emphasis on species causing important plant diseases according to Rossman et al. (1987), as the correct identification of pathogens is of great importance in global disease control. The geographic focus of this study centers on species obtained from North America.

The corresponding collection information of specimens examined is given in the following order: largest geographic unit to smallest, host, date, collector, miscellaneous, herbarium code and number in parentheses. However, in the catalogue of collections some pieces of information were incomplete for certain specimens.

5.3 Identification of host plants

The identity of host plants could only be verified for the isolates collected by myself. For this purpose the following botanical literature was used: Eckenwalder (2009) and Hecker (2006). Additionally, species identification was discussed with specialists in the respective plant group from the University of Frankfurt and the Senckenberg Research Institute. All other isolates used in this study are not linked to a plant herbarium specimen that could be examined and, thus, host identity could not be verified.

5.4 Morphological methods

5.4.1 Light microscopy and morphometrics

In order to obtain permanent microscopic slides, fruiting bodies of dried herbarium specimens were softened with a small drop of sterile water prior to making longitudinal hand sections with a clean razor blade under a dissection microscope. During the slide preparation a small amount of host tissue containing the conidiomata was taken to obtain thin slices with maximum information. In a few cases hand sections were not thin enough to be observed under the microscope; then samples were carefully squashed. All sections were mounted in 85 % lactic acid, heated to 50 °C on a slide warmer and kept there for about 2 h. After two days of air-drying at room temperature the coverslips were sealed with commercial nail polish to permanently preserve the microscopic preparations.

Morphological features of the fungi were measured at BPI using a NIKON DS-Fi2-L3 microscope camera with the accompanying image software NIS-Ar Advanced Research Imaging camera system or at the Senckenberg Biodiversity and Climate Research Centre (BiK-F) Frankfurt, Germany with a Zeiss Axio Imager.M2 and the camera equipment Axio Cam MRc5. These data were exported into an Excel spreadsheet for further analyses. In order to preserve the herbarium material, conidiomata were measured directly from the sample tissue. For each sample, at least five conidiomata were measured using a dissection microscope.

Measurements of morphological structures are given as mean ± standard deviation with extreme values in parentheses. In general, 15 conidia of herbarium specimens and 20 conidia of culture material were measured whenever possible. The exact number is given in parentheses. Measurements were rounded to the next 0.5 µm according to the given measurement accuracy.

In old and desiccated herbarium material occasionally spores and especially their appendages were broken. In this case it was not possible to measure the same quantity of microscopically informative features. This applies also for sparse specimens. In order to preserve herbarium material, I deliberately refrained from examining conidiophores and conidiogenous cells of each specimen.

5.4.2 Microscopic drawings and image capture

Herbarium specimens and living cultures were illustrated by detailed drawings and/or by photographs of their microscopic structures. The drawings were made by hand using an ocular micrometer and a drawing grid or a drawing mirror at a fixed scale. Pencil drawings on conventional plotting paper were precisely traced onto tracing paper (80g/m^2) with precision ink pens (Edding profipen 1800) with pen tips widths of 0.5 mm, 0.3 mm and 0.1 mm. The scientific drawings were scanned (Brother DCP-8085 DN) as black and white line art with a resolution of 600 dpi and saved as TIFF files. Finally, the digitalized drawings were edited with Adobe Photoshop CS5.1. Microscopic photographs were captured in the laboratory of the U.S. National Fungus Collections using a NIKON DS-Fi2-L3 microscope camera with the accompanying image software NIS-Ar Advanced Research Imaging camera system and at the BiK-F with a with a Zeiss Axio Imager.M2 and the camera equipment Axio Cam MRc5.

5.4.3 Statistical analysis of morphological data

In order to test if the species of *Pestalotiopsis* supported by BP&P (Bayesian Phylogenetics and Phylogeography) analysis (chapter 5.6.4) can be distinguished by morphological traits, an analysis of variance was performed. For this analysis, it would have been ideal to incorporate measurements of at least three specimens of each species found by the BP&P analyses (Table 1). However, this was not always possible, because sporulation could not be successfully induced in every culture. For that reason, only measurements of two specimens are included for species D, one for species C and species G, and none for species B and species J. For each specimen the length and width of the conidia, the length of the three middle cells (LM), the length of apical appendages

(LA), and the length of the basal appendage (LB) of 20 conidia (S1) were measured and used for further statistical analysis. The final sample size comprised of 420 cases per trait.

In detail, an analysis of variance (ANOVA) followed by the post-hoc Tukey Honest Significant Differences pairwise comparison test (TukeyHSD) was performed to analyze the power of certain traits to differentiate species of *Pestalotiopsis.* Prior to the analysis, the distribution of the traits, which appeared symmetrically distributed was inspected and traits were log-tranformed to assure a normal distribution. A Kaiser-Meyer-Olkin measure of sampling adequacy and Bartlett's test of sphericity were performed to check for the homogeneity of variance. Further, the normality of the residuals was checked. None of these indicated obvious deviations from the assumptions of normality and homogeneity of the residuals. All analyses were performed in R 2.31 (R Development Core Team, 2016) using the built-in "stats" package, as well as the "rela" package (Chajewski 2009).

Table 1: List of *Pestalotiopsis* specimens and their respective BP&P species that were included in the ANOVA and TukeyHSD test for morphological significance.

Species found by BP&P	Specimen
Species A	AR 4894, CJ 36, CJ 37
Species B	N/A
Species C	AR 5034
Species D	AR 5025, CBS 170.26,
Species E	AR 5012, AR 4999, AR 5027, AR 5019
Species F	AR 5000, AR 5004
Species G	AR 4960
Species H	AR 4992, LCM 301, GJS 09-1528
Species I	AR 4954, AR 5013, AR 4954
Species J	N/A

5.5 Isolation and cultivation

In order to obtain pure cultures of the freshly collected material single spore isolates were obtained using the methods described in detail by Choi et al. (1999). Briefly, the infected plant material was rinsed with water and gently dried with paper tissue. Single ascomata were removed from the substrate surface with a sterile needle under a stereomicroscope and transferred into a drop of sterilized water to obtain a spore suspension. About two drops of the suspension were transferred to a petri dish with corn meal agar (CMA) using a sterilized pipet. The plate was carefully shaken and subsequently incubated at 25 °C for 24–48 h. As soon as sporulation could be observed a small piece of agar containing the spore was transferred to a new petri dish.

All donated cultures used in this study were based on single spore isolates.

5.5.1 Moist incubation chambers

Collected plant material without visible fruiting bodies was incubated in a moist chamber to achieve sporulation. The plant material was placed directly on moist paper tissue and incubated in a common plastic bag. Chambers were checked every first to second day in order to ensure that enough humidity was maintained over the required period of time and to prevent overgrowth by common saprophytic fungi or bacteria. Fruiting structures were commonly observed after five to ten days.

5.5.2 Induce sporulation

In some cases it was necessary to induce sporulation by inoculating alfalfa stems (*Medicago sativa*) on 1.5 % water agar (WA) (pers. com. A.Y. Rossman, 2012). For this purpose alfalfa stems were cut in about three cm long pieces that were surface sterilized. In the following, one sterilized piece of *M. sativa* was placed in a Petri dish containing CMA.

5.5.3 Culture media

In the following the culture media used in this study are listed.

1.5 % Water Agar (WA)
1000 ml distilled water
15 g/l agar-agar (Roth)

Corn Meal Agar (CMA)
1000 ml distilled water
15 g/l agar (Fluka)

Potato Dextrose Agar (PDA)
1000 ml distilled water
15 g/l agar (AppliChem)

Malt Extract Agar (MEA)
1000 ml distilled water
12.75 g/l Agar (Roth)

5.6 Molecular methods

5.6.1 Marker selection

In molecular systematics the marker selection is crucial in order to calculate robust phylogenetic reconstructions. On one hand, the molecular loci must be conserved enough to allow for comparable alignments, and at the other hand, these loci must be variable enough to produce well resolved and well supported phylogenies (Schmitt et al. 2009). Commonly used markers for the phylogenetic analyses of fungi and the molecular identification of fungal species include both nuclear and mitochondrial ribosomal rDNA loci, such as the internal transcript spacer (ITS), 28S nuclear ribosomal large subunit (LSU), 18S nuclear ribosomal small subunit (SSU), as well as protein-coding genes, such as *ß-tubulin*, RNA polymerases (*RPB1* and *RPB2*), and translation elongation factor EF-1α (*TEF1*) (Schmitt et al. 2009; Schoch et al. 2012).

For the molecular phylogenetic approach of the present study, a set of five markers was analyzed. The nuclear rDNA region ITS and four protein-coding genes: *TEF1*, *ß-tubulin*, minichromosome maintenance complex component 7 (*MCM7*), and a putative ribosome biogenesis protein (*TSR1*).

The ITS region is the most commonly sequenced marker for fungi and it serves as the universal DNA barcode marker for fungi (Bergerow 2010; Schoch 2012). For that reason, a large number of ITS sequences for fungal taxa are available in public sequence databases. Consequently, most *Pestalotiopsis* s.l. sequence data available are ITS sequences. The ITS region is a multi-copy segment of about 550bp length and part of the rRNA cistron. In eukaryotes the rRNA cistron consists of three rRNA genes, 18S, 5.8S, and 28S. The ITS region refers to the internal transcribed spacer DNA and the 5.8S rRNA gene situated between 18S and 28S rRNA genes. The RNA polymerase I transcribes this cistron as a unit. Later, this unit is split by posttranscriptional processes that remove two internal transcribed spacer DNA regions, the ITS1 (non-coding, flanked by 18S and 5.8S rRNA genes) and ITS2 (non-coding, flanked by 5.8S and 28S rRNA genes), that are separated by the 5.8S rRNA gene (coding) (Nilsson et al. 2008; Schoch 2012).

The *TEF1* protein is involved in the enzymatic delivery of aminoacyl tRNAs to the ribosome (Lund et al. 1996). *TEF1* sequences contain exon and intron regions and, within fungi, the introns vary significantly in size and location. Intron regions evolve rapidly and, therefore, are suitable for intraspecific phylogenies (Rehner 2001).

The *ß-tubulin* is a main part of the microtubule that forms a major component of the cytoskeleton and is important for many intracellular processes. The tubulin protein-coding genes undergo multiple independent gene duplication and gene loss events in different fungal linages, which leads to the presence of paralogous sequences. Thus, phylogenetic trees based on tubulin protein-coding genes alone should be considered with caution (Landvik et al. 2001; Zhao et al. 2014).

MCM7 and *TSR1* are both single-copy protein-coding genes. The MS456 locus corresponds to the *MCM7* gene and is a component of the DNA replication licensing complex that is required for the initiation of DNA replication (Labib et al. 2001; Lu et al. 1999). The MS277 locus corresponds to the *TSR1* gene and codes for a ribosome biogenesis protein (Gelperin et al. 2001). Aguileta et al. (2008) first discovered MS277 and MS456 to be highly suitable loci for phylogenetic analyses in fungi. In this recent study, the authors have analyzed 246 single-copy protein coding genes from 30 published fungal genomes and could show that *MCM7* and *TSR1* outperformed all other analyzed protein coding genes. One year later, Schmitt et al. (2009) confirmed this finding and developed new degenerated primers for both regions.

5.6.2 DNA Extraction, Amplification and Sequencing

Laboratory work was conducted in cooperation with the BiK-F Frankfurt, Germany and the BPI, Beltsville, USA.

Cultures were incubated on CMA for 5–7 days. Mycelial scrapings (approx. 40 mg) from the leading edge of cultures were harvested and transferred to 2 ml Eppendorf tubes. Genomic DNA was extracted following the “CTAB DNA minipreps of filamentous fungi” protocol from the Vilgalys lab (online document) with some minor modifications: 1) fungal cells were homogenized in tissue disrupter (Mixer Mill MM301, Retsch) for 3 min at 25 cycles sec^{-1} using 0.5 mm glass beads (Roth) and one 3 mm grinding ball (Tungsten Carbide, Retsch); 2) samples were incubated for 30 min at 65 °C; 3) DNA pellets were resuspended in 50 µl ddH_2O.

Following DNA extraction, amplification of multiple loci was performed by polymerase chain reaction (PCR) using standard primers for the gene regions *TEF1*, ITS, *MCM7*, *TSR1*, and *ß-tubulin*. For the regions of *TEF1*, *MCM7*, and *TSR1* group specific primers were designed in this study using Primer3 v. 0.4.0 (Untergasser et al. 2012) as implemented in Geneious 6.1.5. Primer sequence information and references well as PCR cycles conditions are given in Table 2. Each 15 µl PCR reaction mixture included 1.5 µl buffer, 0.1 µl (0.65 U) Ex Taq polymerase, 1.2 µl dNTPs (2.5 mM each), 1.0 µl of each primer set (10 mM), ca. 10 ng of template, and 8.2 µl H_2O. Positive PCR amplification products were visualized on a 1 % agarose gel. DNA fragments of expected size were extracted with the GenElute Gel Extraction Kit (Sigma-Aldrich, St Louis, MO) following the manufacturer's instructions.

PCR products were bidirectionally sequenced with the same primers used for the initial amplification steps and the BigDye XTerminator Purification Kit (Life Technologies) on ABI PRISM 3730 DNA Analyzer (Applied Biosystems).

Table 2: Primer information.

Locus	Thermocycler conditions	Primer	Sequence (5'-3')	Reference
TSR1	Initial denaturation: 4 min. at 95 °C 40 cycles: 30 sec at 95 °C, 30 sec at 52 °C, 50 sec at 72 °C Extension period: 5 min at 72 °C	TSR1-1459F or TSR1-1453F TSR1-2308R	CCNGAYGARATYGARCTNCAYCC GARTTCCCNGAYGARATYGARCT CTTRAARTANCCRTGNGTNCC	Schmitt et al. (2009)
TSR1	Initial denaturation: 4 min. at 95 °C 40 cycles: 30 sec at 95 °C, 30 sec at 58 °C, 50 sec at 72 °C Extension period: 5 min at 72 °C	TSR1-56F TSR1-720R or TSR1-731R	GAAGAGCATCKCCTCAAGCC GGTTGAAGAACATGTAGCGG AACATGTAGCGGATSGTGAC	own
TSR1	Initial denaturation: 4 min. at 95 °C 35 cycles: 30 sec at 95 °C, 40 sec at 56°C, 1 min at 72 °C Extension period: 5 min at 72 °C	TSR1-344F TSR1-731R	ACTACGAAAAGTCCATCAAG AACATGTAGCGGATSGTGAC	own Schmitt et al. (2009)
TSR1	Initial denaturation: 4 min. at 95°C 35 cycles: 30 sec at 95 °C, 40 sec at 52 °C, 45 sec at 72 °C Extension period: 5 min at 72°C	TSR1-56F TSR1-475R	GAAGAGCATCKCCTCAAGCC CAAGAATCTGCAGTRCTTGTG	own
MCM7	Initial denaturation: 4 min. at 95 °C 35 cycles: 30 sec at 95 °C, 30 sec at 52 °C, 45 sec at 72 °C Extension period: 5 min at 72 °C	MCM7-709F MCM7-1348R or MCM7-1447R	ACNMGNGTNTCVGAYGTHAAR GAYTTDGCNACNCCNGGRTCWCCCAT CATNACNGCNGCNGTRAGRCC	Schmitt et al. (2009)
MCM7	Initial denaturation: 4 min. at 95 °C 35 cycles: 30 sec at 95 °C, 30 sec at 52 °C, 45 sec at 72 °C Extension period: 5 min at 72 °C	MCM7-7F or MCM7-16F MCM7-579R or MCM7-587R or MCM7-1348R	GGTGTCGGATGTTAAGCCCA TGTTAAGCCCATCGTCCAGG CCAACGAGCAAAAGCAGCAA TCACACCACCAACGAGCAAA GAYTTDGCNACNCCNGGRTCWCCCAT	own Schmitt et al. (2009)

TEF1	Initial denaturation: 4 min. at 95 °C 35 cycles: 30 sec at 95 °C, 40 sec at 58 °C or 52 °C, 1 min at 72 °C Extension period: 5 min at 72 °C	EF1-559F or EF1-526F EF1-1567R	TTCATCAAGAACATGATTACTGG GTCGTYGTYATYGGH ACHGTRCCRATACCA	own Rehner (2001)
TEF1	Initial denaturation: 4 min. at 95 °C 35 cycles: 30 sec at 95 °C, 30 sec at 58 °C, 1 min at 72 °C Extension period: 5 min at 72 °C	EF1-526F EF1-719R	GTCGTYGTYATYGGH AACGATGAGCTGCTTGACAC	Rehner (2001) own
TEF1	Initial denaturation: 4 min. at 95 °C 35 cycles: 30 sec at 95 °C, 30 sec at 52 °C, 1 min at 72°C Extension period: 5 min at 72 °C	EF1-983F EF1-2218R	GCYCCYGGHCAYCGTGAYTTYAT ATGACACCRACRGCRACRGTY	Carbone & Kohn (1999) Rehner & Buckley (2005)
ITS	Initial denaturation: 4 min. at 95 °C 35 cycles: 30 sec at 95 °C, 30 sec at 52 °C, 45 sec at 72 °C Extension period: 5 min at 72 °C	ITS1-F or ITS5-F ITS4-R	GTAGGTGAACCTGCGG GGAAGTAAAAGTCGTAACAAGG TCCTCCGCTTATTGATATGC	White et al. (1990)
ß-tubulin	Initial denaturation: 4 min. at 95 °C 35 cycles: 30 sec at 95 °C, 30 sec at 55 °C, 45 sec at 72 °C Extension period: 5 min at 72 °C	Bt2a-F Bt2b-R	GGTAACCAAATCGGTGCTGCTTTC ACCCTCAGTGTAGTGACCCTTGGC	Glass & Donaldson (1995)

5.6.3 Phylogenetic analyses of *Pestalotiopsis*

For each locus, consensus sequences were assembled in Geneious v. 6.1.5. (Kearse et al. 2012). The single locus alignments were generated with MAFFT 7.017 (Katoh et al. 2002; Katoh and Toh 2008) as implemented in Geneious using the E-INS-i algorithm and the default settings. Ambiguously aligned regions were manually refined. Gaps were treated as missing data.

In order to find the best nucleotide substitution model, a model test was performed for each single locus separately. The models were specified in JModelTest v. 2.1.3 (Posada and Buckley 2004; Posada 2008) under the corrected Akaike Information Criterion (AICc) (Sugiura 2007).

Maximum likelihood (ML) analyses were performed on each locus using the RAxML-HPC BlackBox v. 8.1.11 (Stamatakis 2014) on the Cipres Science Gateway v. 3.3 (Miller et al. 2010) using the default general time-reverse (GTR) substitution model with a discrete gamma distribution (+G) and 1000 bootstrap (BS) replicates. A conflict was assumed to be relevant, if the same set of taxa were monophyletic in one phylogenetic estimation, but paraphyletic in the other and both received statistical bootstrap support ≥ 70 % (modified Lutzoni et al. 2004). Taxa with conflicts among loci were excluded from further analyses. The resulting topologically congruent single data sets were concatenated in Geneious. The final Maximum likelihood phylogenetic reconstruction was then performed on the reduced concatenated data set. Thereby, only taxa were included for which sequences of at least three loci were available. The maximum likelihood search was performed as described above. The concatenated data sets were partitioned according to the particular genes and the protein coding genes (*TEF1*, *ß-tubulin*, *TSR1*, and *MCM7*) were partitioned by codon position.

The Bayesian inference (BI) was performed for the concatenated data set using the nucleotide substitution models as suggested by jModelTest and as implemented in MrBayes v. 3.2.1 (Huelsenbeck and Ronquist 2001; Ronquist and Huelsenbeck 2003) on the Cipres Scientific Gateway v. 3.3 (Miller et al. 2010). Searches were performed using two parallel Markov Chain Monte Carlo (MCMC) runs each using four chains and 12,500,000 generations. Trees were sampled every 100th generations. After excluding 25 % as burn-in, a 50 % majority rule consensus tree of the combined sample trees was generated.

5.6.4 Species delimitation in *Pestalotiopsis*

Species delimitation analysis was performed using the program BP&P v3 (Bayesian Phylogenetics and Phylogeography) (Yang and Rannala 2014). BP&P is a program for analyzing sequences from multiple loci under the multiple coalescent model (MSC) using the reversible jump Markov chain Monte Carlo (rjMCMC) method (Rannala and Yang 2003; Yang 2015). The resulting posterior speciation probabilities indicate whether two or more pre-defined lineages can be distinguished from each other accounting for coalescent uncertainty (Ruane et al. 2013). Thereby, BP&P takes uncertainties into account like unknown gene trees and ancestral coalescent processes as well as incomplete lineage sorting due to ancestral polymorphism (Yang and Rannala 2014).

Monophyletic clades supported by results of the ML and Bayesian analyses (BS ≥ 70 %, PP ≥ 0.95) based on the concatenated dataset of *Pestalotiopsis* were considered putative species. In addition, speciation probabilities of monophyletic clades with low support were tested if they occurred in single locus phylogenies. The conservative settings have been chosen for the subsequent BP&P analyses.

*BEAST in the BEAST package v. 2.1 was used to estimate a species tree that served as a guide tree for the BP&P analyses. The Birth-Death model and a gamma-distributed population size for the species tree prior and a pairwise linear population size model with a constant root were used. For all other settings default was chosen. JModelTest under the AICc criterion was used to find the best fitting substitution model for each single locus. The best suggested model was chosen as a substitution model in *BEAST. This resulted in a 19-species scenario that was incorporated in the subsequent BP&P analyses to infer the posterior probability of each putative species.

5.6.5 Phylogenetic analyses of *Neopestalotiopsis*

Maximum likelihood (ML) analyses were performed on each locus using the RAxML-HPC BlackBox v. 8.1.11 (Stamatakis 2014) on the Cipres Science Gateway v. 3.3 (Miller et al. 2010) using the default general time-reverse (GTR) substitution model with a discrete gamma distribution (+G) and 1000 bootstrap (BS) replicates. A conflict was assumed to be relevant, if the same set of taxa were monophyletic in one phylogenetic estimation, but paraphyletic in the other and both received statistical bootstrap support ≥ 70 % (modified Lutzoni et al. 2004).

However, inconsistency across single loci trees did not allow for an analysis of a concatenated dataset. Therefore, a species delimitation approach for members of the genus *Neopestalotiopsis* could not be implemented in this work.

5.6.6 Clade naming

The sequences were individually subjected to a Basic Local Alignment Search Tool (BLAST) sequence-similarity search (Benson et al. 2009) at the National Center for Biotechnology Information (NCBI) GenBank platform (Geer et al. 2010) to verify their identity. The first 100 hits or sequences having 97 % or higher similarity were downloaded and considered for an additional ML phylogenetic analysis. Each single locus dataset of *Pestalotiopsis* generated in this study was complemented with the sequence data obtained from NCBI. Additionally, sequences from type specimens in the following recent publications were included: Maharachchikumbura et al. (2012, 2013a, b, 2014). Only those isolates for which sequence information for the three most common loci (ITS, *TEF1*, *ß-tubulin*) were available have been included in the subsequent single-loci analyses. Sequences taken from the NCBI GenBank platform and their corresponding accession numbers are listed in Table 3. A maximum likelihood search was then performed using the RAxML-HPC BlackBox v 8.1.11 on the Cipres Scientific Gateway v. 3.3 (Miller et al. 2010) with the default settings. Results obtained by this method were combined with results from the BP&P species delimitation analysis and the three single-loci phylogenetic trees for final clade naming. Terminal cluster found in at least two single-loci trees were verified against the species assumptions found by the BP&P. Following the rule of priority, the oldest name within an assumed species was chosen to name the clade.

Table 3: GenBank accession numbers of isolates that were used in this study for the identification of the isolates of *Pestalotiopsis*. Ex-holotype or ex-epitype cultures are marked in bold.

Name	**Strain/Isolate**	**ITS**	***ß-tubulin***	***TEF1***
Pestalotiopsis adusta **1**	ICMP 6088	JX399006	JX399037	JX399070
Pestalotiopsis adusta 2	MFLUCC 10-146	JX399007	JX399038	JX399071
Pestalotiopsis anacardiacearum	IFRDCC 2397	KC247154	KC247155	KC247156
Pestalotiopsis arceuthobii	**CBS 434.65**	**KM199341**	**KM199427**	**KM199516**
Pestalotiopsis arengae	CBS 331.92	KM199340	KM199426	KM199515
Pestalotiopsis australasiae 1	**CBS 114126, STE-U 2896**	**KM199297**	**KM199409**	**KM199499**
Pestalotiopsis australasiae 2	CBS 114141, STE-U 2949	KM199298	KM199410	KM199501
Pestalotiopsis australis 1	**CBS 114193, STE-U 3011**	**KM199332**	**KM199383**	**KM199475**
Pestalotiopsis australis 2	CBS 111503, STE-U 1770	KM199331	KM199382	KM199557

Pestalotiopsis australis 3	CBS 119350, CMW 20013	KM199333	KM199384	KM199476
Pestalotiopsis australis 4	CBS 114474, STE-U 1769	KM199334	KM199385	KM199477
***Pestalotiopsis biciliata* 1**	**CBS 124463**	**KM199308**	**KM199399**	**KM199505**
Pestalotiopsis biciliata 2	CBS 236.38	KM199309	KM199401	KM199506
Pestalotiopsis biciliata 3	CBS 790.68	KM199305	KM199400	KM199507
Pestalotiopsis camelliae **1**	MFLUCC 12-0277	JX399010	JX399041	JX399074
Pestalotiopsis camelliae 2	MFLUCC 12-0278	JX399011	JX399042	JX399075
Pestalotiopsis camelliae 3	CBS 443.62	KM199336	KM199424	KM199512
***Pestalotiopsis chamaeropis* 1**	**CBS 186.71**	**KM199326**	**KM199391**	**KM199473**
Pestalotiopsis chamaeropis 2	CBS 237.38	KM199324	KM199392	KM199474
Pestalotiopsis chamaeropis 3	CBS 113604, STE-U 3078	KM199323	KM199389	KM199471
Pestalotiopsis chamaeropis 4	CBS 113607, STE-U 3080	KM199325	KM199390	KM199472
***Pestalotiopsis clavata* 1**	**MFLUCC 12-0268, NN0471340**	**JX398990**	**JX399025**	**JX399056**
Pestalotiopsis clavata 2	MFLUCC 12-0269, NN047005	JX398991	JX399026	JX399057
Pestalotiopsis colombiensis	**CBS 118553, CPC 10969**	**KM199307**	**KM199421**	**KM199488**
Pestalotiopsis diploclisiae **1**	CBS 115587, HKUCC 10130	KM199320	KM199419	KM199486
Pestalotiopsis diploclisiae 2	CBS 115449, HKUCC 9103	KM199314	KM199416	KM199485
Pestalotiopsis diploclisiae 3	CBS 115585, HKUCC 8394	KM199315	KM199417	KM199483
Pestalotiopsis diversiseta	**MFLUCC 12-0287, NN0472610**	**JX399009**	**JX399040**	**JX399073**
Pestalotiopsis ericacearum	IFRDCC 2439	KC537807	KC537821	KC537814
Pestalotiopsis frucata	**MFLUCC 12-0054, CPC 20280**	**JQ683724**	**JQ683708**	**JQ683740**
Pestalotiopsis gaultheria	IFRD 411-014	KC537805	KC537819	KC537812
Pestalotiopsis grevilleae	**CBS 114127, STE-U 2919**	**KM199300**	**KM199407**	**KM199504**
Pestalotiopsis hawaiiensis	CBS 114491, STE-U 2215	KM199339	KM199428	KM199514
Pestalotiopsis hollandica	**CBS 265.33**	**KM199328**	**KM199388**	**KM199481**
Pestalotiopsis humus **1**	CBS 336.97	KM199317	KM199420	KM199484
Pestalotiopsis humus 2	CBS 115450, HKUCC 9100	KM199319	KM199418	KM199487
Pestalotiopsis inflexa	MFLUCC 12-0270, NN0470980	JX399008	JX399039	JX399072
Pestalotiopsis intermedia	**MFLUCC 12-0259, NN0470920**	**JX398993**	**JX399028**	**JX399059**
Pestalotiopsis karstenii	IFRDCC OP13	KC537806	KC537820	KC537813
***Pestalotiopsis kenyana* 1**	**CBS 442.67**	**KM199302**	**KM199395**	**KM199502**
Pestalotiopsis kenyana 2	CBS 911.96	KM199303	KM199396	KM199503
***Pestalotiopsis knightiae* 1**	**CBS 114138, STE-U 2906**	**KM199310**	**KM199408**	**KM199497**
Pestalotiopsis knightiae 2	CBS 111963, STE-U 2905	KM199311	KM199406	KM199495
Pestalotiopsis licualacola	**HGUP4057**	**KC492509**	**KC481683**	**KC481684**
Pestalotiopsis linearis	MFLUCC 12-0271, NN0471900	JX398992	JX399027	JX399058
Pestalotiopsis malayana	**CBS 102220**	**KM199306**	**KM199411**	**KM199482**
Pestalotiopsis monochaeta **1**	CBS 144.97	KM199327	KM199386	KM199479

Pestalotiopsis monochaeta 2	CBS 440.83, IFO 32686	KM199329	KM199387	KM199480
Pestalotiopsis novae-hollandiae	CBS 130973	KM199337	KM199425	KM199511
***Pestalotiopsis oryzae* 1**	**CBS 353.69**	**KM199299**	**KM199398**	**KM199496**
Pestalotiopsis oryzae 2	CBS 111522, STE-U 2083	KM199294	KM199394	KM199493
Pestalotiopsis oryzae 3	CBS 171.26	KM199304	KM199397	KM199494
Pestalotiopsis papuana **1**	CBS 331.96	KM199321	KM199413	KM199491
Pestalotiopsis papuana 2	CBS 887.96	KM199318	KM199415	KM199492
Pestalotiopsis parva **1**	CBS 265.37, BBA 2820	KM199312	KM199404	KM199508
Pestalotiopsis parva 2	CBS 278.35	KM199313	KM199405	KM199509
Pestalotiopsis portugalica	CBS 393.48	KM199335	KM199422	KM199510
Pestalotiopsis rhododendri	**IFRDCC 2399**	**KC537804**	**KC537818**	**KC537811**
Pestalotiopsis rhodomyrtus	HGUP4230	KF412648	KF412642	KF412645
Pestalotiopsis rosea	**MFLUCC 12-0258, NN0471350**	**JX399005**	**JX399036**	**JX399069**
Pestalotiopsis scoparia	CBS 176.25	KM199330	KM199393	KM199478
Pestalotiopsis shorea	**MFLUCC12-0314**	**KJ503811**	**KJ503814**	**KJ503817**
Pestalotiopsis spathulata	CBS 356.86	KM199338	KM199423	KM199513
Pestalotiopsis telopeae 1	**CBS 114161, STE-U 3083**	**KM199296**	**KM199403**	**KM199500**
Pestalotiopsis telopeae 2	CBS 113606, STE-U 3082	KM199295	KM199402	KM199498
Pestalotiopsis telopeae 3	CBS 114137, STE-U 2952	KM199301	KM199469	KM199559
Pestalotiopsis trachicarpicola **1**	OP068, IFRDCC 2440	JQ845947	JQ845945	JQ845946
Pestalotiopsis trachicarpicola 2	MFLUCC 12-0263, NN0470720	JX399000	JX399031	JX399064
Pestalotiopsis trachicarpicola 3	MFLUCC 12-0267, NN0470990	JX399001	JX399032	JX399065
Pestalotiopsis trachicarpicola 4	MFLUCC 12-0266, NN0469780	JX399002	JX399033	JX399066
Pestalotiopsis trachicarpicola 5	MFLUCC 12-0265, NN0469830	JX399003	JX399034	JX399067
Pestalotiopsis trachicarpicola 6	MFLUCC 12-0264, NN0471960	JX399004	JX399035	JX399068
Pestalotiopsis trachicarpicola 7	OP143, IFRDCC2403	KC537809	KC537823	KC537816
Pestalotiopsis unicolor	MFLUCC 12-0275, NN0473080	JX398998	JX399029	JX399063
Pestalotiopsis uvicola	UCD2465TX	FJ790874	GU294730	GU294716

5.6.7 Phylogenetic analyses of the proposed epitype of *Pestalotia pezizoides*

Genomic DNA of the proposed epitype of *Pestalotia pezizoides* (CJ 31) was extracted, amplified, and sequenced as described above in order to amplify two nuclear loci ITS and fragments of the large subunit of nuclear ribosomal DNA (nrLSU) for phylogenetic analysis. For this purpose the following standard primer pairs have been used: (1) ITS1-5`GTAGGTGAACCTGCGG3` and ITS4-5`TCCTCCGCTTATTGATATGC3` (White et al. 1990) and (2) LR5-5`ATCCTGAGGGAAACTTC3` and LROR-5`GTACCCGCTGAACTTAAGC3` (Vilgalys and Sun 1994). PCR cycles were run under the following conditions: 94 °C for 4 min; 30 cycles of 94 °C for 30 sec, 55 °C for 30 sec, and 72 °C for 1 min; and a final 72 °C for 5 min. Each sequence was subjected to a BLAST search at the NCBI GenBank database to verify that the closest hit is within the Amphisphaeriales. After passing this quality control, the phylogenetic relationship of the proposed epitype was estimated under the ML and Bayesian criteria as described in detail for *Pestalotiopsis* above. The performed phylogenetic analyses based on a concatenated data set of the loci ITS and LSU. The final alignment comprises 71 taxa and 1,111 positions of which 304 are variable and 234 parsimony-informative. Information on taxon, specimen voucher, and sequences for specimens used in this study are listed in Table 4.

Table 4: GenBank accession numbers of isolates that were used in this study for the taxonomic placement of *Pestalotia pezizoides*. Ex-holotype or ex-epitype cultures are marked in bold.

Family	**Species**	**Voucher**	**LSU**	**ITS**
Bartaliniaceae	*Bartaliana lateripes*	HKUCC 6654	AF382368	N/A
Bartaliniaceae	*Bartaliana laurina*	HKUCC 6537	AF382369	AF405302
Bartaliniaceae	***Bartaliana robillardoides***	**CBS 122705**	**KJ710438**	**NR126145**
Bartaliniaceae	*Broomella vitalbae* A	MFLUCC:13-0798	KP757749	KR092788
Bartaliniaceae	*Broomella vitalbae* B	MFLUCC:14-1000	KP757750	KP757754
Bartaliniaceae	*Dyrithiopsis lakefuxianensis*	HKUCC 7303	AF452047	N/A
Bartaliniaceae	*Hyalotiella rubi*	MFLUCC:13-0660	KR092775	N/A
Bartaliniaceae	*Hyalotiella spartii*	MFLUCC:13-0397	KP757752	KP757756
Bartaliniaceae	*Truncatella angustata*	ICMP 7062	AF382383	AF405306
Bartaliniaceae	*Truncatella hartigii*	CBS 118148	DQ278928	DQ278913
Bartaliniaceae	*Truncatella laurocerasi*	ICMP 11214	AF382385	N/A
Bartaliniaceae	*Truncatella restionacearum*	CMW 18755	DQ278929	DQ278915
Bartaliniaceae	*Truncatella* sp. A	HKUCC 7987	AF382382	N/A
Bartaliniaceae	*Truncatella* sp. B	EN42	N/A	N/A
Bartaliniaceae	*Truncatella spartii*	MFLUCC:15-0537	KR092782	KR092794
Bartaliniaceae	*Zetiasplozna acaciae*	CPC 23421	KJ869206	KJ869149
Discosiaceae	***Adisciso tricellulare***	**NBRC32705**	**NG042334**	**NR119411**
Discosiaceae	*Adisciso yakushimense*	KT1907	AB593721	AB594789
Discosiaceae	*Discosia artocreas*	NBRC 8975	AB593705	AB594773
Discosiaceae	*Discosia pini*	MAFF 410149	AB593708	AB594776
Discosiaceae	*Discosia* sp.	MAFF 238070	AB593720	AB594788
Discosiaceae	*Discostroma corticola* A	NBRC 32680	AB593739	AB594806
Discosiaceae	*Discostroma corticola* B	NBRC 32625	AB593726	AB594794
Discosiaceae	*Discostroma tostum*	NBRC 32626	AB593727	AB594795
Discosiaceae	*Seimatosporium corni*	MFLUCC:14-0467	KR559739	KT162918
Discosiaceae	*Seimatosporium elegans*	NBRC 32674	AB593733	AB594801

Discosiaceae	*Seimatosporium ficeae*	MFLUCC:15-0519	KR920686	KR092800
Discosiaceae	*Seimatosporium hypericinum*	NBRC 32647	AB593737	AB594805
Discosiaceae	*Seimatosporium rosae*	MFLUCC:140621b	KT198727	KT198726
Pestalotiopsaceae	*Monochaetia monochaeta*	CBS 199.82	AF382370	N/A
Pestalotiopsaceae	***Neopestalotiopsis australis***	**CBS 114159,** **STE-U 3017**	**KM116252**	**KM199348**
Pestalotiopsaceae	***Neopestalotiopsis mesopotamica***	**CBS 336.86**	**KM116271**	**KM199362**
Pestalotiopsaceae	***Neopestalotiopsis natalensis***	**CBS 138.41**	**KM116279**	**KM199377**
Pestalotiopsaceae	***Neopestalotiopsis protearum***	**CBS 114178,** **STE-U 1765**	**JN712564**	**JN712498**
Pestalotiopsaceae	***Neopestalotiopsis rosae***	**CBS 101057**	**KM116245**	**KM199359**
Pestalotiopsaceae	***Neopestalotiopsis steyaertii***	**IMI 192475**	**KM116285**	**KF582796**
Pestalotiopsaceae	***Neopestalotiopsis zimbabwana***	**CBS 111495** **STE-U 1777**	**JX556249**	**JX556231**
Pestalotiopsaceae	***Pestalotiopsis arceuthobii***	**CBS 434.65**	**KM116243**	**KM199341**
Pestalotiopsaceae	***Pestalotiopsis arengae***	**CBS 331.92**	**KM116207**	**KM199340**
Pestalotiopsaceae	***Pestalotiopsis colombiensis***	**CBS 118553** **CPC 10969**	KM116222	**KM199307**
Pestalotiopsaceae	***Pestalotiopsis frucata***	**CPC 20280**	**KM116283**	**JQ683724**
Pestalotiopsaceae	***Pestalotiopsis hawaiiensis***	**CBS 114491** **STE-U 2215**	**KM116239**	**KM199339**
Pestalotiopsaceae	***Pestalotiopsis hollandica***	**CBS 265.33**	**KM116228**	**KM199328**
Pestalotiopsaceae	***Pestalotiopsis jesteri***	**CBS 109350** **MONT 6M-B-3**	**KM116281**	**KM199380**
Pestalotiopsaceae	***Pestalotiopsis knightiae***	**CBS 114138** **STE-U 2906**	**KM116227**	**KM199310**
Pestalotiopsaceae	***Pestalotiopsis malayana***	**CBS 102220**	KM116238	**KM199306**
Pestalotiopsaceae	***Pestalotiopsis spathulata***	**CBS 356.86**	**KM116236**	**KM199338**
Pestalotiopsaceae	***Pseudopestalotiopsis cocos***	**CBS 272.29**	**KM116276**	**KM199378**
Pestalotiopsaceae	*Pseudopestalotiopsis* sp. A	CBS 387.77	KM116277	N/A
Pestalotiopsaceae	*Pseudopestalotiopsis* sp. B	CBS 387.97	KM116278	**N/A**
Pestalotiopsaceae	***Pseudopestalotiopsis theae***	**CPC 20281**	**KM116282**	**JQ683727**
Pestalotiopsaceae	*Seiridium cardinale* A	CBS 172.56	AF382376	N/A
Pestalotiopsaceae	*Seiridium cardinale* B	ICMP 7323	AF382377	AF409995
Pestalotiopsaceae	*Seiridium corni*	MFLUCC:14-0265	KM116280	N/A
Pestalotiopsaceae	*Seiridium cupressi*	ATCC 48158	FJ430600	N/A
Pestalotiopsaceae	***Seiridium marginatum*** **A**	**CBS 140403**	**KT949914**	**KT949914**
Pestalotiopsaceae	***Seiridium marginatum*** **B**	**CBS 140404**	**KT949915**	**KT949915**
Pestalotiopsaceae	*Seiridium papillatum*	CBS 340.97	DQ414531	N/A
Pestalotiopsaceae	***Pestalotia pezizoides***	**CJ 31**	**N/A**	**N/A**
Pestalotiopsaceae	*Seiridium phylicae* A	CPC:19965	KC005809	KC005787
Pestalotiopsaceae	*Seiridium phylicae* B	CPC:19970	KC005810	KC005788

6 Results

6.1 Taxonomic results

The new results obtained in this study required several taxonomic changes in the five genera *Neopestalotiopsis*, *Pestalotia*, *Pestalotiopsis*, *Pseudopestalotiopsis*, and *Truncatella* that are listed in the following section. The taxonomic changes proposed in this thesis will be published in scientific journals at a later point in time. The given synonymy follows the actual taxonomy as listed in *Index Fungorum* (status May 2016).

6.1.1 Taxonomic results in the genus *Neopestalotiopsis*

Neopestalotiopsis coffeae-arabicae (Y. Song, K. Geng, K.D. Hyde & Yong Wang bis) Judith-Hertz et al., a **new combination** will be proposed.

≡ *Pestalotiopsis coffeae-arabicae* Y. Song, K. Geng, K.D. Hyde & Yong Wang bis, in Song, Geng, Zhang, Hyde, Zhao, Wei, Kang, and Wang, Phytotaxa 126:26, 2013.

Type: China, Xinglong County, Hainan Province, on living leaves of *Coffea arabica*, HGUP4019 n.v.

Comments. The species *Pestalotiopsis coffeae-arabicae* was described by Song et al. (2013). *Pestalotiopsis coffeae-arabicae* is characterized by conidia with three versicolourous middle cells. In 2014 the species rich genus *Pestalotiopsis* was divided into three genera, namely *Neopestalotiopsis*, *Pestalotiopsis*, and *Pseudopestalotiopsis* (Mahrachchikumbure et al. 2014). According to that, species in the genus *Neopestalotiopsis* differ from *Pestalotiopsis* and *Pseudopestalotiopsis* by conidia with versicolourous middle cells. Thus, this character suggests that *P. coffeae-arabicae* belongs in the genus *Neopestalotiopsis*. In this study, the type sequences of the three loci, ITS, *TEF1,* and *ß-tubulin* were reanalyzed in order to validate the generic placement of this species on a molecular level. Three independent ML analyses were performed on each locus using the methods described in chapter 5.6.5. Sequences used for these phylogenetic analyses were downloaded from the NCBI GenBank platform and are listed in Appendix 2. In all three analyses *P. coffeae-arabicae* was placed in the genus *Neopestalotiopsis* (Figure 3 and Figure 4) confirming the morphological assumption. Consequently, the name *P. coffeae-arabicae* has to be transferred to *Neopestalotiopsis.*

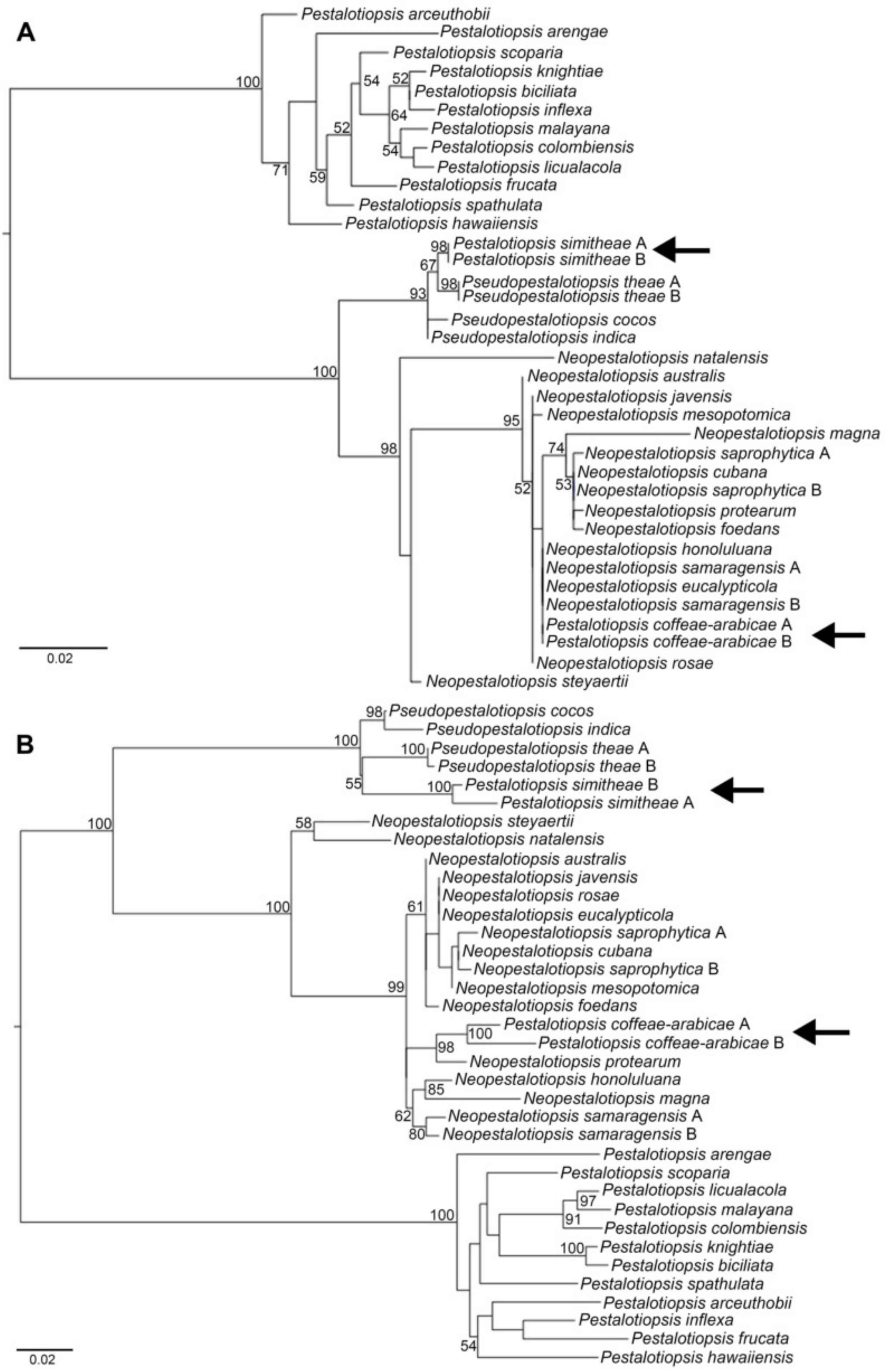


Figure 3: ML phylogenetic trees of members of Pestalotiopsidaceae showing the placements of *Pestalotiopsis simitheae* and *P. coffeae-arabicae* (black arrow) within the *Pseudopestalotiopsis* and *Neopestalotiopsis* clades, respectively. **A** ITS single locus phylogenetic tree. **B** *ß-tubulin* single locus phylogenetic tree. Support values are displayed next to the corresponding node as bootstrap values. Only bootstrap values ≥ 50 % are displayed. Trees are mid-point rooted. Scale bar refers to the number of substitutions per site.

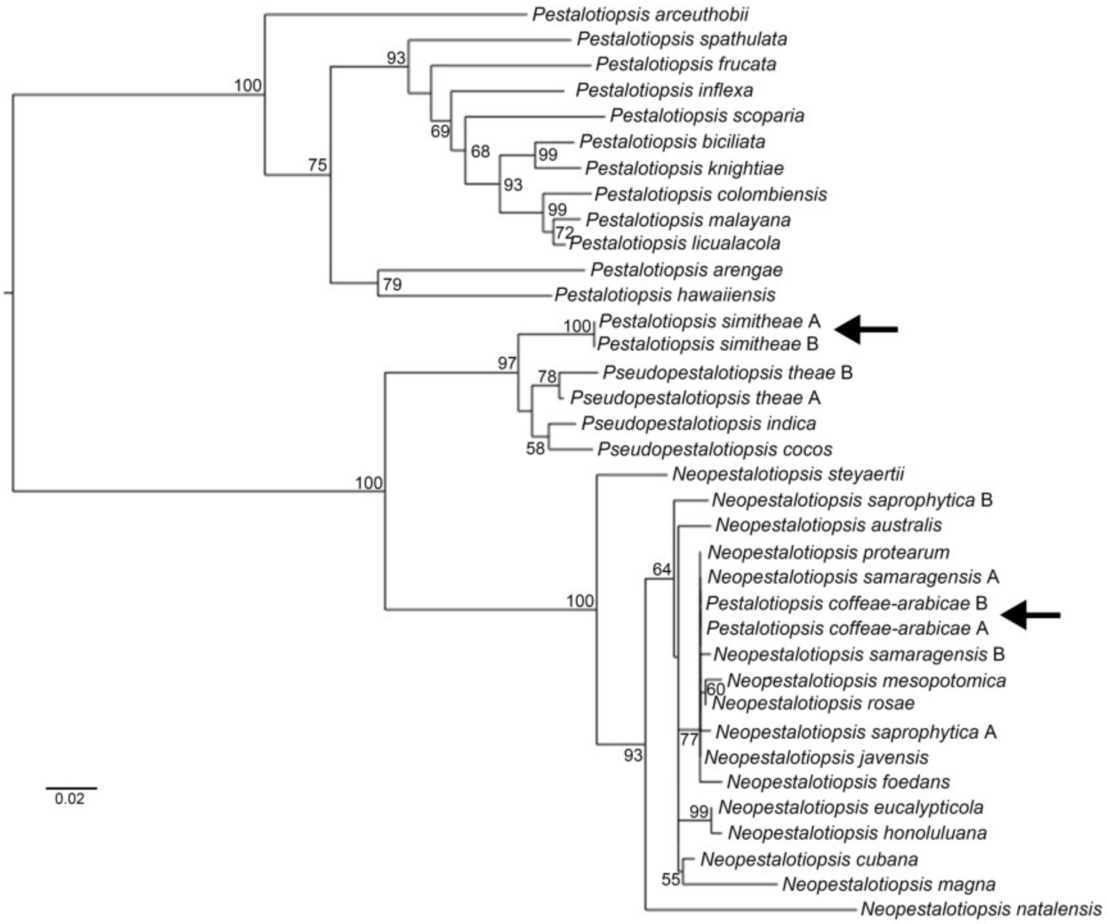


Figure 4: ML *TEF1* single locus phylogenetic tree of members of Pestalotiopsidaceae showing the placements of *Pestalotiopsis simitheae* and *P. coffeae-arabicae* (black arrow) within the *Pseudopestalotiopsis* and *Neopestalotiopsis* clades, respectively. Support values are displayed next to the corresponding node as bootstrap values. Only bootstrap values ≥ 50 % are displayed. Tree is mid-point rooted. Scale bar refers to the number of substitutions per site.

6.1.2 Taxonomic results in the genus *Pestalotia*

In this study, the monotypic genus *Pestalotia* with the single species *P. pezizoides* was cultured and sequenced for the first time. Herein, an epitype specimen with an ex-epitype culture is designated, because type material of *P. pezizoides* is not preserved in a living stage. In the following the ex-epitype culture is described and characterized using morphological and molecular methods. According to morphological and molecular data, *Pestalotia* has to be considered a synonym of *Seiridium* and a new combination *Seiridium pezizoides* is proposed.

Seiridium Nees, Syst. Pilze (Würzburg):22, 1816 [1816-17]

Type: ***Seiridium marginatum*** Nees, Syst. Pilze (Würzburg):22, 1816 [1817] Switzerland, Rothenburg, Jura, on dry stems of *Rosa canina* (Neotype designated by Shoemaker et al. 1966, BPI 405012!).

= ***Pestalotia*** De Not., Mém. R. Accad. Sci. Torino, Ser. 2:80, 1839 [1841], a **new synonym** will be proposed.

Type: ***Pestalotia pezizoides*** De Not**.**, Mém. R. Accad. Sci. Torino, Ser. 2:80, 1839 [1841], now regarded as ***Seiridium pezizoides*** (De Not.) Judith-Hertz et al. see below.

Seiridium pezizoides (De Not.) Judith-Hertz et al., a **new combination** will be proposed.

≡ ***Pestalotia pezizoides*** De Not**.**, Mém. R. Accad. Sci. Torino, Ser. 2:80, 1839 [1841]

Type: Italy Milan, on branches of *Vitis vinifera*, 1845, De Notaris, in herb. Mus. d`Hist. Nat., Paris (n.v.) (Iconotype is given in the original protologue). France, Véronnes, on twigs of *Vitis vinifera*, 23. May 2014, coll. A. Gardiennet, det. C. Judith-Hertz (BPI 892929), **epitype** to be designated here, 14. June 2014, C. Judith-Hertz, BPI = s.n. isolated from BPI 892929, ex-epitype living culture CJ32 = CBS s.n.

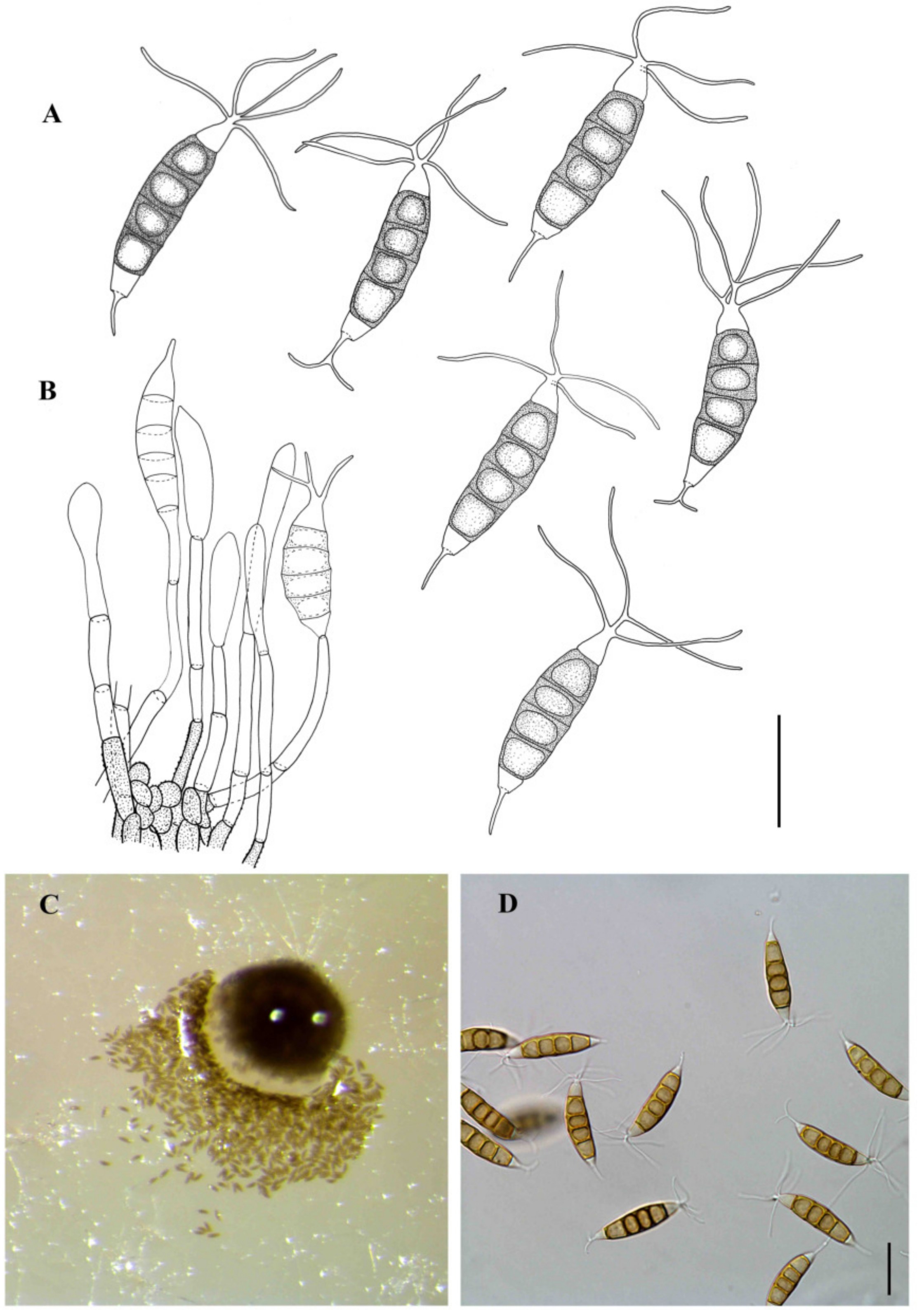


Figure 5: Morphology of *Pestalotia pezizoides* (epitype) herein transferred to *Seiridium*. **A** Mature conidia. **B** Conidiophores and conidiogenous cells with developing conidia. **C** Microscopic photograph of a conidioma on PDA, 12 d. **D** Microscopic photograph of mature conidia. Scale bars A, B, D = 20 µm.

Description of the epitype of *Pestalotia pezizoides* that is referred to as *Seiridium pezizoides* (Figure 5)

Conidiomata caulicolous, gregarious to confluent, apothecioid to pezizoid, immersed, erumpent when mature, dehiscence by irregular fissures, unilocular, glabrous, dark brown to black, 380–400 µm diam. (n=10); wall tissue of textura angularis, light brown. *Conidiophores* elongated, cylindrical, septate and irregularly branched, in lower part thick-walled, minutely verruculose, light to middle brown, in upper part smooth-, thin-walled, hyaline, (29.5)33.5–44.5(46) µm long (n=10). *Conidiogenous cells* cylindrical, smooth-, thin-walled, hyaline, (8.5)9.5–14(15.5) × 2–2.5(3) µm (n=10) with annellations. *Conidia* 6-celled, fusiform, straight to slightly curved, slightly constricted at septa when very mature, (26)28–32(34) × (6)7.5–9(10) µm (n=30); four middle cells doliiform, concolourous, medium brown, thick-walled (18)19–23(29) µm (n=30); exterior cells smooth-, thin-walled, hyaline, apical cell acute, bearing appendages variable in number and size, up to four unbranched or dichotomously branched or irregularly branched, up to 26 µm (n=20); basal cell conic with one single, centric appendage, unbranched or dichotomously branched in a certain distance, very rarely irregularly branched, up to 10.5 µm long (n=20).

Additional specimens examined. France, Dep. Aude, Carcassonne, on undetermined substrate, C. Roumeguere, Fungi Galliae Exs. No. 2886, BPI s.n. Italy, Venetia, Treviso, on *Vitis vinifera*, Oct. 1874, Saccardo, Mycotheca Veneta No. 328, BPI 406491; Venetia, Treviso, on *Vitis vinifera*, Aug. 1903, Saccardo, Mycotheca Italica No. 1371, BPI 406492. USA, New Jersey, on *Vitis labrusca*, Jun 1874, Ellis No. 31, Fungi Nova-Caesareenses, BPI 406486; Pennsylvania, Chester County, New Garden, on *Vitis* sp., Michener Fungi 19:82, No. 2790 and No. 2790 C [sub *P. compacta* Berk. & Curt.], BPI s.n.; locality and collection date N/A, on *Vitis riparia*, E. Bartholomew No. 1631, BPI s.n.; locality and collection date N/A, Ellis and Everhart´s Fungi Columbiani s.n., BPI s.n.; on *Vitis vinifera*, locality and collection date N/A, Ellis, N. Am. Fungi No. 35, BPI s.n.

Comments. The characteristics of the specimen Michener Fungi 19:82, No. 2790 C, originally labelled as *Pestalotia compacta* Berk. & Curt. are similar to those described for *P. pezizoides*. Therefore, the species designation made in this work confirms the one of Guba (1961) that No. 2790 C is *P. pezizoides* and not *P. compacta* Berk. & Curt. There are only a few fruiting bodies left on the specimen of Saccardo, Mycotheca

Italica, No. 1371 (BPI 406492). However, the specimen does not belong to the genus *Pestalotia* as it does not share any characters described for this genus. Instead it more likely belongs to the genus *Hendersonia*. In the specimen Ellis and Everhart´s Fungi Columbiani by E. Bartholomew No. 1631 at least two different fungi forming ascomata could be observed, one of these two most likely belongs to the genus *Pleospora*. Conidiomata that would be typical for *Pestalotia* were not observed.

Description of the neotype of *Seiridium marginatum* (BPI 405012)

Conidiomata stromatic, scattered to confluent, acervuloid to pycnidioid, immersed, erumpent when mature, dehiscence by irregular fissures, unilocular, glabrous, dark brown to black, 312–568 µm diam. (n=5); wall tissue of textura globulosa, light brown. *Conidiophores* elongated, cylindrical, septate, branched, smooth-, thin-walled, hyaline, (32.5)38–52.5(54.5) µm (n=10). *Conidiogenous cells* cylindrical to subcylindrical, smooth-, thin-walled, hyaline, (11.5)13.5–21(22) × 2–3.5 µm (n=10), with annellations. *Conidia* 6-celled, fusiform to ellipsoid, straight to slightly curved, (35.5)38–43(45)×(7)7.5–9(9.5) µm (n=20); four middle cells doliiform, thick-walled, covered with minute warts in longitudinal striae, concolourous, medium to dark brown, (27)28.5–31.5(32) µm (n=20); exterior cells smooth-, thin-walled, hyaline to subhyaline, apical cell conic, bearing one centric appendage, flexuous, unbranched, up to 48 µm long (n=20); basal cell obconic, truncate, with one single, centric appendage, unbranched, up to 37 µm long (n=20).

Additional specimens examined. Switzerland, Jura, on *Rosa canina*, 1894, Fuckel, Fungi Rhenani 2136, Herbier Barbey-Boissier 2491, BPI 405012. USA, Pennsylvania, Bethlehem, on *Rosa* sp., Schweinitz, BPI 453784.

Comments. Shoemaker et al. (1966) designated a neotype (BPI 405012) based on topotypic material from Switzerland, Jura, because the original type material of *Seiridium marginatum* is probably lost. Shoemaker et al. (1966) and Nag Raj (1993) have described and illustrated the neotype in detail. The measurements taken in this work are well within the range reported for this specimen by Shoemaker et al. (1966) and Nag Raj (1993).

Discussion. The conidial morphology of the epitype of *Pestalotia pezizoides* proposed here is entirely in concordance with the description by De Notaris (1841). However, the description of *P. pezizoides* does not include any measurements of the conidia or the conidiophores. Also, the iconotype does not carry a scale bar and, thus, does not provide detailed information on conidial size. Later, different authors studied the morphology of *P. pezizoides* in detail, e.g., Guba (1961), Griffiths and Swart (1974b), Maharachchikumbura et al. (2011), Nag Raj (1993), Steyaert (1949), and Sutton (1969). Nevertheless, only Guba (1961) studied the type specimen of *P. pezizoides*, but he provides only measurements of the conidia and not of the conidiophores. The conidiophores are particularly important to distinguish between *Pestalotia* and *Pestalotiopsis* because they are considerably longer in *Pestalotia*, although the length of this feature is given with notable variations in the literature. The epitype proposed herein is characterized by conidiophores that have an average length of 40 µm (n=10). Nag Raj (1993) indicates the length of the conidiophores of *P. pezizoides* as up to 65 µm, while Steyaert (1949) list them as 50–70 µm, and Sutton (1969) as 20–50 µm. In the drawing by Nag Raj (1993), the conidiophore is 40 µm long at the maximum and Steyaert (1949) does not distinguish in his drawing between conidiophores and conidiogenous cells. The data of the epitype match the measurements given by Sutton (1969) and possibly differ from those of Nag Raj (1993) and Steyaert (1949) due to different measurement methods.

The epitype specimen was obtained from the same host species as the original type specimen. The proposed epitype was collected near the same locality as the type. The type was collected in the surroundings of Milan, Italy while the epitype is obtained from Véronnes, France, which is located about 380 km northwest of Milan north of the Alpes. Although Milan is characterized by a mild Mediterranean climate on the foothills of the Alps, freezing periods may regularly occur. Winter climate in Véronnes is buffered by the proximity to the Atlantic and therefore has relatively mild winters.

There is a need to epitypify *Pestalotia pezizoides* to address the taxonomic confusion that exists with this genus. Fresh material for molecular approaches was needed to prove the taxonomic status of *Pestalotia* in relation to *Pestalotiopsis.*

Previous approaches using morphology only left no doubt that the conidial morphology of *Pestalotia* is distinct from that of *Pestalotiopsis* differing in number of cells in the conidia. *Pestalotiopsis* spp. is characterized by 5-celled conidia while *Pestalotia* spp. forms 6-celled conidia. For this reason, species of *Pestalotia* are more similar to *Seiridium* with which they share the 6-celled conidia with colored middle cells and basal hyaline cells. That fact has led to discussion about the correct taxonomic placement of *Pestalotia* during recent years (e.g., Maharachchikumbura et. al. 2014, 2015). When considering conidial appendage morphology, there is a notable difference between the genus *Pestalotia* and species of *Seiridium*. The type species of *Pestalotia, P. pezizoides*, is characterized by numerous, branched apical appendages, while species of *Seiridium* possess only a single apical appendage that can be branched or unbranched.

The genus *Seiridium* was introduced by Nees (1817) based on the type species *S. marginatum* found on *Rosa carnina.* Jaklitsch (2016) epityped this species and sequenced it for the first time. These new sequence data are included here in order to validate the phylogenetic status of the monotypic genus *Pestalotia*. Phylogenetic analysis of the two gene regions LSU and ITS placed *P. pezizoides* in the Pestalotiopsidaceae (BS = 82, PP = 100). In the Pestalotiopsidaceae *P. pezizoides* fell within *Seiridium* (Figure 6). Therefore, following the principles of priority, the younger generic name *Pestalotia* and its type species, *P. pezizoides*, are transferred to the older genus *Seiridium*. Maharachchikumbura et al. (2014, 2015) have suggested that *Pestalotia* could be congeneric with *Seiridium*, which is confirmed here.

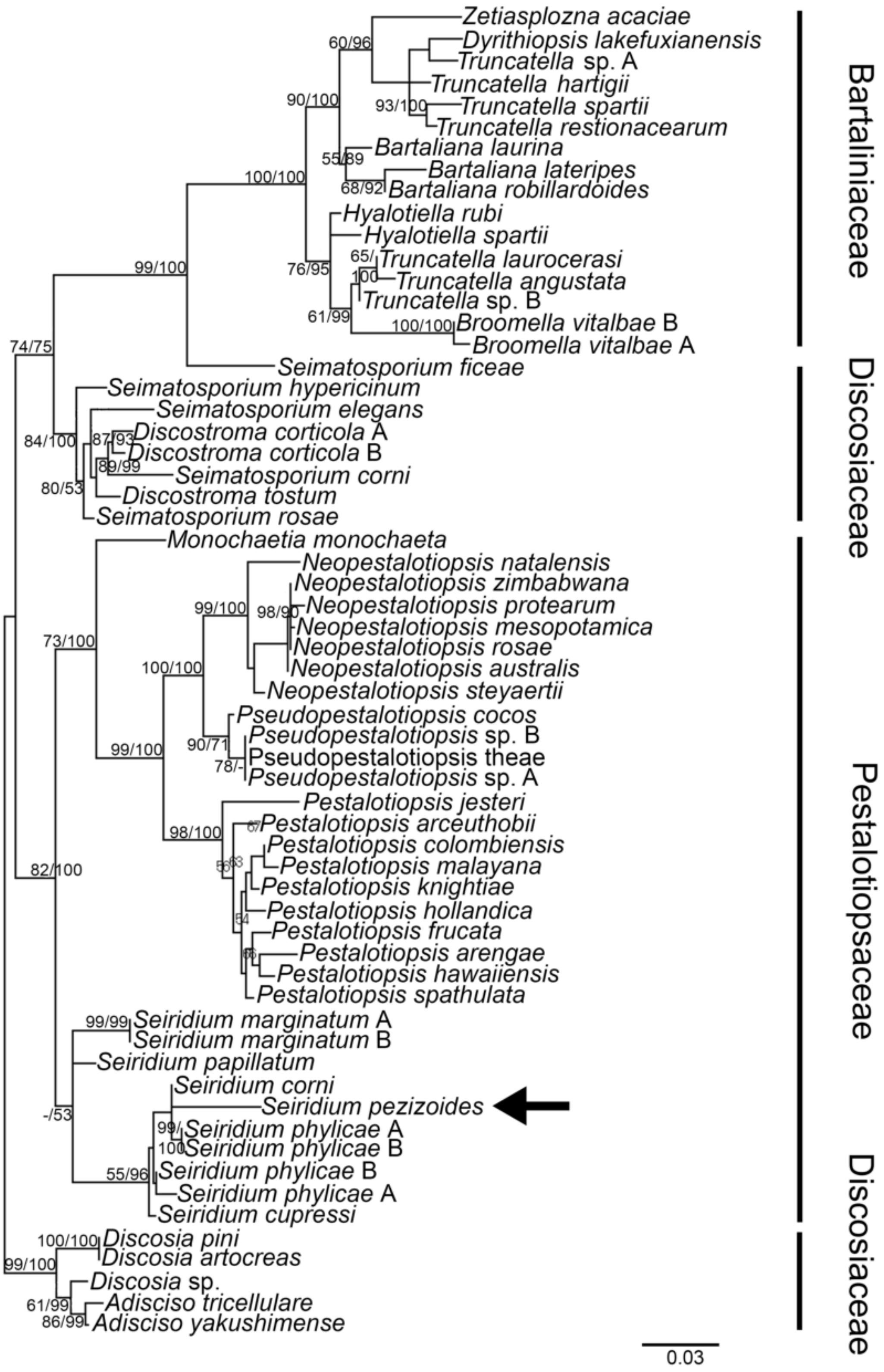


Figure 6: ML phylogenetic tree for members of the Amphisphaeriales of a concatenated dataset of ITS and LSU sequences. The placement of *Seiridium pezizoides* (black arrow) within the Pestalotiopsidaceae clade is highlighted. Support values are displayed next to the corresponding node as bootstrap/posterior probability values. Only bootstrap values and Bayesian PP of ≥ 50 % are displayed. The phylogeny is rooted at two genera of the Discosiaceae. Scale bar refers to the number of substitutions per site.

6.1.3 Taxonomic results in the genus *Pestalotiopsis*

Based on reanalysis of available genetic and morphological data, new combinations and synonymies of species within the genus *Pestalotiopsis* are proposed. Additionally, the rejection of the current epitype of *P. adusta* as well as a new representative specimen for this species is suggested.

Pestalotiopsis adusta (Ellis & Everh.) Steyaert, Trans. Br. mycol. Soc., 36:82, 1953, rejection of an **epitype** will be proposed and a **representative specimen** is given.

≡ ***Pestalotia adusta*** Ellis & Everh., J. Mycol., 4(6) 51, 1888

Type: USA, New Jersey, Newfield, on leaves of *Prunus domestica*, 20 July 1887, NY 00937391 (n.v.). Middlesex County, Grekowski Park, along the banks of the South River, on leaves of *Prunus* sp., 21 June 2014, coll. J. White, det. C. Judith-Hertz, J. McKemy, **representative specimen**, isolated from BPI 910046 (CJ37 = BPI s.n., CBS s.n.). Republic of Fiji, Fiji islands, on the PVC gasket of a refrigerator door, 1 June 1978, leg. McKenzie E.H.C., MFLU12-0425, **epitype** designated in Maharachchikumbura et al. (2012), ex-type living culture ICMP 60880 = PDDCC 6088.

Description of the representative specimen of *Pestalotiopsis adusta* (Figure 7)

Lesions round, sharply delimited by a red-brown margin, or conidiomata at the tips of the teeth of the leaf margins. *Conidiomata* scattered to gregarious, globose, epiphyllous, immersed, erumpent when mature, dehiscence by irregular fissures, unilocular, glabrous, dark brown to black, approx. 200 µm diam. (n=10); wall tissue of textura angularis, light brown. *Conidiophores* reduced to conidiogenous cells. *Conidiogenous cells* ampulliform, smooth-, thin-walled, hyaline, 4–4.5 × 2.5–3 µm (n=5). *Conidia* 5-celled, fusiform to oval, sometimes clavate, slightly constricted at septa when mature, (20)21–24(27) × (5)5.5–6.5(7) µm (n=30); three middle cells doliiform, concolourous, middle cell of colored cells sometimes appears somewhat darker than rest, thick-walled, pale to medium brown, (12.5)13.5–15.5(17) µm (n=30); exterior cells smooth-, thin-walled, hyaline, apical cell acute or collapsed, bearing two to three, occasionally only one, centric appendage, unbranched, up to 20 µm (n=10); basal cell acute to globose, with one single, centric appendage, unbranched, up to 7 µm (n=10).

Additional specimens examined. USA, New Jersey, on *Acer* sp., Ellis J.B., BPI 405329; New York, Long Island, Orient Point, on *Prunus serotina,* 31 July 1911, coll. Latham R., det. Guba E.F., BPI 405323 and BPI 405296; Long Island, Orient Point, on *Prunus cerasus,* 07 Aug. 1911, coll. Latham R., det. Guba E.F., BPI 405326 and BPI 405301; Virginia, Arlington Cemetery, on *Prunus serotina*, 10 Nov. 1929, coll. Davidson R.W., det. Guba E.F., BPI 405328 and BPI 405333.

Commends. In Maharachchikumbura et al. (2012) a detailed description including a photograph of the herbarium label and microscopical photographs of the holotype (NY 0093739) is given. In the same publication Maharachchikumbura et al. (2012) provided an epitype of *Pestalotiopsis adusta* (MB 302600) including an ex-type living culture (ICMP 6088). However, the information on the geographic locality, host species, and substrate does not coincide with the data given in the original species description of *P. adusta*.

During the investigation of the herbarium material at the BPI collections, no *pestalotiopsis*-like conidia could be observed on the two specimens BPI 405328 and BPI 405333. Only two *pestalotia*-like conidia were found on a slide provided with specimen BPI 405328. These conidia may have been carried over from another specimen on improperly cleaned dissecting or mounting tools.

Discussion. The epitype specimen for *Pestalotiopsis adusta* as designated by Maharachchikumbura et al. (2012) was collected on the Fiji islands, on the PVC gasket of a refrigerator door. On the other hand the collection data of the holotype read: USA, New Jersey, Newfield, on *Prunus domestica*. It is therefore questionable whether the epitype specimen corresponds to *Pestalotiopsis adusta*, mainly because of the differences in climate zone and substrate. Ariyawansa et al. (2014) provided guidelines for the appropriate epitypification of fungal species. Among the most important is that (1) an epitype should be based on topotypic material, (2) the epitype should be obtained from the same host or substrate as the original type, (3) in case of pathogenic fungi, the epitype should cause or be associated with the same symptoms on the host as the type. These important recommendations help to avoid incorrect species identification and suggest that the epitype of *Pestalotiopsis adusta* designated by Maharachchikumbura et al. (2012) is not appropriate. Thus, the epitype appears to be incorrectly chosen and the obtained sequence data cause taxonomic confusion instead of stabilizing the interpretation of the species. Sequence data of the holotype for comparison are not available at this point. For those reasons it is recommended to reject this epitype until additional material is obtained that is in accordance with the guidelines proposed by Ariyawansa et al. (2014).

The authors justify the designation of the sample collected from the Fiji islands on identical morphology compared to the holotype. However, the brief original description by Ellis and Everhart (1888), with *Pestalotiopsis adusta* being characterized by 4-septate, clavate to oblong conidia, with three pale brown middle cells, length of the middle cells 12–15 µm, 2–3 apical appendages, 8–12 µm long and hyaline exterior cells, does not provide all morphological characters needed for a precise species identification. Maharachchikumbura et al. (2012) examined the holotype and provided a more comprehensive description of the material. Conidia length of the holotype is given with 16–20 × 5–7 µm and the length of the three colored middle cells with 12.4–13.8 µm. It is notable that the indicated length of the conidia is exactly in concordance with the measurements given in Guba (1961). It might be that the authors confused there own measurements with the ones given in Guba (1961). Unfortunately, Maharachchikumbura et al. (2012) did not give information on how herbarium material was examined. For this reason, the number of conidia that have been measured for the characterization of morphological structures is unclear. The range of the conidia length of the epitype is given as 17–20 × 5.2–6.6 µm (n=30). However, when comparing the scale bar with the illustrated conidia of the epitype in Maharachchikumbura et al. (2012) it is notable that at least one of the conidia has a length of 22 µm.

Furthermore, it seems that Maharachchikumbura et al. (2012) misinterpreted the host information as they state the holotype of *Pestalotiopsis adusta* occurs on leaves of the cherry species *Prunus cerasus*. However, the original protologue states that the specimen was collected on dead tips of living leaves of cultivated plum trees. This information together with the leaf morphology of the specimen of the holotype leads to the assumption that the host species is the common plum *Prunus domestica*.

The herein described representative specimen of *Pestalotiopsis adusta* has been collected in the USA, New Jersey and was found on *Prunus* sp., and, thus, is closer to the original species description than the epitype designated by Maharachchikumbura et al. (2012). The measurements of the morphological structures of the representative specimen are within the range given for *P. adusta* in the original protologue. There is, however, a divergence in two measured characters. First, in the representative specimen conidial length is slightly longer than described by Guba (1961) and Maharachchikumbura et al. (2012) and second the maximum length of the apical appendages is 20 µm and not 15 µm as described by Guba (1961). The reason for this could be that the examined material in this study was taken from fresh collected leaves, while the authors mentioned above used dried herbarium specimen. However, all other morphological characters of the representative specimen such as length of the three colored middle cells, color of conidia, and number of appendages are in concordance with the original description.

In the context of this work, the morphology of the holotype of *Pestalotiopsis adusta* could not be studied, thus many questions regarding the morphology of the type material remain without answers. For this reason it is recommended to designate the herein described specimen as an unofficial reference (Hawksworth 2012) until additional data become available and the holotype has been examined.

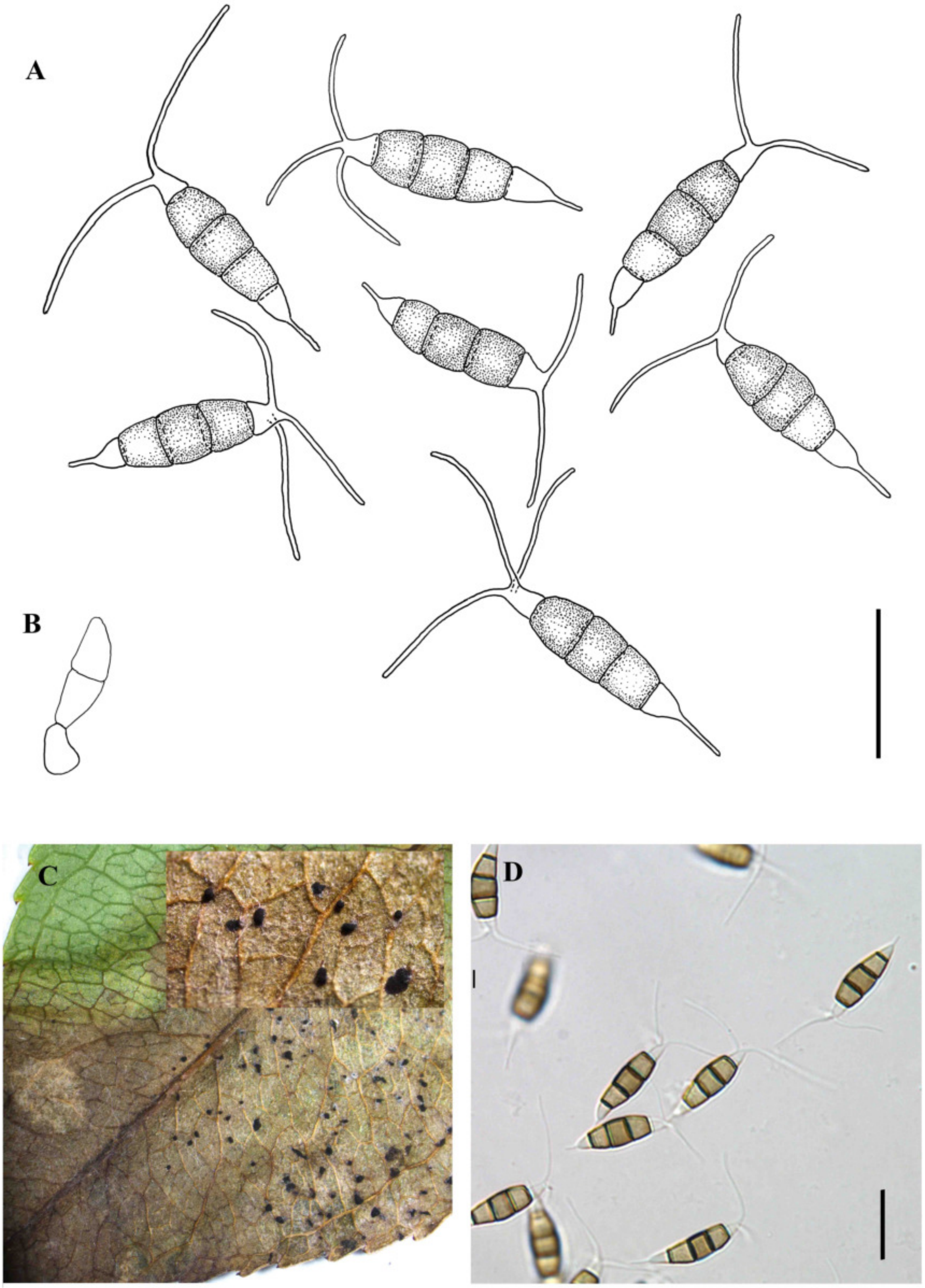


Figure 7: Morphology of *Pestalotiopsis adusta* (BPI 910046). **A** Mature conidia. **B** Conidiogenous cell with developing conidia. **C** Infected leaf of *Prunus* sp. **D** Microscopic photograph of mature conidia. Scale bars = 20 µm.

Pestalotiopsis caroliniana (Guba) Judith-Hertz et al., a **new combination** will be proposed.

≡ ***Pestalotia caroliniana*** Guba, Monograph of *Monochaetia* and *Pestalotia*: 151, 1961

Type: USA, Virginia, Norfolk, 12 Oct. 1908, on *Euonymus japonicus*, coll. R. A. Pope, det. E.F. Guba, (BPI 405453!).

Comments. The name *Pestalotia caroliniana* has to be transferred to the genus *Pestalotiopsis*, following the latest genus concept by Maharachkumbura et al. (2014). The only member of the genus *Pestalotia, P. pezizoides*, is characterized by 6-celled conidia whereas the species *P. caroliniana* has 5-celled conidia. Most likely the species does not belong to the morphologically similar genera *Neopestalotiopsis* or *Pseudopestalotiopsis.* Species of *Neopestalotiopsis* are characterized by versicolourous conidia and most of the species of *Pseudopestalotiopsis* bear appendages with spatulate tips. Both features are not present in *P. caroliniana.* In order to avoid any doubt, an epitype has to be chosen and sequenced. However, considering the current data situation the species has to be placed in the genus *Pestalotiopsis*.

Pestalotiopsis hollandica Maharachch., K.D. Hyde & Crous, in Maharachchikumbura, Hyde, Groenewald, Xu, and Crous, Stud. Mycol. 79:164, 2014 (Type: CBS H-15703 n.v., ex-type culture CBS 265.33 n.v.).

= ***Pestalotiopsis monochaeta*** Maharachch., K.D. Hyde & Crous, in Maharachchikumbura, Hyde, Groenewald, Xu, and Crous, Stud. Mycol. 79:170, 2014 (Type: CBS H-21757 n.v., ex-type culture CBS 144.97 n.v.), a **new synonym** will be proposed.

Comments. Both species *Pestalotiopsis hollandica* and *P. monochaeta* have been recently described in Maharachchikumbura et al. (2014), thus these names have equal priority. The available molecular data of this species were reanalyzed what led to the conclusion that they belong to a single species (see chapter 6.3.5), thus *P. hollandica* was selected for use to avoid confusion with *Pestalotia monochaeta* Desm. 1848.

Pestalotiopsis maculans (Corda) Nag Raj, Mycotaxon 22:47, 1985a

≡ ***Pestalotia maculans*** (Corda) S. Hughes, Can. J. Bot. 36:795, 1958

≡ ***Hendersonia maculans*** (Corda) Lév., Annls Sci. Nat., Bot., sér. 3:288, 1846

≡ ***Sporocadus maculans*** Corda, Icon. fung. (Prague) 3:3, 1839

Type: Czech Republic, Prague, on leaves of *Camellia japonica*, leg. Corda, (PR155665!). Italy, Volterra, Piazza XX Settembre, on *Camellia japonica*, 01. April 2015, coll. C. Judith-Hertz (BPI s.n.), **epitype** to be designated here, 24 April 2015, C. Judith-Hertz, BPI = s.n, ex-epitype culture CJ36 = CBS s.n.

= ***Pestalotiopsis guepinii*** (Desm.) Steyaert *Bull. Jard. bot. État Brux.* 19(3):312, 1949

≡ ***Pestalotia guepinii*** Desm., Annls Sci. Nat., Bot., sér. 2 13:181, 1840

France, Angers, on *Camellia japonica*, in Desmaziéres Plantes Cryptogames de France 1084, BPI 405955!, designated here as **lectotype**.

= ***Pestalotiopsis guepinii*** var. ***macrotricha*** (Kleb.) B. Sutton, Mycol. Pap. 80:11, 1961

≡ ***Pestalotia macrotricha*** Kleb., Mykol. Zentbl. 4: 7, 1914

= ***Pestalotiopsis guepinii*** var. ***major*** Steyaert, Trans. Br. mycol. Soc. 36(3):237, 1953

= ***Pestalosphaeria concentrica*** M.E. Barr, Mycologia 67(1):188, 1975

(syn. fide Nag Raj, 1985a)

Description of the holotype of *Pestalotiopsis maculans* (PR 155665)

Conidiomata amphigenous, scattered to gregarious, orbicular to oval, erumpent when mature, dehiscence by irregular fissures, glabrous, dark brown to black, approx. 250 µm diam (n=5); wall tissue of textura angularis, brown to light brown. *Conidiophores* cylindrical to subcylindrical, unbranched, up to 17.5 µm long (n=4), often reduced to conidiogenous cells. *Conidiogenous cells* ampulliform, smooth-, thin-walled, hyaline, with annellations. *Conidia* 5-celled, shape variable, straight sometimes slightly curved, tend to be ellipsoidal or fusiform, often constricted at septa, septum of second apical cell tends to be thicker, (16)19–23(25.5) × (4.5)6–8.5(8) µm (n=20); three middle cells doliiform, concolourous to versicolourous, then with a slight difference graduated from middle brown to light brown from apical to basal cell, (12)13–15 µm (n=20); exterior cells smooth-, thin-walled, hyaline to subhyaline, apical cell conic, bearing appendages variable in number and size, sometimes only one, centric appendage, branched or unbranched, or with two to three, rarely four appendages, often fork-shaped or secondarily branched, sometimes with slightly spathulate tips, up to 26 µm long (n=20);

basal cell broadly conical, sometimes truncate, with one single, centric appendage, unbranched, up to 5.5 µm long (n=20).

Description of the lectotype of *Pestalotiopsis guepinii* (BPI 405955, Figure 8)

Conidiomata amphigenous but mainly on adaxial side of leaf, scattered to gregarious, globose, erumpent when mature, dehiscence by irregular fissures, glabrous, dark brown, approx. 200 µm diam (n=10); wall tissue of textura angularis, light brown. *Conidiophores* cylindrical to subcylindrical, unbranched, up to 15 µm long (n=3), often reduced to conidiogenous cells. *Conidiogenous cells* ampulliform or cylindrical to subcylindrical, smooth-, thin-walled, hyaline, with annellations. *Conidia* 5-celled, shape variable, straight sometimes slightly curved, tend to be ellipsoidal or fusiform then often strongly constricted at the first apical septum, septum of the second apical cell tends to be thicker, (16.5)17.5–20.5(22) × (5)5.5–6.5 µm (n=27); the three middle cells doliiform, concolourous to versicolourous, than with a slight difference graduated from middle brown to light brown from apical to basal cell, thick-walled, (10)11–20.5(22) µm long (n=27); exterior cells smooth-, thin-walled, hyaline to subhyaline, apical cell conic, bearing appendages variable in number and size, sometimes only one, long, centric appendage, or with two to three, rarely four appendages, appendages often fork-shaped or secondarily branched, in some cases branching begins at some distance (approx. 4.5 µm) from apical cell in these cases appendages thickened in region before branching, sometimes with slightly spathulate tips, up to 38.5 µm long (n=27); basal cell broadly conic with a somewhat truncate base, possessing one single, centric appendage, unbranched, up to 5 µm long (n=27).

Description of the proposed epitype of *Pestalotiopsis maculans* (Figure 9)

Conidiomata amphigenous, scattered to gregarious, oval to globose, erumpent when mature, dehiscence by irregular fissures, glabrous, dark brown to black, approx. 300 µm diam (n=5); wall tissue of textura angularis, light brown to subhyaline. *Conidiophores* cylindrical to subcylindrical, unbranched, up to 17.5 µm long (n=4), often reduced to conidiogenous cells. *Conidiogenous cells* ampulliform or subcylindrical, smooth-, thin-walled, hyaline, with annellations. *Conidia* 5-celled, shape variable, straight sometimes slightly curved, ellipsoidal or fusiform, often constricted at septa, (16)19–23(25.5) × (4.5)6–8.5(8) µm (n=20); three middle cells doliiform, concolourous to versicolourous, than with a slight difference graduated from middle brown to light brown from apical to basal cell, (10)11–13.5(16) µm long (n=20); exterior cells smooth, thin-walled, hyaline to subhyaline, apical cell conic, bearing appendages variable in number and size, sometimes only one, long, centric appendage or with two to three, rarely four appendages, appendages often fork-shaped or secondarily branched, in some cases branching begins at some distance (approx. 4 µm) from apical cell in these cases appendages thickened in region before branching, occasionally minutely knobbed, up to 36.7 µm long (n=20); basal cell broadly conic, with one single, centric appendage, unbranched, up to 5.5 µm long (n=20).

Additional specimens examined. Czech Republic, Prague, on *Camellia japonica*, leg. Corda, PR 155665. France, Angers, on *Camellia* sp., 1840, Desmaziéres, Plantes Crypt. Fr. 22:1084, BPI s.n. and duplicates BPI 405955, BPI 404755, and 404756; Alascae and Lorraine, on *Camellia* sp., Roumeguere Fungi Gallici Exs. 315, BPI 404781. Italy, Naples, Botanical Garden, on *Camellia* sp., leg. Cesati, Rabenhorst Fungi Europ. Exs. 2352, BPI 404782, BPI 404932, BPI 405009, BPI 405951, and BPI 405996; Pavia, Botanical Garden, 1890, on *Camellia* sp., leg. Briossi G., Cavara F., BPI 405937. USA, Massachusetts, Wahltam, on *Camellia japonica*, leg. Guba E.F., BPI 405926.

Comments. Nag Raj (1985a) examined the type specimen of *Pestalotiopsis maculans* (PR 155665) and provided a comprehensive description as well as detailed drawings of it.

On the specimen BPI 405926 only *Alternaria* sp. could be observed and on the specimen BPI 404756 no fungus could be observed during this study.

The specimens BPI 405009, BPI 404782, and BPI 404932 (Rabenhorst Fungi Europ. Exs. 2352) consist only of slides. Details of the conidial morphology, like the hyaline structures and coloration are difficult to discern. However, the size of the conidia of these samples falls into the range described for *Pestalotiopsis guepinii* (compare with description of sample BPI 405955 above).

Discussion. *Pestalotiopsis maculans* was introduced by Corda (1839) as *Sporocadus maculans* and has undergone a number of taxonomic changes since then (see above). During the examination of the holotype of *S. maculans* (PR 155665), it was noted that not all morphological characters of the specimen are in concordance with the original description nor with the illustrated iconotype. For example, apical appendages were clearly visible in the examined holotype specimen. Corda (1839) did not mention any apical appendages in the protologue, which is a key character for the differentiation of species in this group. Likewise, the iconotype of *S. maculans* does not show apical appendages. Solely, the number of septation and shape of the conidia are consistent with my observation. Most likely, this result is explained by the technical possibilities in 1839, when the original description was made, as hyaline structures of the conidia were hard to see with the microscopes used back then.

Nag Raj (1985a) first recognized *Pestalotiopsis guepinii*, the type species of the genus *Pestalotiopsis* as a taxonomic synonym of *Sporocadus maculans* by comparing the holotype specimen of *S. maculans* with the lectotype specimen of *P. guepinii* in Desmazières Exs. Pl. Crypt. Fr. 22:1084, 1040 (BPI 405955). He concluded that the two specimens must belong to the same species as they share all essential morphological characters. Hence, Nag Raj (1985a) published the new combination based on the principle of priority, which resulted in *Pestalotiopsis maculans* as the accepted scientific name for this species. However, not every author followed the nomenclature proposed by Nag Raj (1985a). For this reason the type specimens of *S. maculans* and *P. guepinii* were compared once more to confirm and confidently name the type species of the genus *Pestalotiopsis*.

The morphological examination of the type specimens of *Pestalotiopsis guepinii* and *Sporocadus maculans* conducted in this study confirms the taxonomic changes made by Nag Raj (1985a). The species *P. guepinii* is morphologically characterized by relatively short, variable conidia that tend to be ellipsoidal or fusiform with occasionally forked appendages and short basal appendages that are often missing. This combination of characters has also been recognized and acuratelly illustrated by Guba (1961) during his examination of the lectotype specimen of *P. guepinii* in Desmazières Exs. Pl. Crypt. Fr. 22:1084, 1040. The type specimen of *S. maculans* exhibits identical morphological characters as described for *P. guepinii*, except for the length of apical appendages. This difference is most likely due to the fact that the examined material is very old and desiccated, so that fragile structures are easily broken. Thus, *P. guepinii* should be treated as a synonym of *S. maculans*.

The morphology of the herein proposed epitype of *Pestalotiopsis maculans* has been compared to the lectotype of *P. guepinii* and the holotype of *Sporocadus maculans*. The examination revealed all three specimens to be identical in all essential features (compare descriptions above). Additionally, the herein designated ex-epitype culture was obtained from the same host plant as the type specimens of *P. guepinii* and *S.*

maculans. However, all three types were collected in different geographic areas and the influence of climate on *Pestalotiopsis* spp. distribution is not investigated yet. The holotype of *S. maculans* was collected in Prague, Czech Republic, *P. guepinii* was collected at Angers, France, and the epitype of *P. maculans* in Volterra, Italy. The regions of Angers in France and Volterra in Italy show some climatic commonalities, as both are found in the C category of the Köppen climate classification. Angers is characterized by a gentle oceanic climate (Köppen classification: Cfb) with a mean annual precipitation of 650 mm and a mean annual temperature of 11.5 °C. Volterra, that is located in the North Mediterranean area, has a humid subtropical climate (Köppen classification: Cfa), and receives slightly more precipitation over the year (813 mm). The annual mean temperature is slightly higher with 13.1 °C. Both regions are influenced by moist sea air, and are characterized by mild winters. Freezing temperatures are rare, but possible. The January mean low temperature record is 1.3 °C in Anger and 2.1 °C in Volterra. These climatic conditions make both localities good wine-growing regions. On the contrary, Prague is situated in the basin of Bohemian, a hill country in the Czech Republic, in quite a distance from the sea. The region lies in a transition zone between the oceanic climate and the humid continental climate (Köppen classification: Dfb). The winter temperatures are lower than at the other two collection sites with a mean annual temperature of 9.0 °C and a January mean low record of -3.8 °C. Annual mean precipitation is also lower at 486 mm (Climate-data.org). In previous molecular studies the culture available at the Centraalbureau voor Schimmelcultures (CBS) with the collection number CBS 322.76 has been often considered as a reference specimen for *Pestalotiopsis maculans* (e.g. Jeewon et al. 2002, 2003b). However, the recently published study by Maharachchikumbura et al. (2014) shows that this specimen belongs to the genus *Neopestalotiopsis* and not to the genus *Pestalotiopsis*. This example also indicates that the morphological differentiation by color of conidia as proposed by Maharachchikumbura et al. (2014) to distinguish between the two genera *Neopestalotiopsis* (versicolourous) and *Pestalotiopsis* (concolourous) is not always a clear distinguishing feature considering that some years earlier, Jeewn et al. (2003a) described spore of the same isolate (CBS 322.76) as concolourous. In the original description by Desmaziéres (1840) no color of the conidia is mentioned and Corda (1839) described the conidia as pale honey yellow what I interpreted as conclourous. Guba (1961) described the conidial pigmentation of the lectotype of *P. guepinii* as concolourous. Nag Raj (1985a) noted that pigmentation of both the type of *S. maculans* and the lectotype of *P. guepinii* to be versicolourous. In my opinion, the pigmentation is not differentiated clearly and does obviously change with the age of conidia by becoming darker with time. In the type specimens conidia that are concolourous and versicolourous with only a slight difference in colour can be observed. The same observation was made for the proposed epitype when examining the freshly collected material from the host. However, conidia of the ex-epitype culture tend to be versicolourous only. Generally, fungi are morphologically complex organisms. Their morphology is not only changing during their life cycle, but may also be different with the nature of the growth medium and physical environment (Papagianni 2004). This potential variability of morphological features makes it difficult to compare fungal species that are grown on different media.

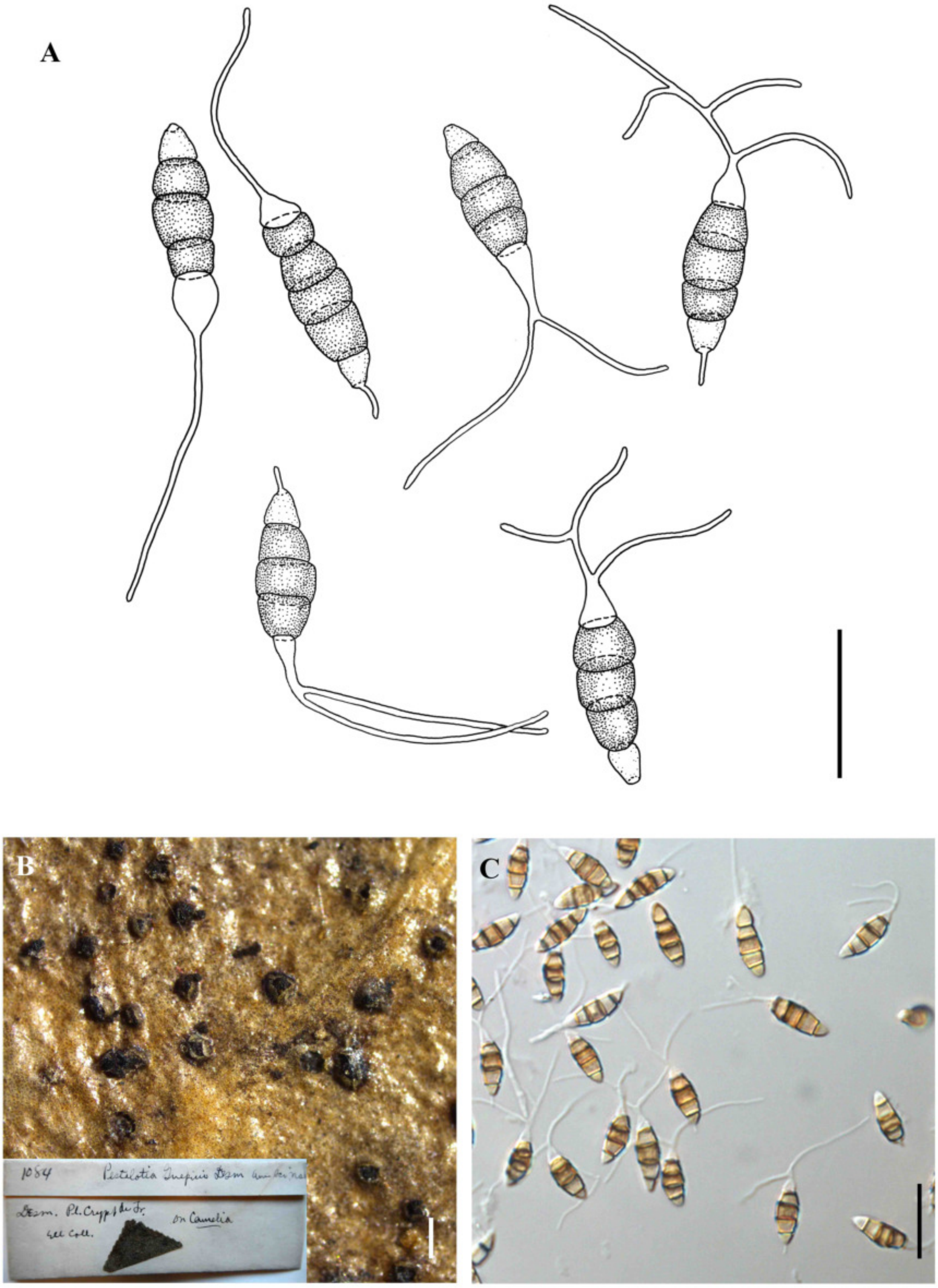


Figure 8: Morphology of the lectotype of *Pestalotiopsis guepinii* (BPI 405955). Drawing (**A**) and microscopic photograph (**C**) of mature conidia. **B** Fruiting bodies and collection label of the herbarium specimen. Scale bars A+C = 20 µm, B = 200 µm.

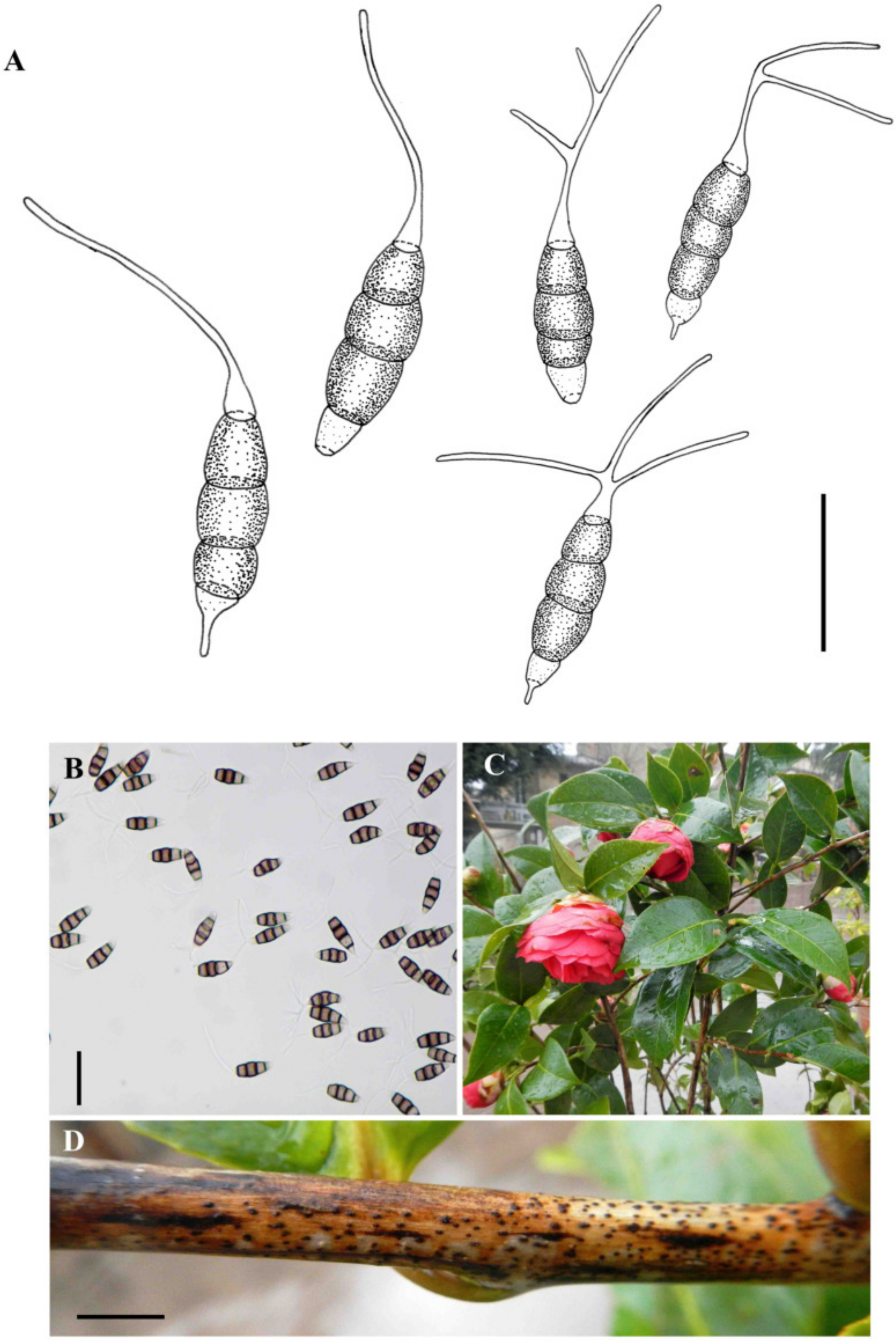


Figure 9: Morphology of the proposed epitype of *Pestalotiopsis maculans*. **A** Drawing of mature conidia. **B** Microscopic photograph of mature conidia. **C** *Camellia japonica*, host plant of the collected specimen. **D** Pattern of infection on a stem of the host plant. Scale bars A+B = 20 µm, D = 0.5 cm.

Pestalotiopsis shorea Y. Song, Tangth., K.D. Hyde & Y. Wang, in Song, Tangthirasunun, Maharachchikunmbura, Jiang, Hyde and Wang, Cryptog. Mycol. 35:142, 2014b (Type: MFLU13-0267 n.v., ex-type culture MFLUCC 12-0314= ICMP 20195 n.v.).

= ***Pestalotiopsis colombiensis*** Maharachch., K.D. Hyde & Crous, in Maharachchikumbura, Hyde, Groenewald, Xu and Crous, Stud. Mycol. 79:158, 2014 (Type: CBS H-21764 n.v., ex-type culture CBS 118553 = CPC10969 n.v.), a **new synonym** will be proposed.

= ***Pestalotiopsis diploclisiae*** Maharachch., K.D. Hyde & Crous, in Maharachchikumbura, Hyde, Groenewald, Xu and Crous, Stud. Mycol. 79:160, 2014 (Type: CBS H-21763 n.v., ex-type culture CBS 115587 = HKUCC 10130 n.v.), a **new synonym** will be proposed.

= ***Pestalotiopsis humus*** Maharachch., K.D. Hyde & Crous, in Maharachchikumbura, Hyde, Groenewald, Xu and Crous, Stud. Mycol. 79:165, 2014 (Type: CBS H-21760 n.v., ex-type culture CBS 336.97 n.v.), a **new synonym** will be proposed.

= ***Pestalotiopsis papuana*** Maharachch., K.D. Hyde & Crous, in Maharachchikumbura, Hyde, Groenewald, Xu and Crous, Stud. Mycol. 79:165, 2014 (Type: CBS H-21755 n.v., ex-type culture CBS 331.96 n.v.), a **new synonym** will be proposed.

Comments. Maharachchikumbura et al. (2014) and Song et al. (2014b) recently described the five species *Pestalotiopsis colombiensis*, *P. diploclisiae*, *P. humus*, *P. papuana*, and *P. shorea* based on molecular data of the three loci *TEF1*, ITS, and *ß-tubulin* as well as morphological data. While reanalyzing the molecular data of these five genetically closely related species using more exhaustive analysis methods, it has been concluded that they belong to one single species. Following the rule of priority *P. shorea* is chosen as the valid name, because Maharachchikumbura et al. (2014) published it four months earlier in the same year. More details on the arguments upon which the decision was based are given in chapter 6.3.5.

Considering the morphology of the relevant species, Maharachchikumbura et al. (2014) highlighted the length of the apical appendages to distinguish between *P. colombiensis*, *P. diploclisiae*, and *P. humus*. However, the length of the apical appendage of *P. diploclisiae* (10–)13–19(–22) µm is completely within the range of *P. colombiensis* (11–)13–25(–28) µm. *Pestalotiopsis humus* (6–) 6.5–12(–13) µm has somewhat shorter apical appendages as *P. colombiensis* and *P. diploclisiae,* but the length is within the range of *P. papuana* 1.5–7 µm and *P. shorea* 5–12 µm. Furthermore, Maharachchikumbura et al. (2014) mentioned conidial width to differentiate between the two species *P. diploclisiae* and *P. humus*. Following the protologue the width of *P. diploclisiae* conidia ranges between 5–6.5(7) µm and of *P. humus* between 5–7(7.5) µm. The overlap in those conidial morphological traits makes it impossible to discriminate morphologically between these species.

Pestalotiopsis trachicarpicola Y.M. Zhang & K.D. Hyde, Cryptog. Mycol. 33:315, 2012b (Type: IFRD 9026, n.v.).

= ***Pestalotiopsis kenyana*** K.D. Hyde & Crous, in Maharachchikumbura, Hyde, Groenewald, Xu and Crous, Stud. Mycol. 79: 166, 2014 (Type: CBS H-15657, n.v.), a **new synonym** will be proposed.

Comments. In comparing the genetic data of the types of *Pestalotiopsis trachicarpicola* and *P. kenyana* almost no differences in the three available loci *TEF1*, ITS, and *ß-tubulin* were discovered. The total number of bp-changes in all three loci is three, one in ITS and two in *ß-tubulin*. In the original species description, Maharachchikumbura et al. (2014) came to the same conclusion. However, Maharachchikumbura et al. (2014) decided to consider their clades 42 and 43 to be separate species, mainly on the basis of a single, weak morphological character, the conidial width. The conidia of *P. kenyana* are slightly wider (7–9 µm) compared to those of *P. trachicarpicola* (5.5–7.2 µm).

In the molecular analyses both type sequences occurred in the *P. uvicola* complex in the same monophyletic subbranch in all analyses.

6.1.4 Taxonomic results in the genus *Pseudopestalotiopsis*

Pseudopestalotiopsis simitheae (Y. Song, Tangthir., K.D. Hyde & Y. Wang) Judith-Hertz et al., a **new combination** will be proposed.

≡ ***Pestalotiopsis simitheae*** Y. Song, Tangthir., K.D. Hyde & Y. Wang, in Song, Tangthirasunun, Maharachchikunmbura, Jiang, Hyde, and Wang, Cryptog. Mycol. 35:145, 2014b

Type: Thailand, Suratthani Province, Kkaho Sok, on dead leaves of *Pandanus odoratissimus*, MFLU 13-0305 n.v.

Comments. *Pestalotiopsis simitheae* was described in 2014. In the same year, Maharachchikumbura et al. (2014) divided the genus *Pestalotiopsis* into three genera: *Neopestalotiopsis*, *Pestalotiopsis*, and *Pseudopestalotiopsis* based on morphological and phylogenetic data. In the present study type sequences of three loci ITS, *TEF1*, and ß-tubulin of *P. simitheae* were reanalyzed (see chapter 5.6.5). Sequences used for these analyses are listed in Appendix 2. The results have clearly shown that the species belongs into the newly introduced genus *Pseudopestalotiopsis* (Figure 3 and Figure 4). Conidial morphology of the two genera *Pestalotiopsis* and *Pseudopestalotiopsis* is similar and cannot be considered for a reliable identification at this taxonomic rank. The same results have been found recently by (Maharachchikumbura et al. 2016), who published the new combination while the work on this dissertation was in process.

6.1.5 Taxonomic results in the genus *Truncatella*

Truncatella casuarinae (Nag Raj) Judith-Hertz et al., a **new combination** will be proposed.

≡ ***Pestalotiopsis casuarinae*** (Cooke & Massee) Nag Raj, Coelomycetous anamorphs with appendage-bearing conidia, 1993

≡ ***Pestalotia casuarinae*** Cooke & Massee, in Cooke, Grevillea 16(80): 114, 1888, (Type: Campbell No. 402, n.v., in National Herbarium of Victoria)

Additional specimens examined. Australia, Australian Capital Territory, Canberra, Murrumbidgee river, 02. Dec. 1954, on *Casuarina cunninghamiana*, leg. E. F. Guba, PRM 874898.

Comments. Nag Raj (1993) did not follow the generic concept as proposed by Steyaert (1949) for the genus *Pestalotiopsis* when he transferred *Pestalotia casuarinae* to *Pestalotiopsis*. In the present work, the generic concept introduced by Steyaert (1949) and redefined by Sutton (1969, 1980) is applied. Based on this concept, species of the three genera *Pestalotia* (6-celled conidia), *Pestalotiopsis* (5-celled conidia), and *Truncatella* (4-celled conidia) can be distinguished by the number of conidial cells. *Pestalotiopsis casuarinae* is characterized by 4-celled conidia. Consequently, the name *Pestalotiopsis casuarinae* has to be newly combined in the genus *Truncatella*.

6.2 Further species accounts from examined herbarium material

In the following section, selected important plant parasitic and most common species of *Pestalotiopsis* are presented and discussed. All examined herbarium specimens are listed in Table 5. Measurements of the examined herbarium specimens are given in S2. Some important type specimens of *Pestalotiopsis* s.l. have not been accessible during my stay at the BPI collections. These are the following: *P. distincta* (BPI 405638), *P.*

funerea (BPI 405754), *P. microspora* (BPI 522478), *P. versicolor* (BPI 439393, 439394) as well as the type of *Pestalotia pezizoides* (BPI 406485). In those cases, it was attempted to examine other representative specimens such as authentic or topotypic material. Unless otherwise stated the given synonymy follows the taxonomy listed in *Index Fungorum* (status January 2016).

Table 5: Herbarium specimens examined. T=type, ST=syntype.

Name	**Herbarium specimens**
Neopestalotiopsis clavispora	BPI 405473 (T), BPI 405477 (T), BPI 405486, BPI 405487, BPI 405488, BPI 505489, BPI 405490 (T), BPI 405491
Neopestalotiopsis foedans	BPI 405695(T), BPI 405697 (T), BPI 405701, BPI 405703, BPI 405705, BPI 405706, BPI 405707, BPI 405708 (T), BPI 405720
Pestalotia herteri nom. nud.	PR 876027
Pestalotia pezizoides	BPI 406491, BPI 406492, BPI 406486, BPI 406487, Roumeguere Fungi Galliae Exs. No. 2886 (BPI s.n.), Michener Fungi 19:82 No. 2790 and No. 2790 C (BPI s.n.), Ellis and Everhart´s Fungi Col. No. 1631 (BPI s.n.), Ellis N. Am. Fungi No. 35 (BPI s.n.)
Pestalotiopsis abietina nom. nud.	Roumeguére Fungi Galliae Exs. No. 735 (T) (BPI s.n.)
Pestalotiopsis adusta	BPI 405296, BPI 405301, BPI 405323, BPI 405326, BPI 405328, BPI 405329, BPI 405333
Pestalotiopsis americana	BPI 453791
Pestalotiopsis bicolor	BPI 405385, BPI 405386
Pestalotiopsis bicornis	BPI 453797 (T)
Pestalotiopsis caroliniana	BPI 405451 (ST), BPI 405453 (ST), BPI 405452
Pestalotiopsis conigena	BPI 405517 (ST), BPI 405551, BPI 405556, BPI 405559, BPI 405560
Pestalotiopsis disseminata	BPI 405619 (T), BPI 405620 (T), BPI 405623(T), BPI 405627 (T), Roumeguère Fungi Galliae Exs. 4069 and 5167 (BPI s.n.), BPI 405631, BPI 405621
Pestalotiopsis funerea	BPI 405730, BPI 405755, BPI 405866, BPI 405763, Ellis and Everhart Fungi Col. No. 3535 (BPI s.n.), Rabenhorst Fungi Europ. Exs. 2898 (BPI s.n.), Roumeguère Fungi Galliae Exs. No. 735(BPI s.n.), PRM 833644
Pestalotiopsis guepinii	BPI 404755 (ST), BPI 404781, BPI 404782, BPI 404932, BPI 405009, BPI 405955 (T) and Desmaziéres, Plantes Crypt. Fr. 22:1084 (T) (BPI s.n.), BPI 405926, BPI 405937, BPI 405951, BPI 405996
Pestalotiopsis macrospora	PR 876309
Pestalotiopsis maculans	BPI 802213, BPI 374220, PR 155665 (T)
Pestalotiopsis neglecta	BPI 406414, BPI 406415 (T), BPI 406417, BPI 406424, Thümen Myc. Univ. No 884 and No. 884b (BPI s.n.)

Pestalotiopsis palmarum	BPI 406500 (T), BPI 406551, BPI 406552, BPI 522508, Roumeguère Fungi Galliae Exs. No. 5166 (BPI s.n.), PRM 875542
Pestalotiopsis sydowiana	PR 818293
Seiridium marginatum	BPI 405012, BPI 453784
Seiridium unicorne	BPI 1106572
Truncatella casuarinae	PR 874898
Truncatella hartigii	BPI 406123 (ST), BPI 406124
Truncatella stevensonii	PR 848045
Truncatella truncata	BPI 406822, BPI 434909, BPI 439410
Truncatella tumefaciens	BPI 405559, BPI 405560, BPI 406765 (T)

Pestalotiopsis neglecta (Thüm.) Steyaert, Trans. Br. myco. Soc. 36(2): 83, 1953

≡ ***Pestalotia neglecta*** Thüm., Contrib. Flor. Mycol, Lusitan.: no. 343, 1879

= ***Pestalotia funerea*** Desm. var. ***euonymi-japonici*** Thüm., Myc. Univ. 884, 1887, nom. nud. (syn. fide Guba, 1961)

= ***Pestalosphaeria gubae*** Tak. Kobay., Ishihara, Yas. Ono, Mycoscience 42(2): 211, 2001

Description of *Pestalotiopsis neglecta* (isotype BPI 406415) (Figure 10**)**

Conidiomata epiphyllous, scattered to gregarious, globose to lenticular, immersed, erumpent when mature, dehiscence by irregular fissures, glabrous, dark brown to black, 228–197 µm diam. (n=10); wall tissue of textura angularis, smooth-, thin-walled, light brown to subhyaline. *Conidiophores* reduced to conidiogenous cells. *Conidiogenous cells* ampulliform, smooth-, thin-walled, hyaline, (6)7–9 µm (n=8) long with annellations. *Conidia* 5-celled, clavate, slightly constricted at septa when mature, (30)32–36(37)×(9)9.5–10.5(11.5) µm (n=20); three middle cells doliiform, versicolourous with a low contrast, middle brown to dark brown, (21)21.5–24(25) µm (n=20); exterior cells smooth-, thin-walled, hyaline, apical cell acute, bearing two to three appendages with spathulate tips, unbranched, up to 43.5 µm (n=20); basal cell conic with one single, centric appendage, unbranched, up to 13.5 µm (n=20).

Additional specimens examined. Italy, Venetia, Conegliano, on *Euonymus japonicus*, Oct. 1876, coll. C. Spegazzini, sub *P. funerea* Desm. var. *euonymi-japonici* in Thümen Myc. Univ. No. 884, BPI s.n., duplicate BPI 406414, and No. 884b, BPI s.n. Japan, on *Euonymus* sp., BPI 406424. Portugal, Zombaria, on *Euonymus japonicus*, Jan. 1879, A. Moller in Thümen, Myc. Lusit. 343 (Ser. II), herb. Jard. Bot. Univ. Coimbra. Portugal, BPI 406415, isotype. USA, South Carolina, Camden, on *Euonymus japonicus*, Feb. 1913, coll. R. K. Beattie, det. E. F. Guba, BPI 406417.

Comments. It is important to note that in the five specimens examined here, the length of conidia is very variable and, thus, does not always correspond to the indicated length from the original description. Conidia of the specimens BPI 406415, in Thümen Myc. Univ. 884 and 884b are on average around 10 µm longer (see discussion).

The fungus on specimen BPI 406417 is not a member of the genus *Pestalotiopsis* and, thus, was not further examined.

Guba (1961) reported that the specimen collected by Spegazzini at Coneglino, Italy, in Thümen Myc. Univ. 884, identified as *Pestalotiopsis funerea* Desm. var. *euonymi-japonici* Thüm. by Thümen is distinct from *P. funerea* Thüm. which is confirmed here. However, to support the synonymy with *P. neglecta* further investigations are necessary.

Discussion. The holotype of *Pestalotiopsis neglecta* is deposited at the herbarium COI, Portugal and a respective isotype is hosted at BPI (BPI 406415). The isotype is characterized by conidia that are on average 34 µm long (n=20) and thus, notably longer then originally described for this species by Thümen (1879). In the protologue Thümen (1879) indicated conidial length as 25 µm. Therefore, it would be important to reexamine the holotype at Coimbra for morphological comparison to the isotype. This would clarify any confusion between the herbarium specimens or if the measurement for the conidia length given by Thümen (1879) refers to the length of the three middle cells. It has not been common practice, but in some descriptions the authors indicate only the length of the three middle cells instead of the total length of the conidia. Thümen (1879) does not give further information on the methodology he used. Unfortunately, a loan of the holotype from COI was not possible and during a personal visit at COI the herbarium was not accessible. *Pestalotiopsis neglecta* is constantly isolated from diseased samples of economically important cultivated plants, such as blueberry, *Vaccinium* spp. (Espinoza et al. 2008), corn, *Zea mays* (Tagne and Mathur 2001), and on different species of the plant families Podocarpaceae, Taxaceae, and Theaceae (Wei et al. 2007b). For this reason, it is of great importance to clarify the morphological concept of this species.

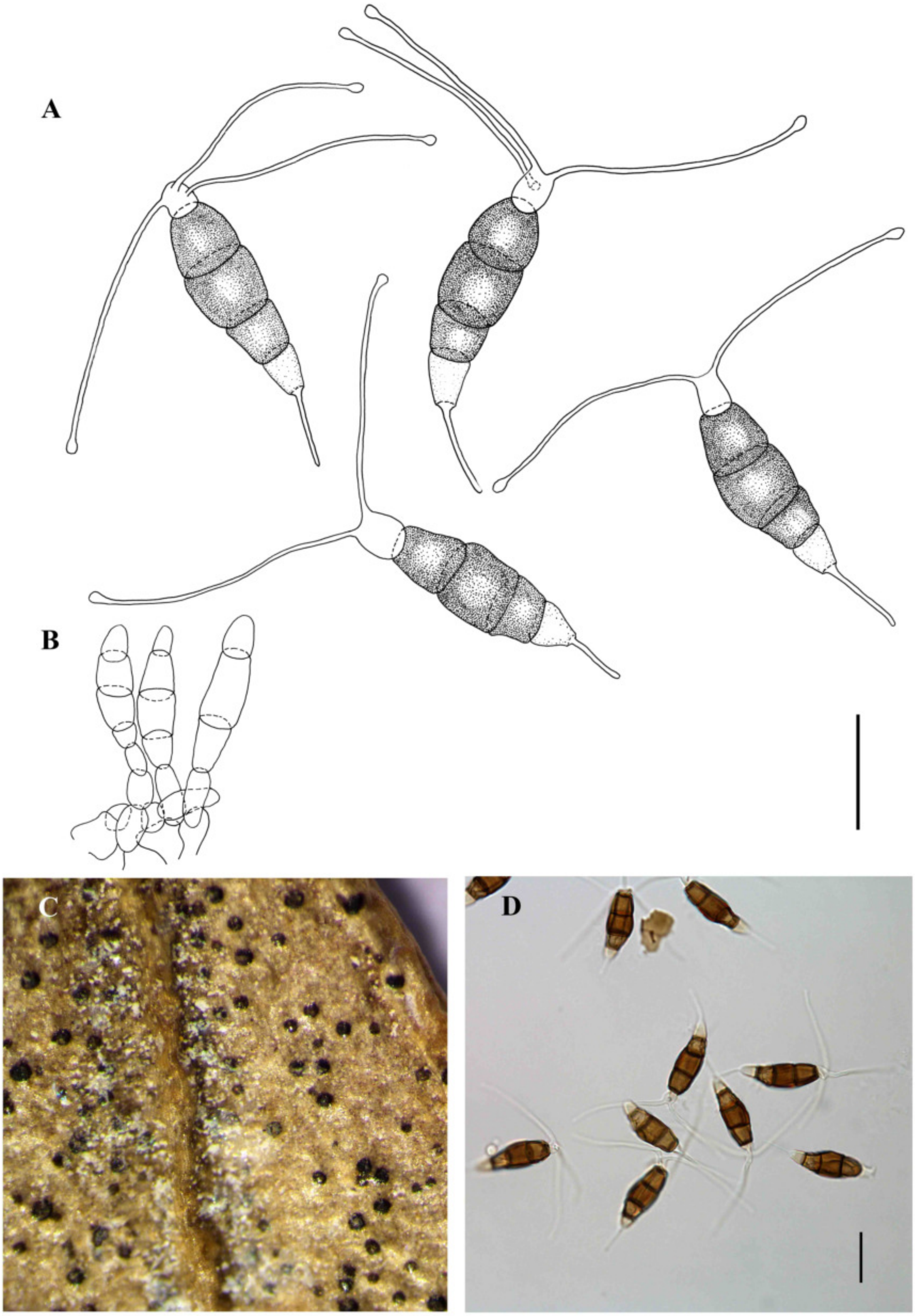


Figure 10: Morphology of *Pestalotiopsis neglecta* (isotype, BPI 406415). **A** Drawing of mature conidia. **B** Drawing of conidiogenous cells with developing conidia. **C** Infected leaf of *Euonymus japonicus* **D** Microscopic photograph of mature, desiccated conidia. Scale bars = 20 µm.

Neopestalotiopsis clavispora (G.F. Atk.) Maharachch., K.D. Hyde & Crous, in Maharachchikumbura, Hyde, Groenewald, Xu and Crous, *Stud. Mycol.* 79:138, 2014

≡ *Pestalotiopsis clavispora* (G.F. Atk.) Steyaert, Bull. Jard. bot. État Brux. 19:335, 1949

≡ *Pestalotia clavispora* G.F. Atk., Bulletin of Cornell University 3(no. 1):37, 1897

Type: USA, AL, Aubrun, on *Quercus* sp., 3. Oct. 1891, leg. G. F. Atkinson, in herb. G. F. Atkinson No. 2288, Dept. Plant Path, Cornell University, holotype (CUP n.v.), isotype (BPI 405490!). China, Guangxi Province, Shiwandashan, on *Magnolia* sp., 28. Dec. 1997, leg. W. Wu, MFLU12-0418 **epitype**; MFLUCC 12-0281 ex-type living culture.

Description of the isotype of *Neopestalotiopsis clavispora* (BPI 405490!)

Conidiomata amphigenous, but mostly epiphyllous, scattered to gregarious, irregular in shape, but tending to be subglobose, immersed, erumpent when mature, dehiscence by irregular fissures, glabrous, dark brown, approx. 250 µm diam (n=5); wall tissue of textura angularis, smooth-, thin-walled, light brown to subhyaline. *Conidiophores* reduced to *conidiogenous cells. Conidiogenous cells* short, cylindrical, smooth-, thin-walled, hyaline to subhyaline, with annellations. *Conidia* 5-celled, fusiform to oval to clavate, often slightly constricted at septae, (21)22–27(29.5) × 6.5–8(9) µm (n=10); three middle cells conical, lowest of them usually slightly longer (up to 2.5 µm difference), sometimes hardly constricted between third and fourth upper cells, versicolourous, two upper cells medium to dark brown and lowest cell light brown, (14.5)15.5–17.5(18) µm (n=10); exterior cells smooth-, thin-walled, hyaline to subhyaline, apical cell conical, bearing one to three, mostly two, rarely one central, appendage, appendages at the bases often somewhat thicker, up to 31 µm long (n=10); basal cell acute with one central basal appendage, occasionally basal appendage absent, up to 7 µm long (n=10).

Additional specimens examined. USA, Alabama, Aubrun, on *Quercus* sp., 3. Oct. 1891, leg. G. F. Atkinson, in herb. G. F. Atkinson No. 2288, Dept. Plant Path, Cornell University, BPI 405490, BPI 405473, and BPI 405477; Florida, Cocoa, on *Quercus minima*, Feb. 1938, leg. G. G. Hedgcock, BPI 405486; Florida, Miami, on *Quercus minima*, 11. Feb. 1917, coll. G. R. Lyman, det. E. F. Guba, BPI 405489; Georgia, Albany, on *Aleurites fordii*, Oct. 1930, leg. E. F. Guba, BPI 405487; Georgia, Savannah, on *Aleurites fordii*, Nov. 1933, coll. D. Bisset, det. E. F. Guba, BPI 405488; Tennesese, Hunters Place, on *Quercus velutina*, 18. Apr. 1914, leg. G. Hedgcock, BPI 405491.

Comments. According to the original description of *Pestalotia clavispora* by Atkinson (1897) conidia are 5-celled, clavate, with three versicolourous middle cells and three rarely four apical appendages that are between 25–35 µm long. Atkinson (1897) does not mention the size of the conidia or a basal appendage. Some years later Guba (1961) examined the type specimen and provided a more detailed description of this species. Maharachchikumbura et al. (2012) examined the holotype specimen of *P. clavispora* at Cornell University, NY, USA. The morphological description by Maharachchikumbura et al. (2012) is in concordance with the descriptions made by Atkinson (1897) and Guba (1961) with the exception that the number of apical appendages differs. The original description by Atkinson (1897) as well as the description by Guba (1961) are pointing out that this species bears three to sometimes four appendages. This finding could be confirmed by Maharachchikumbura et al. (2012) and in this study. In both cases conidia were commonly characterized by possessing two to three, unbranched appendages.

Maharachchikumbura et al. (2012) designated an epitype for the species *Pestalotiopsis neglecta*. Two years later Maharachchikumbura et al. (2014) placed the species in the newly introduced genus *Neopestalotiopsis*, because of the versicolourous conidia, which they considered to be a common characteristic of the genus.

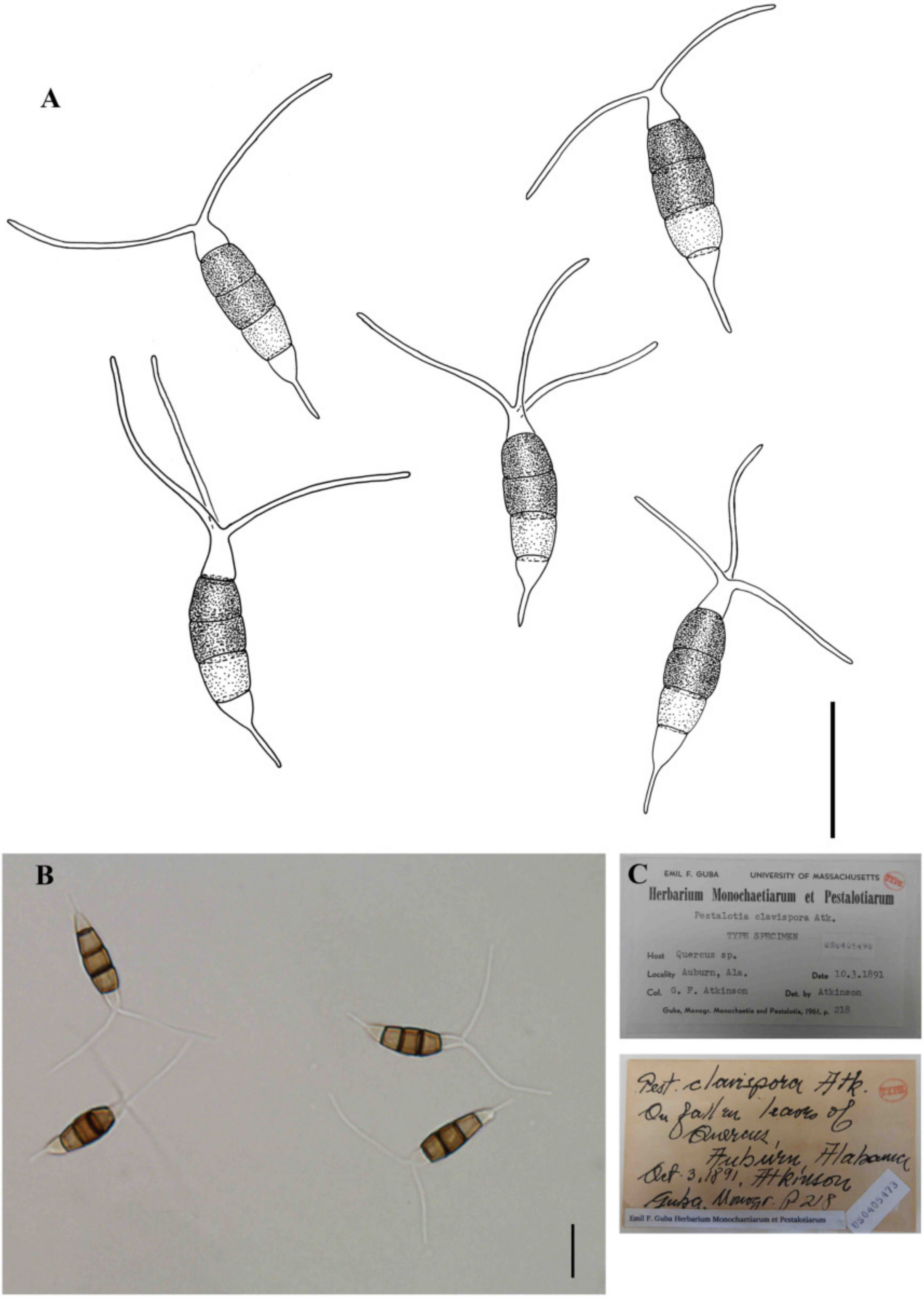
The leaf fungus on the specimen BPI 405491 is not *Pestalotiopsis clavispora*. The observed fungus is characterized by an apical cell with one single, central appendage and two to four lateral appendages arising just above the septum of the apical and the subapical cell. This arrangement of apical appendages is typical for the species *Pestalotiopsis montellica*.

The observed fungi on the specimens BPI 405489, BPI 405475 represent most likely *Neopestalotiopsis clavispora.* However, details of the appendages or septation, which are necessary to identify the species of this group, are not well preserved.

Discussion. The designated epitype by Maharachchikumbura et al. (2012) (MFLU12-0418) of *Pestalotiopsis clavispora* has been collected at a different geographic region and from another host plant than the host from which this species was originally described. The type material of this species has been collected in the USA, Alabama, on *Quercus* sp. whereas the epitype has been described from China, Guangxi Province, Yunnan, on *Magnolia* sp. Hence, the epitype material does not meet the requirements for being an appropriate epitype as described in Ariyawansa et al. (2014). Therefore, the validity of the epitype is questionable and should be proved in future studies.

Furthermore, the genetic analysis in Maharachchikumbura et al. (2012) shows that *Neopestalotiopsis clavispora* is genetically very similar to the species *N. foedans*, *N. saprophyta*, and *N. ellipsospora*. In the phylogenetic analysis of the single ITS marker the genetic intraspecific variability of *N. foedans* is even higher than between the three species *N. foedans*, *N. saprophyta*, and *N. ellipsospora*. Only the phylogenetic analysis of the *TEF1* marker supports the existence of this species.

Neopestalotiopsis clavispora is a common species that has been reported to be a plant pathogen, and has often been isolated as an endophyte (Espinoza et al. 2008; Keith et al. 2006; Liu et al. 2007; Wei et al. 2007b). For this reason, it is of great importance to clearly identify the species in order to prevent pathogen spread.



EMIL F. GUBA UNIVERSITY OF MASSACHUSETTS TYPE

Herbarium Monochaetiarum et Pestalotiarum

Pestalotia clavispora Atk.

TYPE SPECIMEN US0405490

Host Quercus sp.

Locality Auburn, Ala. Date 10.3.1891

Col. G. F. Atkinson Det. by Atkinson

Guba, Monogr. Monochaetia and Pestalotia, 1961, p. 218

Pest. clavispora Atk. TYPE
On fallen leaves of
Quercus,
Auburn, Alabama
Oct. 3, 1891, Atkinson
Guba. Monogr. P 218

Emil F. Guba Herbarium Monochaetiarum et Pestalotiarum US0405473

Figure 11: Morphology of *Neopestalotiopsis clavispora.* **A** Drawing of mature conidia (isotype, BPI 405490). **B** Microscopic photograph of mature conida (BPI 405486). **C** Envelope labels of the type specimens at BPI. Scale bars = 20 µm.

6.3 Phylogenetic analyses

6.3.1 DNA sequences

In this study a total of 191 strains belonging to five genera *Neopestalotiopsis* (76 strains), *Pestalotia* (two strains), *Pestalotiopsis* (109 strains), *Pseudopestalotiopsis* (three strains), and *Truncatella* (one strain) have been sequenced. Further molecular phylogenetic analyses have been conducted for *Neopestalotiopsis*, *Pestalotia*, and *Pestalotiopsis*. The data set used for the phylogenetic analyses in this study comprises 302 sequences of *Neopestalotiopsis*, two sequences of *Pestalotia*, 276 sequences of *Pestalotiopsis*.

6.3.2 Model test and alignment properties

Individual alignment properties from analyses of single loci, the concatenated data set of *Pestalotiopsis*, and the best fitting models estimated by jModelTest are reported in Table 6.

Table 6: Alignment properties from analyses of individual markers for *Pestalotiopsis* and the best model of evolution under the AICc as suggested by jModelTest for the Bayesian analyses.

Locus	No of sequences	alignment length	best model
MCM7	71	551	K80+I
TSR1	41	628	HKY+I+G
TEF1	63	1,242	GTR+I+G
ITS	68	612	GTR+I+G
ß-tubulin	46	447	HKY+G
Concatenated	72	3,480	see above

6.3.3 Phylogenetic analyses of *Pestalotiopsis*

The phylogenies based on single loci generally show similar patterns of topology and are presented in Figure 12 – Figure 16. Each single-locus tree resolves at least five major clades regardless of the phylogenetic method chosen for the analyses. The phylogenies based on ITS, *MCM7*, and *TSR1* show one additional clade (clade VI) that is formed by a single specimen, AR 4951, for which sequences of *ß-tubulin* and *TEF1* could not be generated. In most of the single-gene phylogenetic trees the major Clades I to V could be resolved, albeit not always with sufficient statistical support. Clade I receives maximum support (BS = 100, PP = 100) in *TEF1*, *MCM7*, *ß-tubulin*, moderate support (BS = 89, PP = 90) in *TSR1* and no support in ITS. The specimen AR 5005 is nested in Clade I with maximum support (BS = 100, PP = 100) in *TEF1* and *MCM7*, but fells out of Clade I in ITS with no support. Clade II is well-supported in all single-gene trees (BS ≥ 97, PP = 100), but in *MCM7* four isolates fall out of Clade II building a non-supported branch with Clade IV and Clade V. Clade III is in most cases sister clade to Clade II (BS ≥ 83, PP ≥ 99) except in *TSR1* that has generally low supported deeper nodes. In ITS the close relationship of Clade II with Clade III is supported (BS = 98, PP = 100), albeit the final placement of Clade III within the Clade II/Clade III cluster is not found, resulting in a polytomy. Clade III receives maximum support in *TEF1*, *MCM7*, and *TSR1* (BS = 100, PP = 100) and moderate support in ITS and *ß-tubulin* (BS ≥ 92, PP ≥ 88). Clade IV receives maximum support in *TEF1*, *MCM7*, and *ß-tubulin* while in ITS Clade IV appears as a polytomy within the Clade I/Clade V/Clade IV cluster. *TSR1* sequence data for members of Clade IV could not be generated. Clade V receives highest support in *ß-tubulin* (BS = 100, PP = 100) and is moderately to highly supported by *TEF1*, *ITS*, and *MCM7* data (BS ≥ 80, PP ≥ 98). Based on *TSR1* data, Clade V subdivides into three paraphyletic clusters, but deeper nodes, and thus the paraphyly is not statistically supported. Generally, the current ITS data set provides the least phylogenetic information with the lowest support values in all deeper nodes, while *MCM7* is the single-gene that resolves the topology best with the most maximum supported nodes.

The phylogenetic analyses of the concatenated alignment of five loci resolved all six major clades. These major clades correspond to the supported clades that were found in most single-locus trees as described above and presented in Figure 12 – Figure 16. The Clades I to V are strongly supported as monophyletic with BS ≥ 100 and PP ≥ 100 in both phylogenetic analyses methods applied to the concatenated alignment. Clade VI is represented by a single specimen only. As in most single-gene phylogenies, Clade II and Clade III form sister clades with high support (BS = 99, PP = 100).

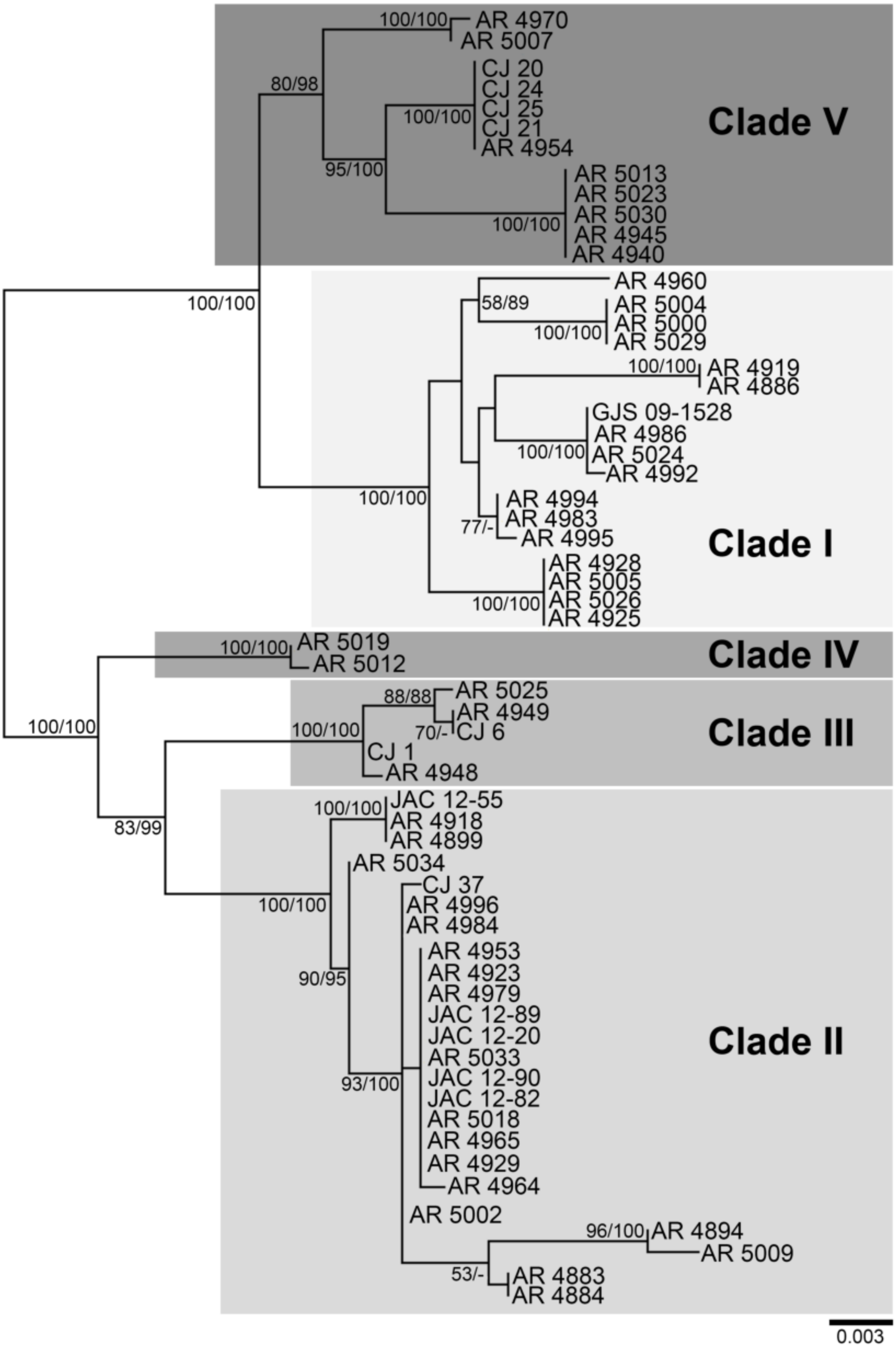


Figure 12: ML phylogenetic analysis of the *TEF1* marker from 60 *Pestalotiopsis* isolates. Support values are displayed next to the corresponding node as bootstrap/posterior probability values. Only bootstrap values of ≥ 50 % and Bayesian PP of ≥ 70 % are displayed. The phylogeny is mid-point rooted. Major clades found in the multi-gene analysis are indicated with grey boxes. Scale bar refers to the number of substitutions per site.

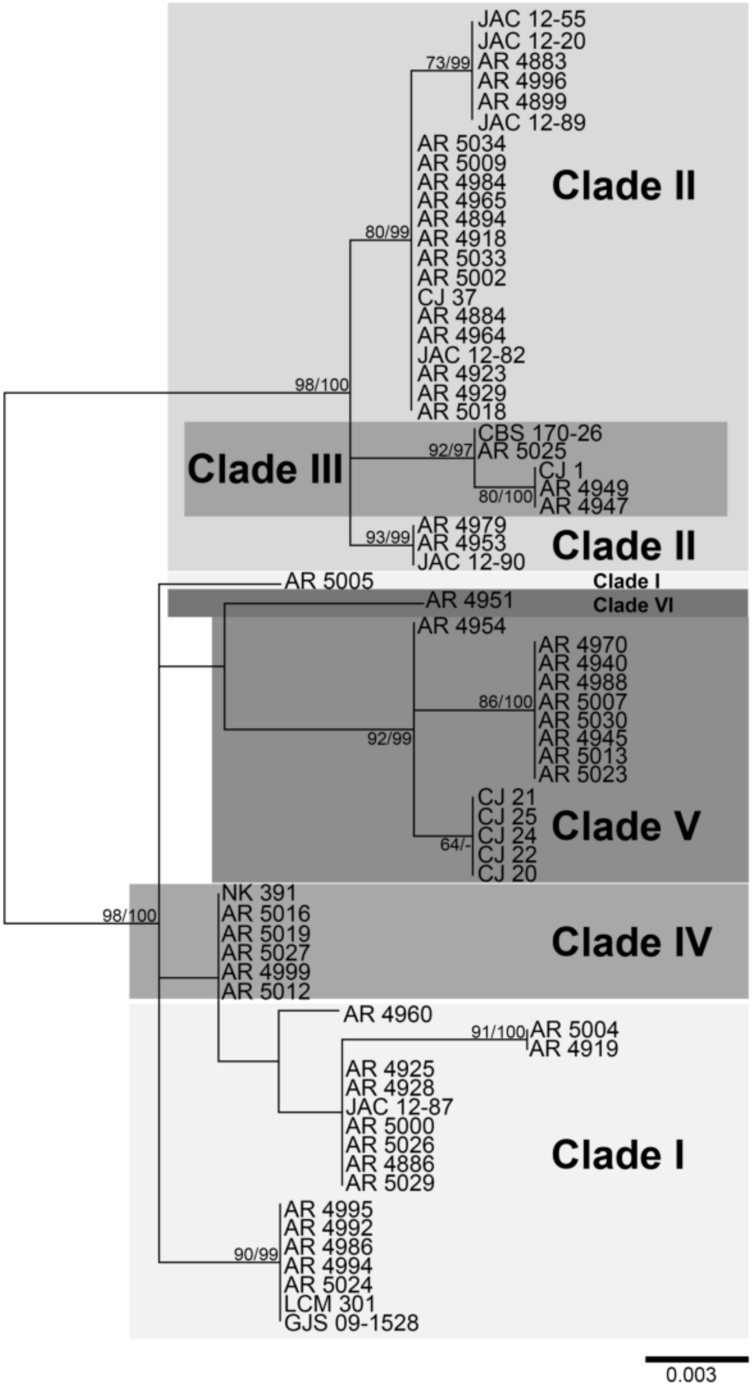


Figure 13: ML phylogenetic analysis of the ITS marker from 68 *Pestalotiopsis* isolates. Support values are displayed next to the corresponding node as bootstrap/posterior probability values. Only bootstrap values of ≥ 50 % and Bayesian PP of ≥ 70 % are displayed. The phylogeny is mid-point rooted. Major clades found in the multi-gene analysis are indicated with grey boxes. Scale bar refers to the number of substitutions per site.

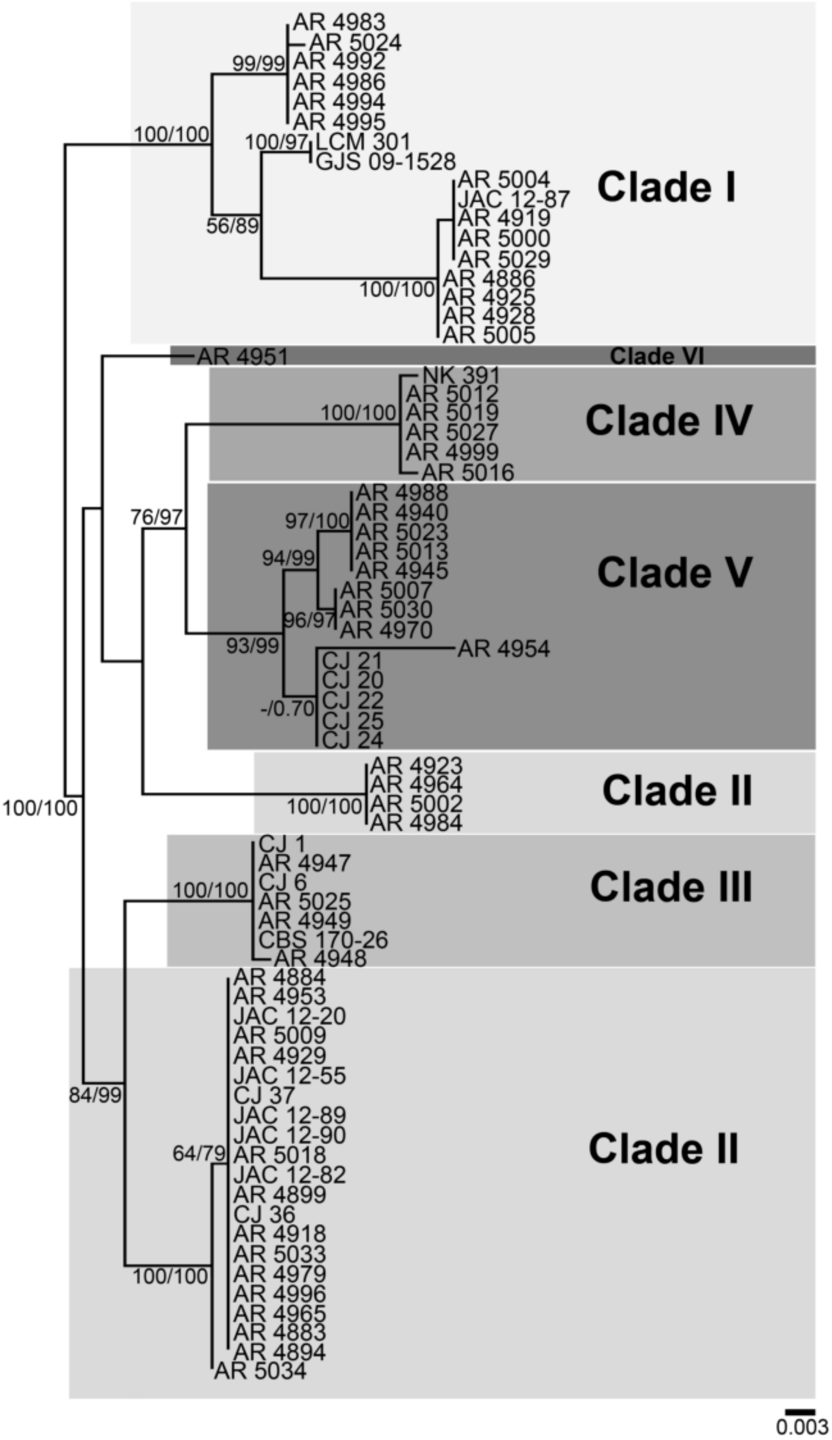


Figure 14: ML phylogenetic analysis of the *MCM7* marker from 70 *Pestalotiopsis* isolates. Support values are displayed next to the corresponding node as bootstrap/posterior probability values. Only bootstrap values of ≥ 50 % and Bayesian PP of ≥ 70 % are displayed. The phylogeny is mid-point rooted. Major clades found in the multi-gene analysis are indicated with grey boxes. Scale bar refers to the number of substitutions per site.

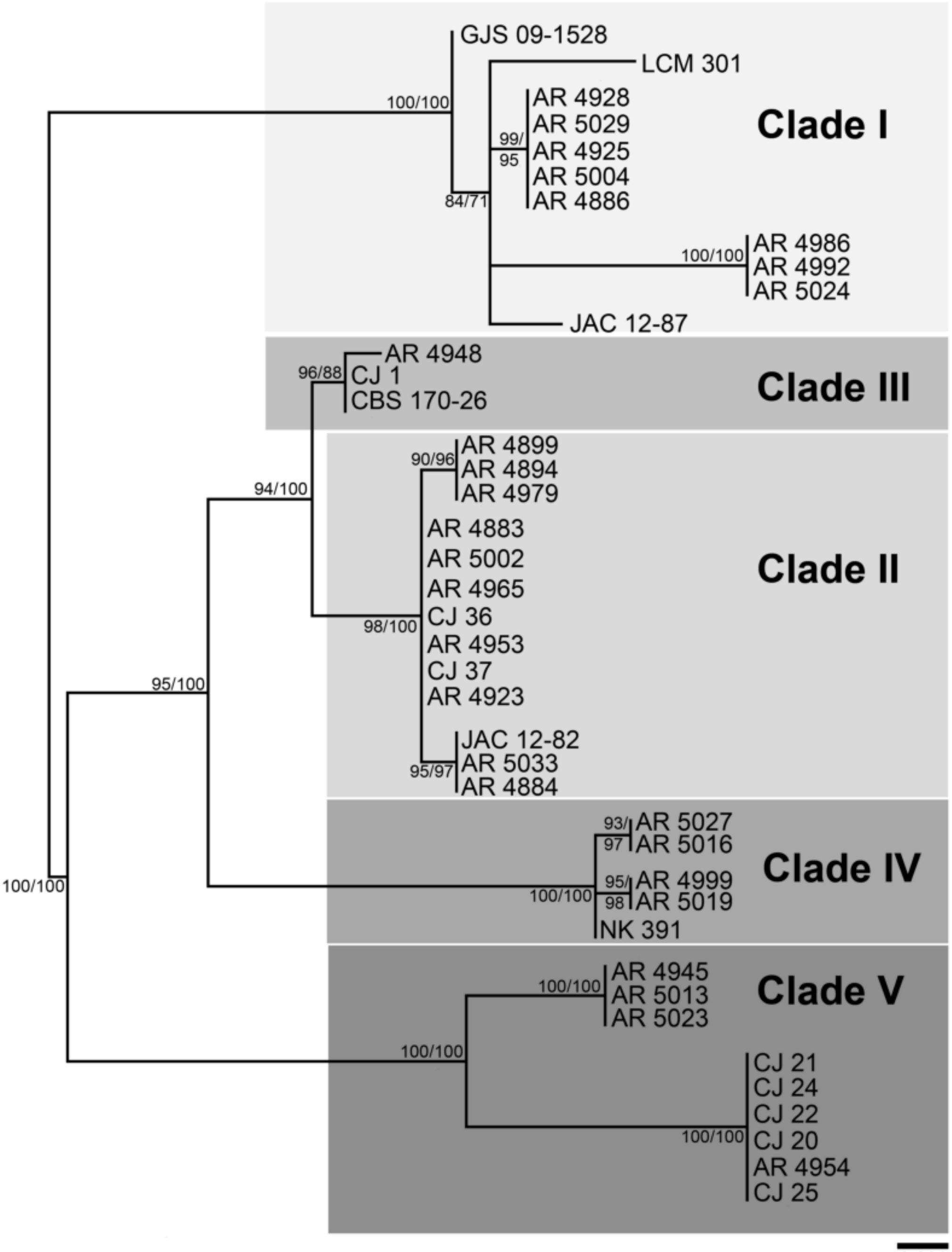


Figure 15: ML phylogenetic analysis of the *ß-tubulin* marker from 41 *Pestalotiopsis* isolates. Support values are displayed next to the corresponding node as bootstrap/posterior probability values. Only bootstrap values of ≥ 50 % and Bayesian PP of ≥ 70 % are displayed. The phylogeny is mid-point rooted. Major clades found in the multi-gene analysis are indicated with grey boxes. Scale bar refers to the number of substitutions per site.

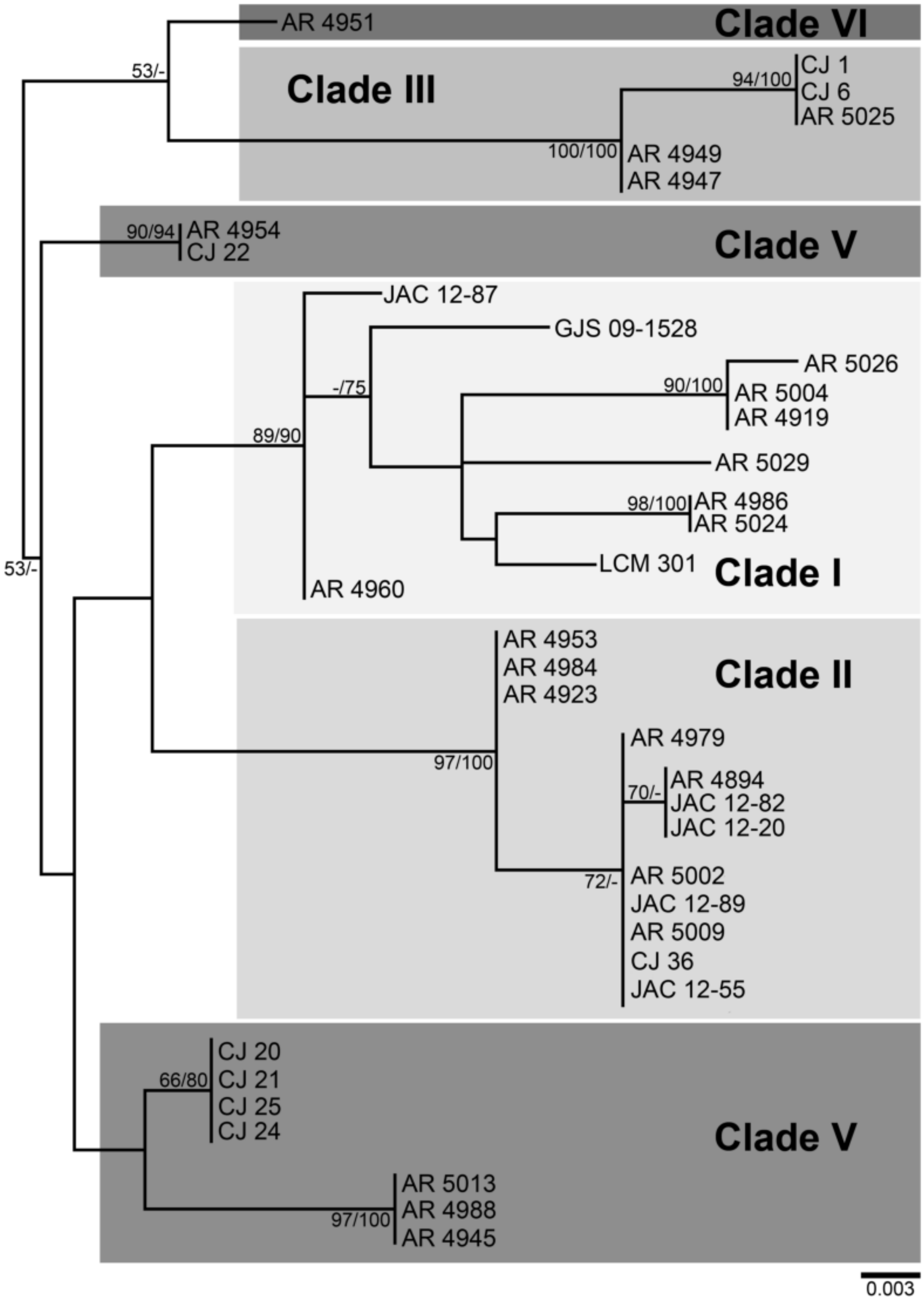


Figure 16: ML phylogenetic analysis of the *TSR1* marker from 37 *Pestalotiopsis* isolates. Support values are displayed next to the corresponding node as bootstrap/posterior probability values. Only bootstrap values of ≥ 50 % and Bayesian PP of ≥ 70 % are displayed. The phylogeny is mid-point rooted. Major clades found in the multi-gene analysis are indicated with grey boxes. Scale bar refers to the number of substitutions per site.

6.3.4 Species delimitation analysis of *Pestalotiopsis*

The BP&P analysis supported the presence of 10 species (A-J) with highest probability (PP = 0.66) out of the 19-species scenario (see chapter 5.6.4) that was incorporated in the analysis. In Figure 23 individual posterior probability values are given for each of the 10 species. Clade III, Clade IV, Clade V, and Clade VI are considered with maximum support (PP = 1.0) to form separated species (D, E, I, J) respectively. The specimen AR 4960 is also considered to represent a separate species (G), supported by a maximum posterior probability of 1.0. AR 4960 is assigned to Clade I in two of three single-gene phylogenies as well as in the concatenated tree. In the ITS single-gene phylogeny the final placement was not resolved. However, it always forms a separated sublineage within Clade I. Sequences clustering in Clade II are grouped into three species (A-C). Most Clade II specimens are combined within species A (PP = 0.94). Four specimens that form a separated subclade in the concatenated tree, as well as in the single-gene tree *MCM7*, are considered to represent an own species (B) (PP = 0.88). The single specimen AR 5034 that is nested in Clade II in all phylogenies, but usually offset of the rest of the Clade II members except in the ITS phylogeny is identified as another separated species (C) with posterior probability (PP = 0.88). The BP&P analysis separates Clade I into three species that are species G (see above), species F, and species H. Species F is supported by a posterior probability value of 0.94 and is represented by the sister clade of species G. The lowest posterior probability value of the BP&P analysis is received by species H (PP = 0.81) that is at the same time the only paraphyletic species resolved.

6.3.5 Clade naming

The single-locus trees combining own isolates with sequences downloaded from the NCBI GenBank platform are shown in Figure 17 – Figure 19.

The clade containing the isolates of Species A, B, and C is found in all three single-loci trees. In Species C, represented by the single own specimen AR 5034, sequencing of *ß-tubulin* failed. However, because species C is found to be nested within Species A and B in the remaining trees it is considered to belong to this relationship. The Species A, B, and C clade is monophyletic in the *TEF1* (BS = 92) and *ß-tubulin* (BS = not supported) trees, but paraphyletic in the ITS tree if Species D is excluded. Anyway, the ITS tree shows generally low statistical node support, for which reason it is discussed separately. Moreover, the terminal cluster in the ITS tree representing Species D receives moderate statistical support (BS = 84). Since the A, B, and C clade is assumed to represent three different species by BP&P, but these species cannot be clearly retrieved from the phylogenetic analyses, the whole monophyletic clade is considered as a species complex, named after the rule of priority. The clade contains the described species *Pestalotiopsis intermedia*, *P. linearis*, and *P. unicolor* that all have been described in the same publication (Maharachchikumbura et al. 2012) as well as *P. chamaeropis* and *P. scoparia* (Maharachchikumbura et al. 2014). Moreover, it contains two named isolates generated during this work, which are the proposed epitype of *P. maculans* and a representative specimen for *P. adusta*. Both names are by far the oldest in the clade with *P. maculans* being older than *P. adusta*. Since ITS and *TEF1* could not be sequenced for the *P. maculans* epitype it is refrained from naming the clade after this species at this point. Accordingly, the proposed monophyletic clade containing Species A, B, and C is a taxon without rank called the *P. adusta* species complex until further information becomes available.

As explained above, Species D is considered a separate species from the *Pestalotiopsis adusta* species complex, even though closely related to this complex. Two names for naming Species D are available, *Pestalotiopsis hollandica* and *P. monochaeta*, both recently published in the same article (Maharachchikumbura et al. 2014). Following the alphabetical order *P. hollandica* is chosen. Nomenclatural details are given in chapter 6.1.3.

Species E corresponds to a monophyletic clade found only in the *ß-tubulin* phylogeny, while ITS and *TEF1* yield ambiguous results. Therefore, clade naming is not possible in this case at this point.

Species F is found in monophyletic subclades together with Species G and H in all single loci trees, as well as in the concatenated tree. In the ITS tree Species E is also nested in this complex, although this receives no statistical support and is not supported by the other phylogenies. In the *TEF1* tree, Species F, G, and H build a moderately supported monophyletic clade (BS = 73). A highly supported monophyletic clade (BS = 96) consisting of Species F and H is found in the *ß-tubulin* tree. Sequence information for *ß-tubulin* of Species G could not be generated. In the concatenated tree, Species F, H, and G build a maximally supported (BS = 100, PP = 100) monophyletic clade (Clade I). Since the program BP&P identified three species that cannot be confirmed with the methods applied here, a conservative approach is chosen by naming the clade as a species complex with the meaning of a monophyletic taxonomic unit with no rank. The oldest name of 12 available names in this clade is *Pestalotiopsis uvicola*, accordingly Clade I is named the *P. uvicola* species complex.

Monophyletic clades in support of Species I are revealed in all three single loci trees. In the ITS tree this node receives moderate statistical support (BS = 72), whereas in the *TEF1* tree the Species I clade receives low statistical support (BS = 53). In the *ß-tubulin* tree, however, Species I is maximally supported (BS = 100), just like in the concatenated tree (BS = 100, PP = 100) where Species I corresponds to Clade V. Since there are no contradictory results between the trees and the BP&P analysis, Species I is considered a single well-supported species. Following the rule of priority *Pestalotiopsis adusta* would be the valid name for this species. However, the sequence data used in the analyses come from the epitype proposed by Maharachchikumbura et al. (2014) and a second specimen identified as *P. adusta* in the same work. For several reasons this epitype is rejected here as described in chapter 6.1.3. The next available name is *Pestalotiopsis shorea* that is chosen for naming Species I. Therefore, four species names falling into this clade in the analyses are synonymized here. For nomenclatural details see chapter 6.1.3.

Species J consists of a single own isolate (AR 4951). Sequence data for this isolate are not available for *TEF1* and *ß-tubulin*. In the ITS tree it fells together with *Pestalotiopsis portugalica* and *P. karstenii*. However, this cluster receives only low statistical support (BS = 53). Therefore, with the current data set clade naming is not possible.

6.3.6 *Pestalotiopsis* spp. host association

When comparing molecular phylogenetic results with host plant families, there is no general pattern observable (Figure 23). The species, as defined by the BP&P analysis, show no host specificity, but each species occurs on a variety of different plant families. The same is true for the clades I to VI. There are no data to support the idea of host specificity in *Pestalotiopsis* at the current state of research.

6.3.7 Morphological species discrimination

All ANOVAs were significant (Table 7), indicating that all the traits contribute to separating morphologically the species tested. However, no conidial morphological character alone has turned out to be practicable to distinguish between species, as conidia are similarly structured across species and clades and values are largely overlapping. The TukeyHSD pairwise comparison test of five morphological characters in eight species found by BP&P generated four to five morphologically distinctive groups (a–d) depending on the character used (Figure 22). Some species show similarity to two or three morphological groups. However, if different measurements are used together, clades show unique combinations of morphological characters. Figure 23 shows the different phylogenetic clades and the color-coded morphological groups (a–d) for each morphological character. It becomes clear that the color combination is unique for each species with the exception of the single isolate species G and C that are not distinguishable by morphological characters.

Table 7: Results of ANOVAs for five different conidial traits. Df = degrees of freedom, LA = length of apical appendages, LB = length of basal appendages, LM = length of the three conidial middle cells.

Trait	**Df**	**Sum of Squares**	**Mean Square**	**F-value**	**p-value**
Length	7	4.474	0.639	57.13	0.000
Width	7	4.740	0.677	46.80	0.000
LM	7	4.443	0.635	47.41	0.000
LA	7	5.594	0.799	13.96	0.000
LB	7	4.094	0.585	19.86	0.000

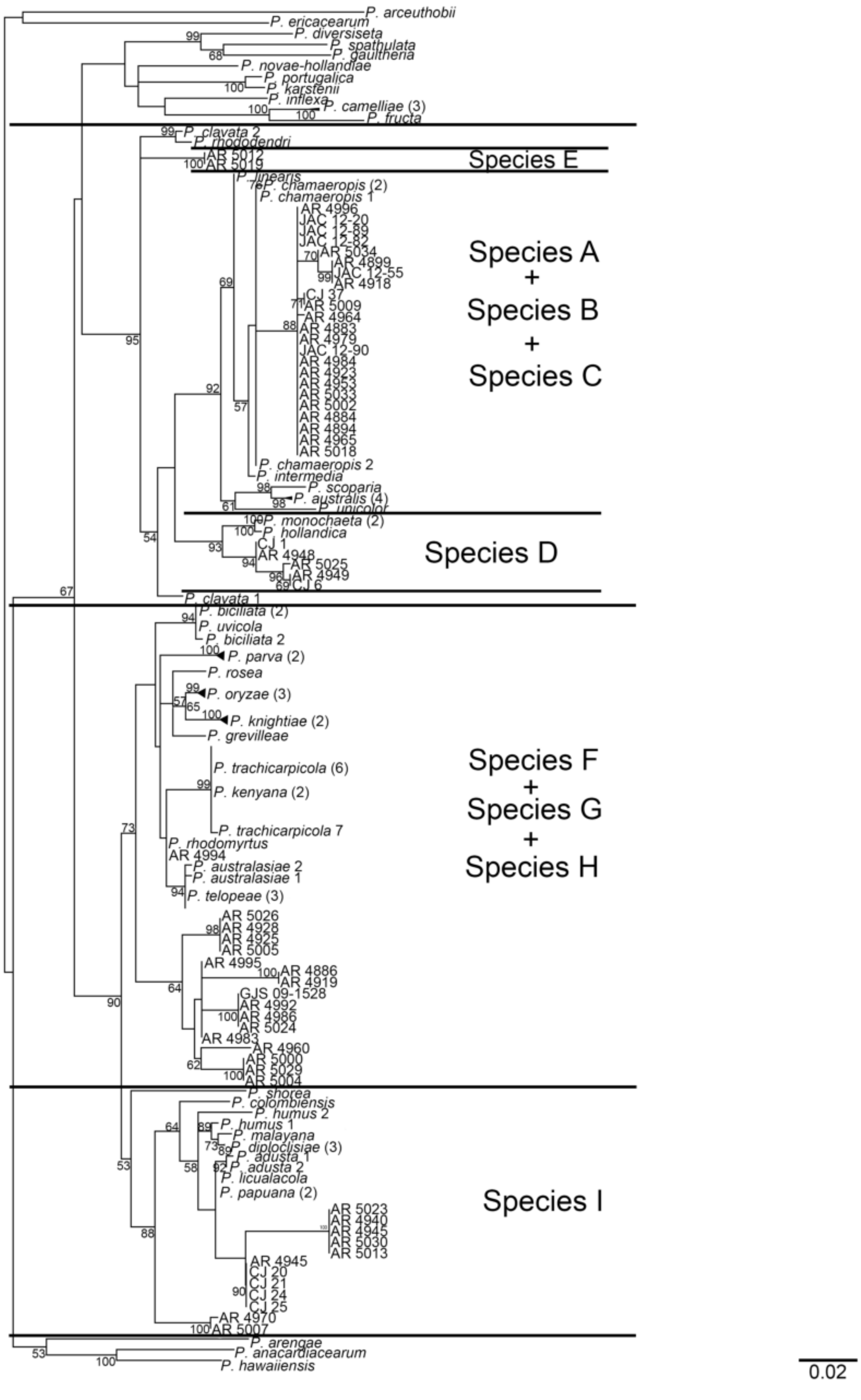


Figure 17: Mid-point rooted phylogeny resulting from the ML analysis of the *TEF1* marker from 135 *Pestalotiopsis* isolates. The analysis includes sequences generated during this study, as well as sequences downloaded from the GenBank NCBI platform. Bootstrap support values are displayed next to the corresponding node. Only bootstrap values of ≥ 50 % are shown. The respective placement in tree of the 10 species (A–J) found by the BP&P analysis emphasized. Numbers in parenthesizes refer to number of isolates included in the analysis. Scale bar refers to the number of substitutions per site.

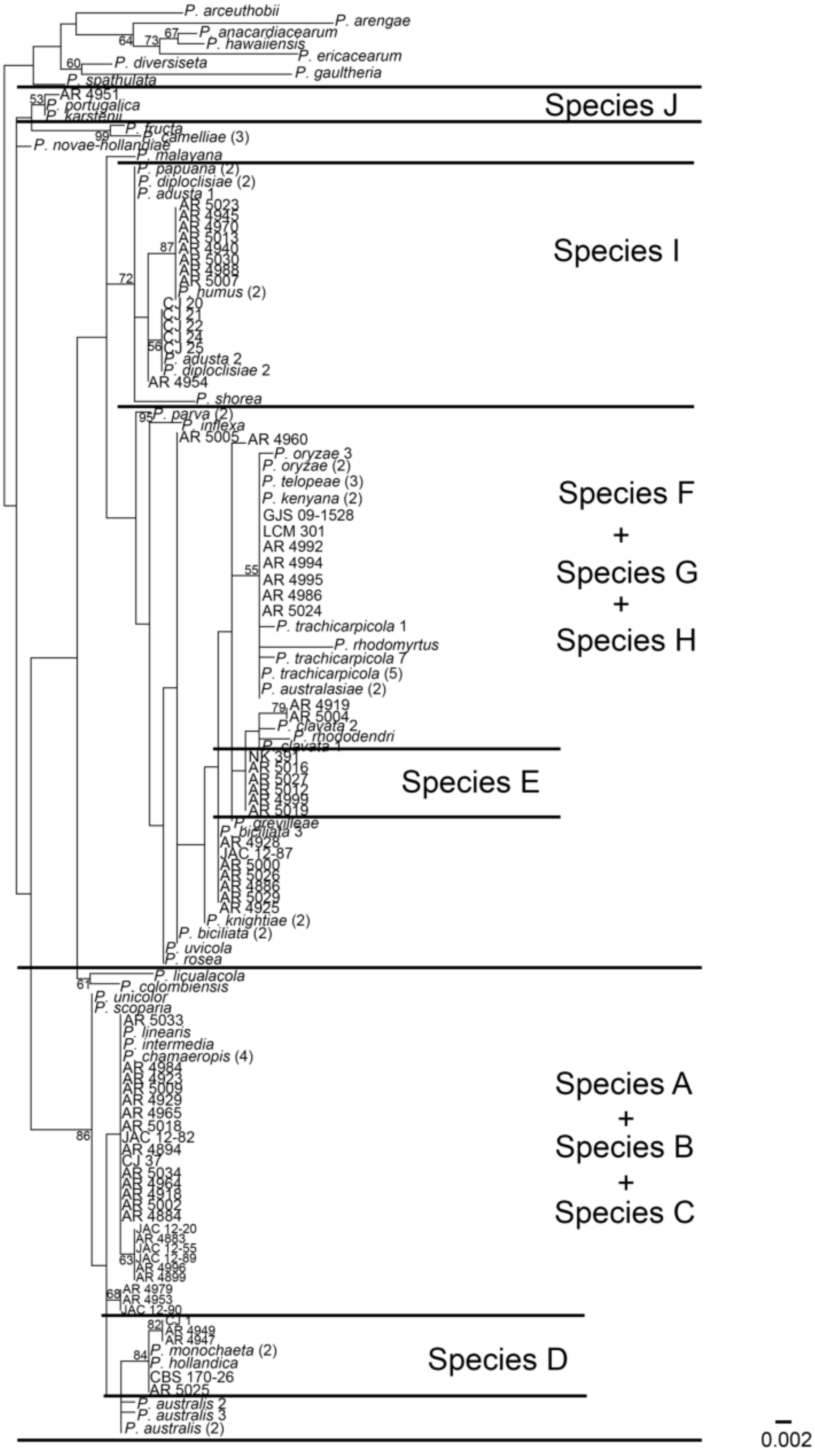


Figure 18: Mid-point rooted phylogeny resulting from the ML analysis of the ITS marker from 143 *Pestalotiopsis* isolates. The analysis includes sequences generated during this study complemented with sequences downloaded from the GenBank NCBI platform. Bootstrap support values are displayed next to the corresponding node. Only bootstrap values of ≥ 50 % are shown. The respective position in the tree of the 10 species (A–J) found by the BP&P analysis is emphasized. Numbers in parenthesizes refer to number of isolates included in the analysis. Scale bar refers to the number of substitutions per site.

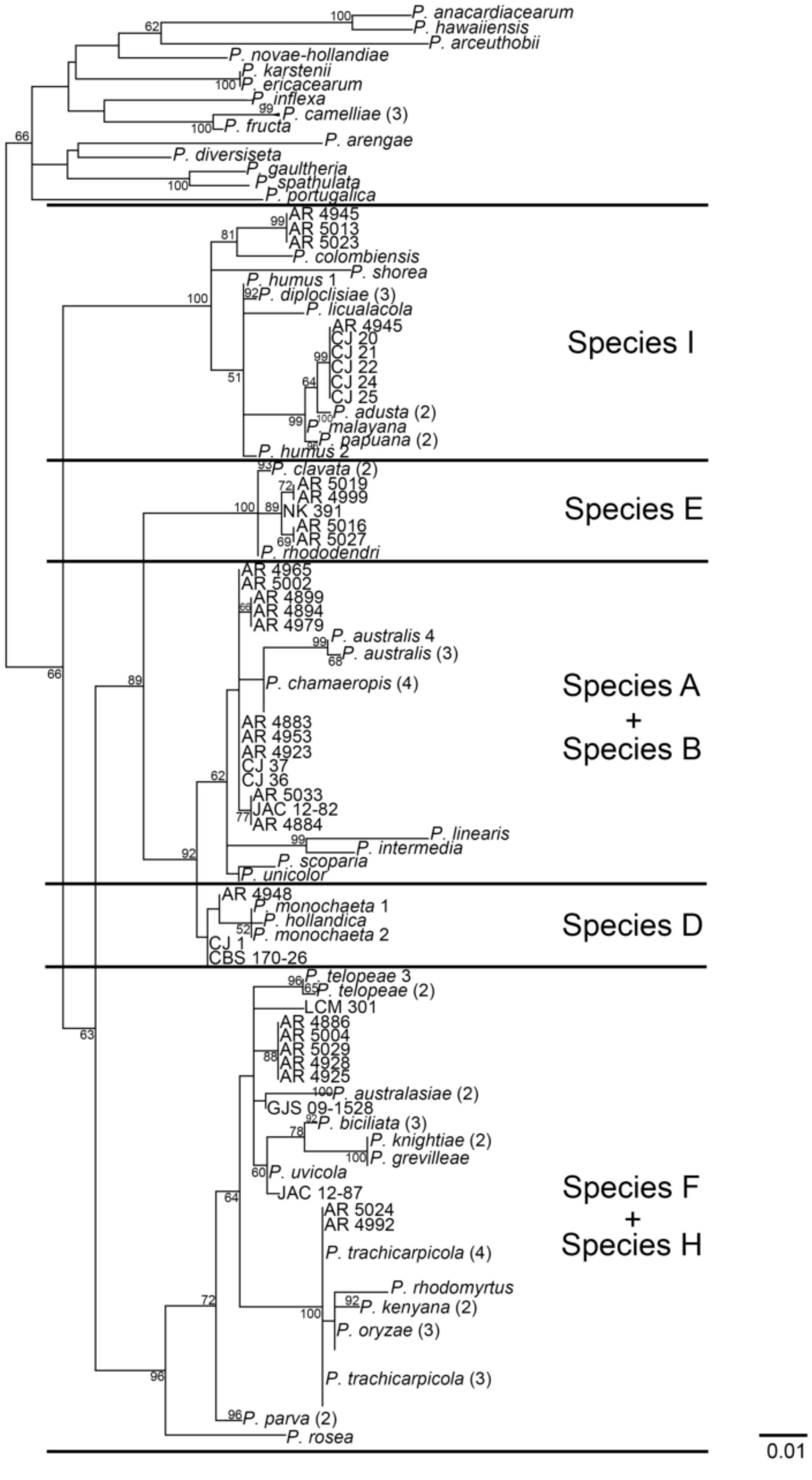


Figure 19: Mid-point rooted phylogeny resulting from the ML analysis of the *ß-tubulin* marker from 116 *Pestalotiopsis* isolates. The analysis includes sequences generated during this study complemented with sequences downloaded from the GenBank NCBI platform. Bootstrap support values are displayed next to the corresponding node. Only bootstrap values of ≥ 50 % are shown. The respective position in the tree of the 10 species (A–J) found by the BP&P analysis is emphasized. Numbers in parenthesizes refer to number of isolates included in the analysis. Scale bar refers to the number of substitutions per site.

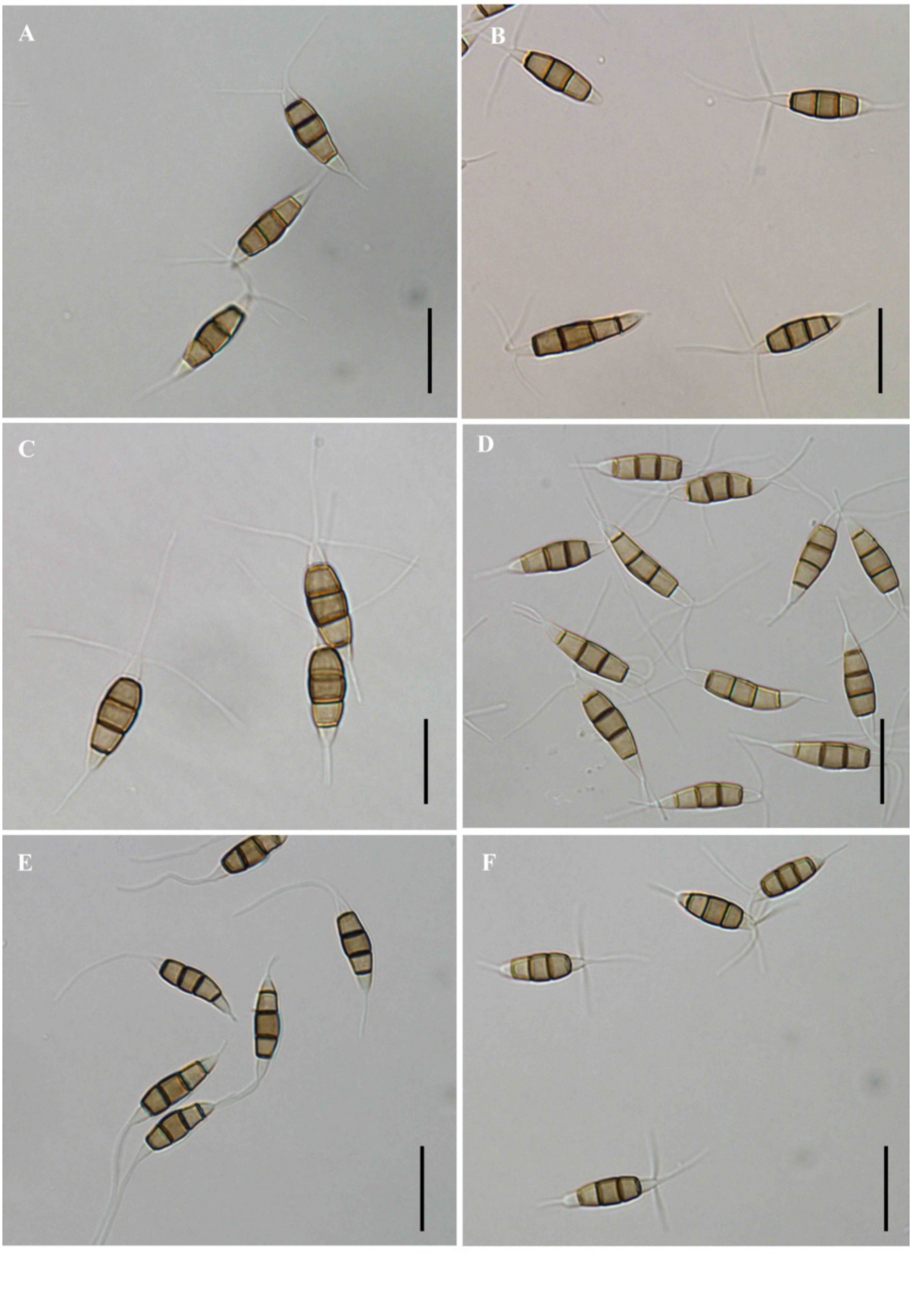


Figure 20: Microscopic photographs showing the morphology of mature conidia of *Pestalotiopsis* spp. on PDA at 26 °C, after 14d. **A** AR 4894 (species A). **B** AR 5034 (species C). **C** AR 5025 (species D). **D** AR 5012 (species E). **E** AR 5000 (compare Figure 21, species F). **F** AR 4992 (species H). Scale bars = 20 µm.

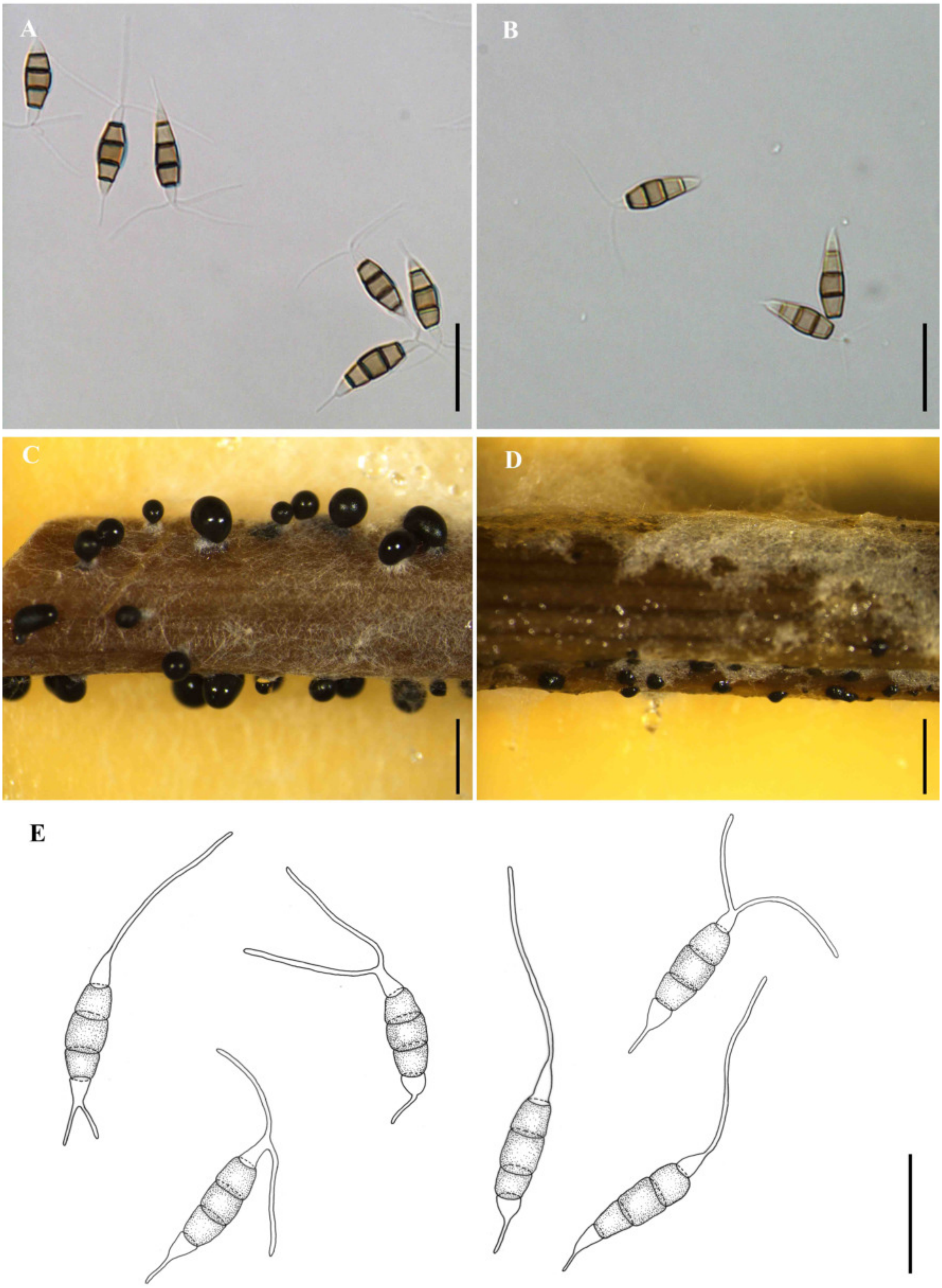


Figure 21: Morphology of mature conidia and fruiting bodies of *Pestalotiopsis* spp. on PDA at 26 °C, after 14d. Microscopic photographs: **A** AR 4945 (species J). **B** AR 5013 (species J). **C** Fruiting bodies, AR 4945 (species J). **D** Fruiting bodies, AR 5013 (species J). Drawing: **E** AR 5000 (compare Figure 20, species F). Scale bars A–B, E = 20 µm, C–D = 500 µm.

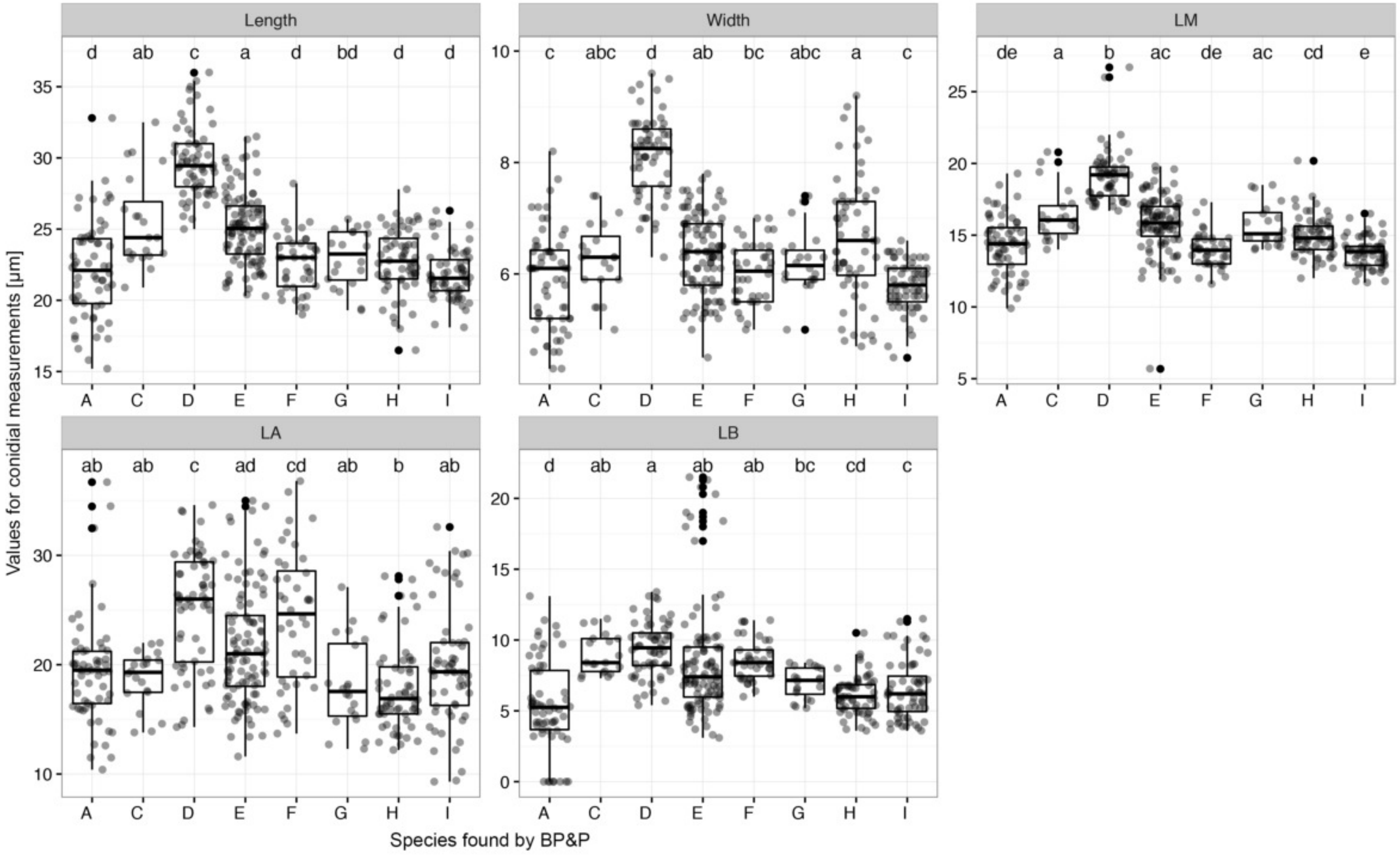


Figure 22: Box plot scatter plots of five conidial morphological traits (in µm) for the species defined by BP&P (A–J). Solid black horizontal lines inside the box show the mean of the values, the upper and lower limits of the boxes show the first and third quartiles. Black dots continuing the whiskers represent outliers. Dark grey dots refer to several measurements with the same value. The morphological groups (a-d) found by the TukeyHSD pairwise comparison test are shown above plots and represent groups of species, which means do not significantly differ.

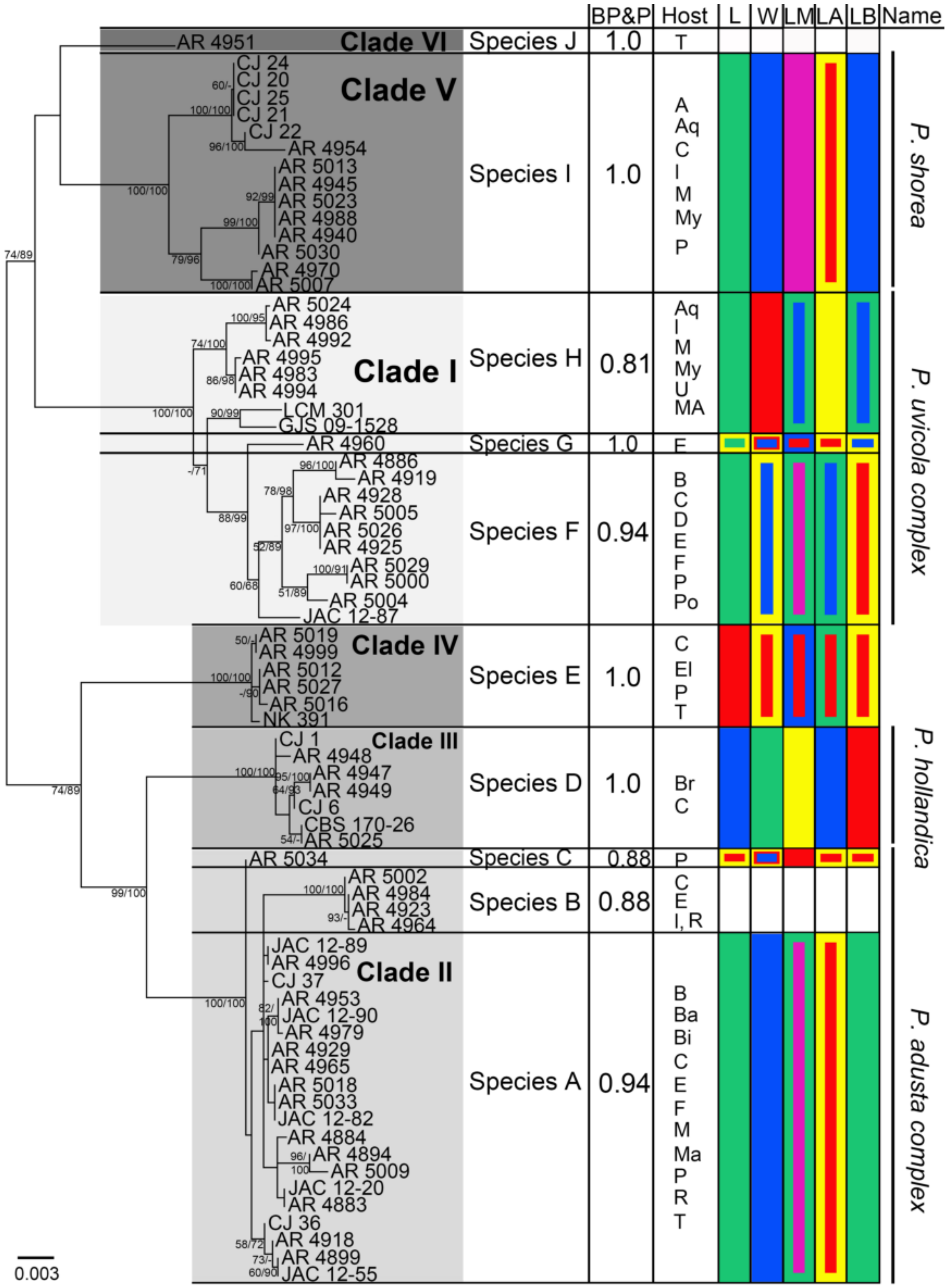


Figure 23: Combining different lines of evidence in *Pestalotiopsis* taxonomy. From left to right: ML phylogenetic tree of the concatenated alignment of five genetic loci in *Pestalotiopsis* spp. The phylogeny is mid-point rooted. Numbers at nodes refer to bootstrap value before and posterior probability after the slash. Only bootstrap values of ≥ 50 % and Bayesian PP of ≥ 70 % are displayed. Scale bar refers to the number of substitutions per site. The different major clades found in all single loci trees are highlighted and combined with the species A-J found by the BP&P analysis followed by the respective posterior probability value. Possible hosts for these species are abbreviated as follows: Arecaceae = A, Aquifoliaceae = Aq,

Bankeraceae = Ba, Bignoniaceae = Bi, Brassicaceae = Br, Buxaceae = B, Cupressaceae = C, Dacrymycetaceae = D, Elaeagnaceae = El, Ericaceae = E, Fagaceae = F, lichen = l, Magnoliaceae = M, Malvaceae = Ma, Myricaceae = My, Pinaceae = P, Poaceae = Po, Theaceae = T, Ulmaceae = U. The color-coded groups from the Tukey test for five different morphological characters are shown for each species: a = red, b = yellow, c = blue, d = green, e = pink (and combinations). The column at the right end shows the names as applicable after integrating the different lines of evidence.

6.3.8 Phylogenetic analyses of *Neopestalotiopsis*

The ML phylogenetic trees of five different single markers of the genus *Neopestalotiopsis* are largely incongruent Appendix 3 – Appendix 7. This is reflected by low bootstrap support for most nodes and that different isolates were randomly lumped together. The only exception is a cluster of *Neopestalotiopsis* cf. *sydowiana* isolates collected in Germany from hosts on the Ericaceae that are resolved in three (*TEF1*, *TSR1*, and *ß-tubulin*) of the five single markers analyzed. However, because of the many topographic inconsistencies across the single trees, the actual single datasets could not be concatenated, thus no species delimitation approach could be performed for the genus *Neopestalotiopsis*. It is further noticeable that distances between clades are extremely short, especially in the ITS tree, what might refer to very low species diversity. Future molecular approaches could explore polymorphic microsatellite loci what might yield new insights into the population structure of *Neopestalotiopsis* spp. Conidial morphology of four different isolates of *Neopestalotiopsis* spp. are exemplarily displayed in Figure 24 and Figure 25.

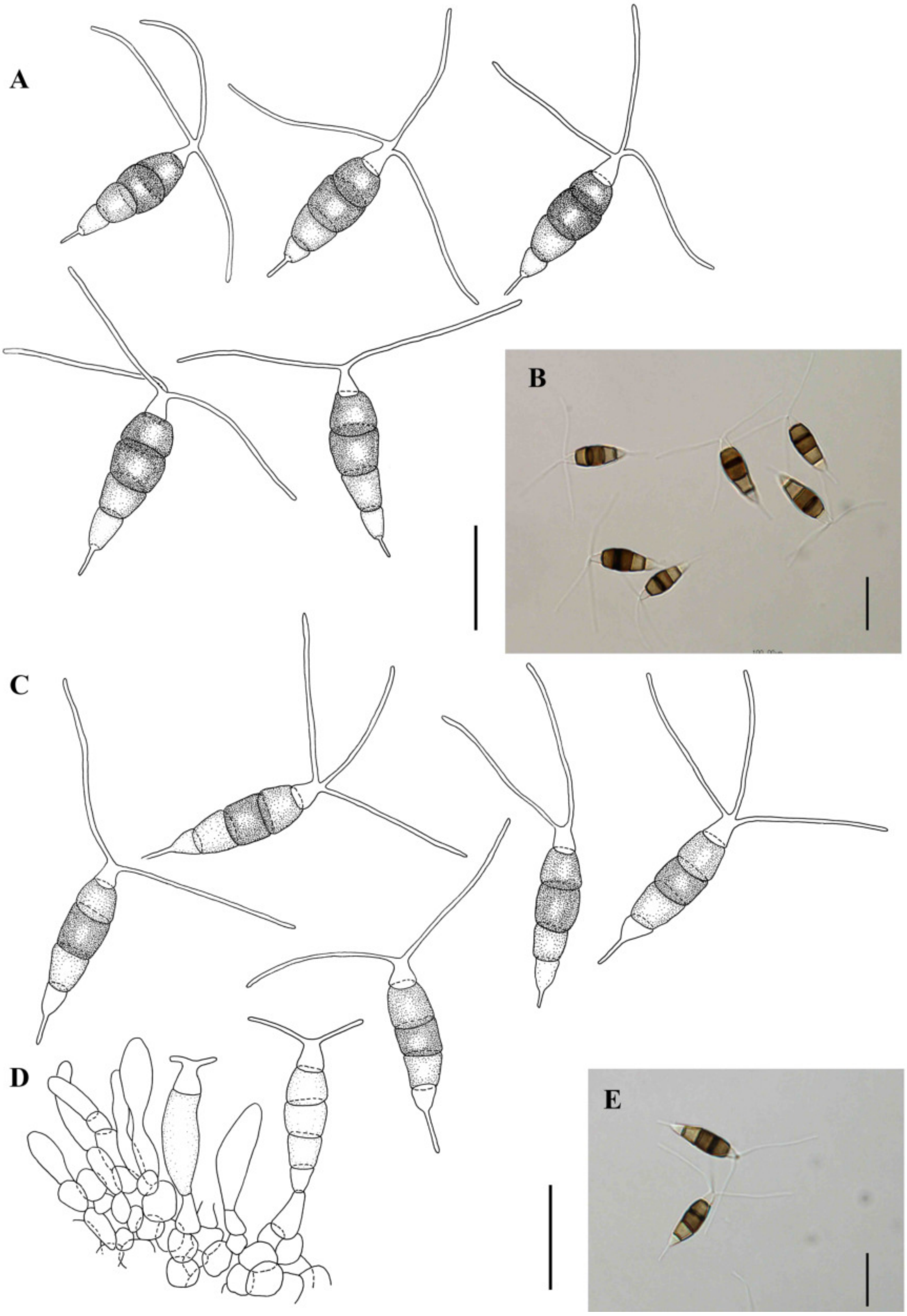


Figure 24: Drawings and photographs showing the morphology of *Neopestalotiopsis* spp. on PDA at 26 °C, after 14d. **A+B** Mature conidia of the specimen AR 4916. **C+E** Mature conidia of the specimen AR 4917. **E** Conidiophores, conidiogenous cells, and developing conidia of the specimen AR 4917. Scale bars = 20 µm.

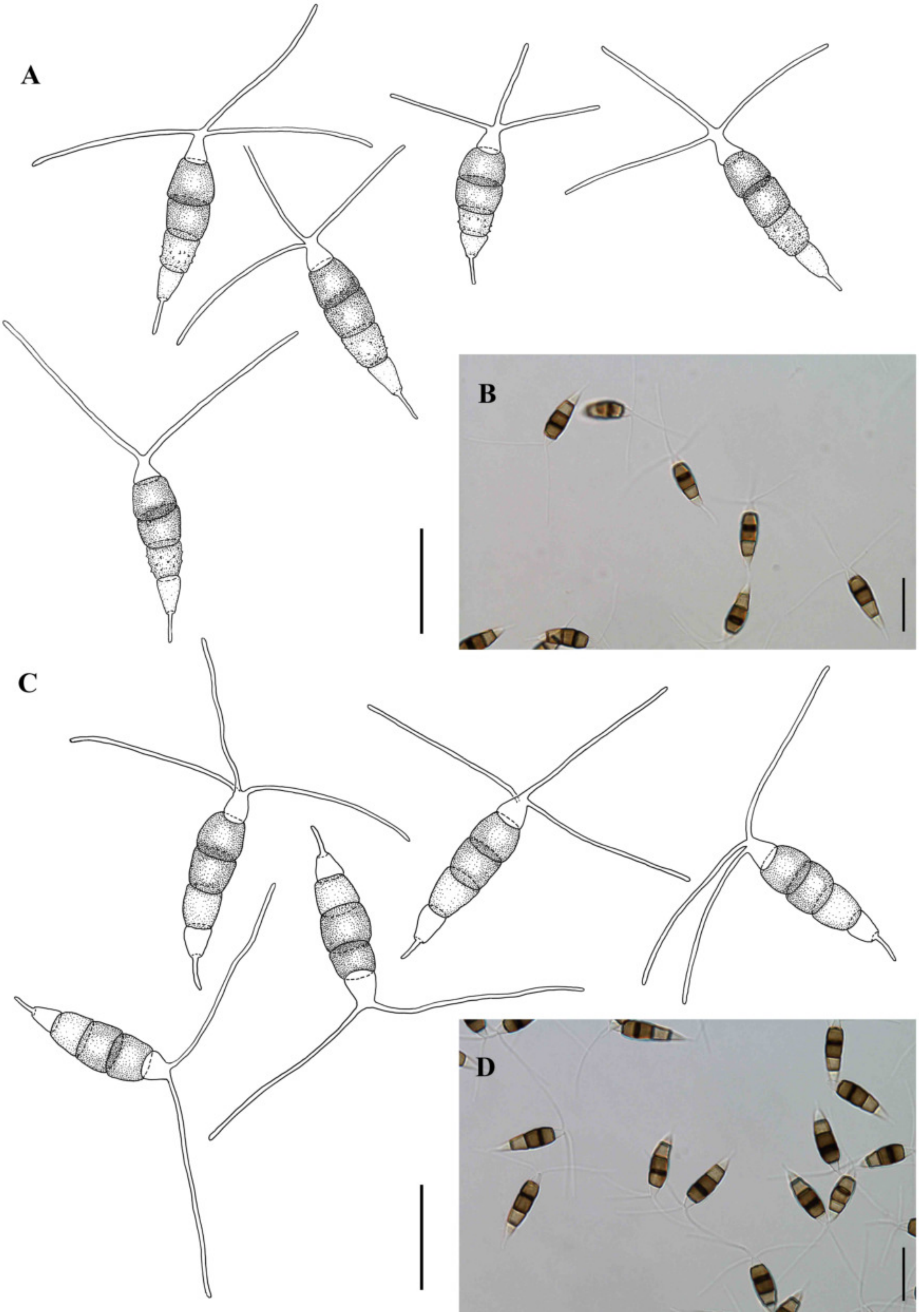


Figure 25: Drawings and photographs showing the morphology of *Neopestalotiopsis* spp. on PDA at 26 °C, after 14d. **A+B** Mature conidia of the specimen AR 4981. **C+D** Mature conidia of the specimen AR 4991. Scale bars = 20 µm.

7 Discussion

7.1 The importance of systematics

Systematics is justly termed the foundation for all research in organismal biology. Moreover, correct species identification and naming provide crucial information for efficient biosecurity and trade policies, disease control, conservation biology as well as sustainable use of natural products. In order to ensure that an organism is accurately identified, described, classified, and named, well-trained taxonomists are needed. Only individuals who have been working on a complicated group for quite a while are capable of producing the framework for those people who apply systematics as part of legislation and disease and pest control. However, the field of systematics remains chronically underfunded compared to other research areas and taxonomists are often seen as second-class scientists who are much less hired to permanent positions (Drew 2011; Ebach and Holdrege 2005).

Identification methods have changed over time and, in particular, molecular phylogenetic methods are frequently used, in fact required, for identifying and describing species in recent years. With the use of molecular methods it is not only possible to develop precise taxonomic knowledge, but can also provide knowledge of the phylogenetic relationships of an organism. However, nucleotide examination alone, especially DNA barcoding, can only be seen as a tool for the identification of described species but cannot replace in depth taxonomic research in order to discover unknown species (Chapple and Ritchie 2013; De Salle 2005, 2006). On the contrary, new species descriptions should definitely include nucleotide sequences of the described organism's type material, in particular in the case of fungi (Seifert and Rossman 2010). For potential plant pathogenic fungi this information is of particular interest as it can help to predict host relations and pathogenicity. This in turn helps to choose a proper approach to disease control (Rossman and Palm-Hernández 2008).

Caution is required if the identification of a species is based only on DNA sequence similarity comparison with sequences, which have been downloaded from public online databases, because many sequences turn out to be based on misidentified specimens or, even worse, lack a physical specimen or culture in a public herbarium or repository. In that case it is difficult, if not impossible, to correct mistakes that have been made previously and that lead to errors with the identification of subsequently collected samples. In GenBank, as the most commonly used database for this purpose, it became evident that in some fungal species approximately 85 % of the available sequences are based on misidentified specimens (Cai et al. 2009; Crouch et al. 2009). Therefore, it is still important to validate the identity of specimens that have been deposited in public herbarium collections whenever possible, but also to collect fresh material from the field. Any taxonomic study becomes more accurate the greater the diversity of samples is that are considered in it.

Microfungi such as *Pestalotiopsis* s.l. are often difficult to distinguish morphologically due to the lack of macro- and microscopic features that allow for species discrimination. In some cases, a species description is mainly based on molecular data, in particular in endophytes. Thereby, the monophyly of the branch or lineage building the taxon is fundamental (De Queiroz 2007; Seifert and Rossman 2010).

7.2 Species concepts and delimitation in fungi

The choice of an appropriate species concept is the theoretical framework for any taxonomic study and varies depending on the group of organism e.g. birds versus microfungi. However, there is a general agreement about the Evolutionary Species Concept (ESC) (Simpson 1951, 1961; Wiley 1978) regarding a species as a separately evolving metapopulation lineage (De Queiroz 2007). First of all, one has to realize that the evolutionary species concept is a theoretical species concept, which lacks species recognition criteria what, in turn, makes it impossible to directly apply in taxonomy. In order to identify species, secondary species concepts, like the Morphological Species Concept (MSC), the Biological Species Concept (BSC), and the Phylogenetic Species Concept (PSC) are used as operational concepts because these concepts apply specified criteria to define species (Taylor et al. 2000). The MSC has been used for most eucaryotic taxa over centuries (Burnett 2003; Lacap et al. 2003). Therefore, its great advantage is the large amount of data for comparison of existing taxa. However, the weak point is the relatively low resolution for species detection in many organisms, for example in fungi that lack distinctive morphology. A group of morphologically similar species may be mistaken for one single species with no possibility to reveal so called cryptic species. On the other hand, populations of a single species might be split into separate species on the basis of morphological polymorphisms. In *Pestalotiopsis* s.l. and also in other microfungi the MSC is difficult to apply, because the simple morphological features that characterize these groups of fungi do not often allow for differentiation at the species level. Furthermore, they often do not produce taxonomically informative vegetative, sexual or asexual reproductive structures under laboratory conditions (Reynolds 1993; Taylor et al. 1999; Wang and Guo 2007). Moreover, species descriptions that are based on the MSC are often quite generally formulated and may apply to several closely related species. Thus, such descriptions are insignificant for species recognition, e.g., the case of *Fusarium oxysporum* f. sp. *cubense* (Bentley et al. 1998; Koenig et al. 1997; O`Donnell et al. 1998). However, the description of morphological characters is still an indispensable part of taxonomical work. The morphological appearance of an organism remains the first point of recognition for many people who have no access to molecular methods, for example, in developing countries. Thus, the more accurate a morphological description of an organism is, the more likely it is to provide the means to identify a given sample specimen correctly. In this sense, morphology has the same restrictions and opportunities as DNA barcoding; it can serve as a powerful tool for specimen identification, but its capabilities to discover species that are new to science are limited, especially in the case of morphologically cryptic species.

The BSC is a commonly used species concept that defines a species as “groups of actually or potentially interbreeding natural populations which are reproductively isolated from other such groups” (Mayr 1940). This concept is widely applied, especially among zoologists, but also in mycology. In the last century, for example, mating tests were used to unmask cryptic fungal species within morphological species (e.g. Brasier 1987; Pore et al. 1965; Shear and Dodge 1927). However, the biological species concept has several deficiencies in fungal species. Mating tests can only be applied to fungi that produce meiospores and about 20 % of fungi reproduce only asexually (Reynolds 1993). Homothallic fungi that produce meiospores by self-fertilization are problematic. A significant number of heterothallic fungi cannot be persuaded to develop a sexual stage in cultivation or to mate under laboratory conditions. In most species of *Pestalotiopsis* s.l., for example, a sexual stage has not been described. Other problems occur when it is possible to apply mating tests on fungi. For example in some organisms, the ability to mate is lost in allopatric, genetically isolated sibling species, if there is no selection against it (Natvig and May 1996).

For the study of fungal species, the PSC is the most appropriate concept, because changes in gene sequences can be recognized before changes in morphology or mating behavior occur during the process of divergence (Taylor et al. 1999, 2000; De Queiroz

2007). Originally the PSC was described by Cracraft (1983), who defined species as "… the smallest diagnosable cluster of individual organisms within which there is a pattern of ancestry descent". This, however, is only feasible in organisms for which genetic information is available. In this context, more sequence data of type or at least topotypic material will be necessary. Another issue is that even though it is certainly possible to group individuals with the PSC, it still remains subjective to determine when a group of individuals should be regarded as a species. This drawback of the PSC can be avoided by considering more than one congruent gene genealogy. By comparing tree topologies that result from different genetic markers, it is possible to distinguish between polymorphic and fixed loci (Taylor et al. 1999). This type of PSC is named the Genealogical Concordance Species Concept (GCSC) (Avise and Ball 1990; Baum and Shaw 1995; Mayden 1997) and is often applied for delimiting species of asexual fungi or fungal species with little morphological differences (Gazis et al. 2011; Nguyen et al. 2015; Udayanga et al. 2014). Currently, for the delimitation of fungal species multigene phylogenies consist mostly of three to six genes (e.g. Gazis et al. 2011; Judith et al. 2015; Manamgoda et al. 2014; Schoch et al. 2006; Udayanga et al. 2014). In the taxonomic study of *Pestalotiopsis* s.l. the GCSC is not applied as a standard yet. However, some studies use different markers to show species boundaries, but usually are not sufficient to apply genealogical concordance, e.g. Maharachchikumbura et al. (2012, 2014). For this reason, it is possible that a clade appears non-monophyletic in the analysis of one locus, but is well-supported and monophyletic in the analysis of another locus. Future studies should compare and discuss such conflicting results.

7.3 Species delimitation in *Pestalotiopsis* s.l.

Species diversity in fungi is subject to ongoing discussion and estimation (e.g. Rossman 1994; Fröhlich and Hyde 1999; Hawksworth 2001; Mueller and Schmit 2007). Most of these estimations find evidence to propose a clear upward adjustment of the proposed number of 1.5 million fungal species on earth (Hawksworth 2001).

Certainly, the differentiation of morphospecies usually leads to an underestimation of species diversity since the resolution of morphology to discover new species is relatively low, but the employment of molecular methods may or may not uncover large numbers of cryptic species. Many studies using multigene phylogenies in combination with statistical tools have uncovered cryptic lineages within previously described fungal species and species complexes (Carter 2012; Divakar et al. 2010; Gamble et al. 2012;

Giarla et al. 2014; Lücking et al. 2014; Satler et al. 2013; Singh et al. 2015). Also in other groups of organisms, cryptic lineages could be identified using multigene phylogenies e.g. Jörger et al. (2012).

However, one has to be cautious with the presumption that this always applies no matter the organismal group being investigated. This becomes evident when looking at the results for *Pestalotiopsis* generated in this work. The BP&P analysis resulted in recognition of only 10 species out of a 19-species scenario in the *Pestalotiopsis* dataset that originally comprised 72 strains. This is partly due to species recognition criteria used in some species descriptions that delimit species on the basis of host and minor genetic differences combined with the use morphological characteristics that are not phylogenetically significant. The commonly used genetic markers for species delimitation, specifically ITS, *ß-tubulin*, and *TEF1,* show the weak points, which were discussed in chapter 7.4 in this work, that make it difficult to distinguish species using genetic distance in the form of base-pair substitutions only. Another problem is the morphological similarity of conidia of different species of *Pestalotiopsis* that result in scientific uncertainty when using these characters.

Furthermore, a fundamental issue of any phylogenetic species concept is that a species must form a monophyletic clade (De Queiroz 2007; Seifert and Rossman 2010). This is not always the case in *Pestalotiopsis*. One example is the recently described species *P. linearis*. The two specimens of the original description appear paraphyletic in the phylogenetic analysis with respect to *P. intermedia* (Maharachikumbura et al. 2012, Fig. 3 + 4). These two names should be considered one species in order to restore monophyly and thus taxonomic stability.

A critical point is the application of methods that are independent of subjective assumptions and therefore reproducible in subsequent studies. BP&P uses a conservative approach to delimit species on the basis of multi locus alignments and has been considered the best method for this type of data (Camargo et al. 2012; Carstens et al. 2013; Leavitt et al. 2015). A weak point of this method is the phylogenetic presumption in the form of a user-generated guide tree that has much influence on the resulting topology of the species tree, with additional false posterior probabilities and overestimation of species diversity (Fujita et al. 2012; Olave et al. 2014). Yang and Rannala (2014) supposedly fixed this issue by introducing a Nearest Neighbor Interchange algorithm that allows for more flexibility in the guide tree to avoid incongruence with the resulting species tree. As an additional conservative concession in this study, a priority was given to monophyletic species even though this stands in contrast to the BP&P result. This was always the case for the BP&P proposed species that are paraphyletic with respect to their closest relatives on the same branch. Such clades consist of more than one species as proposed by BP&P but build a monophyletic group in itself and thus are defined as a species complex. These species complexes will need additional approaches beyond the scope of this dissertation to be taxonomically resolved.

In general, application of molecular methods revealing species overestimation remains the exception. However, a comparable case of species diversity overestimation in fungi has been found in the genus *Diaporthe* (Ascomycota) by the work of Udayanga et al. (2014). Members of the genus *Diaporthe* are plant pathogens that are capable of causing melanose and stem end rot diseases of *Citrus* spp. They have been revised based on molecular and morphological data. The multigene phylogenetic analysis of Udayanga et al. (2014) indicates that the recently described species *D. neotheicola* is conspecific with *D. foeniculina*. Consequently, Udayanga et al. (2014) listed *D. neotheicola* as a synonym of *D. foeniculina.* Not only in fungal related studies the incorporation of molecular data into taxonomic studies reduced the number of described species, e.g. in *Carychium* spp., Microgastropods (Weigand et al. 2012) and *Bolitoglosa nigrescens* complex salamanders (Hertz 2015).

There is no doubt about the advantage of combining morphological and molecular data to describe new species. Like in most Coelomycetes, in former times species of *Pestalotiopsis* s.l. have been described and classified based on morphology alone (Jeewon 2002). Since the genus was established many taxonomic studies have been conducted with the objective to develop an appropriate classification scheme that uses reliable morphological characters (compare chapter 4.2). Traditionally, taxonomists placed special emphasis on the following conidial characters: number of septae, length and width of conidia, pigmentation of the three middle cells, number and length of apical appendages. The present study shows that in theory it should be possible to distinguish species using morphological data alone, but the herein presented analysis shows that morphological features of different species and species complexes are mostly overlapping. In the past, when molecular data was not available the length and width of conidia were among the most important characters to introduce new species (Mordue 1985, 1986; Nag Raj 1986). The results obtained in this study show that in particular conidial length and width has no significance to distinguish between *Pestalotiopsis* species. Five of the ten identified potential species fit in the same group for conidial length and width (Figure 23). This result is in agreement with the conclusions made by Jeewon et al. (2003b), as well as by Dube and Bilgrami (1965). In both studies the authors stated that conidial length is not a suitable feature to delineate species of *Pestalotiopsis*. Despite of that, even today, marginal differences with overlapping values of the length and width of conidia are used to justify the description of new species (e.g., Maharachchikumbura 2014). Even when using a unique combination of morphological characters, morphological species recognition remains challenging and requires considerable experience as well as a large dataset. Therefore, it is rather impractical in every day operation of disease control and mitigation. Furthermore, plant pathogens and endophytes are often isolated for identification purposes, but fungal morphology is strongly influenced by the chemical and physical environment under which the fungus is grown (e.g., Gibbs et al. 2010; Papagianni 2004). This may lead to wrong results when morphology alone is considered to determine species. However, number of conidial cell septation seems to be phylogenetically highly informative on genus level within Pestalotiopsaceae. However, it was not possible to distinguish the closely related genera *Neopestalotiopsis*, *Pestalotiopsis*, and *Pseudopestalotiopsis* using this character alone. It can be questioned if *Neopestalotiopsis* and *Pseudopestalotiopsis* should be treated as valid genera. The closest relatives of *Pestalotiopsis* s.l. are the two genera *Seiridium* and *Monochaetia* that are characterized by conidia with six cells whereas *Pestalotiopsis* s.l. species have five celled conidia (Senanyake et al. 2015). In this context it cannot be excluded that *Monochaetia* and *Seiridium* are congeneric what is supported by the six celled conidia. However, a molecular evidence for this assumption is still missing.

Historically, *Pestalotiopsis* s.l. species have been named after the host species on which the respective species has been found, assuming that species are host specific. This was common practice, even when species found on different hosts were morphologically identical (Guba 1961, Venkatasubbaiah 1991). Nonetheless, host specificity in this group is increasingly questioned between scientists (Jeewon et al. 2004).

Jeewon et al. (2004) found several *Pestalotiopsis* species on the same host that are not closely related and concluded that there is no host specificity. However, one could counter that a plant might act as a host for several *Pestalotiopsis* species, which in turn are host specific. However, the results presented in this study support the fact that there is no host specificity. It was verified whether the herein identified potential species are exclusively found on a single host plant species. This was not the case, so it was checked if single *Pestalotiopsis* species are found in certain plant families only. It turned out that even specificity on the family level of the host plant is not observable as soon as more than one isolate is available (Figure 23). It appears that *Pestalotiopsis* species are very flexible with regard to the choice of the host and have a wide host spectrum. However, other factors that limit the infection potential in *Pestalotiopsis* species are conceivable and may include climatic factors and the health condition of the plant to be infected. In this context, there is a large research potential for future studies to investigate the pathogen ecology of *Pestalotiopsis* species.

7.4 Phylogenetic marker performance

In phylogenetic studies of the genus *Pestalotiopsis* s.l. the three markers ITS, *TEF1*, and *ß-tubulin* are most commonly used for species delimitation. In the present study, those markers were complimented by sequences of the recently recognized protein-coding genes *TSR1* and *MCM7* (Schmitt et al. 2009). The resolution in trees from single-gene analyses varied between markers. However, a great advantage of single markers is the more rapid analysis if one keeps the limits of such analysis in mind.

The widely accepted universal barcoding marker ITS has a variety of advantages. It is easy to amplify across distant fungal taxa (Nilsson et al. 2008) and numerous ITS sequences for comparison are available in public databases. However, a drawback in the use of ITS is the relatively low resolution in closely related taxa in some groups of Ascomycota. This is related to the fact that in some groups of fungi the ITS region is insufficiently variable to resolve clades to species level (Lieckfeldt and Seifert 2000; Maharachchikumbura et al. 2012; Nilsson et al. 2008; Schoch et al. 2012; Weir et al. 2012). In this study, for example, this resulted in the lumping of many *Pestalotiopsis* isolates into single clades that turned out to be more differentiated in other single-locus trees. Moreover, about half of the nodes in the ITS tree received no statistical support (Figure 13). Furthermore, the hypothetical species found by the BP&P analyses could not be reconfirmed as supported monophyletic clades in the phylogeny based on ITS sequences. Consequently, the examined specimens could not be identified using the ITS barcoding approach alone. Thus, the ITS region as an universal barcode marker in *Pestalotiopsis* to identify specimens to species level cannot be recommended here. This result is in concordance with the findings made by Maharachchikumbura et al. (2012), who recommended the use of additional markers. Another issue of the ITS region is that fungi often carry multi copies of the ITS region in tandems or located on different chromosomes (Maleszka and Clark-Walker 1993). These multi copy genes may evolve independently at different rates, because they are not translated, what might result in high intragenomic variation among copies and this, in turn, can lead to species misinterpretation due to overestimation of diversity (Ganley and Kobayashi 2007; Lindner and Banik 2011; Simon and Weiss 2008).

The protein coding markers used in this study have a high information value to resolve species and species complexes in *Pestalotiopsis*. The topologies of trees based on single, protein coding gene sequences were similar to the topology of the concatenated data set tree. Additionally, the nodes found in these phylogenetic analyses received generally higher statistical support than nodes in trees based on ITS. This is in concordance with other recent studies that deal with the subject of evaluating and developing fungal phylogenetic markers (e.g. Schoch et al. 2012; Stielow et al. 2015; Tretter et al. 2013).

The *TEF1* marker is a gene fragment commonly used in fungal taxonomic studies (e.g., Castlebury et al. 2004; Gazis et al. 2011; Ge et al 2014, Udayanga et al. 2014) and was recently suggested to be used as a secondary universal DNA barcode marker for the fungal kingdom in addition to the ITS primary barcode (Stielow et al. 2015). Recently, Maharachchikumbura et al. (2012) analyzed the three loci ITS, *TEF1*, and *ß-tubulin* and concluded that the ITS locus can only be used as a rough identifier for some species of *Pestalotiopsis* and they propose *TEF1* as supplementary barcode marker for this taxon. This demonstrates the limits of DNA barcoding using a single, universal barcoding marker to delimit species of fungi.

The phylogenetic tree based on the *ß-tubulin* marker yielded a well-resolved topology with well-supported nodes. However, the presence of paralogous sequences is commonly known for *ß-tubulin* and thus, this marker does not seem suitable for this kind of studies (Landvik et al. 2001; Zhao et al. 2014). Additionally, in this study another problem occurred exclusively with the *ß-tubulin* marker. When comparing the single-tree phylogenies it turned out that many sequences generated with the *ß-tubulin* marker caused topological conflicts in comparison with trees generated with other markers and had to be excluded from the multigene analysis. A final solution to this problem could not be found during this study.

In this study *MCM7* and *TSR1* were used for the first time as phylogenetic markers to resolve phylogenetic relationships in the genus *Pestalotiopsis*. However, in other groups of fungi, the phylogenetic utility of *MCM7* and *TSR1* in terms of resolving power at different taxonomic ranks and congruence compared to more typically used genes has been tested in various studies. Generally, these studies came to the conclusion that both loci are likely valuable genes for phylogenetic inference from species to even higher taxonomic levels in different groups of fungi (Nguyen et al. 2015; Raja et al 2011; Singh et al. 2015; Stefani et al. 2014; Tretter et al. 2013).

In this study, the comparison of all five markers revealed that *MCM7* performed best with regard to both PCR amplification success and species resolving power and with respect to the species hypothesis inferred based on the BP&P analysis. Also all supported clades of the *MCM7* tree are congruent with the topology of the concatenated tree based of the five loci of interest. In contrast, generation of sequences of *TSR1* was less successful compared to *MCM7*. One reason could be wobble bases even in the genus specific primers that resulted in less specific PCR products. Tretter et al. (2013) tested *MCM7* and *TSR1* across early-diverging fungal clades and also noticed difficulties when generating *TSR1* sequences.

Nevertheless, the analyses based on the concatenated 5-gene dataset shows the best resolving power on taxonomic level compared to any single-gene analyses. Since the ITS analysis resulted in an unresolved phylogenetic tree it is possible that the ITS dataset did not strongly influence the concatenated dataset. However, as the ITS dataset is in concordance with the remaining four gene trees the ITS dataset was still included in the analysis of the concatenated dataset.

It can be summarized that the molecular data generated in this work point in the same direction as the recommendation by Schoch et al. (2012) in considering ITS as a primary barcode maker in *Pestalotiopsis* s.l., but better results will be achieved if it is supplemented with a secondary barcode marker. As a suitable secondary marker *MCM7* is here proposed for that genus. This is contrary to the recommendation of Maharachchikumbura et al. (2012), who recommended *TEF1* as a good secondary barcode marker in *Pestalotiopsis* s.l. (see above). However, Maharachchikumbura et al. (2012) did not test *MCM7* and in the present study *TEF1* turned out to be less informative than *MCM7*. Only with the *MCM7* dataset it was possible to resolve the same hypothetic species that were found by the BP&P analysis. Further, based on the

MCM7 dataset it was possible to reproduce the monophyletic clades resolved in the analyses of the concatenated dataset.

These findings show the need to consider more than one appropriate marker for species delimitation within certain groups of fungi.

7.5 Taxonomic species relationship within the *Pestalotia-Pestalotiopsis* complex

In the present study, the type species of *Pestalotia*, *P. pezizoides*, is represented for the first time by a proposed epitype, which was freshly collected, cultured, morphologically described, and sequenced. This new data made it possible to determine the phylogenetic placement and validity of the genus *Pestalotia* especially in relation to the closely related genus *Pestalotiopsis*. This result was not unexpected and was previously proposed by other authors (e.g., Maharachchikumbura et al. 2014, 2015). Herein, *P. pezizoides* forms a statistically highly supported clade with species of *Seiridium*, consequently, the genus *Pestalotia* is relegated to synonymy with *Seiridium*. Such new insides into the phylogenetic relationships of fungal taxa are more and more often revealed based on the molecular analysis of type material, if possible, or of freshly collected epitypic material (e.g., Jaklitsch et al. 2016; Kepler et al. 2014; Krüger et al. 2011). One may criticize that in the present study, phylogenetic inference is based on rDNA sequences only. Recently, Jaklitsch et al. (2016) claimed that rDNA sequence data are not suitable for delimiting formal higher taxa. Nevertheless, because morphological similarities between *Seiridium* and *Pestalotia* point in the same direction, it is considered that this taxonomical and nomenclatural conclusion is practicable and will be confirmed by future studies that add non-rDNA markers in the phylogenetic analyses.

The phylogenetic relationships on genus and family level have yet to be clarified within the *Pestalotia-Pestalotiopsis* complex. This uncertainty predominantly results from the lack of appropriate type sequence data in many recent phylogenies. For example in 2015 the family Pestalotiopsidaceae was introduced (Senanayake et al. 2015) containing the genera *Monochaetia*, *Seiridium*, *Neopestalotiopsis*, *Pestalotiopsis*, and *Pseudopestalotiopsis*. Nevertheless, in the study of Senanayake et al. (2015) generic type material of *Monochaetia*, *Pestalotiopsis*, and *Seiridium* was not included and therefore future studies that include type sequences may come to other taxonomic conclusions at the generic level. As a consequence, Jaklitsch et al. (2016) rejected the family Pestalotiopsidaceae and listed Pestalotiopsidaceae together with Bartalianaceae, Discosiaceae, and Robillardaceae as synonyms of Sporocadaceae. The main argument was that these families form a natural, monophyletic system and that the family delimitation on the basis of rDNA markers alone is not appropriate to explore relationship of higher taxa. One may assume that this is also true on a generic level suggesting that the split of *Pestalotiopsis* into three genera by Maharachchikumbura et al. (2014) might be inappropriate and should be re-tested with additional markers in future studies. The division of *Pestalotiopsis* into three genera was predominantly based on rDNA sequence data and some minor morphological characters. Moreover, the present work identified the commonly used morphological features as ambiguous and unstable within the genus. Attention should also be paid to the fact that in this study genetic diversity within the genus *Neopestalotiopsis* is very low which supports the assumption that fewer species are involved than previously estimated. This leaves the question open if it is appropriate to create a genus for a small number of species when it would be better to unite the sister clades *Neopestalotiopsis* and *Pseudopestalotiopsis* into one genus. Future studies will have to evaluate this possibility.

7.6 Naming species in *Pestalotiopsis* s.l.

In recent years, the number of *Pestalotiopsis* s.l. species is exploding. To date, 299 names of *Pestalotiopsis* and 601 names of *Pestalotia* exist according to *Index Fungorum*. There is a discernible and general trend towards the production of more and more names which, in this case, causes increasing confusion rather than it solves taxonomic problems. Given the fact that species diversity in *Pestalotiopsis* s.l. is much lower than available names suggest, it appears incomprehensible and contra-productive to name new species on the basis of minor genetic distances and marginal morphological differences.

A solution would be the application of old names to phylogenetic clades whenever available. This might not always be easy to implement, because there is usually not much evidence that a phylogenetic clade corresponds to the respective name. Unfortunately, old name bearing type specimens are usually not suitable for generating molecular sequences. The PCR amplification success depends on many factors such as the age of a herbarium specimen and the preservation technique used, but also the physical and biological features of the examined fungi, such as the structure of the cell wall, as well as the presence of pigments and other biochemicals in the cell wall (Brock et al. 2009). The conidial cell wall of *Pestalotiopsis* s.l. species is characterized by dark brown to light brown pigmented middle cells, and these fungi are known for the production of a wide range of diverse metabolites (Maharachchikumbura 2011). All these factors may negatively influence the PCR amplification success of herbarium material. A trade-off for this issue can be the collection of fresh, topotypic material that could even serve as epitypic material. However, this should follow clearly defined rules. Material should be collected from the same host plant, no matter if host specificity is assumed or not, and should come from at least the same geographic region, if not exactly the same location (Ariyawansa 2014). Additionally, the collected material needs a detailed morphological examination with the result that it meets all the features described in the original description. Of course, all these criteria do not guarantee that topotypic material is conspecific with the species that was originally described, but it is an opportunity to move forward while the production of more and more names rather increases the confusion. In a next step, genetic sequence information needs to be generated, PCR products should be conserved, and living cultures should be established and deposited in public culture collections such as CBS to have the original material available for future examination taking also in consideration that new analysis techniques are continuously developed.

Phylogenetic information gained from such topotypic material can then be used to name terminal, monophyletic clades. Additionally, a clear species delimitation concept is needed. Currently, it seems to be rather arbitrary whether or not a lineage is recognized at the species level.

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8 Appendices

Appendix 1: List of strains with collection details used in this study.

Collection nr.	Species	Country	Location	LAT/ LON	Date	Host order Host family	Host	Substrat	Collector
AR 4878	*Neopestalotiopsis* sp.	Republic of Azerbaijan	Hirkan National Park	38.461000 48.697000	N/A	Saxifragales Hamamelidaceae	*Parrotia persica*	N/A	D. Aghayeva
AR 4879	*Neopestalotiopsis* sp.	Republic of Azerbaijan	Hirkan National Park	38.461000 48.697000	N/A	Saxifragales Hamamelidaceae	*Parrotia persica*	N/A	D. Aghayeva
AR 4880	*Neopestalotiopsis* sp.	Republic of Azerbaijan	Hirkan National Park	38.461000 48.697000	N/A	Saxifragales Hamamelidaceae	*Parrotia persica*	N/A	D. Aghayeva
AR 4881	*Neopestalotiopsis* sp.	Republic of Azerbaijan	Hirkan National Park	38.461000 48.697000	N/A	Saxifragales Hamamelidaceae	*Parrotia persica*	N/A	D. Aghayeva
AR 4883	*Pestalotiopsis* sp.	USA	District of Columbia, National Arboretum	39.207216 -76.981548	N/A	Cupressales Cupressaceae	*Thuja plicata*	dead tissue	N/A
AR 4884	*Pestalotiopsis* sp.	USA	District of Columbia, National Arboretum	39.207216 -76.981548	N/A	Cupressales Cupressaceae	*Thuja plicata*	dead tissue	N/A
AR 4885	*Pestalotiopsis* sp.	USA	District of Columbia, National Arboretum	39.207216 -76.981548	N/A	Cupressales Cupressaceae	*Thuja plicata*	dead tissue	N/A
AR 4886	*Pestalotiopsis* sp.	USA	District of Columbia, National Arboretum	39.207216 -76.981548	N/A	Cupressales Cupressaceae	*Thuja plicata*	dead tissue	N/A
AR 4887	*Pestalotiopsis* sp.	USA	11300 Baltimore Ave	39.041206 -76.906476	N/A	Saxifragales Hamamelidaceae	*Parrotia* sp.	N/A	D. Minnis
AR 4891	*Neopestalotiopsis* sp.	USA	Laurel Falls, GRSM	35.679000 -83.592900	3/10/06	Pinales Pinaceae	*Tsuga canadensis*	bark	R. Baird
AR 4892	*Neopestalotiopsis* sp.	USA	Laurel Falls, GRSM	35.679000 -83.592900	03/10/06	Pinales Pinaceae	*Tsuga canadensis*	bark	R. Baird

AR 4893	*Neopestalotiopsis* sp.	USA	Laurel Falls, GRSM	35.679000 -83.592900	03/10/06	Pinales Pinaceae	*Tsuga canadensis*	bark	R. Baird
AR 4894	*Pestalotiopsis* sp.	USA	Laurel Falls, GRSM	35.679000 -83.592900	03/10/06	Pinales Pinaceae	*Tsuga canadensis*	bark	R. Baird
AR 4895	*Neopestalotiopsis* sp.	USA	Laurel Falls, GRSM	35.679000 -83.592900	03/10/06	Pinales Pinaceae	*Tsuga canadensis*	bark	R. Baird
AR 4896	*Neopestalotiopsis* sp.	USA	Laurel Falls, GRSM	35.679000 -83.592900	03/10/06	Pinales Pinaceae	*Tsuga canadensis*	bark	R. Baird
AR 4897	*Neopestalotiopsis* sp.	USA	Laurel Falls, GRSM	35.679000 -83.592900	03/10/06	Pinales Pinaceae	*Tsuga canadensis*	bark	R. Baird
AR 4898	*Neopestalotiopsis* sp.	USA	Laurel Falls, GRSM	35.679000 -83.592900	03/10/06	Pinales Pinaceae	*Tsuga canadensis*	bark	R. Baird
AR 4899	*Pestalotiopsis* sp.	USA	Laurel Falls, GRSM	35.679000 -83.592900	03/10/06	Pinales Pinaceae	*Tsuga canadensis*	bark	R. Baird
AR 4900	*Neopestalotiopsis* sp.	USA	Laurel Falls, GRSM	35.679000 -83.592900	03/10/06	Pinales Pinaceae	*Tsuga canadensis*	bark	R. Baird
AR 4901	*Neopestalotiopsis* sp.	USA	Laurel Falls, GRSM	35.679000 -83.592900	03/10/06	Pinales Pinaceae	*Tsuga canadensis*	bark	R. Baird
AR 4903	*Neopestalotiopsis* sp.	USA	Laurel Falls, GRSM	35.679000 -83.592900	03/10/06	Pinales Pinaceae	*Tsuga canadensis*	bark	R. Baird
AR 4904	*Neopestalotiopsis* sp.	USA	Laurel Falls, GRSM	35.679000 -83.592900	03/10/06	Pinales Pinaceae	*Tsuga canadensis*	bark	R. Baird
AR 4905	*Neopestalotiopsis* sp.	USA	Laurel Falls, GRSM	35.679000 -83.592900	03/10/06	Pinales Pinaceae	*Tsuga canadensis*	bark	R. Baird
AR 4906	*Neopestalotiopsis* sp.	USA	Laurel Falls, GRSM	35.679000 -83.592900	03/10/06	Pinales Pinaceae	*Tsuga canadensis*	bark	R. Baird
AR 4907	*Neopestalotiopsis* sp.	USA	Laurel Falls, GRSM	35.679000 -83.592900	03/10/06	Pinales Pinaceae	*Tsuga canadensis*	bark	R. Baird
AR 4908	*Neopestalotiopsis* sp.	USA	Laurel Falls, GRSM	35.679000 -83.592900	03/10/06	Pinales Pinaceae	*Tsuga canadensis*	bark	R. Baird
AR 4909	*Neopestalotiopsis* sp.	USA	Laurel Falls, GRSM	35.679000 -83.592900	03/10/06	Pinales Pinaceae	*Tsuga canadensis*	bark	R. Baird
AR 4910	*Neopestalotiopsis* sp.	USA	Laurel Falls, GRSM	35.679000 -83.592900	03/10/06	Pinales Pinaceae	*Tsuga canadensis*	bark	R. Baird
AR 4911	*Neopestalotiopsis* sp.	USA	Laurel Falls, GRSM	35.679000 -83.592900	03/10/06	Pinales Pinaceae	*Tsuga canadensis*	bark	R. Baird
AR 4912	*Neopestalotiopsis* sp.	USA	Laurel Falls, GRSM	35.679000 -83.592900	03/10/06	Pinales Pinaceae	*Tsuga canadensis*	bark	R. Baird

AR 4913	*Neopestalotiopsis* sp.	USA	Laurel Falls, GRSM	35.679000 -83.592900	03/10/06	Pinales Pinaceae	*Tsuga canadensis*	bark	R. Baird
AR 4914	*Neopestalotiopsis* sp.	USA	Laurel Falls, GRSM	35.679000 -83.592900	03/10/06	Pinales Pinaceae	*Tsuga canadensis*	bark	R. Baird
AR 4915	*Neopestalotiopsis* sp.	USA	Clingman Dome, GRSM	35.562058 -83.498566	03/10/06	Fagales Fagaceae	*Fagus grandifolia*	bark	R. Baird
AR 4916	*Neopestalotiopsis* sp.	USA	Clingman Dome, GRSM	35.562058 -83.498566	03/10/06	Pinales Pinaceae	*Abies fraseri*	bark	R. Baird
AR 4917	*Neopestalotiopsis* sp.	USA	Clingman Dome, GRSM	35.562058 -83.498566	03/10/06	Pinales Pinaceae	*Abies fraseri*	bark	R. Baird
AR 4918	*Pestalotiopsis* sp.	USA	Clingman Dome, GRSM	35.562058 -83.498566	03/10/06	Fagales Fagaceae	*Fagus grandifolia*	bark	R. Baird
AR 4919	*Pestalotiopsis* sp.	USA	Sugarlands Cent., GRSM	35.685470 -83.536581	01/05/06	Fagales Fagaceae	*Fagus grandifolia*	bark	R. Baird
AR 4920	*Pestalotiopsis* sp.	USA	Sugarlands Cent., GRSM	35.685470 -83.536581	01/05/06	Fagales Fagaceae	*Fagus grandifolia*	bark	R. Baird
AR 4921	*Neopestalotiopsis* sp.	USA	For.k Ridge Tr., GRSM	35.571290 -83.439952	07/08/06	Fagales Fagaceae	*Fagus grandifolia*	bark	R. Baird
AR 4922	*Pestalotiopsis* sp.	USA	For.k Ridge Tr., GRSM	35.571290 -83.439952	14/08/06	Fagales Fagaceae	*Fagus grandifolia*	bark	R. Baird
AR 4923	*Pestalotiopsis* sp.	USA	Alb. Mt. Nant. Nat. For.	35.170911 -83.594206	10/08/06	Ericales Ericaceae	*Rhododendron maximum*	roots	W. Starrett
AR 4924	*Pestalotiopsis* sp.	USA	Laurel Falls, GRSM	35.679000 -83.592900	10/08/06	Ericales Ericaceae	*Rhododendron maximum*	roots	W. Starrett
AR 4925	*Pestalotiopsis* sp.	USA	Laurel Falls, GRSM	35.679000 -83.592900	10/08/06	Ericales Ericaceae	*Rhododendron maximum*	roots	W. Starrett
AR 4926	*Neopestalotiopsis* sp.	USA	N/A	N/A N/A	10/08/06	Ericales Ericaceae	*Rhododendron maximum*	roots	W. Starrett
AR 4927	*Pestalotiopsis* sp.	USA	Alb. Mt. Nant. Nat. For.	35.170911 -83.594206	10/08/06	Ericales Ericaceae	*Rhododendron maximum*	roots	W. Starrett
AR 4928	*Pestalotiopsis* sp.	USA	Laurel Falls, GRSM	35.679000 -83.592900	10/08/06	Ericales Ericaceae	*Rhododendron maximum*	roots	W. Starrett
AR 4929	*Pestalotiopsis* sp.	USA	Alb. Mt. Nant. Nat. For.	35.170911 -83.594206	10/08/06	Ericales Ericaceae	*Rhododendron maximum*	roots	W. Starrett
AR 4930	*Pestalotiopsis* sp.	USA	Laurel Falls, GRSM	35.679000 -83.592900	10/08/06	Ericales Ericaceae	*Rhododendron maximum*	roots	W. Starrett
AR 4931	*Neopestalotiopsis* sp.	USA	Laurel Falls, GRSM	35.679000 -83.592900	10/08/06	Ericales Ericaceae	*Rhododendron maximum*	roots	W. Starrett

AR 4933	*Pestalotiopsis* sp.	USA	Alb. Mt. Nant. Nat. For.	35.170911 -83.594206	11/08/06	Ericales Ericaceae	*Rhododendron maximum*	roots	W. Starrett
AR 4934	*Pestalotiopsis* sp.	USA	Starkville	33.450400 -88.818387	16/04/08	Rosales Rosaceae	*Photinia* sp.	dead leaves	P. Scott
AR 4935	*Pestalotiopsis* sp.	USA	Stone Co.	30.801307 -89.170600	14/04/08	Fagales Myricaceae	*Myrica cerifera*	diseased plant	A. Henn
AR 4936	*Pestalotiopsis* sp.	USA	Stone Co	30.801307 -89.170600	14/04/08	Fagales Myricaceae	*Myrica cerifera*	diseased plant	A. Henn
AR 4937	*Neopestalotiopsis* sp.	USA	Stone Co.	30.801307 -89.170600	14/04/08	Fagales Myricaceae	*Myrica cerifera*	diseased plant	A. Henn
AR 4938	*Neopestalotiopsis* sp.	USA	Cairo	30.875000 -84.201700	08/10/08	Austrobaileyales Schisandraceae	*Illicium parviflorum*	stem dieback	M. Marion
AR 4939	*Pestalotiopsis* sp.	USA	cairo	30.875000 -84.201700	08/10/08	Rosales Rosaceae	*Rosa* sp.	stem dieback	M. Marion
AR 4940	*Pestalotiopsis* sp.	USA	MSU	33.458221 -88.791479	24/02/09	Pinales Pinaceae	× *Cupressocyparis leylandii*	leaves	P. Scott
AR 4941	*Neopestalotiopsis* sp.	USA	Montgomery Co.	37.161783 -80.430373	31/05/10	Ericales Ericaceae	*Rhododendron maximum*	tip dieback	M. Hensen
AR 4942	*Pestalotiopsis* sp.	USA	MSU	33.458221 -88.791479	26/02/09	Pinales Pinaceae	× *Cupressocyparis leylandii*	leaves	P. Scott
AR 4943	*Neopestalotiopsis* sp.	USA	MSU	33.458221 -88.791479	24/04/09	Ericales Ericaceae	*Rhododendron* sp.	leaf spot	P. Scott
AR 4944	*Neopestalotiopsis* sp.	USA	MSU	33.458221 -88.791479	24/04/09	Ericales Ericaceae	*Rhododendron* sp.	leaf spot	P. Scott
AR 4945	*Pestalotiopsis* sp.	USA	MSU	33.458221 -88.791479	15/05/09	Cupressales Cupressaceae	*Cupressus sempervirens*	dead leaves	P. Scott
AR 4946	*Pestalotiopsis* sp.	USA	MSU	33.458221 -88.791479	01/05/09	Cupressales Cupressaceae	*Chamaecyparis nootkatensis*	dead leaves	P. Scott
AR 4947	*Pestalotiopsis* sp.	USA	MSU	33.458221 -88.791479	01/05/09	Cupressales Cupressaceae	*Chamaecyparis nootkatensis*	dead leaves	P. Scott
AR 4948	*Pestalotiopsis* sp.	USA	MSU	33.458221 -88.791479	01/05/09	Cupressales Cupressaceae	*Chamaecyparis nootkatensis*	dead leaves	P. Scott
AR 4949	*Pestalotiopsis* sp.	USA	MSU	33.458221 -88.791479	01/05/09	Cupressales Cupressaceae	*Chamaecyparis nootkatensis*	dead leaves	P. Scott
AR 4950	*Neopestalotiopsis* sp.	USA	Overton	32.274598 -94.978552	05/05/09	Rosales Rosaceae	*Rosa* sp.	leaf spot	K. Steddom
AR 4951	*Pestalotiopsis* sp.	USA	MSU	33.458221 -88.791479	25/02/09	Ericales Theaceae	*Camellia japonica*	leaf spot	P. Scott

AR 4953	*Pestalotiopsis* sp.	USA	MSU	33.458221 -88.791479	08/05/09	Cupressales Cupressaceae	*Chamaecyparis nootkatensis*	dead leaves	P. Scott
AR 4954	*Pestalotiopsis* sp.	USA	Clemson	34.683330 -82.834082	05/06/09	Magnoliales Magnoliaceae	*Magnolia grandifolia*	N/A	M. Williamson
AR 4955	*Neopestalotiopsis* sp.	USA	MSU	33.458221 -88.791479	05/06/09	Cupressales Cupressaceae	*Chamaecyparis pisafera*	dead leaves	P. Scott
AR 4956	*Neopestalotiopsis* sp.	USA	Clemson	34.683330 -82.834082	29/06/09	Ericales Ericaceae	*Rhododendron maximum*	N/A	M. Williamson
AR 4957	*Pestalotiopsis* sp.	USA	Cornell	42.452339 -76.471528	29/06/09	Pinales Pinaceae	× *Cupressocyparis leylandii*	N/A	M. Daughtrey
AR 4958	*Neopestalotiopsis* sp.	USA	Clemson	34.683330 -82.834082	07/07/09	Myrtales Lythraceae	*Lagerstroemia indica*	N/A	M. Williamson
AR 4959	*Pestalotiopsis* sp.	USA	Cross Plains	38.944341 -85.202861	11/07/09	Ericales Ericaceae	*Vaccinium corymbosum*	diseased plant	T. Creswell
AR 4960	*Pestalotiopsis* sp.	USA	Cross Plains	38.944341 -85.202861	11/07/09	Ericales Ericaceae	*Vaccinium corymbosum*	diseased plant	T. Creswell
AR 4961	*Neopestalotiopsis* sp.	USA	N/A	N/A N/A	N/A	Pinales Pinaceae	*Pinus albicaulis*	cones	C. Smith
AR 4962	*Pestalotiopsis* sp.	USA	GRSM	35.641800 -83.521200	15/07/09	Rosales Moraceae	*Morus rubra*	diseased plant	R. Baird
AR 4964	*Pestalotiopsis* sp.	USA	N/A	43.332400 -71.591800	04/08/09	Cupressales Cupressaceae	*Juniperus squamata*	diseased plant	C. Smith
AR 4965	*Pestalotiopsis* sp.	USA	N/A	43.332400 -71.591800	07/08/09	Cupressales Cupressaceae	*Juniperus virginiana*	diseased plant	C. Smith
AR 4966	*Pestalotiopsis* sp.	USA	N/A	43.332400 -71.591800	07/08/09	Cupressales Cupressaceae	*Juniperus virginiana*	diseased plant	C. Smith
AR 4967	*Pestalotiopsis* sp.	USA	MSU	33.458221 -88.791479	16/12/11	Ericales Theaceae	*Camellia japonica*	leaf spot	P. Scott
AR 4968	*Pestalotiopsis* sp.	USA	Simpson Co.	31.901774 -89.925323	01/11/11	Saxifragales Altingiaceae	*Liquidambar styraciflua*	diseased plant	C. Balbalian
AR 4969	*Neopestalotiopsis* sp.	USA	Simpson Co.	31.901774 -89.925323	01/11/11	Saxifragales Altingiaceae	*Liquidambar styraciflua*	diseased plant	C. Balbalian
AR 4970	*Pestalotiopsis* sp.	USA	hillsdale	30.931800 -89.455100	09/07/09	Aquifoliales Aquifoliaceae	*Ilex* sp.	leaf spot	P. Scott
AR 4972	*Neopestalotiopsis* sp.	USA	MSU	33.458221 -88.791479	29/08/09	Cupressales Cupressaceae	*Thuja plicata*	leaf blight	P. Scott
AR 4973	*Neopestalotiopsis* sp.	USA	Lauderdale Co.	32.429217 -88.721242	03/09/09	Cupressales Cupressaceae	*Taxodium distichum*	leaves	C. Balbalian

AR 4974	*Pestalotiopsis* sp.	USA	Stone Co.	30.801307 -89.170600	01/09/09	Ericales Ebenaceae	*Diospyros kaki*	leaf spot	C. Balbalian
AR 4975	*Pestalotiopsis* sp.	USA	GRSM	35.641800 -83.521200	29/09/09	Ericales Ericaceae	*Rhododendron maximum*	leaf spot	P. Scott
AR 4976	*Pestalotiopsis* sp.	USA	N/A	43.332400 -71.591800	01/09/09	Cupressales Cupressaceae	*Thuja occidentalis* (smaragd)	dead leaves	C. Smith
AR 4977	*Neopestalotiopsis* sp.	USA	MSU	33.458221 -88.791479	10/11/09	Cornales Cornaceae	*Cornus kousa*	dead leaves	P. Scott
AR 4978	*Neopestalotiopsis* sp.	USA	Lafayette	30.223030 -92.018966	29/11/09	Thelephorales Bankeraceae	*Hydnellum* sp.	roots	P. Scott
AR 4979	*Pestalotiopsis* sp.	USA	GRSM	35.641800 -83.521200	05/12/09	Thelephorales Bankeraceae	*Hydnellum* sp.	fruiting body	R. Baird
AR 4980	*Neopestalotiopsis* sp.	USA	MSU	33.458221 -88.791479	09/12/09	N/A N/A	lichen	endophyte	P. Scott
AR 4981	*Neopestalotiopsis* sp.	USA	MSU	33.458221 -88.791479	11/12/09	Fagales Fagaceae	*Quercus* sp.	dead wood	P. Scott
AR 4982	*Pestalotiopsis* sp.	USA	GRSM	35.641800 -83.521200	20/07/07	Ericales Ericaceae	*Rhododendron maximum*	roots	W. Starrett
AR 4983	*Pestalotiopsis* sp.	USA	MSU	33.458221 -88.791479	09/12/09	N/A N/A	lichen	endophyte	P. Scott
AR 4984	*Pestalotiopsis* sp.	USA	MSU	33.458221 -88.791479	15/12/09	N/A N/A	lichen	endophyte	P. Scott
AR 4985	*Neopestalotiopsis* sp.	USA	West Point	33.607619 -88.650325	14/12/09	N/A N/A	lichen	endophyte	M. Alexander
AR 4986	*Pestalotiopsis* sp.	USA	MSU	33.458221 -88.791479	14/12/09	N/A N/A	lichen	endophyte	P. Scott
AR 4987	*Pestalotiopsis* sp.	USA	MSU	33.458221 -88.791479	10/12/09	N/A N/A	lichen	endophyte	P. Scott
AR 4988	*Pestalotiopsis* sp.	USA	MSU	33.458221 -88.791479	11/12/09	N/A N/A	lichen	endophyte	P. Scott
AR 4990	*Neopestalotiopsis* sp.	USA	MSU	33.458221 -88.791479	15/12/09	N/A N/A	lichen	endophyte	P. Scott
AR 4991	*Neopestalotiopsis* sp.	USA	MSU	33.458221 -88.791479	11/12/09	N/A N/A	lichen	endophyte	P. Scott
AR 4992	*Pestalotiopsis* sp.	USA	MSU	33.458221 -88.791479	10/12/09	N/A N/A	lichen	endophyte	P. Scott
AR 4993	*Pestalotiopsis* sp.	USA	Pink Beds, Pisgah Nat. For.	35.367888 -82.758461	15/04/79	Ericales Ericaceae	*Rhododendron maximum*	leaf spot	P. Scott

AR 4994	*Pestalotiopsis* sp.	USA	MSU	33.458221 -88.791479	03/02/10	Aquifoliales Aquifoliaceae	*Ilex* sp.	leaf spot	P. Scott
AR 4995	*Pestalotiopsis* sp.	USA	MSU	33.458221 -88.791479	15/03/09	Magnoliales Magnoliaceae	*Magnolia grandifolia*	ascospores	P. Scott
AR 4996	*Pestalotiopsis* sp.	USA	MSU	33.458221 -88.791479	15/03/09	Magnoliales Magnoliaceae	*Magnolia grandifolia*	leaf spot	P. Scott
AR 4997	*Pestalotiopsis* sp.	USA	Plano	33.022382 -96.699576	01/03/10	N/A N/A	N/A	rubber boot	R Lutz
AR 4998	*Neopestalotiopsis* sp.	USA	Starkville	33.450400 -88.818387	24/03/09	Magnoliales Magnoliaceae	*Magnolia grandifolia*	leaf spot	P. Scott
AR 4999	*Pestalotiopsis* sp.	USA	Starkville	33.450400 -88.818387	28/04/10	Rosales Elaeagnaceae	*Elaeagnus* sp.	endophyte	C. Balbalian
AR 5000	*Pestalotiopsis* sp.	USA	MSU	33.458221 -88.791479	23/04/10	Cupressales Cupressaceae	*Cryptomeria japonica*	leaf spot	P. Scott
AR 5001	*Pestalotiopsis* sp.	USA	Harrison Co.	30.382700 -89.517000	23/04/10	N/A Arecaceae	N/A	dead leaves	C. Balbalian
AR 5002	*Pestalotiopsis* sp.	USA	Jefferson Davis Co.	31.613700 -89.815100	27/04/10	Rosales Rosaceae	*Prunus* sp.	diseased plant	C. Balbalian
AR 5004	*Pestalotiopsis* sp.	USA	Lovett Arboretum	32.367698 -90.361422	17/05/10	Dacrymycetales Dacrymycetaceae	*Calocera* sp.	diseased plant	T. Creswell
AR 5005	*Pestalotiopsis* sp.	USA	MSU	33.458221 -88.791479	19/05/10	Pinales Pinaceae	*Pinus bungeana*	dead cones	P. Scott
AR 5006	*Neopestalotiopsis* sp.	USA	MSU	33.458221 -88.791479	21/05/10	Magnoliales Magnoliaceae	*Magnolia grandifolia*	leaf spot	P. Scott
AR 5007	*Pestalotiopsis* sp.	USA	MSU	33.458221 -88.791479	13/05/10	Magnoliales Magnoliaceae	*Magnolia grandifolia*	endophyte	P. Scott
AR 5008	*Neopestalotiopsis* sp.	USA	Gatlinburg golf course	35.785200 -83.541800	10/05/10	Pinales Pinaceae	× *Cupressocyparis leylandii*	dead leaves	B. Moore
AR 5009	*Pestalotiopsis* sp.	USA	MSU	33.458221 -88.791479	20/05/10	Magnoliales Magnoliaceae	*Magnolia grandifolia*	leaf spot	P. Scott
AR 5010	*Neopestalotiopsis* sp.	USA	MSU	33.458221 -88.791479	07/07/10	Cupressales Cupressaceae	*Cunninghamia lanceolata*	dead leaves	P. Scott
AR 5011	*Neopestalotiopsis* sp.	USA	Tombigbee NF	33.210288 -89.056153	06/07/10	Polypodiales Pteridaceae	*Pteris aquilina*	endophyte	P. Scott
AR 5012	*Pestalotiopsis* sp.	USA	Marianna	30.778050 -85.231870	08/07/10	Cupressales Cupressaceae	*Cunninghamia lanceolata*	dead leaves	G. Blackman
AR 5013	*Pestalotiopsis* sp.	USA	Marianna	30.778050 -85.231870	08/07/10	Cupressales Cupressaceae	*Cunninghamia lanceolata*	dead leaves	G. Blackman

AR 5014	*Neopestalotiopsis* sp.	USA	MSU	33.458221 -88.791479	16/07/10	Cupressales Cupressaceae	*Taxodium distichum*	dead leaves	P. Scott
AR 5015	*Neopestalotiopsis* sp.	USA	Hancock Co.	30.382700 -89.517000	02/09/10	Sapindales Rutaceae	*Citrus* sp.	fruit peel	C. Balbalian
AR 5016	*Pestalotiopsis* sp.	USA	MSU	33.458221 -88.791479	12/10/10	Cupressales Cupressaceae	*Cunninghamia lanceolata*	dead leaves	P. Scott
AR 5017	cf. *Pestalotiopsis* sp.	USA	MSU	33.458221 -88.791479	19/05/10	Cupressales Cupressaceae	*Cupressus sempervirens*	dead leaves	P. Scott
AR 5018	*Pestalotiopsis* sp.	USA	Starkville	33.450400 -88.818387	22/01/10	Lamiales Bignoniaceae	*Campsis radicans*	dead vines	P. Scott
AR 5019	*Pestalotiopsis* sp.	USA	MSU	33.458221 -88.791479	22/11/10	Ericales Theaceae	*Camellia sasanqua*	leaf spot	P. Scott
AR 5020	*Pestalotiopsis* sp.	USA	Caney Lake NRA	32.243675 -92.518675	24/11/10	Aquifoliales Aquifoliaceae	*Ilex opaca*	leaf spot	P. Scott
AR 5021	*Neopestalotiopsis* sp.	USA	Caney Lake NRA	32.243675 -92.518675	24/11/10	Aquifoliales Aquifoliaceae	*Ilex opaca*	leaf spot	P. Scott
AR 5022	*Neopestalotiopsis* sp.	USA	MSU	33.458221 -88.791479	23/02/11	Fagales Fagaceae	*Quercus virginiana*	endophyte	P. Scott
AR 5023	*Pestalotiopsis* sp.	USA	Woodsman	N/A N/A	15/03/11	Fagales Myricaceae	*Morella cerifera*	diseased plant	A. Henn
AR 5024	*Pestalotiopsis* sp.	USA	Woodsman	N/A N/A	15/03/11	Fagales Myricaceae	*Morella cerifera*	diseased plant	A. Henn
AR 5025	*Pestalotiopsis* sp.	USA	MSU	33.458221 -88.791479	22/04/11	Cupressales Cupressaceae	*Cupressus sempervirens*	dead leaves	P. Scott
AR 5026	*Pestalotiopsis* sp.	USA	MSU	33.458221 -88.791479	30/08/11	Poales Poaceae	Miscanthus x giganteus	leaf spot	M. Gilley
AR 5027	*Pestalotiopsis* sp.	USA	Mt. Sterling, GRSM	35.700697 -83.119941	06/05/05	Pinales Pinaceae	Abies fraseri	bark	R. Baird
AR 5028	*Pestalotiopsis* sp.	USA	Mt. Sterling, GRSM	35.700697 -83.119941	06/05/05	Pinales Pinaceae	Abies fraseri	bark	R. Baird
AR 5029	*Pestalotiopsis* sp.	USA	Mt. Sterling, GRSM	35.700697 -83.119941	06/05/05	Pinales Pinaceae	*Abies fraseri*	bark	R. Baird
AR 5030	*Pestalotiopsis* sp.	USA	MSU	33.458221 -88.791479	06/03/09	Pinales Pinaceae	× *Cupressocyparis leylandii*	dead leaves	P. Scott
AR 5032	*Neopestalotiopsis* sp.	USA	Perry Co	40.373824 -77.218582	22/05/11	Fabales Fabaceae	*Arachis hypogaea*	leaf spot	A. Henn
AR 5033	*Pestalotiopsis* sp.	USA	GRSM	35.641800 -83.521200	03/10/06	Pinales Pinaceae	*Tsuga canadensis*	bark	R. Baird

AR 5034	*Pestalotiopsis* sp.	USA	Laurel Falls, GRSM	35.679000 -83.592900	03/10/06	Pinales Pinaceae	*Tsuga canadensis*	bark	R. Baird
CBS 138.41	*Pestalotiopsis natalensis*	Republic of South Africa	N/A	-28.935845 30.500628	Jan 1941	Fabales Fabaceae	*Acacia mollissima*	N/A	M.S.J. Ledeboer
CBS 170_26	*Pestalotiopsis brassicae*	New Zealand	N/A	N/A N/A	May 1926	Brassicales Brassicaeae	*Brassica napus*	seed	G.H. Cunningham
CBS 266.37	*Neopestalotiopsis* sp.	Germany	N/A	N/A N/A	June 1937	Ericales Ericaceae	*Erica* sp.	N/A	H.W. Wollenweber
CBS 322.76	*Neopestalotiopsis* sp.	France	N/A	48.803429 2.126001	June 1975	Ericales Theaceae	*Camellia* sp.	twig	I. Vegh
CJ 1	*Pestalotiopsis* cf. *funerea*	Germany	Mörfelden-Walldorf	49.992283 8.558250	10/06/13	Pinales Cupressaceae	*Thuja* sp.	dead twigs/leaves	C. Judith-Hertz
CJ 6	*Pestalotiopsis* cf. *funerea*	Germany	Mörfelden-Walldorf	49.992283 8.558250	13/06/13	Pinales Cupressaceae	*Thuja* sp.	dead twigs/leaves	C. Judith-Hertz
CJ 12	*Neopestalotiopsis* cf. *sydowiana*	Germany	Niedersachsen, Hogen Kamp 52	53.197453 7.985667	10/09/13	Ericales Ericaceae	*Erica* cf. *carnea*	dead twigs/leaves	H. Beltz, C. Judith
CJ 13	*Neopestalotiopsis* cf. *sydowiana*	Germany	Niedersachsen, Hogen Kamp 52	53.197453 7.985667	10/09/13	Ericales Ericaceae	*Erica* cf. *carnea*	dead twigs/leaves	H. Beltz, C. Judith-Hertz
CJ 14	*Neopestalotiopsis* cf. *sydowiana*	Germany	Niedersachsen, Hogen Kamp 52	53.197453 7.985667	10/09/13	Ericales Ericaceae	*Erica* cf. *carnea*	dead twigs/leaves	H. Beltz, C. Judith
CJ 20	*Pestalotiopsis* sp.	Panama	Boca del drago	9.414230 -82.320552	18/03/12	Arecales Arecaceae	*Cocos nucifera*	leaf spot	C. Judith-Hertz
CJ 21	*Pestalotiopsis* sp.	Panama	Boca del drago	9.414230 -82.320552	18/03/12	Arecales Arecaceae	*Cocos nucifera*	leaf spot	C. Judith-Hertz
CJ 22	*Pestalotiopsis* sp.	Panama	Boca del drago	9.414230 -82.320552	18/03/12	Arecales Arecaceae	*Cocos nucifera*	leaf spot	C. Judith-Hertz
CJ 23	*Pseudopestalotiopsis* sp.	Panama	Boca del drago	9.414230 -82.320552	18/03/12	Arecales Arecaceae	*Cocos nucifera*	leaf spot	C. Judith-Hertz
CJ 24	*Pestalotiopsis* sp.	Panama	Boca del drago	9.414230 -82.320552	18/03/12	Arecales Arecaceae	*Cocos nucifera*	leaf spot	C. Judith-Hertz
CJ 25	*Pestalotiopsis* sp.	Panama	Boca del drago	9.414230 -82.320552	18/03/12	Arecales Arecaceae	*Cocos nucifera*	leaf spot	C. Judith-Hertz
CJ 31	*Pestalotia pezizoides*	France	Véronnes	N/A N/A	14/06/14	Vitales Vitaceae	*Vitis* sp.	twigs	C. Judith-Hertz
CJ 32	*Pestalotia pezizoides*	France	Véronnes	N/A N/A	14/06/14	Vitales Vitaceae	*Vitis* sp.	twigs	C. Judith-Hertz

CJ 35	*Pestalotiopsis maculans*	Italy	Volterra, Piazza XX Settembre	43.401470 10.862868	01/04/15	Ericales Theaceae	*Camellia* cf. *japonica*	leaving twigs	C. Judith-Hertz
CJ 36	*Pestalotiopsis maculans*	Italy	Volterra, Piazza XX Settembre	43.401470 10.862868	01/04/15	Ericales Theaceae	*Camellia* cf. *japonica*	leaving twigs	C. Judith-Hertz
CJ 37	*Pestalotiopsis adusta*	USA	Middlesex County, Grekowski Park	N/A N/A	21/06/14	Rosales Rosaceae	*Prunus* sp.	leaf spot	J.White, C.Judith-Hertz J.McKemy
DMW 242.2	*Pestalotiopsis* sp.	Costa Rica	Las Cruces, Java river bed	8.790460 -82.954915	01/08/09	Malpighiales Euphorbiaceae	*Alchornea glandulosa*	N/A	N/A
DMW 277.1	*Neopestalotiopsis* sp.	Costa Rica	Las Cruces, Gamboa trail	8.790460 -82.954915	01/08/09	N/A N/A	N/A	leaf	N/A
EN 42	*Truncatella* cf. *hartigii*	Germany	Taunus	50.141111 8.268194	01/05/14	N/A N/A	N/A	aire	E. Mager
GJS 08-82	*Pestalotiopsis* sp.	Cameroon	Soa	3.975763 11.598582	19/03/08	Malvales Malvaceae	*Theobroma cacao*	twig	G.J.Samuels
GJS 09-1527	*Pseudopestalotiopsis* sp.	Peru	Rio Santiago	-4.112849 -78.066537	01/12/09	Malvales Malvaceae	*Theobroma cacao*	endophyte	G.J.Samuels
GJS 09-1528	*Pestalotiopsis* sp.	Peru	Rio Santiago	-4.112849 -78.066537	19/02/09	Malvales Malvaceae	*Theobroma cacao*	endophyte	G.J.Samuels
GJS 09-420	*Pseudopestalotiopsis* cf. *theae*	Indonesia	N/A	N/A N/A	30/04/09	N/A N/A	N/A	N/A	G.J.Samuels
JAC 12-20	*Pestalotiopsis* sp.	N/A	N/A	N/A N/A	N/A	Buxales Buxaceae	*Buxus sempervirens*	N/A	J. A. Crouch
JAC 12-55	*Pestalotiopsis* sp.	USA	N/A	N/A N/A	2012	Buxales Buxaceae	*Buxus sempervirens*	N/A	J. A. Crouch
JAC 12-82	*Pestalotiopsis* sp.	USA	N/A	N/A N/A	2012	Buxales Buxaceae	*Buxus sempervirens*	N/A	J. A. Crouch
JAC 12-87	*Pestalotiopsis* sp.	USA	District of Columbia	38.895000 -77.036667	2012	Buxales Buxaceae	*Buxus sempervirens*	N/A	J. A. Crouch
JAC 12-89	*Pestalotiopsis* sp.	USA	District of Columbia	38.895000 -77.036667	2012	Buxales Buxaceae	*Buxus microphylla*	N/A	J. A. Crouch
JAC 12-90	*Pestalotiopsis* sp.	USA	District of Columbia	38.895000 -77.036667	2012	Buxales Buxaceae	*Buxus microphylla*	N/A	J. A. Crouch
JKI 1839a	*Neopestalotiopsis* cf. *sydowiana*	Germany	JKI, Braunschweig	52.276900 10.569100	10/09/13	Ericales Ericaceae	*Rhododentron simii*	leaf spot	U. Brielmaier-Liebetanz
JKI 1865	*Neopestalotiopsis* sp.	Germany	JKI, Braunschweig	52.276900 10.569100	10/09/13	Ericales Ericaceae	*Rhododentron simii*	leaf spot	U. Brielmaier-Liebetanz

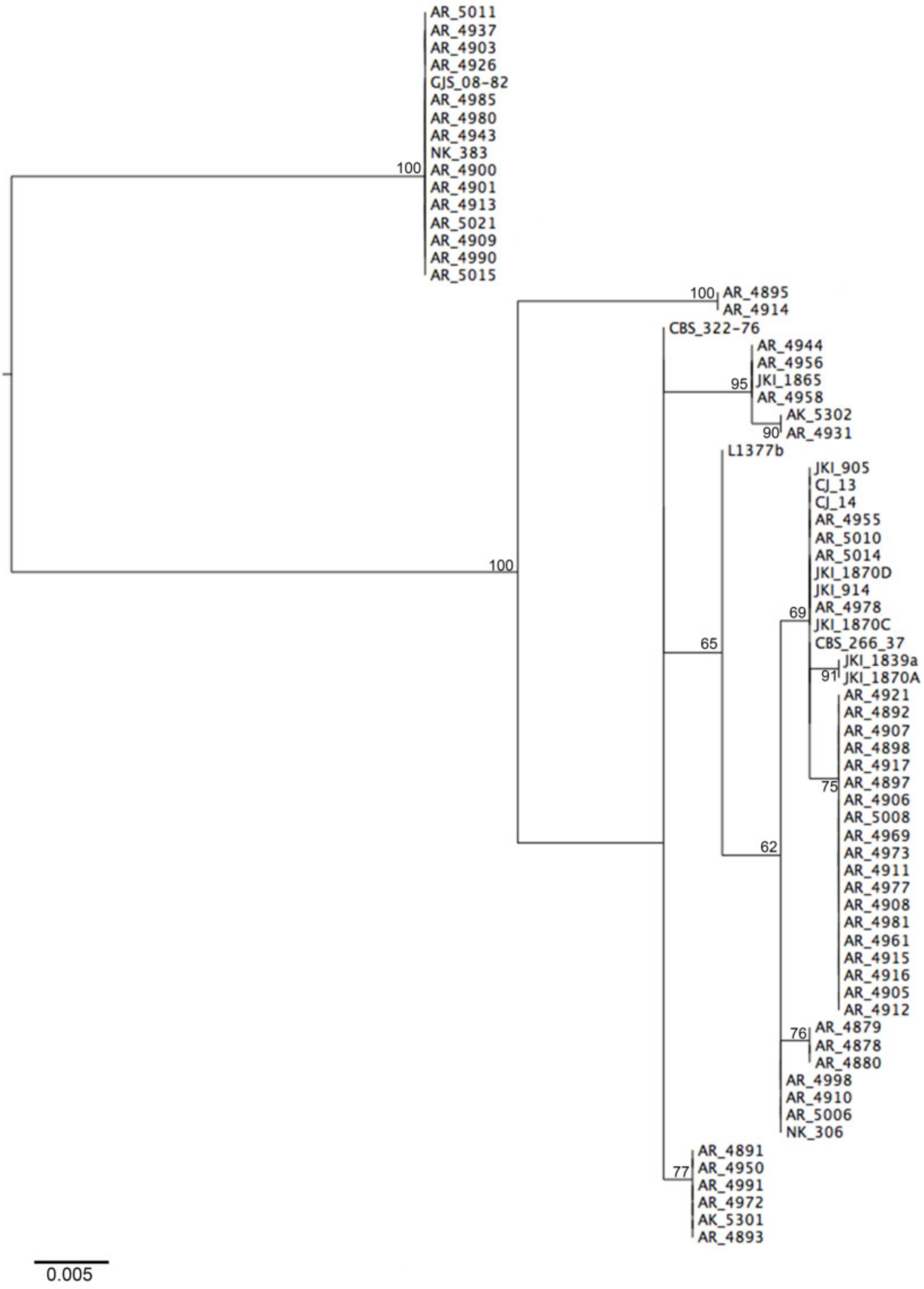
JKI 1870 A	*Neopestalotiopsis* cf. *sydowiana*	Germany	JKI, Braunschweig	52.276900 10.569100	10/09/13	Ericales Ericaceae	*Rhododentron simii*	leaf spot	U. Brielmaier-Liebetanz
JKI 1870 C	*Neopestalotiopsis* cf. *sydowiana*	Germany	JKI, Braunschweig	52.276900 10.569100	10/09/13	Ericales Ericaceae	*Rhododentron simii*	leaf spot	U. Brielmaier-Liebetanz
JKI 1870 D	*Neopestalotiopsis* cf. *sydowiana*	Germany	JKI, Braunschweig	52.276900 10.569100	10/09/13	Ericales Ericaceae	*Rhododentron simii*	leaf spot	U. Brielmaier-Liebetanz
JKI 905	*Neopestalotiopsis* cf. *sydowiana*	Germany	JKI, Braunschweig	52.276900 10.569100	2002	Ericales Ericaceae	*Rhododentron simii*	leaf spot	U. Brielmaier-Liebetanz
L1337b	*Neopestalotiopsis* sp.	France	N/A	N/A N/A	N/A	N/A N/A	N/A	N/A	N/A
LCM 301	*Pestalotiopsis* cf. *cocculi*	Panama	Bambito	8.830076 -82.611242	11/12/07	Rosales Ulmaceae	*Ulmus mexicana*	endophyte	N/A
NK 306	*Neopestalotiopsis* sp.	India	Himalaya	31.870000 77.650000	03/07/05	Coniferales Pinaceae	*Pinus* sp.	needles	J. Voříšková
NK 353	*Pestalotiopsis* sp.	Portugal	Azores, Pico Island	38.552579 -28.443183	04/08/13	Coniferales Pinaceae	*Pinus* sp.	needles	D. Říhová
NK 383	*Neopestalotiopsis* sp.	Colombia	Cauca, Puracé	2.371940 -76.401448	09/03/14	Coniferales Pinaceae	*Pinus* sp.	needles	V. Zeisek
NK 384	*Pestalotiopsis* sp.	Ecuador	Cañar, Ingapirca	-2.538792 -78.873167	25/03/14	Coniferales Pinaceae	*Pinus* sp.	needles	V. Zeisek
NK 391	*Pestalotiopsis* sp.	Thailand	Taksim Maharat NP	16.786048 98.925874	22/01/14	Coniferales Pinaceae	*Pinus* sp.	needles	F. Kolář

Appendix 2: Accession numbers of isolates that were used in this study for the taxonomic placement of *Pestalotiopsis coffeae-arabicae* and *Pestalotiopsis simitheae*. Ex-holotype or ex-epitype cultures are marked in bold.

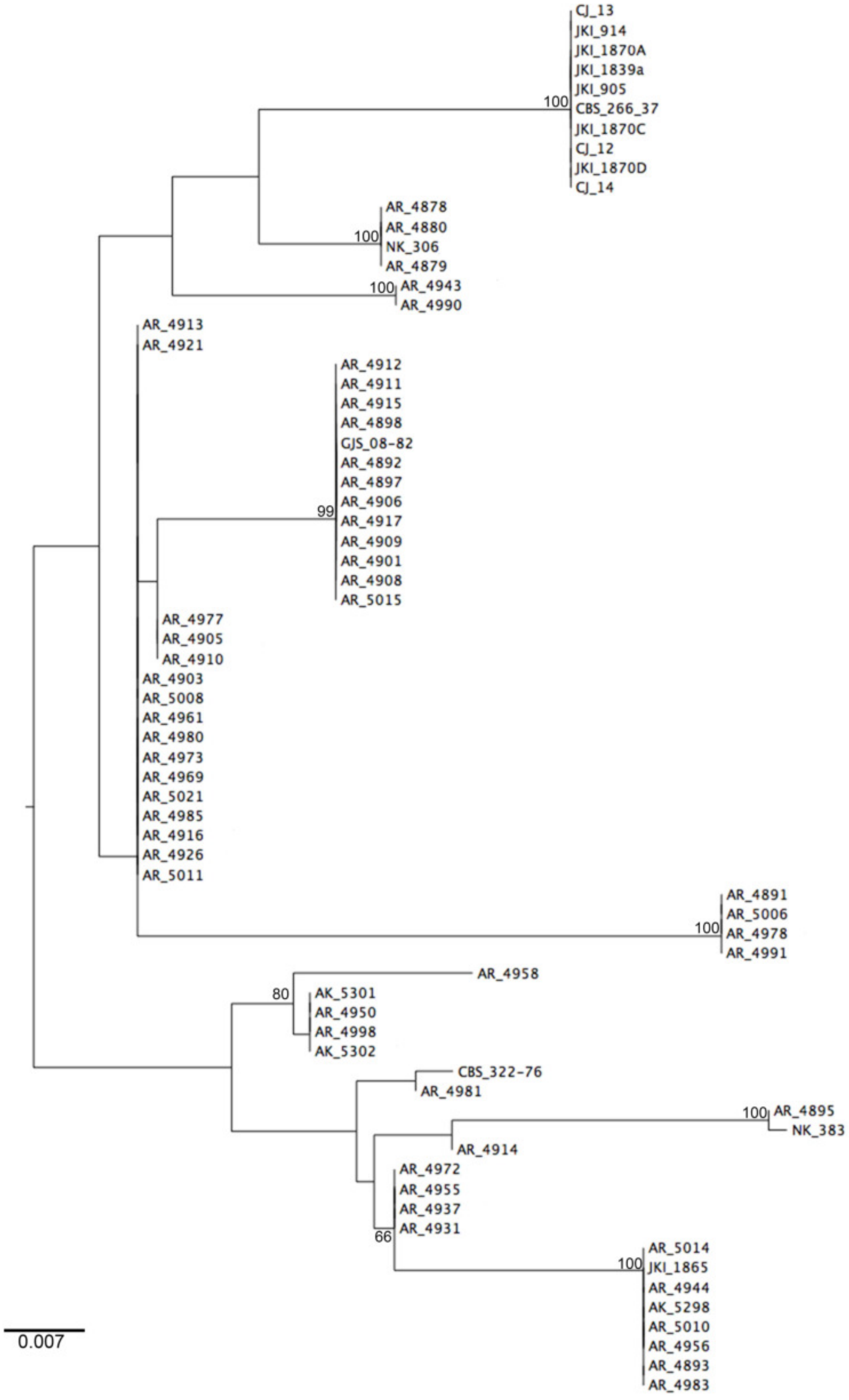
Family	**Species**	**Voucher**	**ITS**	***ß-tubulin***	***TEF1***
Pestalotiopsaceae	***Neopestalotiopsis australis***	**CBS 114159, STE-U 3017**	**KM199348**	**KM199432**	**KM199537**
Pestalotiopsaceae	***Neopestalotiopsis cubana***	**CBS 600.96 INIFAT C96/44-4**	**KM199347**	**KM199438**	**KM199521**
Pestalotiopsaceae	***Neopestalotiopsis eucalypticola***	**CBS 264.37, BBA 5300**	**KM199376**	**KM199431**	**KM199551**
Pestalotiopsaceae	***Neopestalotiopsis foedans***	**CGMCC 3.9123**	**JX398987**	**JX399022**	**JX399053**
Pestalotiopsaceae	***Neopestalotiopsis honoluluana***	**CBS 114495, STE-U 2076**	**KM199364**	**KM199457**	**KM199548**
Pestalotiopsaceae	***Neopestalotiopsis javaensis***	**CBS 257.31**	**KM199357**	**KM199437**	**KM199543**
Pestalotiopsaceae	***Neopestalotiopsis magna***	**MFLUCC 12-652, ICMP 2011**	**KF582795**	**KF582793**	**KF582791**
Pestalotiopsaceae	***Neopestalotiopsis mesopotamica***	**CBS 336.86**	**KM199362**	**KM199441**	**KM199555**
Pestalotiopsaceae	***Neopestalotiopsis natalensis***	**CBS 138.41**	**KM199377**	**KM199466**	**KM199552**
Pestalotiopsaceae	***Neopestalotiopsis protearum***	**CBS 114178, STE-U 1765**	**JN712498**	**KM199463**	**KM199542**
Pestalotiopsaceae	***Neopestalotiopsis rosae***	**CBS 101057**	**KM199359**	**KM199429**	**KM199523**
Pestalotiopsaceae	***Neopestalotiopsis samaragensis* A**	**MFLUCC 12-0233**	**JQ968609**	**JQ968610**	**JQ968611**
Pestalotiopsaceae	*Neopestalotiopsis samaragensis* B	CBS 115451, HKUCC 9095	KM199365	KM199447	KM199556
Pestalotiopsaceae	***Neopestalotiopsis saprophytica* A**	**MFLUCC 12-0282, NN047136**	**JX398982**	**JX399017**	**JX399048**
Pestalotiopsaceae	*Neopestalotiopsis saprophytica* B	CBS 115452, HKUCC 8684	KM199345	KM199433	KM199538
Pestalotiopsaceae	***Neopestalotiopsis steyaertii***	**IMI 192475**	**KF582796**	**KF582794**	**KF582792**
Pestalotiopsaceae	***Pestalotiopsis arceuthobii***	**CBS 434.65**	**KM199341**	**KM199427**	**KM199516**
Pestalotiopsaceae	***Pestalotiopsis arengae***	**CBS 331.92**	**KM199340**	**KM199426**	**KM199515**
Pestalotiopsaceae	***Pestalotiopsis biciliata***	**CBS 124463**	**KM199308**	**KM199399**	**KM199505**
Pestalotiopsaceae	***Pestalotiopsis coffeae-arabicae***	**HGUP4015**	**KF412647**	**KF412641**	**KF412644**
Pestalotiopsaceae	*Pestalotiopsis coffeae-arabicae*	HGUP4019	KF412649	KF412643	KF412646
Pestalotiopsaceae	***Pestalotiopsis colombiensis***	**CBS 118553, CPC 10969**	**KM199307**	**KM199421**	**KM199488**
Pestalotiopsaceae	***Pestalotiopsis frucata***	**CPC 20280**	**JQ683724**	**JQ683708**	**JQ683740**
Pestalotiopsaceae	***Pestalotiopsis hawaiiensis***	**CBS 114491, STE-U 2215**	**KM199339**	**KM199428**	**KM199514**
Pestalotiopsaceae	***Pestalotiopsis inflexa***	**MFLUCC 12-0270, NN0470980**	**JX399008**	**JX399039**	**JX399072**
Pestalotiopsaceae	***Pestalotiopsis knightiae***	**CBS 114138, STE-U 2906**	**KM199310**	**KM199408**	**KM199497**
Pestalotiopsaceae	***Pestalotiopsis licualacola***	**HGUP4057**	**KC492509**	**KC481683**	**KC481684**

Pestalotiopsaceae	***Pestalotiopsis malayana***	**CBS 102220**	**KM199306**	**KM199411**	**KM199482**
Pestalotiopsaceae	***Pestaltiopsis scoparia***	**CBS 176.25**	**KM199330**	**KM199393**	**KM199478**
Pestalotiopsaceae	***Pestalotiopsis simitheae***	**MFLUCC12-0121**	**KJ503812**	**KJ503815**	**KJ503818**
Pestalotiopsaceae	*Pestalotiopsis simitheae*	MFLUCC12-0125	KJ503813	KJ503816	KJ503819
Pestalotiopsaceae	***Pestalotiopsis spathulata***	**CBS 356.86**	**KM199338**	**KM199423**	**KM199513**
Pestalotiopsaceae	***Pseudopestalotiopsis cocos***	**CBS 272.29**	**KM199378**	**KM199467**	**KM199553**
Pestalotiopsaceae	***Pseudopestalotiopsis indica***	**CBS 459.78**	**KM199381**	**KM199470**	**KM199560**
Pestalotiopsaceae	***Pseudopestalotiopsis theae***	**CPC 20281**	**JQ683727**	**JQ683711**	**JQ683743**
Pestalotiopsaceae	*Pseudopestalotiopsis theae*	SC011	JQ683726	JQ683710	JQ683742

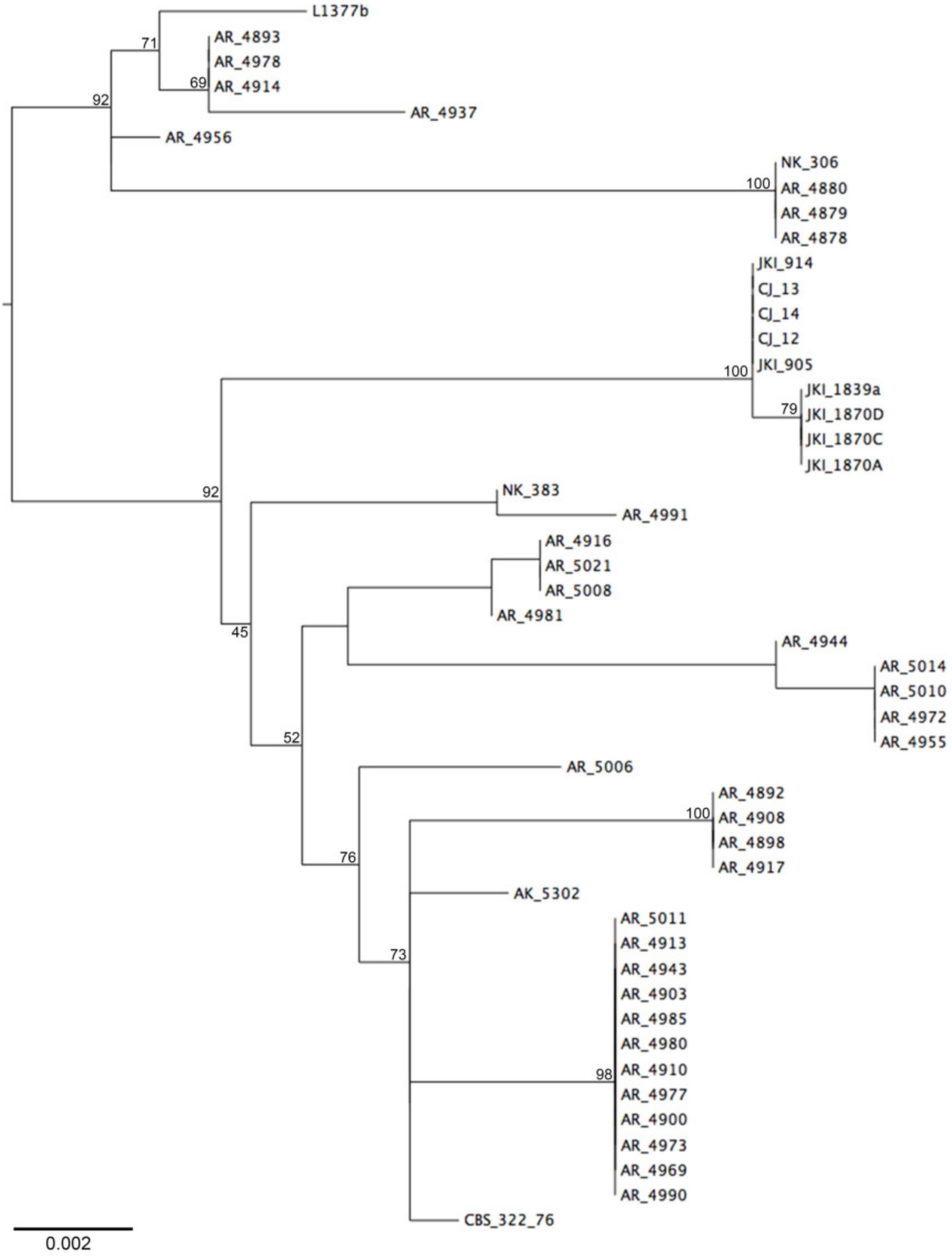
Appendix 3: Mid-point rooted phylogeny resulting from the ML analysis of the *MCM7* marker from 71 *Neopestalotiopsis* isolates. Bootstrap support values are displayed next to the corresponding node. Only bootstrap values of ≥ 50 % are shown. Scale bar refers to the number of substitutions per site.



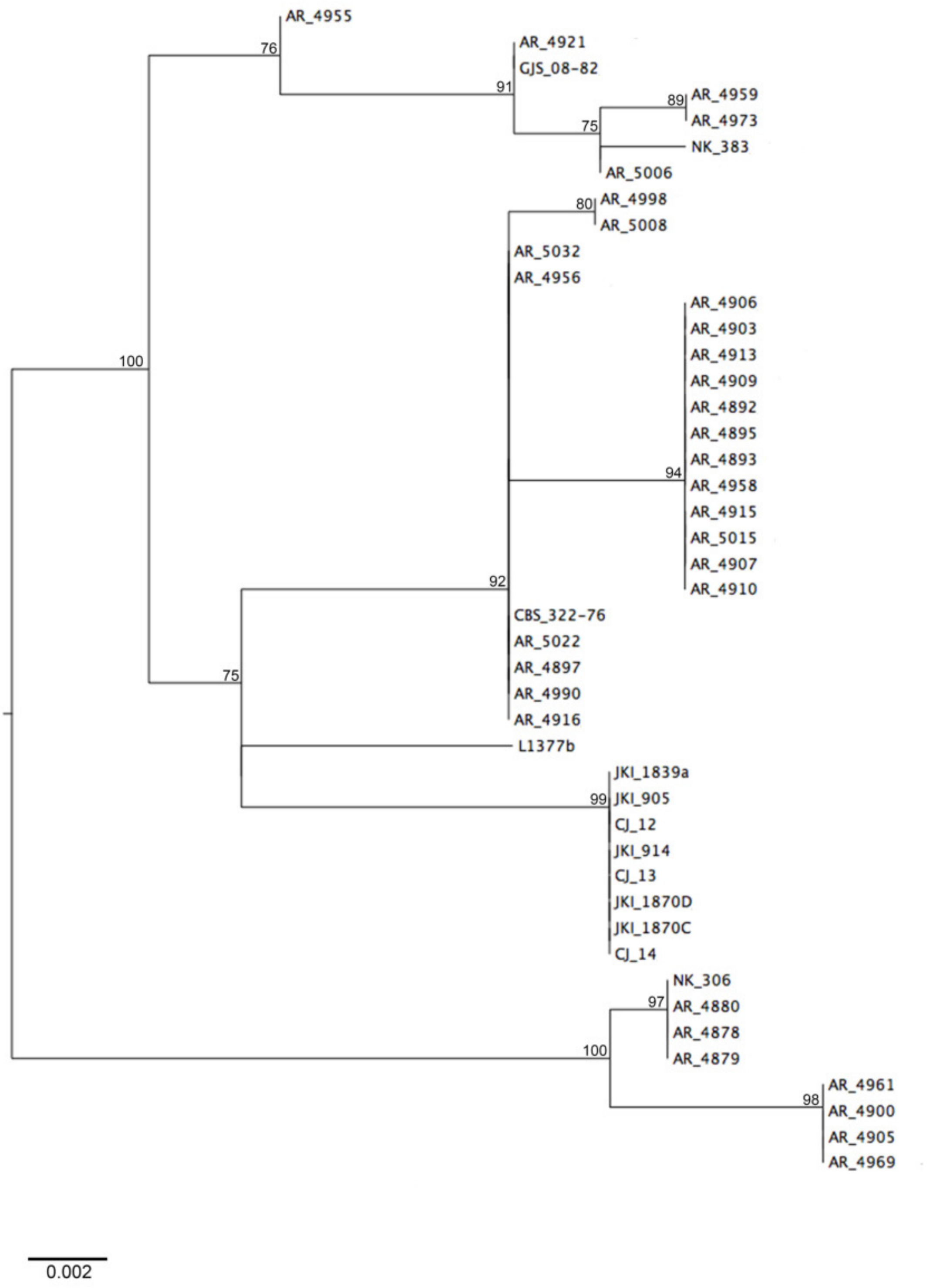
Appendix 4: Mid-point rooted phylogeny resulting from the ML analysis of the *TSR1* marker from 69 *Neopestalotiopsis* isolates. Bootstrap support values are displayed next to the corresponding node. Only bootstrap values of ≥ 50 % are shown. Scale bar refers to the number of substitutions per site.



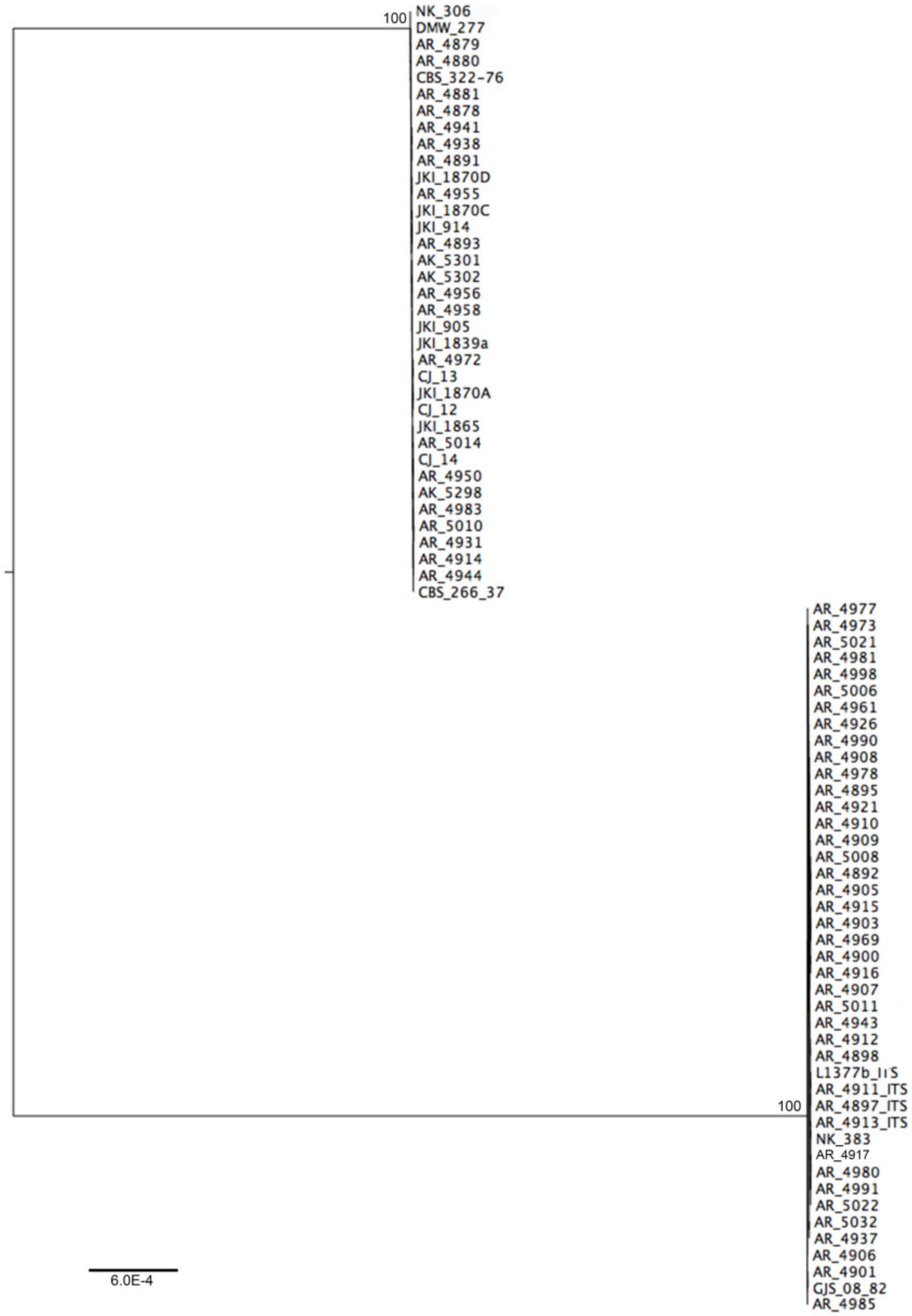
Appendix 5: Mid-point rooted phylogeny resulting from the ML analysis of the *TEF1* marker from 49 *Neopestalotiopsis* isolates. Bootstrap support values are displayed next to the corresponding node. Only bootstrap values of ≥ 50 % are shown. Scale bar refers to the number of substitutions per site.



Appendix 6: Mid-point rooted phylogeny resulting from the ML analysis of the *ß-tubulin* marker from 42 *Neopestalotiopsis* isolates. Bootstrap support values are displayed next to the corresponding node. Only bootstrap values of ≥ 50 % are shown. Scale bar refers to the number of substitutions per site.



Appendix 7: Mid-point rooted phylogeny resulting from the ML analysis of the ITS marker from 71 *Neopestalotiopsis* isolates. Bootstrap support values are displayed next to the corresponding node. Only bootstrap values of ≥ 50 % are shown. Scale bar refers to the number of substitutions per site.



8.1 Eidesstattliche Versicherung

Ich erkläre hiermit an Eides Statt, dass ich die vorgelegte Dissertation

SYSTEMATICS AND SPECIES DELIMITATION IN *PESTALOTIA* AND *PESTALOTIOPSIS* S.L. (XYLARIALES, ASCOMYCOTA)

selbständig angefertigt und mich anderer Hilfsmittel als der in ihr angegebenen nicht bedient habe, insbesondere, dass alle Entlehnungen aus anderen Schriften mit Angabe der betreffenden Schrift gekennzeichnet sind.

Ich versichere, die Grundsätze der guten wissenschaftlichen Praxis beachtet, und nicht die Hilfe einer kommerziellen Promotionsvermittlung in Anspruch genommen zu haben.

Frankfurt am Main, den ....

(Unterschrift)

8.2 Curriculum Vitae

Dipl.-Biol. Caroline Judith-Hertz

Born: 16.01.1981, Darmstadt, Germany

Nationality: German

E-mail: caroline.judith@ymail.com

Education

09/2011 – present	**Goethe-University, Frankfurt a.M.** PhD student: Doctoral dissertation: “Systematics and species delimitation in *Pestalotiopsis* s.l.” (Supervisors: Prof. Dr. M. Piepenbring, Prof. Dr. I. Schmitt)
10/2008 – 03/2009	**Goethe-University, Frankfurt a.M.** Studies of Geography, Focus: Geographic Information Systems (GIS)
09/2006 – 09/2007	**Universidad de Los Andes (ULA), Mérida, Venezuela** Studies of Biology Focus: Systematics of vascular plants
10/2002 – 09/2008	**Goethe-University, Frankfurt a.M.** Studies of Biology Major subjects: Ecology and evolution of plants (Prof. Dr. G Zizka); Ecology and evolution of animals (PD Dr. K. Schwenk); Cell and Developmental biology (Prof. Dr. P. von Koskull-Döring) Diploma degree in Biology: Diploma thesis: "Diversity and distribution of the Bromeliaceae in the city area of Mérida, Venezuela"
1999 – 2002	**Johann-Philipp-Reis-Schule, Weinheim** Gymnasium
1992 – 1999	**Alexander-von-Humboldt-Schule, Viernheim** Secondary School
1988 – 1992	**Sepp-Herberger-Grundschule, Hohensachsen** Primary School

Research Experience

09/2011 – present	**Goethe – University, Frankfurt a.M., Department: Mycology** Research associate

05/2012 – 12/2012	**United States Department of Agriculture (USDA-ARS), Beltsville, MD, USA** International visiting scientist with the Systematic Mycology & Microbiology Laboratory (SMML) of the U.S. Department of Agriculture in Beltsville, Maryland (Supervisor: Dr. Amy Rossman). Objectives: “Nomenclature of the rust fungi order *Hemileia*, phylogeny, taxonomy and diversity of ascomycetous fungi, with special emphasis on the genus *Pestalotiopsis*” and database management of the SMML database.
01/2006 – 02/2006	**Goethe – University, Frankfurt a.M.** Research internship (Supervisor: Prof. Dr. B. Streit): Contributing to a PhD-project characterizing the phylogeography and diversity of freshwater snails.
01/2005 - 02/2005	**Rainforest Reservation „Fundación Jatun Sacha“, Ecuador** Internship: Jatun Sacha biological station at the upper Napo River in the Ecuadorian Amazon.
08/2005 – 10/2005	**Peptide Specialty Laboratories, Heidelberg** Research internship (Supervisor: Dr. H.-R. Rackwitz): Peptide synthesis using solid phase peptide synthesis and HPLC purification.

Fieldwork experience

02/2012 – 04/2012	**Collection trip to Panama** Research objective: Plant pathogenic fungi on cultivated plants. Collaboration project with Universidad Autónoma de Chiriquí (UNACHI).
03/2006 – 04/2006	**Collection trip to Cuba** Research objective: Systematics, morphology and ecology of tropical vascular plants (Supervisor: Prof. Dr. G. Zizka).

University teaching and assistantship

2012 – 2015	**Goethe – University, Frankfurt a.M.** Supervision and teaching of the practical course "Ecology and Systematics of organisms and their habitats".
2006 – 2011	**Goethe – University, Frankfurt a.M.** Student research assistant of the practical course "Ecology and Systematics of organisms and their habitats".

Work experience

02/2011 – 07/2011	**Science Center Experiminta, Frankfurt a.M.** Employee. Science education and guided tours for kids, teenagers, and adults and elaboration and accomplishment of special events.
11/2009 – 10/2010	**German Society for International Cooperation (GIZ), La Paz, Bolivia** Assistant to the program director. Coordinating cooperation with scientific institutions, accomplishing training programs for local partners, and project management on an international level.

04/2009 – 09/2010	**German Society for International Cooperation (GIZ), Eschborn** Internship: Contributing to a training course for employers entitled „Agriculture and Climate Change” and expert reports related to genetic modified organisms.
12/2008 – 03/2009	**German Federal Agency of Cartography and Geodesy, Frankfurt a.M.** Consultant. Responsible for the data quality control and analysis of aero-photos and thematic maps in ArcGIS 9.2.
10/2005 – 12/2005	**Senckenberg Research Institute, Frankfurt a.M.** Student research assistant. BIOTA Project for sustainable use and conservation of biodiversity in Africa: Maintenance of the literature data-base and the herbarium plant collection.

Grants

05/2014 – 07/2014	**German Academic Exchange Service (DAAD)** Research grant for a two-month stay at the US Department of Agriculture, Beltsville, MD, USA
09/2006 – 09/2007	One-Year Scholarship for studying at the ULA, Merida, Venezuela
01/2013	**Hermann-Willkomm-Stiftung** Scholarship for the participation at the Workshop "Molecular Evolution 2013", Krumlov, Czech Republic
05/2012 – 11/2012	**US-Forest Service International Program** Research grant for a seven-month stay at the US Department of Agriculture, Beltsville, MD, USA
09/2010 – 10/2010	**Centro Boliviano de Estudios Multidisciplinarios** Scholarship for the online training course on possible causes of the global climate change and its impacts and challenges to Andean regions.
11/2007	**ESRI-Training: Cartography with ArcGIS 9.x** Scholarship for an intensive course. Theoretical and practical lessons on the usage of ArcGIS 9.x.

Memberships

02/2014 – present	German Scientific Society for Plant Protection and Plant Health (DPG)
01/2009 – present	German Botanical Association (DBG)
09/2005 – 10/2009	Mentor Network for Women in Natural Science
01/1996 – present	Society for the protection of valuable landscapes in the Upper Palatinate

Peer-review ad hoc reviewer

Mycological Progress

Personal skills

Computer skills

Microsoft office (2003, 2007, 2010)

Image (Adobe Photoshop, Illustrater)

Geography (ArcGIS 9.2, 9.3,10.0)

Phylogeny (Geneious, MrBayes, RAxML)

Languages

German: mother tongue

English: fluent in spoken and writing

Spanish: business fluent

Publications

Peer-reviewed articles

Réblova M, Miller AN, Rossman AY, Seifert KA, Crous PW, Hawksworth DL, Abdel-Wahab MA, Cannon PF, Daranagama DA, De Beer ZW, Huang SK, Hyde KD, Jayawardena R, Jaklitsch W, Gareth Jones EB, Ju YM, **Judith C**, Maharachchikumbura SSN, Pang KL, Petrini LE, Raja HA, Romero AI, Shearer C, Senanayake IC, Voglmayr H, Weir BS, Wijayawarden NN (2016) Recommendations for competing sexual-asexually typified generic names in *Sordariomycetes* (except *Diaporthales*, *Hypocreals*, and *Magnaporthales*). *IMA Fungus* 7:131–153

Judith C, Rossman AY (2014) Revised scientific names of the genus *Hemileia* (*Uredinales*) based on the new ICN. *MycoKeys*, 8:1–10

Judith C, Rossman AY, Kennedy AH, Cáceres O, Piepenbring M (2015) *Microchrysosphaera graminicola*, an enigmatic new genus and species in the Hypocreals from Panama. *Mycological Progress*, 14:1–12

Judith C, Schneider JV, Schmidt M, Ortega R, Gaviria J, Zizka G (2013) Using high-resolition remote sensing data for habitat suitability models of Bromeliaceae in the city of Mérida, Venezuela. *Landscape and Urban Planning*, 120:107–118

Poster Session

Piepenbring M, Hofmann TA, Unterseher M, Kost G, **Judith C** (2012) Species richness of plants and fungi in western Panama – towards a fungi inventory in the tropics. Poster Session at the Annual Meeting of the “Mycological Society of America (MSA)”

Others

Cuellar, D.J., Ibarnegray, V., Heredia, J., **Judith, C.** and Espinoza, S. (2011) Manual Didáctico sobre Cambio Climático: Un aporte para el aprendizaje y la adaptación al Cambio Climático (Manual about climate change: An aid for the understanding and adaption to climate change). ISBN: 978-99954-63-00-7

Caroline Judith-Hertz   Frankfurt a.M., 10/10/2016

8.3 Supplementary files on CD-ROM

S1: List of conidial measurements of *Pestalotiopsis* spp. specimens included in the ANOVA and TukeyHSD test

S2: Measurements of the examined herbarium specimens

S1

Genus	**Isolate**	**Sample**	**Length**	**Width**	**LM**	**LA**	**LB**	**BP&P**
Pestalotiopsis	AR_4894	1	26.9	6.1	16.9	16.7	8.0	A
Pestalotiopsis	AR_4894	2	23.8	7.5	14.4	21.2	8.9	A
Pestalotiopsis	AR_4894	3	25.6	6.8	16.4	16.0	5.9	A
Pestalotiopsis	AR_4894	4	25.3	6.5	17.7	20.0	9.4	A
Pestalotiopsis	AR_4894	5	27.4	5.6	18.5	16.3	7.8	A
Pestalotiopsis	AR_4894	6	24.3	6.4	16.5	16.9	8.2	A
Pestalotiopsis	AR_4894	7	22.3	7.2	14.4	21.2	13.1	A
Pestalotiopsis	AR_4894	8	24.4	6.8	15.5	18.3	5.4	A
Pestalotiopsis	AR_4894	9	27.2	6.6	16.4	19.4	8.9	A
Pestalotiopsis	AR_4894	10	21.9	7.0	15.2	20.1	10.3	A
Pestalotiopsis	AR_4894	11	24.0	6.4	15.9	17.3	11.4	A
Pestalotiopsis	AR_4894	12	24.3	7.2	16.2	21.5	9.7	A
Pestalotiopsis	AR_4894	13	22.4	7.0	14.5	16.5	7.8	A
Pestalotiopsis	AR_4894	14	26.5	6.2	17.4	22.1	6.2	A
Pestalotiopsis	AR_4894	15	21.1	6.7	14.7	21.3	9.7	A
Pestalotiopsis	AR_4894	16	24.4	6.2	15.3	17.4	10.6	A
Pestalotiopsis	AR_4894	17	32.8	5.3	19.3	18.3	8.2	A
Pestalotiopsis	AR_4894	18	24.5	7.7	15.6	15.8	9.5	A
Pestalotiopsis	AR_4894	19	27.2	8.2	15.9	19.3	11.0	A
Pestalotiopsis	AR_4894	20	28.4	6.4	17.2	20.1	10.4	A
Pestalotiopsis	CJ_36	1	19.8	5.2	12.3	24.6	3.2	A
Pestalotiopsis	CJ_36	2	17.5	4.8	11.1	34.5	4.2	A
Pestalotiopsis	CJ_36	3	18.8	4.7	11.4	19	5.3	A
Pestalotiopsis	CJ_36	4	20.2	4.7	13.4	21.5	3.6	A
Pestalotiopsis	CJ_36	5	18	4.3	11.3	32.5	4.2	A
Pestalotiopsis	CJ_36	6	16.6	4.8	11.7	19	5.3	A
Pestalotiopsis	CJ_36	7	17.4	5	10.6	18	5.1	A
Pestalotiopsis	CJ_36	8	17.3	5.3	11.5	22	3.4	A
Pestalotiopsis	CJ_36	9	20.3	5	11.7	24.2	3	A
Pestalotiopsis	CJ_36	10	18.4	5.8	13.4	23.4	4.2	A
Pestalotiopsis	CJ_36	11	18.9	5.2	12.4	16.7	3.6	A
Pestalotiopsis	CJ_36	12	20.7	5.9	11.8	27.4	4.2	A
Pestalotiopsis	CJ_36	13	19.7	4.6	13.8	20.3	5.6	A
Pestalotiopsis	CJ_36	14	15.2	5	16.2	21.3	5.3	A
Pestalotiopsis	CJ_36	15	18.6	5.2	9.9	19.8	4	A
Pestalotiopsis	CJ_36	16	19.8	4.6	12.2	19.4	5.2	A
Pestalotiopsis	CJ_36	17	19.6	5.2	13	22.4	3.2	A
Pestalotiopsis	CJ_36	18	18.7	4.6	12.3	36.7	3.2	A
Pestalotiopsis	CJ_36	19	17.3	4.3	12.9	25.3	3.7	A
Pestalotiopsis	CJ_36	20	15.8	4.9	11.5	20.4	4.1	A
Pestalotiopsis	CJ_37	1	23.1	6.1	14.0	11.5	5.0	A
Pestalotiopsis	CJ_37	2	22.5	6.3	14.7	12.6	0.0	A
Pestalotiopsis	CJ_37	3	24.7	6.1	14.4	20.0	5.5	A
Pestalotiopsis	CJ_37	4	22.7	5.4	14.4	19.5	0.0	A
Pestalotiopsis	CJ_37	5	24.0	6.5	15.4	15.9	0.0	A
Pestalotiopsis	CJ_37	6	27.1	5.4	17.2	10.4	4.9	A
Pestalotiopsis	CJ_37	7	21.6	5.9	15.1	14.7	5.6	A
Pestalotiopsis	CJ_37	8	23.1	6.1	14.1	19.5	6.3	A
Pestalotiopsis	CJ_37	9	22.4	6.5	14.5	13.8	0.0	A
Pestalotiopsis	CJ_37	10	24.1	5.7	14.6	16.0	5.8	A

Pestalotiopsis	CJ_37	11	21.5	6.1	13.7	20.5	4.3	A
Pestalotiopsis	CJ_37	12	20.9	6.4	14.0	11.5	4.8	A
Pestalotiopsis	CJ_37	13	21.4	5.8	13.9	12.7	0.0	A
Pestalotiopsis	CJ_37	14	21.7	5.2	15.3	20.0	5.7	A
Pestalotiopsis	CJ_37	15	21.1	7.2	13.5	20.1	0.0	A
Pestalotiopsis	CJ_37	16	20.0	6.3	13.5	19.6	0.0	A
Pestalotiopsis	CJ_37	17	22.6	6.1	15.0	14.8	4.2	A
Pestalotiopsis	CJ_37	18	24.1	6.4	14.3	19.5	4.6	A
Pestalotiopsis	CJ_37	19	21.4	6.1	14.6	13.9	0.0	A
Pestalotiopsis	CJ_37	20	24.9	5.4	15.1	16.2	5.5	A
Pestalotiopsis	AR_5034	1	25.9	6.5	16.3	20.0	11.3	C
Pestalotiopsis	AR_5034	2	25.9	7.4	16.2	19.2	7.7	C
Pestalotiopsis	AR_5034	3	30.3	5.4	19.4	13.8	7.5	C
Pestalotiopsis	AR_5034	4	23.5	5.4	14.9	22.0	8.4	C
Pestalotiopsis	AR_5034	5	23.2	6.6	14.9	21.3	11.5	C
Pestalotiopsis	AR_5034	6	25.5	6.3	17.0	18.8	7.6	C
Pestalotiopsis	AR_5034	7	30.4	5.0	20.1	20.4	8.9	C
Pestalotiopsis	AR_5034	8	20.9	6.4	14.0	21.9	10.1	C
Pestalotiopsis	AR_5034	9	23.1	6.3	15.7	14.6	7.4	C
Pestalotiopsis	AR_5034	10	26.4	5.9	16.4	17.4	8.3	C
Pestalotiopsis	AR_5034	11	24.4	6.3	15.5	20.0	9.8	C
Pestalotiopsis	AR_5034	12	32.5	5.4	18.1	15.5	11.2	C
Pestalotiopsis	AR_5034	13	23.3	5.9	15.2	17.5	10.1	C
Pestalotiopsis	AR_5034	14	22.9	6.9	16.0	21.1	7.8	C
Pestalotiopsis	AR_5034	15	29.8	6.2	20.8	20.5	8.3	C
Pestalotiopsis	AR_5034	16	22.2	6.1	14.6	19.4	9.9	C
Pestalotiopsis	AR_5034	17	24.4	7.4	15.6	17.6	8.4	C
Pestalotiopsis	AR_5034	18	23.0	7.1	16.1	18.4	10.4	C
Pestalotiopsis	AR_5034	19	28.5	5.9	17.2	20.1	7.3	C
Pestalotiopsis	AR_5034	20	23.4	6.9	14.6	13.9	8.1	C
Pestalotiopsis	AR_5025	1	33.4	7.2	21.3	29.4	7.5	D
Pestalotiopsis	AR_5025	2	29.3	8.7	19.3	30.3	7.8	D
Pestalotiopsis	AR_5025	3	28.0	7.5	17.8	26.4	8.3	D
Pestalotiopsis	AR_5025	4	36.0	7.8	26.7	28.3	10.3	D
Pestalotiopsis	AR_5025	5	31.0	8.5	19.0	25.0	9.3	D
Pestalotiopsis	AR_5025	6	28.7	8.4	17.6	26.0	8.2	D
Pestalotiopsis	AR_5025	7	30.2	8.7	19.5	30.0	10.0	D
Pestalotiopsis	AR_5025	8	35.0	8.0	26.0	25.4	12.0	D
Pestalotiopsis	AR_5025	9	30.0	9.5	17.0	27.3	9.6	D
Pestalotiopsis	AR_5025	10	29.5	8.7	19.3	29.1	12.9	D
Pestalotiopsis	AR_5025	11	34.0	8.6	22.0	25.0	10.0	D
Pestalotiopsis	AR_5025	12	25.0	8.7	18.0	30.4	11.8	D
Pestalotiopsis	AR_5025	13	29.2	8.3	18.6	26.3	10.3	D
Pestalotiopsis	AR_5025	14	27.5	8.5	17.8	25.7	8.2	D
Pestalotiopsis	AR_5025	15	27.5	9.3	17.0	29.0	11.5	D
Pestalotiopsis	AR_5025	16	26.5	9.1	17.0	26.0	9.7	D
Pestalotiopsis	AR_5025	17	32.0	8.5	19.3	29.5	11.0	D
Pestalotiopsis	AR_5025	18	28.5	8.2	19.7	30.0	8.0	D
Pestalotiopsis	AR_5025	19	26.8	9.0	18.3	27.0	11.2	D
Pestalotiopsis	AR_5025	20	31.0	8.3	19.2	30.0	13.0	D
Pestalotiopsis	CBS_170.26	1	30.4	8.7	17.3	18.2	7.2	D
Pestalotiopsis	CBS_170.26	2	27.4	8.3	19.2	19.9	11.1	D
Pestalotiopsis	CBS_170.26	3	34.4	7.4	19.7	14.9	9.0	D

Pestalotiopsis	CBS_170.26	4	25.7	8.0	17.3	19.5	10.8	D
Pestalotiopsis	CBS_170.26	5	29.4	7.0	20.0	26.3	8.3	D
Pestalotiopsis	CBS_170.26	6	26.7	7.6	17.6	16.0	7.0	D
Pestalotiopsis	CBS_170.26	7	32.1	8.4	20.3	25.3	9.2	D
Pestalotiopsis	CBS_170.26	8	30.1	7.5	17.4	20.1	11.5	D
Pestalotiopsis	CBS_170.26	9	28.3	6.9	19.3	19.3	10.2	D
Pestalotiopsis	CBS_170.26	10	27.4	6.8	18.4	14.5	8.4	D
Pestalotiopsis	CBS_170.26	11	29.0	7.3	17.3	15.8	9.5	D
Pestalotiopsis	CBS_170.26	12	29.4	7.5	19.2	17.9	10.2	D
Pestalotiopsis	CBS_170.26	13	30.4	7.2	17.4	20.3	7.3	D
Pestalotiopsis	CBS_170.26	14	33.1	8.2	20.1	18.3	9.1	D
Pestalotiopsis	CBS_170.26	15	25.9	6.3	18.3	19.7	10.0	D
Pestalotiopsis	CBS_170.26	16	30.7	8.1	19.3	25.8	8.2	D
Pestalotiopsis	CBS_170.26	17	29.3	7.6	20.4	26.0	9.6	D
Pestalotiopsis	CBS_170.26	18	34.8	7.0	16.7	19.3	9.1	D
Pestalotiopsis	CBS_170.26	19	27.4	6.8	17.2	18.1	10.4	D
Pestalotiopsis	CBS_170.26	20	29.4	8.1	19.9	14.3	7.4	D
Pestalotiopsis	AR_5012	1	27.2	6.8	15.8	24.2	9.5	E
Pestalotiopsis	AR_5012	2	31.5	6.2	18.6	27.3	7.2	E
Pestalotiopsis	AR_5012	3	28.0	6.8	15.6	21.0	8.3	E
Pestalotiopsis	AR_5012	4	25.0	6.5	16.0	23.9	9.4	E
Pestalotiopsis	AR_5012	5	27.5	6.7	15.5	26.9	7.2	E
Pestalotiopsis	AR_5012	6	24.8	6.9	16.0	24.5	11.7	E
Pestalotiopsis	AR_5012	7	29.0	7.0	18.3	21.0	9.0	E
Pestalotiopsis	AR_5012	8	30.3	7.5	17.9	21.2	8.3	E
Pestalotiopsis	AR_5012	9	25.4	7.2	16.3	27.8	10.0	E
Pestalotiopsis	AR_5012	10	25.0	7.5	15.9	23.9	7.0	E
Pestalotiopsis	AR_5012	11	28.5	6.5	18.5	28.0	9.5	E
Pestalotiopsis	AR_5012	12	25.5	6.5	16.3	28.5	13.2	E
Pestalotiopsis	AR_5012	13	25.7	5.5	17.1	21.9	13.0	E
Pestalotiopsis	AR_5012	14	27.5	5.8	17.0	26.4	12.3	E
Pestalotiopsis	AR_5012	15	30.0	4.5	19.5	28.0	9.2	E
Pestalotiopsis	AR_5012	16	25.5	6.5	17.0	23.9	10.2	E
Pestalotiopsis	AR_5012	17	22.0	7.0	14.5	22.8	8.1	E
Pestalotiopsis	AR_5012	18	24.5	6.3	17.0	17.3	10.2	E
Pestalotiopsis	AR_5012	19	28.0	7.5	17.3	25.4	8.1	E
Pestalotiopsis	AR_5012	20	30.0	7.1	18.2	26.0	7.1	E
Pestalotiopsis	AR_4999	1	26.8	6.2	16.5	19.7	5.9	E
Pestalotiopsis	AR_4999	2	22.7	7.3	15.7	20.3	8.5	E
Pestalotiopsis	AR_4999	3	24.7	7.4	16.7	18.5	9.8	E
Pestalotiopsis	AR_4999	4	26.1	6.3	16.9	19.2	5.2	E
Pestalotiopsis	AR_4999	5	23.1	5.3	15.3	11.6	8.1	E
Pestalotiopsis	AR_4999	6	23.5	5.8	15.4	18.1	9.4	E
Pestalotiopsis	AR_4999	7	24.8	6.9	13.5	16.6	6.7	E
Pestalotiopsis	AR_4999	8	25.4	5.5	15.6	16.4	6.2	E
Pestalotiopsis	AR_4999	9	25.1	5.2	14.7	21.0	8.0	E
Pestalotiopsis	AR_4999	10	23.6	5.5	13.6	18.3	8.5	E
Pestalotiopsis	AR_4999	11	23.9	5.4	15.8	23.1	10.2	E
Pestalotiopsis	AR_4999	12	24.4	5.8	16.4	21.4	7.4	E
Pestalotiopsis	AR_4999	13	25.4	6.4	16.6	20.4	8.4	E
Pestalotiopsis	AR_4999	14	25.4	7.4	13.5	19.4	6.9	E
Pestalotiopsis	AR_4999	15	26.9	7.2	14.7	18.4	7.4	E
Pestalotiopsis	AR_4999	16	23.9	6.7	15.4	13.4	9.8	E

Pestalotiopsis	AR_4999	17	24.4	5.3	14.4	16.4	8.5	E
Pestalotiopsis	AR_4999	18	26.4	5.3	15.4	20.1	5.9	E
Pestalotiopsis	AR_4999	19	26.0	7.8	16.3	15.9	6.7	E
Pestalotiopsis	AR_4999	20	25.2	5.3	15.4	20.4	8.3	E
Pestalotiopsis	AR_5027	1	21.9	5.5	15.4	15.9	5.1	E
Pestalotiopsis	AR_5027	2	24.9	6.4	16.3	15.8	4.9	E
Pestalotiopsis	AR_5027	3	22.4	7.5	12.5	17.8	5.7	E
Pestalotiopsis	AR_5027	4	23.1	5.9	15.7	19.4	5.4	E
Pestalotiopsis	AR_5027	5	27.2	7.3	17.4	21.3	6.8	E
Pestalotiopsis	AR_5027	6	20.4	6.6	12.9	21.9	5.4	E
Pestalotiopsis	AR_5027	7	22.8	6.7	16.1	16.2	6.1	E
Pestalotiopsis	AR_5027	8	26.4	6.0	18.1	22.5	7.5	E
Pestalotiopsis	AR_5027	9	24.1	6.9	14.6	17.1	4.4	E
Pestalotiopsis	AR_5027	10	21.3	6.9	15.5	19.5	6.4	E
Pestalotiopsis	AR_5027	11	21.8	5.3	16.1	15.2	5.0	E
Pestalotiopsis	AR_5027	12	26.9	6.4	12.0	18.1	6.1	E
Pestalotiopsis	AR_5027	13	23.8	7.7	15.8	19.6	5.5	E
Pestalotiopsis	AR_5027	14	20.3	5.8	17.2	21.0	7.1	E
Pestalotiopsis	AR_5027	15	22.5	7.2	13.0	22.1	5.4	E
Pestalotiopsis	AR_5027	16	24.9	6.4	16.4	16.4	6.2	E
Pestalotiopsis	AR_5027	17	23.9	5.8	18.4	23.0	7.0	E
Pestalotiopsis	AR_5027	18	20.8	7.1	14.3	17.3	4.8	E
Pestalotiopsis	AR_5027	19	21.8	5.3	15.8	19.3	5.4	E
Pestalotiopsis	AR_5027	20	22.8	6.7	16.0	15.0	6.6	E
Pestalotiopsis	AR_5019	1	21.7	6.3	11.9	16.3	3.1	E
Pestalotiopsis	AR_5019	2	23.6	6.0	17.2	13.5	5.1	E
Pestalotiopsis	AR_5019	3	21.2	6.8	12.5	18.9	6.0	E
Pestalotiopsis	AR_5019	4	21.7	5.9	12.0	13.4	4.6	E
Pestalotiopsis	AR_5019	5	23.5	5.5	13.8	22.2	7.6	E
Pestalotiopsis	AR_5019	6	25.2	7.0	15.2	19.0	6.8	E
Pestalotiopsis	AR_5019	7	23.0	6.3	15.2	16.2	3.3	E
Pestalotiopsis	AR_5019	8	26.0	6.9	18.4	18.8	7.7	E
Pestalotiopsis	AR_5019	9	22.5	6.5	14.5	15.7	3.7	E
Pestalotiopsis	AR_5019	10	22.5	5.7	14.0	18.1	7.8	E
Pestalotiopsis	AR_5019	11	21.4	6.1	16.2	20.3	7.2	E
Pestalotiopsis	AR_5019	12	23.4	5.8	13.2	21.3	4.2	E
Pestalotiopsis	AR_5019	13	26.7	5.2	12.5	14.5	5.2	E
Pestalotiopsis	AR_5019	14	22.7	7.2	14.2	19.0	6.9	E
Pestalotiopsis	AR_5019	15	25.1	5.9	5.7	18.4	5.2	E
Pestalotiopsis	AR_5019	16	21.5	6.3	17.0	16.9	3.9	E
Pestalotiopsis	AR_5019	17	20.9	5.2	12.5	22.0	7.2	E
Pestalotiopsis	AR_5019	18	24.7	6.9	13.9	20.5	4.9	E
Pestalotiopsis	AR_5019	19	27.1	5.0	15.6	14.9	5.3	E
Pestalotiopsis	AR_5019	20	25.3	6.1	15.8	15.6	6.2	E
Pestalotiopsis	AR_5012	1	31.3	5.4	19.6	26.4	10.2	E
Pestalotiopsis	AR_5012	2	25.8	6.1	16.6	23.8	17.0	E
Pestalotiopsis	AR_5012	3	27.5	6.8	16.7	23.1	20.8	E
Pestalotiopsis	AR_5012	4	26.0	6.2	17.4	31.2	11.1	E
Pestalotiopsis	AR_5012	5	25.1	7.1	15.3	34.5	18.7	E
Pestalotiopsis	AR_5012	6	30.1	5.7	17.2	28.4	6.6	E
Pestalotiopsis	AR_5012	7	26.2	6.5	15.1	24.4	18.0	E
Pestalotiopsis	AR_5012	8	28.7	6.1	16.8	30.4	6.9	E
Pestalotiopsis	AR_5012	9	29.0	5.4	17.6	25.6	8.2	E

Pestalotiopsis	AR_5012	10	29.3	6.3	18.8	33.1	12.3	E
Pestalotiopsis	AR_5012	11	26.4	6.4	16.4	29.4	19.0	E
Pestalotiopsis	AR_5012	12	24.9	6.1	17.4	27.4	21.5	E
Pestalotiopsis	AR_5012	13	27.0	6.4	17.0	30.1	10.3	E
Pestalotiopsis	AR_5012	14	23.5	6.4	15.6	24.2	7.8	E
Pestalotiopsis	AR_5012	15	24.7	7.2	17.4	28.4	9.2	E
Pestalotiopsis	AR_5012	16	26.6	6.9	18.1	30.1	18.4	E
Pestalotiopsis	AR_5012	17	26.5	5.9	15.7	35.0	20.3	E
Pestalotiopsis	AR_5012	18	26.2	7.2	16.6	24.5	9.4	E
Pestalotiopsis	AR_5012	19	29.7	5.7	19.8	33.5	10.0	E
Pestalotiopsis	AR_5012	20	23.3	6.3	15.0	34.1	21.3	E
Pestalotiopsis	AR_5004	1	23.0	6.5	14.0	18.0	8.0	F
Pestalotiopsis	AR_5004	2	25.5	6.8	14.8	26.0	8.3	F
Pestalotiopsis	AR_5004	3	24.0	5.6	13.5	20.4	7.3	F
Pestalotiopsis	AR_5004	4	21.5	6.2	13.0	26.3	6.0	F
Pestalotiopsis	AR_5004	5	19.5	5.6	11.6	24.3	7.3	F
Pestalotiopsis	AR_5004	6	22.0	5.5	13.8	16.0	8.9	F
Pestalotiopsis	AR_5004	7	19.5	6.3	13.0	17.4	8.0	F
Pestalotiopsis	AR_5004	8	23.0	6.5	14.8	25.0	7.2	F
Pestalotiopsis	AR_5004	9	23.8	5.2	14.8	19.2	10.5	F
Pestalotiopsis	AR_5004	10	21.0	5.5	13.6	23.3	6.9	F
Pestalotiopsis	AR_5004	11	22.3	6.7	13.0	15.0	7.0	F
Pestalotiopsis	AR_5004	12	20.5	5.9	12.5	21.0	7.3	F
Pestalotiopsis	AR_5004	13	20.0	6.2	12.1	14.6	7.5	F
Pestalotiopsis	AR_5004	14	21.5	5.4	13.0	18.5	8.4	F
Pestalotiopsis	AR_5004	15	20.0	5.5	13.1	19.0	8.2	F
Pestalotiopsis	AR_5004	16	25.5	6.5	15.0	21.0	9.0	F
Pestalotiopsis	AR_5004	17	23.0	5.1	14.0	27.0	8.5	F
Pestalotiopsis	AR_5004	18	22.0	6.3	13.5	25.9	10.0	F
Pestalotiopsis	AR_5004	19	19.0	5.0	12.0	27.8	10.3	F
Pestalotiopsis	AR_5004	20	24.0	6.5	15.0	18.2	8.2	F
Pestalotiopsis	AR_5000	1	23.5	7.0	14.1	22.8	8.0	F
Pestalotiopsis	AR_5000	2	24.5	6.1	14.7	31.0	8.6	F
Pestalotiopsis	AR_5000	3	22.0	5.9	13.6	36.8	8.7	F
Pestalotiopsis	AR_5000	4	23.0	6.4	13.5	13.7	11.3	F
Pestalotiopsis	AR_5000	5	28.2	5.9	16.6	27.9	6.4	F
Pestalotiopsis	AR_5000	6	24.3	5.3	14.1	33.4	9.3	F
Pestalotiopsis	AR_5000	7	23.7	5.5	15.5	23.7	8.3	F
Pestalotiopsis	AR_5000	8	20.2	7.0	12.9	35.8	11.3	F
Pestalotiopsis	AR_5000	9	21.5	6.1	13.1	25.9	10.5	F
Pestalotiopsis	AR_5000	10	23.4	6.1	14.4	28.4	7.5	F
Pestalotiopsis	AR_5000	11	25.0	5.7	17.3	31.4	9.3	F
Pestalotiopsis	AR_5000	12	25.1	5.5	15.6	17.9	8.4	F
Pestalotiopsis	AR_5000	13	20.9	6.4	14.2	29.1	8.6	F
Pestalotiopsis	AR_5000	14	23.0	6.2	14.8	23.8	10.0	F
Pestalotiopsis	AR_5000	15	24.3	5.5	14.6	26.0	9.3	F
Pestalotiopsis	AR_5000	16	20.3	5.6	12.9	32.1	11.3	F
Pestalotiopsis	AR_5000	17	23.6	5.7	13.9	15.4	7.2	F
Pestalotiopsis	AR_5000	18	21.6	6.8	13.0	29.4	8.6	F
Pestalotiopsis	AR_5000	19	24.3	6.0	14.3	33.2	6.9	F
Pestalotiopsis	AR_5000	20	20.9	6.8	14.0	29.7	11.4	F
Pestalotiopsis	AR_4960	1	25.7	6.4	14.7	15.0	8.2	G
Pestalotiopsis	AR_4960	2	23.8	6.0	14.9	12.7	5.7	G

Pestalotiopsis	AR_4960	3	25.0	6.5	16.0	18.0	8.4	G
Pestalotiopsis	AR_4960	4	24.0	6.3	18.4	15.4	5.4	G
Pestalotiopsis	AR_4960	5	22.0	5.9	14.2	17.8	8.0	G
Pestalotiopsis	AR_4960	6	19.3	6.6	14.7	23.0	6.7	G
Pestalotiopsis	AR_4960	7	24.7	7.3	17.4	21.8	7.1	G
Pestalotiopsis	AR_4960	8	21.2	6.0	14.7	12.9	6.5	G
Pestalotiopsis	AR_4960	9	22.7	5.8	16.5	16.4	7.4	G
Pestalotiopsis	AR_4960	10	20.6	5.0	14.2	18.2	5.3	G
Pestalotiopsis	AR_4960	11	25.3	6.3	14.3	14.8	8.2	G
Pestalotiopsis	AR_4960	12	23.9	5.9	14.8	12.3	5.2	G
Pestalotiopsis	AR_4960	13	24.8	6.3	15.9	17.3	7.3	G
Pestalotiopsis	AR_4960	14	25.2	5.8	16.2	15.8	8.4	G
Pestalotiopsis	AR_4960	15	22.5	6.2	18.5	17.2	5.8	G
Pestalotiopsis	AR_4960	16	19.4	7.1	14.0	22.3	8.1	G
Pestalotiopsis	AR_4960	17	24.8	6.1	15.3	23.1	6.3	G
Pestalotiopsis	AR_4960	18	21.5	5.9	16.8	18.3	7.2	G
Pestalotiopsis	AR_4960	19	22.1	7.4	18.3	24.0	6.6	G
Pestalotiopsis	AR_4960	20	20.8	5.9	14.1	27.1	7.3	G
Pestalotiopsis	AR_4992	1	21.4	8.4	14.7	15.5	8.8	H
Pestalotiopsis	AR_4992	2	21.5	8.3	14.5	15.7	7.5	H
Pestalotiopsis	AR_4992	3	21.8	7.0	14.0	14.5	6.5	H
Pestalotiopsis	AR_4992	4	19.7	8.3	13.5	13.3	6.0	H
Pestalotiopsis	AR_4992	5	23.0	7.4	15.0	15.5	10.5	H
Pestalotiopsis	AR_4992	6	22.3	6.0	14.5	15.5	6.0	H
Pestalotiopsis	AR_4992	7	18.0	7.5	12.0	17.0	6.7	H
Pestalotiopsis	AR_4992	8	18.8	7.3	13.4	13.5	7.3	H
Pestalotiopsis	AR_4992	9	21.0	9.2	14.0	16.2	6.8	H
Pestalotiopsis	AR_4992	10	21.2	6.7	13.5	17.8	8.0	H
Pestalotiopsis	AR_4992	11	19.0	7.5	13.2	17.5	6.6	H
Pestalotiopsis	AR_4992	12	21.4	8.8	14.5	19.5	6.6	H
Pestalotiopsis	AR_4992	13	21.0	7.7	13.0	16.5	8.2	H
Pestalotiopsis	AR_4992	14	20.7	8.6	14.7	18.0	6.6	H
Pestalotiopsis	AR_4992	15	22.0	8.0	14.0	17.0	8.6	H
Pestalotiopsis	AR_4992	16	23.0	9.0	14.7	16.0	7.6	H
Pestalotiopsis	AR_4992	17	24.0	7.3	15.6	13.0	6.7	H
Pestalotiopsis	AR_4992	18	22.6	7.8	14.0	13.6	7.0	H
Pestalotiopsis	AR_4992	19	23.8	7.0	14.8	16.0	9.0	H
Pestalotiopsis	AR_4992	20	21.8	7.0	15.0	16.8	7.0	H
Pestalotiopsis	LCM_301	1	22.6	5.8	14.8	16.5	4.9	H
Pestalotiopsis	LCM_301	2	23.3	5.0	15.1	20.4	4.5	H
Pestalotiopsis	LCM_301	3	23.1	5.2	14.7	18.1	6.8	H
Pestalotiopsis	LCM_301	4	24.7	5.8	16.3	21.1	5.9	H
Pestalotiopsis	LCM_301	5	23.9	4.7	14.5	12.7	5.8	H
Pestalotiopsis	LCM_301	6	21.8	6.3	13.4	14.3	5.8	H
Pestalotiopsis	LCM_301	7	22.7	6.2	15.0	15.9	5.7	H
Pestalotiopsis	LCM_301	8	23.9	4.9	16.0	16.0	3.8	H
Pestalotiopsis	LCM_301	9	16.5	6.1	12.8	12.2	6.0	H
Pestalotiopsis	LCM_301	10	24.5	4.9	14.7	20.6	5.2	H
Pestalotiopsis	LCM_301	11	25.0	6.1	15.5	14.3	4.9	H
Pestalotiopsis	LCM_301	12	21.9	4.8	12.7	16.4	5.4	H
Pestalotiopsis	LCM_301	13	18.4	5.4	13.3	17.4	5.7	H
Pestalotiopsis	LCM_301	14	22.2	6.0	14.3	20.7	4.8	H
Pestalotiopsis	LCM_301	15	23.8	5.3	15.4	15.9	6.8	H

Pestalotiopsis	LCM_301	16	21.8	5.8	14.3	20.4	4.7	H
Pestalotiopsis	LCM_301	17	19.3	4.9	13.7	12.9	4.8	H
Pestalotiopsis	LCM_301	18	21.9	6.1	13.7	14.9	5.7	H
Pestalotiopsis	LCM_301	19	23.8	5.6	15.7	15.9	5.8	H
Pestalotiopsis	LCM_301	20	22.8	4.8	15.9	19.7	4.0	H
Pestalotiopsis	GJS_09-1528	1	25.6	7.3	17.7	27.8	5.4	H
Pestalotiopsis	GJS_09-1528	2	25.8	7.4	17.5	13.5	7.2	H
Pestalotiopsis	GJS_09-1528	3	25.7	6.7	20.2	16.0	3.7	H
Pestalotiopsis	GJS_09-1528	4	25.2	6.4	16.2	18.3	6.3	H
Pestalotiopsis	GJS_09-1528	5	24.8	6.9	15.3	24.0	5.3	H
Pestalotiopsis	GJS_09-1528	6	25.9	5.9	16.7	15.5	7.0	H
Pestalotiopsis	GJS_09-1528	7	26.1	7.2	15.9	26.3	6.8	H
Pestalotiopsis	GJS_09-1528	8	25.5	6.4	17.2	24.5	4.9	H
Pestalotiopsis	GJS_09-1528	9	27.8	7.3	16.0	19.6	4.2	H
Pestalotiopsis	GJS_09-1528	10	25.2	6.2	15.6	20.1	7.4	H
Pestalotiopsis	GJS_09-1528	11	23.6	6.8	15.4	28.1	3.6	H
Pestalotiopsis	GJS_09-1528	12	23.2	7.1	16.7	18.4	6.5	H
Pestalotiopsis	GJS_09-1528	13	22.3	6.6	13.9	25.3	5.3	H
Pestalotiopsis	GJS_09-1528	14	23.5	6.4	15.4	14.2	4.9	H
Pestalotiopsis	GJS_09-1528	15	25.3	7.3	15.2	17.3	5.2	H
Pestalotiopsis	GJS_09-1528	16	24.3	6.6	17.0	24.2	6.4	H
Pestalotiopsis	GJS_09-1528	17	21.5	7.1	16.7	26.3	7.1	H
Pestalotiopsis	GJS_09-1528	18	25.6	6.1	15.6	19.3	6.8	H
Pestalotiopsis	GJS_09-1528	19	19.8	6.2	14.2	20.4	4.2	H
Pestalotiopsis	GJS_09-1528	20	22.1	6.2	15.3	17.3	5.1	H
Pestalotiopsis	AR_4954	1	25.5	5.4	15.8	19.4	4.5	I
Pestalotiopsis	AR_4954	2	20.0	6.4	12.5	15.3	6.2	I
Pestalotiopsis	AR_4954	3	22.8	6.4	13.8	12.1	6.9	I
Pestalotiopsis	AR_4954	4	23.4	6.4	14.9	20.1	3.6	I
Pestalotiopsis	AR_4954	5	22.2	5.9	14.2	16.4	6.5	I
Pestalotiopsis	AR_4954	6	21.2	5.6	14.1	12.2	7.1	I
Pestalotiopsis	AR_4954	7	21.7	6.0	15.4	15.7	4.2	I
Pestalotiopsis	AR_4954	8	20.1	6.3	12.8	19.0	3.7	I
Pestalotiopsis	AR_4954	9	19.6	6.3	13.5	13.7	6.0	I
Pestalotiopsis	AR_4954	10	26.3	5.4	16.5	20.6	4.8	I
Pestalotiopsis	AR_4954	11	19.8	6.3	12.8	18.3	5.1	I
Pestalotiopsis	AR_4954	12	25.4	5.8	15.1	17.4	3.9	I
Pestalotiopsis	AR_4954	13	22.5	6.1	14.5	14.9	7.2	I
Pestalotiopsis	AR_4954	14	20.8	6.4	12.8	19.0	4.5	I
Pestalotiopsis	AR_4954	15	21.5	6.1	13.9	20.1	5.2	I
Pestalotiopsis	AR_4954	16	20.7	5.5	12.7	15.7	6.9	I
Pestalotiopsis	AR_4954	17	20.4	6.1	13.2	12.9	6.1	I
Pestalotiopsis	AR_4954	18	22.1	5.6	15.1	13.9	5.2	I
Pestalotiopsis	AR_4954	19	21.4	5.6	13.9	19.3	7.0	I
Pestalotiopsis	AR_4954	20	20.4	5.4	14.3	15.3	4.2	I
Pestalotiopsis	AR_5013	1	20.1	5.7	12.9	21.7	6.5	I
Pestalotiopsis	AR_5013	2	21.8	5.7	14.2	9.4	3.8	I
Pestalotiopsis	AR_5013	3	21.9	6.2	14.2	17.4	4.0	I
Pestalotiopsis	AR_5013	4	18.3	6.1	11.8	20.1	4.1	I
Pestalotiopsis	AR_5013	5	20.7	5.2	13.7	19.5	7.1	I
Pestalotiopsis	AR_5013	6	21.0	5.9	13.0	16.2	6.3	I
Pestalotiopsis	AR_5013	7	23.0	5.4	14.9	22.1	5.2	I
Pestalotiopsis	AR_5013	8	20.1	5.6	12.3	9.3	8.2	I

Pestalotiopsis	AR_5013	9	23.5	4.5	14.0	18.1	3.9	I
Pestalotiopsis	AR_5013	10	21.2	5.6	13.4	22.0	4.2	I
Pestalotiopsis	AR_5013	11	25.2	6.3	15.2	19.8	5.3	I
Pestalotiopsis	AR_5013	12	21.9	5.2	14.2	18.0	5.6	I
Pestalotiopsis	AR_5013	13	21.8	5.5	13.6	10.2	6.2	I
Pestalotiopsis	AR_5013	14	20.1	5.7	12.9	22.1	5.2	I
Pestalotiopsis	AR_5013	15	23.7	4.9	14.1	19.3	4.1	I
Pestalotiopsis	AR_5013	16	19.3	5.7	12.5	14.3	7.1	I
Pestalotiopsis	AR_5013	17	21.2	6.0	15.1	20.1	5.6	I
Pestalotiopsis	AR_5013	18	24.3	5.7	14.2	17.5	4.5	I
Pestalotiopsis	AR_5013	19	22.6	6.1	12.4	19.3	5.9	I
Pestalotiopsis	AR_5013	20	23.5	5.8	13.9	22.0	6.3	I
Pestalotiopsis	AR_4945	1	24.5	6.0	14.9	20.5	6.3	I
Pestalotiopsis	AR_4945	2	23.3	5.6	14.0	23.4	8.2	I
Pestalotiopsis	AR_4945	3	20.3	6.3	12.9	19.4	11.5	I
Pestalotiopsis	AR_4945	4	21.3	6.1	13.7	30.4	10.3	I
Pestalotiopsis	AR_4945	5	22.2	6.6	13.9	28.4	5.0	I
Pestalotiopsis	AR_4945	6	21.6	5.6	13.6	27.4	8.3	I
Pestalotiopsis	AR_4945	7	22.6	5.8	14.9	16.3	9.1	I
Pestalotiopsis	AR_4945	8	20.6	5.5	11.8	28.0	10.3	I
Pestalotiopsis	AR_4945	9	21.5	6.1	13.1	19.3	5.3	I
Pestalotiopsis	AR_4945	10	21.0	6.0	13.4	21.3	7.2	I
Pestalotiopsis	AR_4945	11	21.1	5.3	12.8	32.6	8.2	I
Pestalotiopsis	AR_4945	12	22.0	5.9	13.4	20.4	6.3	I
Pestalotiopsis	AR_4945	13	18.1	5.9	13.1	28.7	10.3	I
Pestalotiopsis	AR_4945	14	23.0	5.7	15.1	26.4	9.5	I
Pestalotiopsis	AR_4945	15	25.3	6.3	16.2	30.1	11.3	I
Pestalotiopsis	AR_4945	16	23.3	5.4	14.2	18.6	10.1	I
Pestalotiopsis	AR_4945	17	21.2	4.7	11.7	29.3	9.3	I
Pestalotiopsis	AR_4945	18	20.7	5.4	13.5	28.4	8.3	I
Pestalotiopsis	AR_4945	19	22.3	5.0	14.2	30.2	10.0	I
Pestalotiopsis	AR_4945	20	19.9	6.0	12.6	23.0	5.7	I

S2

Name	Herbarium code	Sample	Length	Width	LM	LA	LB
Neopestalotiopsis clavispora	BPI 405486	1	24.3	5.6	16.8	22.9	5.1
Neopestalotiopsis clavispora	BPI 405486	2	21.3	6.2	15.4	19.7	4.7
Neopestalotiopsis clavispora	BPI 405486	3	21.4	5.8	14.0	31.0	5.5
Neopestalotiopsis clavispora	BPI 405486	4	24.1	6.3	13.5	32.0	6.3
Neopestalotiopsis clavispora	BPI 405486	5	25.7	7.4	16.7	14.3	4.3
Neopestalotiopsis clavispora	BPI 405486	6	23.8	6.3	13.8	30.0	6.7
Neopestalotiopsis clavispora	BPI 405486	7	25.2	5.8	15.9	18.6	4.9
Neopestalotiopsis clavispora	BPI 405486	8	28.0	5.2	18.0	14.9	6.2
Neopestalotiopsis clavispora	BPI 405486	9	26.5	5.4	17.2	24.0	5.3
Neopestalotiopsis clavispora	BPI 405486	10	24.0	6.8	15.8	18.6	6.0
Neopestalotiopsis clavispora	BPI 405487	1	21.9	7.4	N/A	N/A	N/A
Neopestalotiopsis clavispora	BPI 405487	2	20.4	7.5	N/A	N/A	N/A
Neopestalotiopsis clavispora	BPI 405487	3	25.2	7.7	N/A	N/A	N/A
Neopestalotiopsis clavispora	BPI 405487	4	258.0	7.9	N/A	N/A	N/A
Neopestalotiopsis clavispora	BPI 405487	5	25.8	9.0	N/A	N/A	N/A
Neopestalotiopsis clavispora	BPI 405487	6	22.6	7.7	N/A	N/A	N/A
Neopestalotiopsis clavispora	BPI 405487	7	20.8	7.8	N/A	N/A	N/A
Neopestalotiopsis clavispora	BPI 405487	8	22.6	7.7	N/A	N/A	N/A
Neopestalotiopsis clavispora	BPI 405487	9	22.0	8.4	N/A	N/A	N/A
Neopestalotiopsis clavispora	BPI 405487	10	23.1	7.0	N/A	N/A	N/A
Neopestalotiopsis clavispora	BPI 405488	1	24.9	6.3	18.3	N/A	N/A
Neopestalotiopsis clavispora	BPI 405488	2	23.0	6.9	16.8	N/A	N/A
Neopestalotiopsis clavispora	BPI 405488	3	26.1	6.8	15.8	N/A	N/A
Neopestalotiopsis clavispora	BPI 405488	4	26.9	6.3	17.4	17.5	N/A
Neopestalotiopsis clavispora	BPI 405488	5	22.4	6.8	15.0	32.8	4.1
Neopestalotiopsis clavispora	BPI 405488	6	28.1	6.9	16.4	10.3	7.9
Neopestalotiopsis clavispora	BPI 405488	7	23.1	6.8	14.7	28.4	7.7
Neopestalotiopsis clavispora	BPI 405488	8	21.7	6.1	17.0	31.0	3.0
Neopestalotiopsis clavispora	BPI 405488	9	25.6	7.0	18.5	20.4	6.4
Neopestalotiopsis clavispora	BPI 405488	10	23.3	6.6	17.5	27.8	4.6
Neopestalotiopsis clavispora	BPI 405490	1	29.7	7.9	18.2	25.8	4.3
Neopestalotiopsis clavispora	BPI 405490	2	24.0	6.7	16.7	28.1	6.5
Neopestalotiopsis clavispora	BPI 405490	3	21.8	8.2	15.4	30.0	6.7
Neopestalotiopsis clavispora	BPI 405490	4	23.8	6.8	16.6	27.2	7.0
Neopestalotiopsis clavispora	BPI 405490	5	24.3	7.4	16.4	25.5	5.7
Neopestalotiopsis clavispora	BPI 405490	6	23.6	6.6	16.3	26.9	7.1
Neopestalotiopsis clavispora	BPI 405490	7	21.1	8.3	14.7	28.7	4.9
Neopestalotiopsis clavispora	BPI 405490	8	24.7	7.3	17.0	25.7	5.3
Neopestalotiopsis clavispora	BPI 405490	9	25.2	8.8	17.8	27.8	6.2
Neopestalotiopsis clavispora	BPI 405490	10	26.7	6.9	16.4	30.7	6.8
Neopestalotiopsis clavispora	BPI 405477	1	19.9	7.5	14.8	28.4	6.1
Neopestalotiopsis clavispora	BPI 405477	2	22.6	7.4	16.3	20.4	5.7
Neopestalotiopsis clavispora	BPI 405477	3	18.9	7.3	14.2	29.7	7.2

Neopestalotiopsis clavispora	BPI 405477	4	22.8	8.1	15.9	25.8	5.2
Neopestalotiopsis clavispora	BPI 405477	5	20.4	7.5	15.7	30.2	7.8
Neopestalotiopsis clavispora	BPI 405477	6	22.5	7.3	16.3	31.0	5.1
Neopestalotiopsis clavispora	BPI 405477	7	18.2	7.7	15.8	25.6	6.2
Neopestalotiopsis clavispora	BPI 405477	8	20.5	7.0	15.1	29.2	7.5
Neopestalotiopsis clavispora	BPI 405477	9	24.8	8.6	17.3	27.5	6.8
Neopestalotiopsis clavispora	BPI 405477	10	20.9	7.3	15.3	23.0	5.4
Neopestalotiopsis foedans	BPI 405695	1	23.9	6.7	N/A	N/A	N/A
Neopestalotiopsis foedans	BPI 405695	2	24.1	5.7	N/A	N/A	N/A
Neopestalotiopsis foedans	BPI 405695	3	23.7	6.9	N/A	N/A	N/A
Neopestalotiopsis foedans	BPI 405695	4	23.5	6.3	N/A	N/A	N/A
Neopestalotiopsis foedans	BPI 405695	5	23.4	7.1	N/A	N/A	N/A
Neopestalotiopsis foedans	BPI 405695	6	22.2	7.7	N/A	N/A	N/A
Neopestalotiopsis foedans	BPI 405695	7	23.9	5.5	N/A	N/A	N/A
Neopestalotiopsis foedans	BPI 405695	8	24.3	6.6	N/A	N/A	N/A
Neopestalotiopsis foedans	BPI 405695	9	23.0	6.7	N/A	N/A	N/A
Neopestalotiopsis foedans	BPI 405695	10	21.2	8.6	N/A	N/A	N/A
Neopestalotiopsis foedans	BPI 405697	1	21.1	6.3	15.0	15.9	3.6
Neopestalotiopsis foedans	BPI 405697	2	23.5	6.0	14.4	9.1	5.8
Neopestalotiopsis foedans	BPI 405697	3	22.7	6.8	15.3	21.3	7.1
Neopestalotiopsis foedans	BPI 405697	4	22.9	7.0	15.3	26.4	4.6
Neopestalotiopsis foedans	BPI 405697	5	19.4	6.0	12.5	18.5	5.8
Neopestalotiopsis foedans	BPI 405697	6	22.8	6.6	15.0	10.5	3.6
Neopestalotiopsis foedans	BPI 405697	7	23.6	7.2	17.1	21.4	7.9
Neopestalotiopsis foedans	BPI 405697	8	21.1	5.6	15.5	23.5	6.5
Neopestalotiopsis foedans	BPI 405697	9	22.9	7.1	15.0	15.8	4.0
Neopestalotiopsis foedans	BPI 405697	10	19.5	6.6	14.3	16.5	5.3
Neopestalotiopsis foedans	BPI 405701	1	23.2	6.0	14.3	24.0	4.8
Neopestalotiopsis foedans	BPI 405701	2	19.1	6.5	14.2	20.4	3.5
Neopestalotiopsis foedans	BPI 405701	3	21.9	6.1	16.6	15.8	N/A
Neopestalotiopsis foedans	BPI 405701	4	23.5	6.5	15.9	12.4	N/A
Neopestalotiopsis foedans	BPI 405701	5	22.1	5.6	14.8	N/A	N/A
Neopestalotiopsis foedans	BPI 405701	6	22.5	6.6	14.3	N/A	N/A
Neopestalotiopsis foedans	BPI 405701	7	21.2	5.2	15.2	N/A	N/A
Neopestalotiopsis foedans	BPI 405701	8	23.7	6.6	16.0	N/A	N/A
Neopestalotiopsis foedans	BPI 405701	9	23.7	6.4	15.7	N/A	N/A
Neopestalotiopsis foedans	BPI 405701	10	25.3	6.3	17.8	N/A	N/A
Neopestalotiopsis foedans	BPI 405708	1	23.9	6.9	17.3	10.7	6.5
Neopestalotiopsis foedans	BPI 405708	2	23.0	6.2	14.6	8.3	7.4
Neopestalotiopsis foedans	BPI 405708	3	23.1	6.1	16.0	27.0	7.5
Neopestalotiopsis foedans	BPI 405708	4	22.3	7.2	15.1	28.4	7.7
Neopestalotiopsis foedans	BPI 405708	5	21.7	7.2	13.6	17.6	10.7
Neopestalotiopsis foedans	BPI 405708	6	18.7	6.4	13.3	22.6	11.2
Neopestalotiopsis foedans	BPI 405708	7	22.1	6.6	15.6	18.5	8.4
Neopestalotiopsis foedans	BPI 405708	8	25.6	6.7	15.0	15.0	10.2
Neopestalotiopsis foedans	BPI 405708	9	21.6	5.2	15.7	27.8	9.4

N_AA	Color	Type
14	2	N/A
14	2	N/A
14	2	N/A
14	2	N/A
14	2	N/A
14	2	N/A
14	2	N/A
14	2	N/A
14	2	N/A
14	2	N/A
3	2	N/A
3	2	N/A
3	2	N/A
3	2	N/A
3	2	N/A
3	2	N/A
3	2	N/A
3	2	N/A
3	2	N/A
3	2	N/A
3	2	N/A
3	2	N/A
3	2	N/A
3	2	N/A
3	2	N/A
3	2	N/A
3	2	N/A
3	2	N/A
3	2	N/A
3	2	N/A
14	2	T
14	2	T
14	2	T
14	2	T
14	2	T
14	2	T
14	2	T
14	2	T
14	2	T
14	2	T
3	2	T
3	2	T
3	2	T

N_AA	2 to 3, mostly 3 = 1
N_AA	3 to 4 = 2
N_AA	2 to 3 = 3
N_AA	1 to 3, sometimes secondary branched = 4
N_AA	1 to 3 = 5
N_AA	2 to 3, sometimes 1; secondarly branched=6
N_AA	2 to 3, sometimes 1; no secondary branchin
N_AA	2 to 3, mostly 2=8
N_AA	3 to 4, mostly 3=9
N_AA	1 to 2, mostly 2=10
N_AA	3=11
N_AA	1 to 2, mostly 1=12
N_AA	2, often secondarly branched=13
N_AA	2 to 3, mostly 2, rarely 1=14
N_AA	3 to 6, mostly 4 to 5=15
N_AA	3 to 5=16

Color

1	concolorous
2	versicolourous

3	2	T
3	2	T
3	2	T
3	2	T
3	2	T
3	2	T
3	2	T
N/A	2	T
N/A	2	T
N/A	2	T
N/A	2	T
N/A	2	T
N/A	2	T
N/A	2	T
N/A	2	T
N/A	2	T
N/A	2	T
1	2	T
1	2	T
1	2	T
1	2	T
1	2	T
1	2	T
1	2	T
1	2	T
1	2	T
1	2	T
1	2	N/A
1	2	N/A
1	2	N/A
1	2	N/A
1	2	N/A
1	2	N/A
1	2	N/A
1	2	N/A
1	2	N/A
1	2	N/A
1	2	T
1	2	T
1	2	T
1	2	T
1	2	T
1	2	T
1	2	T
1	2	T
1	2	T

Name	**Herbarium code**	**Sample**	**Length**	**Width**	**LM**	**LA**	**LB**
Pestalotia pezizoides	BPI 406487	1	35.2	7.2	25.6	25.0	7.3
Pestalotia pezizoides	BPI 406487	2	35.8	7.8	26.1	20.4	9.8
Pestalotia pezizoides	BPI 406487	3	34.0	8.1	24.7	33.5	7.4
Pestalotia pezizoides	BPI 406487	4	34.0	8.4	23.8	26.8	5.6
Pestalotia pezizoides	BPI 406487	5	30.9	7.7	21.1	34.4	8.2
Pestalotia pezizoides	BPI 406487	6	34.5	8.7	25.0	28.3	N/A
Pestalotia pezizoides	BPI 406487	7	37.5	8.5	29.6	N/A	N/A
Pestalotia pezizoides	BPI 406487	8	36.9	8.3	25.3	N/A	N/A
Pestalotia pezizoides	BPI 406487	9	36.7	9.4	25.2	N/A	N/A
Pestalotia pezizoides	BPI 406487	10	34.6	8.2	25.6	N/A	N/A
Pestalotia pezizoides	BPI 406491	1	30.9	7.5	23.6	20.5	8.4
Pestalotia pezizoides	BPI 406491	2	33.2	7.7	25.0	18.1	9.1
Pestalotia pezizoides	BPI 406491	3	30.2	7.8	22.4	30.0	10.2
Pestalotia pezizoides	BPI 406491	4	34.9	8.4	24.1	27.3	10.2
Pestalotia pezizoides	BPI 406491	5	35.3	6.9	24.4	31.3	10.4
Pestalotia pezizoides	BPI 406491	6	33.8	7.8	25.2	22.3	8.8
Pestalotia pezizoides	BPI 406491	7	35.9	7.0	24.6	26.1	8.0
Pestalotia pezizoides	BPI 406491	8	34.9	7.0	24.4	28.4	9.6
Pestalotia pezizoides	BPI 406491	9	31.3	7.2	21.8	19.3	7.4
Pestalotia pezizoides	BPI 406491	10	33.9	7.2	25.3	28.3	7.6
Pestalotia pezizoides	BPI 406491	11	36.2	7.7	25.5	25.0	N/A
Pestalotia pezizoides	BPI 406491	12	37.7	7.3	25.3	30.2	N/A
Pestalotia pezizoides	BPI 406491	13	35.1	6.3	24.6	24.3	N/A
Pestalotia pezizoides	BPI 406491	14	34.1	7.4	24.9	31.4	N/A
Pestalotia pezizoides	BPI 406491	15	36.7	6.7	26.8	25.3	N/A
Pestalotia pezizoides	BPI 406491	16	31.8	7.8	24.1	N/A	N/A
Pestalotia pezizoides	BPI 406491	17	39.1	7.2	28.1	N/A	N/A
Pestalotia pezizoides	BPI 406491	18	33.6	8.9	24.0	N/A	N/A
Pestalotia pezizoides	BPI 406491	19	33.5	8.2	24.6	N/A	N/A
Pestalotia pezizoides	BPI 406491	20	31.3	7.6	24.7	N/A	N/A
Pestalotia pezizoides	Ellis N. Am. Fungi No. 35	1	29.5	9.2	26.5	15.0	4.0
Pestalotia pezizoides	Ellis N. Am. Fungi No. 35	2	32.5	8.8	21.9	21.9	8.8
Pestalotia pezizoides	Ellis N. Am. Fungi No. 35	3	30.4	9.4	19.5	36.4	9.4
Pestalotia pezizoides	Ellis N. Am. Fungi No. 35	4	31.1	8.3	23.5	19.2	5.3
Pestalotia pezizoides	Ellis N. Am. Fungi No. 35	5	33.2	8.1	30.3	32.0	6.3
Pestalotia pezizoides	Ellis N. Am. Fungi No. 35	6	31.3	8.1	24.5	30.1	8.5
Pestalotia pezizoides	Ellis N. Am. Fungi No. 35	7	32.6	9.7	20.9	29.3	8.0
Pestalotia pezizoides	Ellis N. Am. Fungi No. 35	8	31.8	8.3	22.3	28.3	9.3
Pestalotia pezizoides	Ellis N. Am. Fungi No. 35	9	34.0	9.8	24.7	32.3	5.0
Pestalotia pezizoides	Ellis N. Am. Fungi No. 35	10	28.1	9.6	23.7	18.0	6.3

N_AA	Type
irregular	N/A
irregular	N/A
irregular	N/A
irregular	N/A
irregular	N/A
irregular	N/A
irregular	N/A
irregular	N/A
irregular	N/A
irregular	N/A
irregular	N/A
irregular	N/A
irregular	N/A
irregular	N/A
irregular	N/A
irregular	N/A
irregular	N/A
irregular	N/A
irregular	N/A
irregular	N/A
irregular	N/A
irregular	N/A
irregular	N/A
irregular	N/A
irregular	N/A
irregular	N/A
irregular	N/A
irregular	N/A
irregular	N/A
irregular	N/A
irregular	N/A
irregular	N/A
irregular	N/A
irregular	N/A
irregular	N/A
irregular	N/A
irregular	N/A
irregular	N/A
irregular	N/A
irregular	N/A

Name	**Herbarium code**	**Sample**	**Length**	**Width**	**LM**	**LA**	**LB**
Pestalotiopsis adusta	BPI 405296	1	18.3	5.0	N/A	N/A	N/A
Pestalotiopsis adusta	BPI 405296	2	17.9	6.2	N/A	N/A	N/A
Pestalotiopsis adusta	BPI 405296	3	16.7	6.4	N/A	N/A	N/A
Pestalotiopsis adusta	BPI 405296	4	19.4	5.5	N/A	N/A	N/A
Pestalotiopsis adusta	BPI 405296	5	19.8	7.7	N/A	N/A	N/A
Pestalotiopsis adusta	BPI 405296	6	14.9	6.1	N/A	N/A	N/A
Pestalotiopsis adusta	BPI 405296	7	17.9	5.6	N/A	N/A	N/A
Pestalotiopsis adusta	BPI 405296	8	18.5	5.9	N/A	N/A	N/A
Pestalotiopsis adusta	BPI 405296	9	15.0	6.0	N/A	N/A	N/A
Pestalotiopsis adusta	BPI 405296	10	17.4	6.2	N/A	N/A	N/A
Pestalotiopsis adusta	BPI 405301	1	21.2	6.3	N/A	10.5	2.2
Pestalotiopsis adusta	BPI 405301	2	17.1	7.4	N/A	19.6	2.0
Pestalotiopsis adusta	BPI 405301	3	17.3	6.7	N/A	11.0	2.6
Pestalotiopsis adusta	BPI 405301	4	17.4	6.5	N/A	18.5	1.6
Pestalotiopsis adusta	BPI 405301	5	16.9	5.1	N/A	16.8	2.7
Pestalotiopsis adusta	BPI 405301	6	18.5	7.3	N/A	10.3	3.0
Pestalotiopsis adusta	BPI 405301	7	16.6	7.3	N/A	19.8	3.5
Pestalotiopsis adusta	BPI 405301	8	16.3	6.2	N/A	10.8	2.8
Pestalotiopsis adusta	BPI 405301	9	21.5	6.8	N/A	20.5	1.8
Pestalotiopsis adusta	BPI 405301	10	19.4	7.1	N/A	11.2	2.7
Pestalotiopsis adusta	BPI 405323	1	17.5	6.8	12.2	N/A	N/A
Pestalotiopsis adusta	BPI 405323	2	19.3	5.9	12.6	N/A	N/A
Pestalotiopsis adusta	BPI 405323	3	17.6	5.8	12.1	N/A	N/A
Pestalotiopsis adusta	BPI 405323	4	17.3	5.6	11.4	N/A	N/A
Pestalotiopsis adusta	BPI 405323	5	18.6	6.6	13.0	N/A	N/A
Pestalotiopsis adusta	BPI 405323	6	17.6	6.7	12.2	N/A	N/A
Pestalotiopsis adusta	BPI 405323	7	18.4	6.3	12.5	N/A	N/A
Pestalotiopsis adusta	BPI 405323	8	20.0	6.3	13.0	N/A	N/A
Pestalotiopsis adusta	BPI 405323	9	17.2	6.3	12.5	N/A	N/A
Pestalotiopsis adusta	BPI 405323	10	17.8	6.4	12.5	5.4	N/A
Pestalotiopsis adusta	BPI 405326	1	18.3	4.9	12.2	N/A	N/A
Pestalotiopsis adusta	BPI 405326	2	18.7	5.0	13.5	10.0	3.6
Pestalotiopsis adusta	BPI 405326	3	19.4	5.0	13.7	3.8	3.2
Pestalotiopsis adusta	BPI 405326	4	18.4	5.7	13.5	9.9	2.3
Pestalotiopsis adusta	BPI 405326	5	21.0	5.7	13.6	6.2	5.7
Pestalotiopsis adusta	BPI 405326	6	18.9	5.8	12.3	7.0	5.8
Pestalotiopsis adusta	BPI 405326	7	18.3	4.8	13.2	9.7	4.8
Pestalotiopsis adusta	BPI 405326	8	22.4	5.4	15.4	12.5	4.3
Pestalotiopsis adusta	BPI 405326	9	18.4	6.4	12.9	13.0	5.8
Pestalotiopsis adusta	BPI 405326	10	19.4	5.9	13.0	8.3	3.7
Pestalotiopsis adusta	BPI 405326	11	20.2	5.2	13.5	9.7	2.9
Pestalotiopsis adusta	BPI 405329	1	22.3	6.1	15.2	22.5	4.5
Pestalotiopsis adusta	BPI 405329	2	20.4	5.5	14.4	14.0	6.2
Pestalotiopsis adusta	BPI 405329	3	22.3	6.4	15.2	19.1	2.6
Pestalotiopsis adusta	BPI 405329	4	21.5	6.0	13.0	21.9	3.1
Pestalotiopsis adusta	BPI 405329	5	19.8	5.5	13.8	22.4	6.7
Pestalotiopsis adusta	BPI 405329	6	22.8	5.8	14.9	13.2	2.7
Pestalotiopsis adusta	BPI 405329	7	24.5	5.3	16.2	23.0	6.5
Pestalotiopsis adusta	BPI 405329	8	21.9	6.1	15.1	18.7	4.3
Pestalotiopsis adusta	BPI 405329	9	22.9	6.2	14.5	16.8	5.2
Pestalotiopsis adusta	BPI 405329	10	24.4	5.4	16.6	19.7	3.5
Pestalotiopsis bicolor	BPI 405386	1	25.5	8.0	18.0	22.5	4.0

Pestalotiopsis bicolor	BPI 405386	2	26.0	8.0	15.4	23.4	6.5
Pestalotiopsis bicolor	BPI 405386	3	25.0	8.3	16.8	27.0	5.0
Pestalotiopsis bicolor	BPI 405386	4	25.5	7.0	16.3	21.5	9.3
Pestalotiopsis bicolor	BPI 405386	5	28.6	7.5	16.8	39.0	10.2
Pestalotiopsis bicolor	BPI 405386	6	27.3	7.9	16.2	41.0	9.5
Pestalotiopsis bicolor	BPI 405386	7	26.2	7.8	15.5	30.2	9.4
Pestalotiopsis bicolor	BPI 405386	8	25.4	8.3	17.0	35.1	10.0
Pestalotiopsis bicolor	BPI 405386	9	25.3	8.6	17.3	29.0	10.3
Pestalotiopsis bicolor	BPI 405386	10	26.0	6.5	16.8	30.4	8.4
Pestalotiopsis caroliniana	BPI 405453	1	24.4	7.5	16.0	17.3	5.0
Pestalotiopsis caroliniana	BPI 405453	2	24.5	6.0	15.5	27.8	5.2
Pestalotiopsis caroliniana	BPI 405453	3	22.0	7.0	15.0	26.4	4.7
Pestalotiopsis caroliniana	BPI 405453	4	26.0	7.0	15.2	33.2	5.9
Pestalotiopsis caroliniana	BPI 405453	5	25.0	7.3	16.2	31.4	4.2
Pestalotiopsis caroliniana	BPI 405453	6	25.5	7.0	16.5	21.4	5.3
Pestalotiopsis caroliniana	BPI 405453	7	28.2	7.5	17.3	27.3	5.8
Pestalotiopsis caroliniana	BPI 405453	8	28.5	7.2	18.0	30.2	4.9
Pestalotiopsis caroliniana	BPI 405453	9	30.0	7.0	19.3	20.0	5.0
Pestalotiopsis caroliniana	BPI 405453	10	23.4	6.5	18.3	20.4	4.2
Pestalotiopsis conigena	BPI 405517	1	22.4	6.7	17.6	N/A	N/A
Pestalotiopsis conigena	BPI 405517	2	22.4	6.6	17.7	N/A	N/A
Pestalotiopsis conigena	BPI 405517	3	22.5	6.7	16.1	N/A	N/A
Pestalotiopsis conigena	BPI 405517	4	19.4	5.2	16.6	N/A	N/A
Pestalotiopsis conigena	BPI 405517	5	23.5	6.9	15.6	N/A	N/A
Pestalotiopsis conigena	BPI 405517	6	23.0	7.0	16.9	N/A	N/A
Pestalotiopsis conigena	BPI 405517	7	21.9	7.2	14.8	N/A	N/A
Pestalotiopsis conigena	BPI 405517	8	22.5	7.3	17.1	N/A	N/A
Pestalotiopsis conigena	BPI 405517	9	24.1	6.5	18.5	N/A	N/A
Pestalotiopsis conigena	BPI 405517	10	23.5	6.1	15.9	N/A	N/A
Pestalotiopsis conigena	BPI 405551	1	26.7	7.4	18.7	24.4	6.8
Pestalotiopsis conigena	BPI 405551	2	28.2	8.2	18.9	21.4	5.9
Pestalotiopsis conigena	BPI 405551	3	23.8	7.4	15.7	26.0	5.4
Pestalotiopsis conigena	BPI 405551	4	23.5	6.5	17.5	22.5	5.2
Pestalotiopsis conigena	BPI 405551	5	24.2	7.1	17.9	26.8	6.3
Pestalotiopsis conigena	BPI 405551	6	28.3	6.8	21.5	23.0	6.8
Pestalotiopsis conigena	BPI 405551	7	22.0	7.4	15.1	21.1	5.0
Pestalotiopsis conigena	BPI 405551	8	27.7	8.0	18.3	25.4	5.2
Pestalotiopsis conigena	BPI 405551	9	22.4	6.9	16.8	27.6	6.9
Pestalotiopsis conigena	BPI 405551	10	25.9	7.3	17.6	24.9	5.7
Pestalotiopsis disseminata	BPI 405620	1	20.7	5.9	14.2	12.8	4.3
Pestalotiopsis disseminata	BPI 405620	2	19.3	6.2	12.5	12.0	3.4
Pestalotiopsis disseminata	BPI 405620	3	20.6	6.0	13.9	8.9	3.1
Pestalotiopsis disseminata	BPI 405620	4	20.1	6.6	13.2	15.5	6.5
Pestalotiopsis disseminata	BPI 405620	5	18.5	5.5	12.9	18.7	4.6
Pestalotiopsis disseminata	BPI 405620	6	24.2	6.4	14.3	15.2	3.9
Pestalotiopsis disseminata	BPI 405620	7	21.6	5.7	13.9	17.5	4.9
Pestalotiopsis disseminata	BPI 405620	8	19.2	5.0	13.8	18.0	6.7
Pestalotiopsis disseminata	BPI 405620	9	21.4	5.6	13.7	13.9	6.1
Pestalotiopsis disseminata	BPI 405620	10	20.1	5.6	14.1	12.6	5.3
Pestalotiopsis disseminata	BPI 405620	1	19.1	6.5	13.7	19.4	2.9
Pestalotiopsis disseminata	BPI 405620	2	19.9	5.7	13.9	13.5	2.0
Pestalotiopsis disseminata	BPI 405620	3	20.6	5.7	14.1	10.5	4.3
Pestalotiopsis disseminata	BPI 405620	4	21.1	6.0	13.6	18.2	5.6

Pestalotiopsis disseminata	BPI 405620	5	21.1	6.2	14.3	17.5	3.4
Pestalotiopsis disseminata	BPI 405620	6	21.9	6.3	14.0	12.0	4.0
Pestalotiopsis disseminata	BPI 405620	7	23.1	6.5	16.1	19.6	4.9
Pestalotiopsis disseminata	BPI 405620	8	24.7	6.1	16.0	14.2	2.6
Pestalotiopsis disseminata	BPI 405620	9	20.7	4.8	12.9	16.5	4.3
Pestalotiopsis disseminata	BPI 405620	10	21.8	6.3	15.4	18.2	3.7
Pestalotiopsis disseminata	BPI 405631	1	22.0	6.2	19.5	N/A	N/A
Pestalotiopsis disseminata	BPI 405631	2	20.6	6.1	16.1	N/A	N/A
Pestalotiopsis disseminata	BPI 405631	3	19.5	6.1	15.4	N/A	N/A
Pestalotiopsis disseminata	BPI 405631	4	19.8	5.9	20.2	N/A	N/A
Pestalotiopsis disseminata	BPI 405631	5	17.8	5.9	16.2	N/A	N/A
Pestalotiopsis disseminata	BPI 405631	6	20.7	6.1	20.7	N/A	N/A
Pestalotiopsis disseminata	BPI 405631	7	18.7	7.4	17.6	N/A	N/A
Pestalotiopsis disseminata	BPI 405631	8	20.5	6.6	16.9	N/A	N/A
Pestalotiopsis disseminata	BPI 405631	9	18.6	5.9	15.4	N/A	N/A
Pestalotiopsis disseminata	BPI 405631	10	22.2	7.3	14.9	N/A	N/A
Pestalotiopsis disseminata	Roum. Exs. 5167	1	20.2	6.9	15.1	10.5	5.7
Pestalotiopsis disseminata	Roum. Exs. 5167	2	18.4	6.2	13.2	15.5	2.3
Pestalotiopsis disseminata	Roum. Exs. 5167	3	16.6	6.3	13.8	17.7	6.0
Pestalotiopsis disseminata	Roum. Exs. 5167	4	17.1	6.3	15.0	21.6	4.4
Pestalotiopsis disseminata	Roum. Exs. 5167	5	20.1	6.8	14.8	22.0	5.8
Pestalotiopsis disseminata	Roum. Exs. 5167	6	20.5	7.2	13.8	15.6	5.4
Pestalotiopsis disseminata	Roum. Exs. 5167	7	17.7	5.8	13.8	18.3	4.3
Pestalotiopsis disseminata	Roum. Exs. 5167	8	19.1	7.0	14.7	19.7	3.1
Pestalotiopsis disseminata	Roum. Exs. 5167	9	23.6	7.3	12.9	13.5	3.9
Pestalotiopsis disseminata	Roum. Exs. 5167	10	20.6	7.0	14.0	20.0	4.2
Pestalotiopsis funerea	BPI 405730	1	20.2	7.0	15.3	4.4	16.9
Pestalotiopsis funerea	BPI 405730	2	21.7	5.7	14.7	5.0	13.8
Pestalotiopsis funerea	BPI 405730	3	25.4	6.5	14.1	4.2	25.2
Pestalotiopsis funerea	BPI 405730	4	20.0	4.6	13.3	5.9	25.5
Pestalotiopsis funerea	BPI 405730	5	20.4	6.1	14.6	7.9	9.0
Pestalotiopsis funerea	BPI 405730	6	22.9	7.3	16.7	12.6	17.3
Pestalotiopsis funerea	BPI 405730	7	23.5	6.6	13.7	10.4	25.0
Pestalotiopsis funerea	BPI 405730	8	27.8	6.8	13.8	5.4	12.6
Pestalotiopsis funerea	BPI 405730	9	22.6	6.4	14.6	8.5	14.9
Pestalotiopsis funerea	BPI 405730	10	22.3	6.4	14.4	10.3	9.6
Pestalotiopsis funerea	BPI 405755	1	27.6	10.0	N/A	N/A	N/A
Pestalotiopsis funerea	BPI 405755	2	18.6	5.7	N/A	N/A	N/A
Pestalotiopsis funerea	BPI 405755	3	25.3	9.4	N/A	N/A	N/A
Pestalotiopsis funerea	BPI 405755	4	27.5	8.3	N/A	N/A	N/A
Pestalotiopsis funerea	BPI 405755	5	27.7	9.6	N/A	N/A	N/A
Pestalotiopsis funerea	BPI 405755	6	26.3	8.6	N/A	N/A	N/A
Pestalotiopsis funerea	BPI 405755	7	28.4	9.9	N/A	N/A	N/A
Pestalotiopsis funerea	BPI 405755	8	28.5	8.9	N/A	N/A	N/A
Pestalotiopsis funerea	BPI 405755	9	26.5	8.4	N/A	N/A	N/A
Pestalotiopsis funerea	BPI 405755	10	28.2	8.6	N/A	N/A	N/A
Pestalotiopsis funerea	BPI 405866	1	25.7	6.5	17.4	16.4	9.7
Pestalotiopsis funerea	BPI 405866	2	23.8	7.4	16.9	24.9	7.2
Pestalotiopsis funerea	BPI 405866	3	28.9	6.8	18.4	27.6	11.0
Pestalotiopsis funerea	BPI 405866	4	20.5	8.7	19.7	28.7	9.5
Pestalotiopsis funerea	BPI 405866	5	27.8	8.3	19.2	18.5	10.5
Pestalotiopsis funerea	BPI 405866	6	28.5	7.7	20.4	26.9	8.5
Pestalotiopsis funerea	BPI 405866	7	31.7	8.3	20.9	27.7	9.6

Pestalotiopsis funerea	BPI 405866	8	28.0	7.2	17.4	15.8	7.5
Pestalotiopsis funerea	BPI 405866	9	30.0	6.9	20.9	18.7	11.3
Pestalotiopsis funerea	BPI 405866	10	30.1	8.8	24.3	20.0	9.3
Pestalotiopsis funerea	Ellis Everhart 3535	1	27.5	8.1	19.7	16.2	6.1
Pestalotiopsis funerea	Ellis Everhart 3535	2	30.0	7.8	21.2	18.9	8.2
Pestalotiopsis funerea	Ellis Everhart 3535	3	28.6	8.4	20.4	20.4	7.2
Pestalotiopsis funerea	Ellis Everhart 3535	4	27.8	8.2	19.5	17.9	8.1
Pestalotiopsis funerea	Ellis Everhart 3535	5	27.1	8.5	19.8	18.3	8.3
Pestalotiopsis funerea	Ellis Everhart 3535	6	20.1	8.2	14.8	23.0	6.7
Pestalotiopsis funerea	Ellis Everhart 3535	7	29.6	8.2	19.3	16.8	7.5
Pestalotiopsis funerea	Ellis Everhart 3535	8	31.2	8.3	21.4	22.7	8.4
Pestalotiopsis funerea	Ellis Everhart 3535	9	28.7	8.9	22.0	21.9	6.0
Pestalotiopsis funerea	Ellis Everhart 3535	10	28.9	9.3	20.6	19.5	7.7
Pestalotiopsis funerea	PR 833644	1	25.4	6.0	19.6	17.0	6.0
Pestalotiopsis funerea	PR 833644	2	27.6	8.4	18.2	21.8	6.2
Pestalotiopsis funerea	PR 833644	3	26.3	7.2	18.2	19.6	5.5
Pestalotiopsis funerea	PR 833644	4	26.0	7.9	15.9	22.9	3.4
Pestalotiopsis funerea	PR 833644	5	26.2	7.7	17.5	24.5	3.3
Pestalotiopsis funerea	PR 833644	6	23.0	7.3	17.2	12.7	4.9
Pestalotiopsis funerea	PR 833644	7	26.6	7.1	18.4	23.3	4.5
Pestalotiopsis funerea	PR 833644	8	28.8	7.8	17.9	20.1	8.5
Pestalotiopsis funerea	PR 833644	9	27.2	8.4	17.7	18.1	5.4
Pestalotiopsis funerea	PR 833644	10	23.0	7.1	15.3	14.8	3.5
Pestalotiopsis funerea	PR 833644	11	23.5	7.7	17.3	16.7	6.5
Pestalotiopsis funerea	Rabenhorst 2898	1	26.0	8.9	17.2	13.3	3.9
Pestalotiopsis funerea	Rabenhorst 2898	2	30.5	9.1	22.3	12.1	4.3
Pestalotiopsis funerea	Rabenhorst 2898	3	28.7	8.5	17.6	11.4	5.5
Pestalotiopsis funerea	Rabenhorst 2898	4	27.6	10.0	18.4	13.9	6.2
Pestalotiopsis funerea	Rabenhorst 2898	5	28.6	7.9	20.3	16.1	9.8
Pestalotiopsis funerea	Rabenhorst 2898	6	24.5	8.5	17.1	14.4	5.8
Pestalotiopsis funerea	Rabenhorst 2898	7	27.2	8.3	18.7	15.7	4.6
Pestalotiopsis funerea	Rabenhorst 2898	8	27.1	8.8	19.5	16.0	8.4
Pestalotiopsis funerea	Rabenhorst 2898	9	28.4	9.9	21.0	14.0	3.8
Pestalotiopsis funerea	Rabenhorst 2898	10	26.9	8.2	19.9	11.8	5.3
Pestalotiopsis guepinii	BPI 405009	1	14.9	6.2	10.6	16.6	4.2
Pestalotiopsis guepinii	BPI 405009	2	16.3	6.4	11.4	13.5	3.9
Pestalotiopsis guepinii	BPI 405009	3	17.3	5.3	12.5	18.9	3.2
Pestalotiopsis guepinii	BPI 405009	4	17.0	6.1	13.2	18.6	4.3
Pestalotiopsis guepinii	BPI 405009	5	13.5	5.9	10.8	21.8	0.0
Pestalotiopsis guepinii	BPI 405009	6	22.9	6.3	13.9	16.1	0.0
Pestalotiopsis guepinii	BPI 405009	7	17.8	6.8	12.8	20.5	0.0
Pestalotiopsis guepinii	BPI 405009	8	14.2	6.1	13.3	18.4	0.0
Pestalotiopsis guepinii	BPI 405009	9	13.5	5.4	11.2	13.3	0.0
Pestalotiopsis guepinii	BPI 405009	10	12.8	5.6	13.6	18.9	4.7
Pestalotiopsis guepinii	BPI 405955	1	19.8	6.4	13.1	28.7	3.6
Pestalotiopsis guepinii	BPI 405955	2	20.8	4.8	10.9	34.5	3.4
Pestalotiopsis guepinii	BPI 405955	3	17.4	6.2	11.1	23.8	3.4
Pestalotiopsis guepinii	BPI 405955	4	21.5	5.5	12.9	20.3	3.9
Pestalotiopsis guepinii	BPI 405955	5	22.1	5.6	12.3	20.3	4.1
Pestalotiopsis guepinii	BPI 405955	6	19.8	5.6	12.3	28.2	3.3
Pestalotiopsis guepinii	BPI 405955	7	17.4	5.9	11.3	35.3	3.0
Pestalotiopsis guepinii	BPI 405955	8	18.7	6.1	11.2	26.4	3.9
Pestalotiopsis guepinii	BPI 405955	9	17.3	5.6	9.8	25.0	4.7

Pestalotiopsis guepinii	BPI 405955	10	20.9	5.5	12.8	35.3	4.0
Pestalotiopsis guepinii	BPI 405955	11	20.8	5.5	13.4	29.4	3.2
Pestalotiopsis guepinii	BPI 405955	12	17.8	5.6	11.1	25.4	4.9
Pestalotiopsis guepinii	BPI 405955	13	19.3	5.0	12.0	34.2	4.2
Pestalotiopsis guepinii	BPI 405955	14	18.8	6.3	11.7	27.4	3.8
Pestalotiopsis guepinii	BPI 405955	15	19.6	6.5	11.3	38.5	3.0
Pestalotiopsis guepinii	BPI 405955	16	18.0	6.0	12.2	21.1	3.1
Pestalotiopsis guepinii	BPI 405955	17	18.5	6.4	11.3	36.2	0.0
Pestalotiopsis guepinii	BPI 405955	18	17.8	5.6	10.9	27.4	0.0
Pestalotiopsis guepinii	BPI 405955	19	18.1	6.1	11.8	28.4	0.0
Pestalotiopsis guepinii	BPI 405955	20	19.0	6.6	11.2	33.2	0.0
Pestalotiopsis guepinii	BPI 405955	21	18.0	5.9	10.8	32.2	0.0
Pestalotiopsis guepinii	BPI 405955	22	18.1	5.9	12.8	29.3	0.0
Pestalotiopsis guepinii	BPI 405955	23	19.9	6.3	10.5	27.2	0.0
Pestalotiopsis guepinii	BPI 405955	24	16.4	6.0	11.7	20.2	0.0
Pestalotiopsis guepinii	BPI 405955	25	19.6	5.9	11.5	22.1	0.0
Pestalotiopsis guepinii	BPI 405955	26	16.6	5.6	11.7	29.0	0.0
Pestalotiopsis guepinii	BPI 405955	27	17.7	5.9	11.2	29.2	0.0
Pestalotiopsis guepinii	BPI 405937	1	19.1	3.6	10.9	17.1	3.5
Pestalotiopsis guepinii	BPI 405937	2	16.9	4.6	11.8	18.6	0.0
Pestalotiopsis guepinii	BPI 405937	3	16.6	6.6	10.5	20.2	4.1
Pestalotiopsis guepinii	BPI 405937	4	15.6	5.7	12.7	20.6	3.2
Pestalotiopsis guepinii	BPI 405937	5	16.9	6.1	11.5	16.2	3.2
Pestalotiopsis guepinii	BPI 405937	6	16.4	3.8	10.7	21.0	4.0
Pestalotiopsis guepinii	BPI 405937	7	14.5	5.6	11.2	17.3	4.3
Pestalotiopsis guepinii	BPI 405937	8	17.9	5.5	13.3	20.5	0.0
Pestalotiopsis guepinii	BPI 405937	9	18.2	5.0	10.5	19.4	0.0
Pestalotiopsis guepinii	BPI 405937	10	15.0	5.4	13.8	18.1	0.0
Pestalotiopsis guepinii	BPI 405937	11	17.4	5.1	11.4	21.9	0.0
Pestalotiopsis guepinii	BPI 405937	12	18.3	5.7	12.5	20.3	0.0
Pestalotiopsis guepinii	BPI 405937	13	15.4	5.8	12.7	18.3	0.0
Pestalotiopsis guepinii	BPI 405937	14	16.3	5.9	10.6	21.4	0.0
Pestalotiopsis guepinii	BPI 405937	15	15.0	7.0	12.6	22.0	0.0
Pestalotiopsis macrospora	PR 876309	1	37.2	8.3	25.8	18.9	0.0
Pestalotiopsis macrospora	PR 876309	2	39.6	9.3	26.3	20.4	5.4
Pestalotiopsis macrospora	PR 876309	3	44.5	9.5	32.7	20.0	10.3
Pestalotiopsis macrospora	PR 876309	4	37.2	9.0	24.9	18.7	7.9
Pestalotiopsis macrospora	PR 876309	5	32.2	10.4	22.5	16.5	7.9
Pestalotiopsis macrospora	PR 876309	6	38.9	8.7	26.2	14.9	13.0
Pestalotiopsis macrospora	PR 876309	7	33.5	8.6	24.2	18.3	8.5
Pestalotiopsis macrospora	PR 876309	8	36.2	8.2	24.0	17.3	9.9
Pestalotiopsis macrospora	PR 876309	9	39.8	6.2	26.9	21.3	10.3
Pestalotiopsis macrospora	PR 876309	10	36.9	7.9	27.6	14.9	11.2
Pestalotiopsis macrospora	PR 876309	11	42.6	9.1	28.0	21.9	5.4
Pestalotiopsis macrospora	PR 876309	12	31.1	9.1	21.1	20.8	13.0
Pestalotiopsis macrospora	PR 876309	13	41.3	7.5	28.5	22.9	12.0
Pestalotiopsis macrospora	PR 876309	14	32.8	8.5	23.1	17.0	11.3
Pestalotiopsis macrospora	PR 876309	15	34.1	9.3	31.8	17.9	9.3
Pestalotiopsis macrospora	PR 876309	16	40.8	8.8	27.8	19.2	8.0
Pestalotiopsis macrospora	PR 876309	17	38.8	8.3	26.1	20.2	8.3
Pestalotiopsis macrospora	PR 876309	18	40.0	8.0	29.4	20.0	6.3
Pestalotiopsis macrospora	PR 876309	19	35.9	8.6	26.9	19.2	5.3
Pestalotiopsis macrospora	PR 876309	20	37.8	7.9	27.4	21.0	5.3

Pestalotiopsis maculans	BPI 802213	1	26.7	7.2	16.2	23.7	4.3
Pestalotiopsis maculans	BPI 802213	2	24.8	6.1	15.9	30.8	4.6
Pestalotiopsis maculans	BPI 802213	3	23.3	7.4	13.9	30.8	5.1
Pestalotiopsis maculans	BPI 802213	4	22.7	7.6	15.7	30.1	0.0
Pestalotiopsis maculans	BPI 802213	5	23.4	6.9	15.4	28.3	6.2
Pestalotiopsis maculans	BPI 802213	6	23.5	6.8	15.9	24.1	0.0
Pestalotiopsis maculans	BPI 802213	7	26.6	5.1	17.2	29.2	0.0
Pestalotiopsis maculans	BPI 802213	8	23.8	7.4	14.7	26.2	0.0
Pestalotiopsis maculans	BPI 802213	9	23.6	6.1	14.9	28.2	0.0
Pestalotiopsis maculans	BPI 802213	10	23.7	7.9	17.1	23.4	0.0
Pestalotiopsis maculans	BPI 374220	1	16.86	4.99	11.13	14.38	N/A
Pestalotiopsis maculans	BPI 374220	2	15.29	5.13	9.86	8.56	N/A
Pestalotiopsis maculans	BPI 374220	3	16.07	5.05	10.1	N/A	N/A
Pestalotiopsis maculans	BPI 374220	4	15.54	4.73	10.16	N/A	N/A
Pestalotiopsis maculans	BPI 374220	5	15.01	5.03	10.68	N/A	N/A
Pestalotiopsis maculans	BPI 374220	6	17.71	5.19	11.53	N/A	N/A
Pestalotiopsis maculans	BPI 374220	7	15.17	5.85	10.8	N/A	N/A
Pestalotiopsis maculans	BPI 374220	8	15.69	4.64	11.56	N/A	N/A
Pestalotiopsis maculans	BPI 374220	9	16.52	5.35	13.1	N/A	N/A
Pestalotiopsis maculans	BPI 374220	10	15.22	4.84	10.46	N/A	N/A
Pestalotiopsis maculans	PR 155665	1	21.5	6.2	13.9	15.7	5.6
Pestalotiopsis maculans	PR 155665	2	22.5	6.7	14.4	11.1	4.3
Pestalotiopsis maculans	PR 155665	3	22.4	8.7	14.3	18.7	3.4
Pestalotiopsis maculans	PR 155665	4	19.9	7.1	13.3	10.1	3.7
Pestalotiopsis maculans	PR 155665	5	23.1	7.3	14.5	25.6	4.3
Pestalotiopsis maculans	PR 155665	6	18.9	7.1	12.2	22.9	4.0
Pestalotiopsis maculans	PR 155665	7	19.9	7.0	13.6	21.0	3.8
Pestalotiopsis maculans	PR 155665	8	19.7	6.7	12.1	26.1	0.0
Pestalotiopsis maculans	PR 155665	9	21.0	7.5	13.7	23.4	0.0
Pestalotiopsis maculans	PR 155665	10	21.2	6.5	14.2	22.4	0.0
Pestalotiopsis maculans	PR 155665	11	21.5	6.4	12.6	25.3	0.0
Pestalotiopsis maculans	PR 155665	12	20.7	6.0	13.6	23.4	0.0
Pestalotiopsis maculans	PR 155665	13	18.0	6.3	14.0	23.0	0.0
Pestalotiopsis maculans	PR 155665	14	16.1	6.2	12.9	22.4	0.0
Pestalotiopsis maculans	PR 155665	15	25.5	7.8	14.8	25.3	0.0
Pestalotiopsis maculans	PR 155665	16	22.4	7.1	13.6	26.3	0.0
Pestalotiopsis maculans	PR 155665	17	23.8	4.5	14.9	21.0	0.0
Pestalotiopsis maculans	PR 155665	18	18.7	6.3	12.9	23.4	0.0
Pestalotiopsis maculans	PR 155665	19	20.7	7.7	14.8	20.2	0.0
Pestalotiopsis maculans	PR 155665	20	23.1	8.4	15.2	24.4	0.0
*Pestalotiopsis neglecta*_A	BPI 406414	1	20.7	6.1	13.5	18.2	3.8
*Pestalotiopsis neglecta*_A	BPI 406414	2	19.8	6.5	13.9	19.4	4.9
*Pestalotiopsis neglecta*_A	BPI 406414	3	23.0	6.3	15.4	16.5	5.4
*Pestalotiopsis neglecta*_A	BPI 406414	4	21.8	5.8	14.2	20.1	6.2
*Pestalotiopsis neglecta*_A	BPI 406414	5	22.3	5.4	15.4	17.5	3.6
*Pestalotiopsis neglecta*_A	BPI 406414	6	21.9	6.6	4.6	17.3	4.3
*Pestalotiopsis neglecta*_A	BPI 406414	7	20.8	5.1	12.7	19.3	5.9
*Pestalotiopsis neglecta*_A	BPI 406414	8	18.5	6.3	12.1	18.3	3.2
*Pestalotiopsis neglecta*_A	BPI 406414	9	19.7	5.1	13.6	19.2	5.7
*Pestalotiopsis neglecta*_A	BPI 406414	10	19.3	5.2	12.9	20.6	4.3
*Pestalotiopsis neglecta*_A	BPI 406414	11	21.2	5.4	13.9	15.7	5.8
*Pestalotiopsis neglecta*_A	BPI 406414	12	21.0	6.1	12.2	21.0	5.2
*Pestalotiopsis neglecta*_A	BPI 406414	13	18.8	5.2	12.6	19.3	4.7

*Pestalotiopsis neglecta*_A	BPI 406414	14	18.2	5.3	11.7	18.3	5.9
*Pestalotiopsis neglecta*_A	BPI 406414	15	23.6	5.1	15.0	17.7	3.9
*Pestalotiopsis neglecta*_A	BPI 406414	16	22.6	4.2	13.8	21.1	6.3
*Pestalotiopsis neglecta*_A	BPI 406414	17	21.2	5.9	14.2	20.3	6.9
*Pestalotiopsis neglecta*_A	BPI 406414	18	19.6	6.1	13.3	19.7	6.8
*Pestalotiopsis neglecta*_A	BPI 406414	19	20.5	5.7	13.7	16.3	5.3
*Pestalotiopsis neglecta*_A	BPI 406414	20	21.3	5.7	14.1	18.8	4.3
*Pestalotiopsis neglecta*_B	BPI 406415	1	34.5	10.4	22.5	38.2	11.0
*Pestalotiopsis neglecta*_B	BPI 406415	2	35.8	10.4	22.7	36.8	8.2
*Pestalotiopsis neglecta*_B	BPI 406415	3	34.3	10.4	22.2	35.2	12.6
*Pestalotiopsis neglecta*_B	BPI 406415	4	31.7	10.0	21.6	43.5	11.3
*Pestalotiopsis neglecta*_B	BPI 406415	5	32.6	11.6	21.0	37.0	12.3
*Pestalotiopsis neglecta*_B	BPI 406415	6	36.6	9.3	23.8	40.0	13.4
*Pestalotiopsis neglecta*_B	BPI 406415	7	31.5	9.9	22.8	38.4	8.3
*Pestalotiopsis neglecta*_B	BPI 406415	8	35.9	10.2	23.9	40.2	10.4
*Pestalotiopsis neglecta*_B	BPI 406415	9	37.1	9.9	25.2	36.3	9.3
*Pestalotiopsis neglecta*_B	BPI 406415	10	36.1	10.7	22.5	37.0	7.3
*Pestalotiopsis neglecta*_B	BPI 406415	11	33.8	9.8	23.5	39.0	11.2
*Pestalotiopsis neglecta*_B	BPI 406415	12	30.2	8.8	21.0	35.8	13.2
*Pestalotiopsis neglecta*_B	BPI 406415	13	34.7	10.1	23.2	36.4	10.3
*Pestalotiopsis neglecta*_B	BPI 406415	14	33.6	11.1	21.6	40.5	8.9
*Pestalotiopsis neglecta*_B	BPI 406415	15	35.8	10.3	23.8	35.2	9.2
*Pestalotiopsis neglecta*_B	BPI 406415	16	35.1	9.4	22.8	42.8	10.4
*Pestalotiopsis neglecta*_B	BPI 406415	17	36.3	10.0	23.3	37.3	11.4
*Pestalotiopsis neglecta*_B	BPI 406415	18	32.2	9.4	21.9	39.0	10.4
*Pestalotiopsis neglecta*_B	BPI 406415	19	35.0	10.3	22.7	37.3	9.9
*Pestalotiopsis neglecta*_B	BPI 406415	20	30.1	10.4	21.2	40.1	13.2
*Pestalotiopsis neglecta*_A	BPI 406424	1	27.7	8.3	17.1	29.3	7.4
*Pestalotiopsis neglecta*_A	BPI 406424	2	24.8	6.3	15.5	26.9	6.3
*Pestalotiopsis neglecta*_A	BPI 406424	3	27.0	6.4	15.9	31.5	9.4
*Pestalotiopsis neglecta*_A	BPI 406424	4	28.7	7.4	18.4	33.2	10.3
*Pestalotiopsis neglecta*_A	BPI 406424	5	26.3	6.4	17.3	28.3	9.3
*Pestalotiopsis neglecta*_A	BPI 406424	6	26.0	5.0	15.6	30.3	8.3
*Pestalotiopsis neglecta*_A	BPI 406424	7	25.0	6.6	15.3	32.8	10.8
*Pestalotiopsis neglecta*_A	BPI 406424	8	28.3	6.7	17.4	29.3	9.9
*Pestalotiopsis neglecta*_A	BPI 406424	9	25.5	7.5	15.2	28.8	9.0
*Pestalotiopsis neglecta*_A	BPI 406424	10	25.0	7.3	15.5	32.8	10.0
*Pestalotiopsis neglecta*_B	Myc Univ 884	1	36.1	8.5	24.1	38.3	9.1
*Pestalotiopsis neglecta*_B	Myc Univ 884	2	35.1	10.2	23.7	40.1	8.2
*Pestalotiopsis neglecta*_B	Myc Univ 884	3	38.9	8.3	23.9	36.3	10.5
*Pestalotiopsis neglecta*_B	Myc Univ 884	4	32.1	8.8	20.7	32.1	8.7
*Pestalotiopsis neglecta*_B	Myc Univ 884	5	41.2	8.5	26.2	36.7	10.7
*Pestalotiopsis neglecta*_B	Myc Univ 884	6	38.7	7.4	23.9	39.4	10.4
*Pestalotiopsis neglecta*_B	Myc Univ 884	7	35.0	10.0	25.0	35.3	9.8
*Pestalotiopsis neglecta*_B	Myc Univ 884	8	31.8	10.7	20.6	39.1	10.8
*Pestalotiopsis neglecta*_B	Myc Univ 884	9	36.5	8.0	22.6	37.2	8.9
*Pestalotiopsis neglecta*_B	Myc Univ 884	10	32.4	9.9	22.0	40.2	9.2
*Pestalotiopsis neglecta*_B	Myc Univ 884b	1	38.1	9.1	24.9	25.3	8.0
*Pestalotiopsis neglecta*_B	Myc Univ 884b	2	33.4	8.7	19.9	32.0	5.9
*Pestalotiopsis neglecta*_B	Myc Univ 884b	3	32.8	9.6	21.4	35.6	10.3
*Pestalotiopsis neglecta*_B	Myc Univ 884b	4	26.7	8.0	17.8	33.9	12.0
*Pestalotiopsis neglecta*_B	Myc Univ 884b	5	32.5	8.3	21.3	28.7	13.7
*Pestalotiopsis neglecta*_B	Myc Univ 884b	6	35.1	9.0	22.6	30.1	7.0

*Pestalotiopsis neglecta*_B	Myc Univ 884b	7	36.7	8.6	23.3	26.4	10.7
*Pestalotiopsis neglecta*_B	Myc Univ 884b	8	35.6	10.2	22.0	28.8	9.4
*Pestalotiopsis neglecta*_B	Myc Univ 884b	9	32.0	9.4	22.5	35.7	11.8
*Pestalotiopsis neglecta*_B	Myc Univ 884b	10	36.3	9.1	24.6	34.1	12.1
Pestalotiopsis palmarum	BPI 406551	1	17.6	5.2	11.7	17.1	3.1
Pestalotiopsis palmarum	BPI 406551	2	20.2	6.2	12.3	33.4	3.2
Pestalotiopsis palmarum	BPI 406551	3	19.6	5.9	12.0	5.4	4.3
Pestalotiopsis palmarum	BPI 406551	4	20.6	5.7	12.0	21.7	4.0
Pestalotiopsis palmarum	BPI 406551	5	17.5	4.9	11.4	N/A	N/A
Pestalotiopsis palmarum	BPI 406551	6	21.2	6.2	13.9	N/A	N/A
Pestalotiopsis palmarum	BPI 406551	7	19.9	5.4	13.3	N/A	N/A
Pestalotiopsis palmarum	BPI 406551	8	24.1	5.7	11.9	N/A	N/A
Pestalotiopsis palmarum	BPI 406551	9	22.1	5.1	7.4	N/A	N/A
Pestalotiopsis palmarum	BPI 406551	10	18.5	5.5	9.7	N/A	N/A
Pestalotiopsis palmarum	BPI 406551	11	12.4	3.2	11.3	N/A	N/A
Pestalotiopsis palmarum	BPI 406551	12	13.7	3.7	12.6	N/A	N/A
Pestalotiopsis palmarum	BPI 406551	13	21.4	5.9	8.3	N/A	N/A
Pestalotiopsis palmarum	BPI 406551	14	21.0	5.7	9.2	N/A	N/A
Pestalotiopsis palmarum	BPI 406551	15	16.4	6.6	12.5	N/A	N/A
Pestalotiopsis palmarum	BPI 406551	16	18.7	5.3	12.9	N/A	N/A
Pestalotiopsis palmarum	BPI 406551	17	20.7	5.4	13.5	N/A	N/A
Pestalotiopsis palmarum	BPI 406551	18	20.1	6.9	13.6	N/A	N/A
Pestalotiopsis palmarum	BPI 406551	19	19.8	5.8	10.2	N/A	N/A
Pestalotiopsis palmarum	BPI 406551	20	19.1	5.6	11.5	N/A	N/A
Pestalotiopsis palmarum	BPI 406500	1	20.1	5.3	15.6	8.6	3.3
Pestalotiopsis palmarum	BPI 406500	2	19.0	5.8	12.6	12.0	4.2
Pestalotiopsis palmarum	BPI 406500	3	19.7	5.1	13.2	20.2	4.3
Pestalotiopsis palmarum	BPI 406500	4	19.8	5.3	13.5	16.6	5.3
Pestalotiopsis palmarum	BPI 406500	5	20.3	5.6	12.1	11.5	3.9
Pestalotiopsis palmarum	BPI 406500	6	19.0	5.4	12.3	15.9	4.8
Pestalotiopsis palmarum	BPI 406500	7	18.3	5.6	11.3	14.8	5.3
Pestalotiopsis palmarum	BPI 406500	8	20.7	5.7	13.6	15.1	3.2
Pestalotiopsis palmarum	BPI 406500	9	19.1	4.7	11.4	12.7	5.9
Pestalotiopsis palmarum	BPI 406500	10	19.7	5.3	12.0	9.5	4.9
Pestalotiopsis palmarum	BPI 406500	11	18.7	4.5	11.6	16.1	5.0
Pestalotiopsis palmarum	BPI 406500	12	20.4	5.6	14.0	16.9	6.1
Pestalotiopsis palmarum	BPI 406500	13	20.3	5.8	13.9	8.8	3.8
Pestalotiopsis palmarum	BPI 406500	14	20.1	5.5	11.3	12.0	5.4
Pestalotiopsis palmarum	BPI 406500	15	18.4	5.2	14.5	14.8	4.8
Pestalotiopsis palmarum	BPI 406500	16	20.4	5.1	12.6	15.8	4.9
Pestalotiopsis palmarum	BPI 406500	17	19.5	5.6	11.2	17.4	5.4
Pestalotiopsis palmarum	BPI 406500	18	17.9	5.0	13.9	9.5	3.9
Pestalotiopsis palmarum	BPI 406500	19	20.7	5.4	15.3	18.8	4.2
Pestalotiopsis palmarum	BPI 406500	20	19.8	5.4	12.5	10.7	5.9
Pestalotiopsis palmarum	PR 875542	1	18.9	5.6	14.1	N/A	N/A
Pestalotiopsis palmarum	PR 875542	2	17.8	5.0	15.1	N/A	N/A
Pestalotiopsis palmarum	PR 875542	3	16.3	5.4	13.1	N/A	N/A
Pestalotiopsis palmarum	PR 875542	4	24.1	6.4	15.6	N/A	N/A
Pestalotiopsis palmarum	PR 875542	5	17.6	6.5	11.8	N/A	N/A
Pestalotiopsis palmarum	PR 875542	6	19.8	6.4	11.4	N/A	N/A
Pestalotiopsis palmarum	PR 875542	7	20.3	6.3	12.4	N/A	N/A
Pestalotiopsis palmarum	PR 875542	8	20.4	5.8	13.2	N/A	N/A
Pestalotiopsis palmarum	PR 875542	9	18.4	6.5	12.4	N/A	N/A

Pestalotiopsis palmarum	PR 875542	10	21.4	5.8	11.4	N/A	N/A
Pestalotiopsis sydowiana	PR 81293	1	18.4	7.5	12.9	18.2	2.4
Pestalotiopsis sydowiana	PR 81293	2	19.0	8.0	12.8	13.7	6.2
Pestalotiopsis sydowiana	PR 81293	3	18.3	7.0	14.2	20.2	4.9
Pestalotiopsis sydowiana	PR 81293	4	17.8	8.4	13.0	14.8	5.3
Pestalotiopsis sydowiana	PR 81293	5	19.1	7.6	13.7	17.7	6.3
Pestalotiopsis sydowiana	PR 81293	6	19.0	7.9	13.4	18.9	2.8
Pestalotiopsis sydowiana	PR 81293	7	20.2	8.8	15.1	14.9	2.5
Pestalotiopsis sydowiana	PR 81293	8	20.6	9.4	13.9	17.8	3.3
Pestalotiopsis sydowiana	PR 81293	9	18.4	9.6	15.1	20.1	4.6
Pestalotiopsis sydowiana	PR 81293	10	20.6	9.6	14.4	14.2	2.5
Pestalotiopsis sydowiana	PR 81293	11	22.7	8.7	15.8	20.8	3.5
Pestalotiopsis sydowiana	PR 81293	12	17.3	8.2	12.7	31.1	5.3
Pestalotiopsis sydowiana	PR 81293	13	18.8	5.6	10.8	31.9	2.7
Pestalotiopsis sydowiana	PR 81293	14	15.7	6.1	11.2	20.4	5.3
Pestalotiopsis sydowiana	PR 81293	15	15.5	6.5	11.5	22.5	4.3
Pestalotiopsis sydowiana	PR 81293	16	18.3	7.8	13.6	27.5	2.3
Pestalotiopsis sydowiana	PR 81293	17	18.2	9.5	13.7	19.7	6.4
Pestalotiopsis sydowiana	PR 81293	18	21.0	9.2	16.4	18.4	5.8
Pestalotiopsis sydowiana	PR 81293	19	19.5	8.7	14.6	25.8	2.3
Pestalotiopsis sydowiana	PR 81293	20	19.5	8.1	13.5	18.4	4.3

N_AA	**Color**	**Type**
N/A	1	N/A
N/A	1	N/A
N/A	1	N/A
N/A	1	N/A
N/A	1	N/A
N/A	1	N/A
N/A	1	N/A
N/A	1	N/A
N/A	1	N/A
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1	1	N/A
1	1	N/A
3	1	N/A

N_AA	2 to 3, mostly 3 = 1
N_AA	3 to 4 = 2
N_AA	2 to 3 = 3
N_AA	1 to 3, sometimes secondary branched = 4
N_AA	1 to 3 = 5
N_AA	2 to 3, sometimes 1; secondarly branched=6
N_AA	2 to 3, sometimes 1; no secondary branching=7
N_AA	2 to 3, mostly 2=8
N_AA	3 to 4, mostly 3=9
N_AA	1 to 2, mostly 2=10
N_AA	3=11
N_AA	1 to 2, mostly 1=12
N_AA	2, often secondarly branched=13
N_AA	2 to 3, mostly 2, rarely 1=14
N_AA	3 to 6, mostly 4 to 5=15
N_AA	3 to 5=16

Color

1	concolorous
2	versicolourous

3	1	N/A
3	1	N/A
3	1	N/A
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3	1	N/A
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7	2	N/A

Name	**Herbarium code**	**Sample**	**Length**	**Width**	**LM**	**LA**	**LB**	**N_AA**
Seiridium marginatum	BPI 405012	1	44.9	8.5	30.8	36.0	17.8	17
Seiridium marginatum	BPI 405012	2	42.1	7.8	28.3	40.1	24.4	17
Seiridium marginatum	BPI 405012	3	40.1	8.2	30.3	38.4	25.6	17
Seiridium marginatum	BPI 405012	4	42.6	8.4	30.0	41.4	19.3	17
Seiridium marginatum	BPI 405012	5	39.6	7.2	20.8	36.4	22.4	17
Seiridium marginatum	BPI 405012	6	42.1	8.4	31.1	39.1	34.0	17
Seiridium marginatum	BPI 405012	7	43.0	8.3	30.2	42.3	31.0	17
Seiridium marginatum	BPI 405012	8	41.4	9.0	31.2	47.1	27.0	17
Seiridium marginatum	BPI 405012	9	38.2	9.0	31.8	37.0	22.3	17
Seiridium marginatum	BPI 405012	10	39.7	8.0	30.2	40.7	31.0	17
Seiridium marginatum	BPI 405012	11	36.6	6.8	27.2	41.3	34.0	17
Seiridium marginatum	BPI 405012	12	42.5	8.4	30.5	48.2	35.2	17
Seiridium marginatum	BPI 405012	13	41.0	8.0	31.4	42.3	27.4	17
Seiridium marginatum	BPI 405012	14	38.9	7.4	27.4	36.4	37.0	17
Seiridium marginatum	BPI 405012	15	35.6	8.9	28.1	38.5	25.7	17
Seiridium marginatum	BPI 405012	16	44.2	9.3	32.0	41.9	25.4	17
Seiridium marginatum	BPI 405012	17	41.3	9.4	30.9	42.0	31.2	17
Seiridium marginatum	BPI 405012	18	39.8	8.4	29.9	39.8	27.1	17
Seiridium marginatum	BPI 405012	19	40.2	8.3	30.2	40.3	23.6	17
Seiridium marginatum	BPI 405012	20	39.0	7.5	29.4	46.5	29.5	17
Seiridium unicorne	BPI 1106572	1	24.1	7.6	19.8	5.8	3.7	17
Seiridium unicorne	BPI 1106572	2	27.2	8.8	18.8	8.6	4.8	17
Seiridium unicorne	BPI 1106572	3	23.8	8.9	17.8	9.2	0.0	17
Seiridium unicorne	BPI 1106572	4	28.0	9.2	20.6	6.0	3.5	17
Seiridium unicorne	BPI 1106572	5	22.5	8.5	17.9	5.9	3.5	17
Seiridium unicorne	BPI 1106572	6	26.4	9.4	20.1	10.2	4.8	17
Seiridium unicorne	BPI 1106572	7	27.4	8.5	18.4	7.5	5.1	17
Seiridium unicorne	BPI 1106572	8	23.5	8.7	17.5	8.9	0.0	17
Seiridium unicorne	BPI 1106572	9	28.3	9.3	18.7	8.6	2.8	17
Seiridium unicorne	BPI 1106572	10	24.5	10.0	19.5	10.4	3.4	17

Type		
T	N_AA	2 to 3, mostly 3 = 1
T	N_AA	3 to 4 = 2
T	N_AA	2 to 3 = 3
T	N_AA	1 to 3, sometimes secondary branched = 4
T	N_AA	1 to 3 = 5
T	N_AA	2 to 3, sometimes 1; secondarly branched=6
T	N_AA	2 to 3, sometimes 1; no secondary branching=7
T	N_AA	2 to 3, mostly 2=8
T	N_AA	3 to 4, mostly 3=9
T	N_AA	1 to 2, mostly 2=10
T	N_AA	3=11
T	N_AA	1 to 2, mostly 1=12
T	N_AA	2, often secondarly branched=13
T	N_AA	2 to 3, mostly 2, rarely 1=14
T	N_AA	3 to 6, mostly 4 to 5=15
T	N_AA	3 to 5=16
T	N_AA	1=17
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N/A		

Name	**Herbarium code**	**Sample**	**Length**	**Width**	**LM**	**LA**	**LB**
Truncatella casuarinae	PR 874898	1	16.2	5.6	11.2	N/A	N/A
Truncatella casuarinae	PR 874898	2	15.8	7.3	9.2	N/A	N/A
Truncatella casuarinae	PR 874898	3	15.0	7.0	10.4	N/A	N/A
Truncatella casuarinae	PR 874898	4	19.6	6.1	12.4	N/A	N/A
Truncatella casuarinae	PR 874898	5	17.8	7.0	11.1	N/A	N/A
Truncatella casuarinae	PR 874898	6	18.7	9.1	12.1	N/A	N/A
Truncatella casuarinae	PR 874898	7	20.1	6.7	12.5	N/A	N/A
Truncatella casuarinae	PR 874898	8	19.3	6.6	11.3	N/A	N/A
Truncatella casuarinae	PR 874898	9	18.5	7.4	10.7	N/A	N/A
Truncatella casuarinae	PR 874898	10	18.6	7.5	11.5	N/A	N/A
Truncatella casuarinae	PR 874898	11	19.0	7.2	12.4	8.1	N/A
Truncatella casuarinae	PR 874898	12	18.3	7.5	10.0	10.1	N/A
Truncatella casuarinae	PR 874898	13	18.8	6.0	11.8	18.6	N/A
Truncatella casuarinae	PR 874898	14	20.3	7.9	11.1	11.5	N/A
Truncatella casuarinae	PR 874898	15	17.7	8.0	12.5	13.6	N/A
Truncatella casuarinae	PR 874898	16	14.7	4.6	8.5	14.9	N/A
Truncatella casuarinae	PR 874898	17	20.0	7.0	12.6	9.3	N/A
Truncatella casuarinae	PR 874898	18	19.6	6.1	11.6	16.2	N/A
Truncatella casuarinae	PR 874898	19	17.2	6.2	11.3	17.3	N/A
Truncatella casuarinae	PR 874898	20	16.1	6.1	10.6	10.6	N/A
Truncatella hartigii	BPI 406124	1	16.2	7.0	11.1	20.5	N/A
Truncatella hartigii	BPI 406124	2	19.1	7.2	12.2	17.0	N/A
Truncatella hartigii	BPI 406124	3	18.6	5.5	13.1	17.8	N/A
Truncatella hartigii	BPI 406124	4	18.7	5.9	12.9	19.7	N/A
Truncatella hartigii	BPI 406124	5	18.3	6.7	11.4	20.1	N/A
Truncatella hartigii	BPI 406124	6	18.1	6.7	12.5	19.4	N/A
Truncatella hartigii	BPI 406124	7	18.3	7.2	11.4	21.0	N/A
Truncatella hartigii	BPI 406124	8	17.4	6.4	11.8	20.4	N/A
Truncatella hartigii	BPI 406124	9	20.5	6.3	13.0	18.7	N/A
Truncatella hartigii	BPI 406124	10	17.3	6.6	13.2	19.4	N/A
Truncatella stevensonii	PR 848045	1	21.5	6.2	13.9	N/A	N/A
Truncatella stevensonii	PR 848045	2	22.5	6.7	14.4	N/A	N/A
Truncatella stevensonii	PR 848045	3	22.4	8.7	14.3	N/A	N/A
Truncatella stevensonii	PR 848045	4	19.9	7.1	13.3	N/A	N/A
Truncatella stevensonii	PR 848045	5	23.1	7.3	14.5	N/A	N/A
Truncatella stevensonii	PR 848045	6	18.9	7.1	12.2	N/A	N/A
Truncatella stevensonii	PR 848045	7	19.9	7.0	13.6	N/A	N/A
Truncatella stevensonii	PR 848045	8	19.7	6.7	12.1	N/A	N/A
Truncatella stevensonii	PR 848045	9	21.0	7.5	13.7	N/A	N/A
Truncatella stevensonii	PR 848045	10	21.2	6.5	14.2	N/A	N/A
Truncatella stevensonii	PR 848045	11	21.5	6.4	12.6	N/A	N/A
Truncatella stevensonii	PR 848045	12	20.7	5.7	13.0	N/A	N/A
Truncatella stevensonii	PR 848045	13	21.9	7.7	12.1	N/A	N/A
Truncatella stevensonii	PR 848045	14	19.6	7.4	12.5	N/A	N/A
Truncatella stevensonii	PR 848045	15	20.3	6.7	13.4	N/A	N/A
Truncatella stevensonii	PR 848045	16	21.7	6.7	14.0	N/A	N/A
Truncatella stevensonii	PR 848045	17	20.7	7.5	12.8	N/A	N/A
Truncatella stevensonii	PR 848045	18	20.3	6.8	13.7	N/A	N/A
Truncatella stevensonii	PR 848045	19	22.4	6.4	13.6	N/A	N/A
Truncatella stevensonii	PR 848045	20	18.1	5.6	12.9	N/A	N/A
Truncatella truncata	BPI 406822	2	18.9	5.8	9.9	10.7	N/A
Truncatella truncata	BPI 406822	3	19.2	7.0	13.7	11.9	N/A

Truncatella truncata	BPI 406822	4	18.0	7.0	12.3	15.6	N/A
Truncatella truncata	BPI 406822	5	19.3	6.8	12.5	13.4	N/A
Truncatella truncata	BPI 406822	6	17.4	6.4	11.5	17.0	N/A
Truncatella truncata	BPI 406822	7	18.1	7.0	12.1	10.4	N/A
Truncatella truncata	BPI 406822	8	17.6	6.6	12.5	12.9	N/A
Truncatella truncata	BPI 406822	9	15.8	6.1	11.7	14.4	N/A
Truncatella truncata	BPI 406822	10	18.8	7.1	12.6	13.9	N/A
Truncatella truncata	BPI 406822	11	22.3	7.5	12.5	N/A	N/A
Truncatella truncata	BPI 406822	12	17.6	6.7	13.1	N/A	N/A
Truncatella truncata	BPI 406822	13	18.0	6.6	11.5	N/A	N/A
Truncatella truncata	BPI 406822	14	15.8	7.7	11.4	N/A	N/A
Truncatella truncata	BPI 406822	15	14.7	7.3	10.5	N/A	N/A
Truncatella truncata	BPI 406822	16	19.3	7.4	12.9	N/A	N/A
Truncatella truncata	BPI 406822	17	20.1	6.6	12.5	N/A	N/A
Truncatella truncata	BPI 406822	18	17.0	6.4	11.2	N/A	N/A
Truncatella truncata	BPI 406822	19	17.4	5.8	11.6	N/A	N/A
Truncatella truncata	BPI 406822	20	16.9	6.4	14.1	N/A	N/A
Truncatella truncata	BPI 434909	1	14.9	6.9	N/A	20.9	N/A
Truncatella truncata	BPI 434909	2	14.8	7.2	N/A	20.1	N/A
Truncatella truncata	BPI 434909	3	15.7	9.0	N/A	21.5	N/A
Truncatella truncata	BPI 434909	4	16.2	7.5	N/A	22.4	N/A
Truncatella truncata	BPI 434909	5	18.7	7.6	N/A	21.3	N/A
Truncatella truncata	BPI 434909	6	15.5	7.2	N/A	19.4	N/A
Truncatella truncata	BPI 434909	7	16.0	7.8	N/A	20.4	N/A
Truncatella truncata	BPI 434909	8	17.7	8.4	N/A	20.3	N/A
Truncatella truncata	BPI 434909	9	16.7	7.8	N/A	21.4	N/A
Truncatella truncata	BPI 434909	10	18.2	8.5	N/A	24.0	N/A
Truncatella truncata	BPI 434909	11	15.6	7.9	N/A	22.4	N/A
Truncatella truncata	BPI 434909	12	17.2	7.8	N/A	20.3	N/A
Truncatella truncata	BPI 434909	13	19.0	6.9	N/A	21.4	N/A
Truncatella truncata	BPI 434909	14	17.0	7.1	N/A	18.4	N/A
Truncatella truncata	BPI 434909	15	16.8	6.9	N/A	19.4	N/A
Truncatella truncata	BPI 434909	16	16.7	7.8	N/A	17.9	N/A
Truncatella truncata	BPI 434909	17	18.1	7.5	N/A	20.4	N/A
Truncatella truncata	BPI 434909	18	14.6	7.5	N/A	21.3	N/A
Truncatella truncata	BPI 434909	19	16.1	6.7	N/A	21.4	N/A
Truncatella truncata	BPI 434909	20	18.4	6.9	N/A	23.5	N/A
Truncatella truncata	BPI 434909	21	18.0	8.9	N/A	20.4	N/A
Truncatella truncata	BPI 434909	22	19.2	9.1	N/A	19.4	N/A
Truncatella truncata	BPI 434909	23	17.1	7.5	N/A	21.3	N/A
Truncatella truncata	BPI 434909	24	17.2	7.1	N/A	24.4	N/A
Truncatella truncata	BPI 434909	25	17.1	8.6	N/A	19.3	N/A
Truncatella truncata	BPI 439410	1	20.9	7.5	N/A	N/A	N/A
Truncatella truncata	BPI 439410	2	16.1	7.3	N/A	N/A	N/A
Truncatella truncata	BPI 439410	3	17.8	7.9	N/A	N/A	N/A
Truncatella truncata	BPI 439410	4	19.5	7.8	N/A	N/A	N/A
Truncatella truncata	BPI 439410	5	18.4	7.2	N/A	N/A	N/A
Truncatella tumefaciens	BPI 406765	1	20.9	6.3	15.5	N/A	N/A
Truncatella tumefaciens	BPI 406765	2	17.8	5.3	13.0	N/A	N/A
Truncatella tumefaciens	BPI 406765	3	18.0	5.2	13.1	N/A	N/A
Truncatella tumefaciens	BPI 406765	4	17.9	5.3	12.1	N/A	N/A
Truncatella tumefaciens	BPI 406765	5	19.1	6.5	14.1	N/A	N/A
Truncatella tumefaciens	BPI 406765	6	18.3	5.8	13.3	N/A	N/A

Truncatella tumefaciens	BPI 406765	7	18.2	5.3	13.2	N/A	N/A
Truncatella tumefaciens	BPI 406765	8	20.5	5.4	12.8	N/A	N/A
Truncatella tumefaciens	BPI 406765	9	18.2	5.8	13.6	N/A	N/A
Truncatella tumefaciens	BPI 406765	10	17.3	4.8	14.9	N/A	N/A

N_AA	Type
N/A	N/A
N/A	N/A
N/A	N/A
N/A	N/A
N/A	N/A
N/A	N/A
N/A	N/A
N/A	N/A
N/A	N/A
N/A	N/A
N/A	N/A
N/A	N/A
N/A	N/A
N/A	N/A
N/A	N/A
N/A	N/A
N/A	N/A
N/A	N/A
N/A	N/A
N/A	N/A
17	N/A
17	N/A
17	N/A
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17	N/A
17	N/A
8	N/A
8	N/A
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8	N/A
8	N/A
6	N/A
6	N/A

N_AA	2 to 3, mostly 3 = 1
N_AA	3 to 4 = 2
N_AA	2 to 3 = 3
N_AA	1 to 3, sometimes secondary branched = 4
N_AA	1 to 3 = 5
N_AA	2 to 3, sometimes 1; secondarly branched=6
N_AA	2 to 3, sometimes 1; no secondary branching=7
N_AA	2 to 3, mostly 2=8
N_AA	3 to 4, mostly 3=9
N_AA	1 to 2, mostly 2=10
N_AA	3=11
N_AA	1 to 2, mostly 1=12
N_AA	2, often secondarly branched=13
N_AA	2 to 3, mostly 2, rarely 1=14
N_AA	3 to 6, mostly 4 to 5=15
N_AA	3 to 5=16
N_AA	1 to 4, sometimes secondarly branched=17

6	N/A
6	N/A
6	N/A
6	N/A
6	N/A
6	N/A
6	N/A
6	N/A
6	N/A
6	N/A
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3	T
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N/A	N/A
N/A	N/A
N/A	N/A
N/A	N/A
N/A	N/A
N/A	T
N/A	T
N/A	T
N/A	T
N/A	T
N/A	T

N/A	T
N/A	T
N/A	T
N/A	T