The forgotten *Calonectria* collection: Pouring old wine into new bags

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Abstract: The genus *Calonectria* with its *Cylindrocladium* asexual morphs has been subject to several taxonomic revisions in the past. These have resulted in the recognition of 116 species, of which all but two species (*C. hederae* and *C. pyrochroa*) are supported by ex-type cultures and supplemented with DNA barcodes. The present study is based on a large collection of unidentified *Calonectria* isolates that have been collected over a period of 20 years from various substrates worldwide, which has remained unstudied in the basement of the CBS-KNAW Fungal Biodiversity Centre. Employing a polyphasic approach, the identities of these isolates were resolved and shown to represent many new phylogenetic species. Of these, 24 are newly described, while *C. uniseptata* is reinstated at species level. We now recognise 141 species that include some of the most important plant pathogens globally.

Key words: *Cylindrocladium*, Cryptic species, Phylogeny, Taxonomy.

Taxonomic novelties: New species: *Calonectria amazonica* L. Lombard & Crous, *C. amazoniensis* L. Lombard & Crous, *C. brasiliana* L. Lombard & Crous, *C. brassicicola* L. Lombard & Crous, *C. brevispilita* L. Lombard & Crous, *C. cliformicola* L. Lombard & Crous, *C. ericae* L. Lombard & Crous, *C. indonesiana* L. Lombard & Crous, *C. lageniformis* L. Lombard & Crous, *C. machaenaeae* L. Lombard & Crous, *C. multilateralis* L. Lombard & Crous, *C. paracolhounii* L. Lombard & Crous, *C. parva* L. Lombard & Crous, *C. plurilateralis* L. Lombard & Crous, *C. pseudocucurbitae* L. Lombard & Crous, *C. pseudoxuvaliensis* L. Lombard & Crous, *C. putiramiosa* L. Lombard & Crous, *C. stipitata* L. Lombard & Crous, *C. syzygiicola* L. Lombard & Crous, *C. tereicorinns* L. Lombard & Crous, *C. terricola* L. Lombard & Crous, *C. tropicalis* L. Lombard & Crous, *C. unalmensis* L. Lombard & Crous, *C. venezuelana* L. Lombard & Crous.

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INTRODUCTION

The genus *Calonectria*, first introduced in 1867 (Rossman 1979), has been the subject of numerous taxonomic studies since the 1990s (Crous & Wingfield 1994, Crous 2002, Lombard et al. 2010b, 2015a, Alfenas et al. 2015). These studies have resulted in the recognition of 116 species, of which all but two (*C. hederae* and *C. pyrochroa*) are supported by ex-type cultures and supplemented with DNA barcodes (Crous 2002, Lechat et al. 2010, Lombard et al. 2010b). This large number of species has arisen mainly due to the introduction of DNA sequence data and subsequent phylogenetic inference enabling delimitation of numerous previously unrecognised cryptic taxa. These species often share the same plant hosts, informing knowledge of the epidemiology and fungicide resistance (Graça et al. 2009, Vitale et al. 2013, Ghesquières et al. 2016).

*Calonectria* spp. are characterised by sexual morphs that have yellow to dark red perithecia, with scaly to warty ascocarp walls, and *Cylindrocladium* asexual morphs in which the cylindrical and septate conidia are produced from phialides clustered below and surrounding a stipe extension terminating in variously shaped vesicles (Rossman 1993, Crous 2002, Lombard et al. 2010b,c). For many years these fungi were best known by their *Cylindrocladium* names associated with important plant diseases (Crous & Wingfield 1994, Crous 2002, Lombard et al. 2010c). Following convention that only one scientific name should be used for a fungal species (Hawksworth 2011, 2012, Hawksworth et al. 2011, McNeill et al. 2012), *Calonectria* has been chosen (Rossman et al. 2013). This newly adopted convention should resolve confusion regarding their names (Wingfield et al. 2011). However, it is important to recognise that the asexual *Cylindrocladium* morph represents the life phase most commonly found in nature and many species are known only in this form, which also plays a major role in the dissemination of *Calonectria* spp.

*Calonectria* spp. cause important diseases in numerous plant hosts worldwide. This includes leaf blight, cutting rot, damping-off and root rot (Crous 2002, Lombard et al. 2010c, 2015a, Vitale et al. 2013, Alfenas et al. 2015). The majority of the diseases caused by *Calonectria* spp. are associated with forestry-related plants (see Lombard et al. 2010c), where *Calonectria* leaf blight (CLB) is an important constraint to plantation productivity in South America (Rodas et al. 2005, Alfenas et al. 2015) and Southeast Asia (Crous & Kang 2001, Old et al. 2003, Chen et al. 2011, Lombard et al. 2015a). In other regions, such as southern Africa and Australia, *Calonectria* spp. appear mostly to be limited to forestry nurseries (Crous 2002, Lombard et al. 2009, 2010a,b,c). In agricultural and horticultural crops, *Calonectria* spp. have chiefly been reported only from South America and the Northern Hemisphere, where they are mostly associated with nursery diseases (Lombard et al. 2010c, Vitale et al. 2013), *Cylindrocladium* black rot of peanut (Bell & Sobers 1966, Beute & Rowe 1973, Hollowell et al. 1998) and box blight of *Buxus* spp. (Hencriv et al. 2000, Crepel & Inghelbrecht 2003, Brand 2005, Saracchi et al. 2008, Saurat et al. 2012, Mirabolfathy et al. 2013, Ghesquières et al. 2016).
The present study is based on a large collection of unidentified Calonectria isolates that were collected over a period of 20 years from various substrates worldwide. This collection of isolates, deposited in the CBS-KNAW culture collection in 2002 has remained unstudied in the basement of the institute and hence, the title of this study “the forgotten basement collection”. The large majority of these isolates were initially identified based solely on morphology and at a time when robust and multigene DNA sequence data were not commonly available. This implied that cryptic species could not be resolved (Lombard et al. 2010b, 2015a, Alfenas et al. 2015). The aim of the present study was to employ a polyphasic approach to identify these isolates.

MATERIALS AND METHODS

Isolates

Calonectria strains were obtained from the culture collection of the CBS-KNAW Fungal Biodiversity Centre (CBS), Utrecht, The Netherlands and the working collection of the senior author (CPC) housed at the CBS (Table 1).

Phylogeny

Total genomic DNA was extracted from 7-d-old axenic cultures, grown on MEA at room temperature, using the UltraClean™ Microbial DNA isolation kit (Mo Bio Laboratories, Inc., California, USA) following the protocols provided by the manufacturer. Based on previous studies (Lombard et al. 2010b, 2015b, Alfenas et al. 2015), partial gene sequences were determined for β-tubulin (tub2), calmodulin (cmdA), and the translation elongation factor 1-alpha (lef1) regions as these regions provided the best phylogenetic signal at species level for the genus Calonectria. Therefore, the primers and protocols described by Lombard et al. (2015b) were used to determine these regions.

To ensure the integrity of the sequences, the amplicons were sequenced in both directions using the same primers used for amplification. Consensus sequences for each locus were assembled in MEGA v. 7 (Kumar et al. 2016) and compared with representative sequences from Alfenas et al. (2013a,b, 2015), Chen et al. (2011) and Lombard et al. (2010a,b, 2011, 2015a). Subsequent alignments for each locus were generated in MAFFT v. 7.110 (Katoh & Standley 2013) and the ambiguously aligned regions of both ends were truncated. Congruency of the three loci was tested using the 70 % reciprocal bootstrap criterion (Mason-Gamer & Kellogg 1996) following the protocols of Lombard et al. (2015b).

Phylogenetic analyses of the individual gene regions and the combined dataset were based on Bayesian inference (BI), Maximum Likelihood (ML) and Maximum Parsimony (MP). For BI and ML, the best evolutionary models for each locus were determined using MrModeltest (Nylander 2004) and incorporated into the analyses. MrBayes v. 3.2.1 (Ronquist & Huelsenbeck 2003) was used for BI to generate phylogenetic trees under optimal criteria for each locus. A Markov Chain Monte Carlo (MCMC) algorithm of four chains was initiated in parallel from a random tree topology with the heating parameter set at 0.3. The MCMC analysis lasted until the average standard deviation of split frequencies was below 0.01 with trees saved every 1 000 generations. The first 25 % of saved trees were discarded as the “burn-in” phase and posterior probabilities (PP) were determined from the remaining trees.

The ML analyses were preformed using RAxML v. 8.0.9 (randomised accelerated (sic) maximum likelihood for high performance computing; Stamatakis 2014) through the CIPRES website (http://www.phylo.org) to obtain another measure of branch support. The robustness of the analysis was evaluated by bootstrap support (BS) with the number of bootstrap replicates automatically determined by the software.

For MP, analyses were done using PAUP (Phylogenetic Analysis Using Parsimony, v. 4.0b10; Swofford 2003) with phylogenetic relationships estimated by heuristic searches with 1 000 random addition sequences. Tree-bisection-reconnection was used, with branch swapping option set on “best trees” only. All characters were weighted equally and alignment gaps treated as fifth state. Measures calculated for parsimony included tree length (TL), consistency index (CI), retention index (RI) and rescaled consistency index (RC). Bootstrap analyses (Hillis & Bull 1993) were based on 1 000 replications. All new sequences generated in this study were deposited in GenBank (Table 1) and alignments and trees in TreeBASE.

Taxonomy

Axenic cultures were transferred to synthetic nutrient-poor agar (SNA; Nirenburg 1981) and incubated at room temperature for 7 d. Gross morphological characteristics were studied by mounting the fungal structures in 85 % lactic acid and 30 measurements were made at ×1 000 magnification for all taxonomically informative characters using a Zeiss Axioscope 2 microscope with differential interference contrast (DIC) illumination. The 95 % confidence levels were determined for the conidial measurements with extremes given in parentheses. For all other fungal structures measured, only the extremes are provided. Colony colour was assessed using 7-d-old cultures on MEA incubated at room temperature and the colour charts of Rayner (1970). All descriptions, illustrations and nomenclatural data were deposited in MycoBank (Crous et al. 2004a).

RESULTS

Phylogenetic analyses

Approximately 500–550 bases were determined for the three gene regions included in this study. The congruency analyses revealed no conflicts in tree topologies, with only minor differences in branch support. Therefore, the sequences of the three loci determined here were combined in a single dataset for analyses. For the BI and ML analyses, a HKY+I+G model was selected for all three gene regions and incorporated into the analyses. The ML tree topology confirmed the tree topologies obtained from the BI and MP analyses, and therefore, only the ML tree is presented.

The combined cmdA, tef1 and tub2 sequences dataset included 278 ingroup taxa and Curvicladiella cignea (CBS 109167) as outgroup taxon. This dataset consisted of 1680
| Species          | Isolate nr. | Substrate                  | Locality                  | GenBank accession no. |
|-----------------|-------------|----------------------------|---------------------------|-----------------------|
|                 |             |                            |                           |                       |
| Calonectria acicola | CBS 114812  | Phoenix canariensis        | New Zealand               | DQ190590 GQ267359 GQ267291 |
|                 | CBS 114813  | P. canariensis             | New Zealand               | DQ190591 GQ267360 GQ267292 |
| C. acondialis    | CBS 136086  | Soil in Eucalyptus planting| Hainan, China             | – KJ463017 KJ462785   |
|                 | CMW 35174;  |                            |                           |                       |
|                 | CERC 1850   |                            |                           |                       |
|                 | CBS 136091; | Soil in Eucalyptus planting| Hainan, China             | – – KJ462786         |
|                 | CBS 136091; |                            |                           |                       |
|                 | CPC 3889    |                            |                           |                       |
| C. amazonica     | CBS 115486; | E. tereticomis             | Brazil                    | KX784611 KX784554 KX784681 |
|                 | CPC 3894    |                            |                           |                       |
| C. amanzoniensis | CBS 115438; | E. tereticomis             | Brazil                    | KX784613 KX784556 KX784682 |
|                 | CPC 3890    |                            |                           |                       |
| C. angustata     | CBS 109065; | Tillandsia capitata        | USA                       | AF207543 GQ267361 FJ918551 |
|                 | CPC 2347    |                            |                           |                       |
| C. barbata       | CBS 136079; | Soil in Eucalyptus planting| Guangxi, China            | KJ462904 KJ463018 KJ462787 |
|                 | CMW 31370;  |                            |                           |                       |
|                 | CERC 1705   |                            |                           |                       |
| C. asiatica      | CBS 112711; | Leaf litter                | Thailand                  | AY725613 AY725738 AY725702 |
|                 | CPC 3898    |                            |                           |                       |
| C. australiensis | CBS 111475; | Ficus pleurocarpa          | Australia                 | DQ190596 GQ267363 GQ267293 |
|                 | CPC 21859   |                            |                           |                       |
| C. brevistipitata| CBS 134855; | Soil                       | Teresina, Piaui, Brazil   | KM395969 KM396056 KM395882 |
|                 | CBS 134856  |                            | Teresina, Piaui, Brazil   | KM395970 KM396057 KM395883 |
| C. brassicaceae  | CBS 111478; | Soil                       | Brazil                    | DQ190561 GQ267363 FJ918568 |
|                 | CPC 1921    |                            |                           |                       |
| C. brassiccola   | CBS 111869; | Argyeia splendens          | Indonesia                 | AF232857 GQ267382 FJ918567 |
|                 | CPC 2409    |                            |                           |                       |
| C. brassicicola  | CBS 112756; | Brassica sp.               | Indonesia                 | KX784618 – KX784688   |
|                 | CPC 4502    |                            |                           |                       |
| C. brevistipitata| CBS 134857; | Soil                       | Mexico                    | KX784611 KX784561 KX784689 |
|                 | CPC 4688    |                            |                           |                       |
| C. canadania     | CBS 110817; | Soil                       | Canada                    | AF348212 AY725743 GQ267297 |
|                 | CPC 499     |                            |                           |                       |
| C. candelabrum   | CPC 1675    | Eucalyptus sp.             | Amazonas, Brazil          | FJ917246 GQ267367 FJ972525 |
|                 | CMW 31001   | Eucalyptus sp.             | Amazonas, Brazil          | GQ421779 GQ267368 GQ267298 |
| C. cerciana      | CBS 123693; | Eucalyptus cutting         | Zhanjiang, China          | FJ918510 GQ267369 FJ918559 |
|                 | CMW 25309   |                            |                           |                       |
| C. chinensis     | CBS 123695; | Eucalyptus cutting         | Zhanjiang, China          | FJ918511 GQ267370 FJ918560 |
|                 | CMW 25290   |                            |                           |                       |
| C. clavata       | CBS 114827; | Soil                       | Hong Kong, China          | AY725746 AY725747 AY725709 |
|                 | CPC 4101    |                            |                           |                       |
| C. cliffordicola | CBS 111812; | Soil                       | South Africa              | KX784624 KX784566 KX784694 |
|                 | CPC 2631    |                            |                           |                       |
|                 | CBS 111814; | P. avium                   | South Africa              | KX784625 KX784567 KX784695 |
|                 | CPC 2617    |                            |                           |                       |
|                 | CBS 111819; | Prunus avium               | South Africa              | KX784626 KX784568 KX784696 |
|                 | CPC 2604    |                            |                           |                       |

(continued on next page)
| Species         | Isolate nr. | Substrate               | Locality            | GenBank accession no. |
|-----------------|-------------|-------------------------|---------------------|-----------------------|
| C. colhounii    | CBS 293.79  | *Camellia sinensis*     | Bandung, Indonesia  | DQ190564 GQ267373 GQ267301 |
|                 | CBS 114704  | *Arachis pintoi*        | Australia            | DQ190563 GQ267372 GQ267300 |
| Ca. colombiana  | CBS 115127; CPC 1160 | Soil | La Selva, Colombia | FJ972423 GQ267455 FJ972492 |
|                 | CBS 115638; CPC 1161 | Soil | La Selva, Colombia | FJ972422 GQ267456 FJ972491 |
| C. colombiensis | CBS 112220; CPC 723 | Eucalyptus grandis     | La Selva, Colombia  | GQ267207 AY725748 AY725711 |
|                 | CBS 112221; CPC 724 | *Pistacia lentiscus*    | Italy               | AY725620 AY725749 AY725712 |
| C. crousiana    | CBS 127198; CMW 27249 | E. grandis | Fujian, China      | HQ285794 – HQ285822 |
|                 | CBS 127199; CMW 27253 | E. grandis | Fujian, China      | HQ285795 – HQ285823 |
| C. cylindrospora| CBS 110666; CPC 496 | Soil La Selva, Colombia | USA                | FJ918509 GQ267423 FJ918557 |
|                 | CBS 119670; CPC 12766 | Soil La Selva, Colombia | Italy             | DQ521600 – GQ241797 |
| C. densa        | CBS 125249; CMW 31184 | Soil Las Golondrinas, Pichincha, Ecuador | – | GQ267230 GQ267442 GQ267350 |
| CBS 125261; CMW 31182 | Soil Las Golondrinas, Pichincha, Ecuador | – | GQ267232 GQ267444 GQ267352 |
| C. duoramosa    | CBS 134656; LPF434 | Soil Monte Dourado, Pará, Brazil | – | KM395940 KM396027 KM395853 |
|                 | LPF453 | Soil in Eucalyptus plantation Monte Dourado, Pará, Brazil | – | KM395941 KM396028 KM395854 |
| C. eucadoriae   | CBS 111406; CPC 1635 | Soil Ecuador            | – | DQ190600 GQ267375 GQ267303 |
|                 | CBS 111394; CPC 1628 | Soil Ecuador            | – | DQ190599 GQ267376 GQ267304 |
| C. ericae       | CBS 114456; CPC 1984 | *Erica sp.* USA         | – | KX784627 KX784569 KX784697 |
|                 | CBS 114457; CPC 1985 | *Erica sp.* USA         | – | KX784628 KX784570 KX784698 |
| C. eucalypti    | CBS 125273; CMW 14890 | E. grandis Indonesia     | – | GQ267217 GQ267429 GQ267337 |
|                 | CBS 125275; CMW 18444 | E. grandis Indonesia     | – | GQ267218 GQ267430 GQ267338 |
| C. eucalypticola| CBS 134846 | Eucalyptus leaf Eunápolis, Bahia, Brazil | – | KM395963 KM396050 KM395876 |
| CBS 134847 | Eucalyptus seedling Santa Bárbara, Minas Gerais, Brazil | – | KM395964 KM396051 KM395877 |
| C. expansa      | CBS 136078; CMW 31441; CERC 1776 | Soil in Eucalyptus plantation Guangdong, China | – | KJ462913 KJ463028 KJ462979 |
|                 | CBS 136247; CMW 31392; CERC 1727 | Soil in Eucalyptus plantation Guangxi, China | – | KJ462914 KJ463029 KJ462978 |
| C. fujianensis  | CBS 127200; CMW 27254 | E. grandis Fujian, China | – | HQ285791 – HQ285819 |
| CBS 127201; CMW 27257 | E. grandis Fujian, China | – | HQ285792 – HQ285820 |
| C. glaeboicola  | CBS 134852 | Soil Martinho Campos, Minas Gerais, Brazil | – | KM395966 KM396053 KM395879 |
|                 | CBS 134853 | Soil Bico do Papagaio, Tocantins, Brazil | – | KM395967 KM396054 KM395880 |
| C. gordoniae    | CBS 112142; CPC 3136; ATCC 201837 | *Gordonia iliasanthus* USA | – | AF449449 GQ267381 GQ267309 |
| C. gracilpes    | CBS 111141 | Soil La Selva, Colombia | – | DQ190566 GQ267385 GQ267311 |
|                 | CBS 115674 | Soil La Selva, Colombia | – | AF333406 GQ267384 GQ267310 |
| C. gracilis     | CBS 111284 | Soil Brazil             | – | DQ190567 GQ267408 GQ267324 |
| CBS 111807 | Manilkara zapota | Belem, Pará, Brazil | – | AF232858 GQ267407 GQ267323 |
| C. guangxiensis | CBS 136092; CMW 35409; CERC 1900 | Soil in Eucalyptus plantation Guangxi, China | – | KJ462919 KJ463034 KJ462803 |
|                 | CBS 136094; CMW 35411; CERC 1902 | Soil in Eucalyptus plantation Guangxi, China | – | KJ462920 KJ463035 KJ462804 |
| C. hainanensis  | CBS 136248; CMW 35187; CERC 1863 | Soil in Eucalyptus plantation Hainan, China | – | – KJ463036 KJ462805 |
| Species          | Isolate nr.      | Substrate | Locality          | GenBank accession no.         |
|------------------|------------------|-----------|-------------------|------------------------------|
| **C. hawksworthii** | CBS 111870; CPC 2405; MUCL 30866 | Nelumbo nucifera | Mauritius | AF333407 GQ267386 FJ918558 |
| C. henricotiae   | CB041            | Buoxus sempervirens | Belgium | KF815129 KF815156 – |
| **C. hodgessi**  | CBS 138102; CB045 | B. sempervirens | Belgium | JX535038 KF815157 – |
| C. hongkongensis | CBS 114711; CPC 686 | Anadenanthera peregrina | Viçosa, Brazil | KC491228 KC491222 KC491225 |
| C. humicola      | CBS 114828; CPC 4670 | Soil | Hong Kong, China | AY725621 AY725754 AY725716 |
| **C. hurae**     | CBS 114182; CPC 1714 | Soil | Hong Kong, China | AY725622 AY725755 AY725717 |
| C. ilicicola     | CBS 115897; CPC 493; UFV 108 | Soil | Las Gordioninas, Pichincha, Ecuador | GQ267233 GQ267445 GQ267353 |
| **C. indonesiae**| CBS 112823; CPC 4508 | Soil | Waramburga, Indonesia | AY725623 AY725756 AY725718 |
| C. indonesiana   | CBS 112840; CPC 4554 | Syzygium aromaticum | Indonesia | AY725625 AY725758 AY725720 |
| C. indusiata     | CBS 118.36 | Camellia sinensis | Sri Lanka | GQ267239 GQ267453 GQ267332 |
| C. insularis     | CBS 114558; CPC 768 | Soil | Tamatave, Madagascar | AF210861 GQ267389 FJ918556 |
| C. kyotensis     | CBS 114525; CPC 2367; ATCC 18834 | Soil | Acacia dealbata | AY725647 GQ267403 AY725729 |
| C. lageniformis  | CBS 114542; CPC 2352 | Soil | China | KX784649 – KX784720 |
| C. lateralis     | CBS 114542; CPC 2352 | Soil | China | KX784650 KX784567 KX784721 |
| C. laurii        | CBS 113324; CPC 1473 | Soil in Eucalyptus plantation | KJ462955 KJ463070 KJ462840 |
| C. leucothoe     | CBS 1109166; CPC 2385; ATCC 64824 | Leucothoe axillaris | Gainsville, Florida, USA | FJ918508 GQ267392 FJ918553 |
| C. macaerinae    | CBS 114571; CPC 2253 | Soil | Madagascar | KX784571 KX784702 |
| C. magnispora    | CBS 136629; CMW 31412; CERC 1747 | Soil | Greece | KJ462955 KJ463070 KJ462840 |
| C. malesiana     | CBS 112710; CPC 3899 | Leaf litter | Thailand | AY725626 AY725759 AY725721 |
| C. marathensis   | CBS 112752; CPC 4223 | Soil | Sumatra, Indonesia | AY725627 AY725760 AY725722 |
| C. macrocondialis| CBS 134811 | Eucalyptus sp. | Australia | KM395948 KM396035 KM395861 |
| C. metisoreri     | CBS 133603; LPF101 | Soil | Eucalyptus sp. | KM395949 KM396036 KM395862 |
| C. metrosideri   | CBS 133604; LPF 103 | M. polymorpha | Viçosa, Brazil | KC294313 KC294304 KC294310 |

(continued on next page)
| Species               | Isolate nr. | Substrate                                                                 | Locality                  | GenBank accession no. |
|-----------------------|-------------|----------------------------------------------------------------------------|---------------------------|----------------------|
| **C. mexicana**        | CBS 110918; CPC 927 | Soil                                                                       | Mexico                    | AF210868 GQ267396 FJ972526 |
| **C. microconidialis** | CBS 136636; CMW 31475; CER C 1810 | *E. urophylla × E. grandis* clone seedling leaf               | CERC Nursery, Zhanjiang, Guangdong, China | KJ462969 KJ463074 KJ462844 |
| **C. monticola**       | CBS 140645; CPC 28835 | Soil                                                                       | Thailand                  | KT964769 KT964771 KT964773 |
| **C. mossambicensis**  | CBS 137243 | *E. grandis × E. camal dulensis* cutting                              | Mozambique                | – JX570722 JX570718  |
| **C. multilateralis**  | CBS 110926; CPC 947 | Soil                                                                       | Mexico                    | KX784639 KX784578 KX784709 |
| **C. multinaviculata** | CBS 134858; LPF233 | Soil in Eucalyptus plantation                                                 | Mucuri, Bahia, Brazil    | KM395985 KM396072 KM395898 |
| **C. multiseptata**    | CBS 115606 | Soil                                                                       | Amazonas, Brazil         | GQ267396 GQ267316    |
| **C. nemicola**        | CBS 134837 | Soil                                                                       | Anaponga, Minas Gerais, Brazil | KM395979 KM396066 KM395892 |
| **C. orientalis**      | CBS 112687 | Soil                                                                       | Teso East, Indonesia     | GQ267137 GQ267357    |
| **C. ovata**           | CBS 111029 | *E. urophylla × E. grandis* clone seedling leaf               | Tucurui, Pará, Brazil    | GQ267212 GQ267400 GQ267318 |
| **C. pacifica**        | CBS 109063; CPC 2534; IMI 354528 | Leaf litter                                                               | Hawai, USA                | GQ267213 AY725762 AY725723 |
| **C. papillata**       | CBS 116080; CPC 947 | Soil                                                                       | Amazonas, Brazil         | AF333409 GQ267396 GQ267316 |
| **C. pauciramosa**     | CBS 136087; CMW 5683 | Soil                                                                       | South Africa             | FJ918514 GQ267405 FJ919565 |
| **C. penicilloides**   | CBS 136095; CPC 2445 | Soil in Eucalyptus plantation                                                 | Trichilia, Brazil        | KJ463081 KJ462851    |
| **C. parvum**          | CBS 110798; CPC 410 | Soil                                                                       | South Africa             | KX784646 KX784583 KX784716 |
| **C. parvum**          | CBS 138824; CMW 30823 | *E. grandis*                                                              | South Africa             | FJ918514 GQ267405 FJ919565 |
| **C. parvum**          | CBS 138824; CMW 31477; CER 1853 | *E. grandis*                                                              | South Africa             | FJ918514 GQ267405 FJ919565 |
| **C. parvum**          | CBS 136087; CMW 35169; CER 1845 | Soil in Eucalyptus plantation                                                 | Guangdong, China         | KJ462966 KJ463083 KJ462853 |
| **C. parvum**          | CBS 136095; CMW 35413; CER 1904 | Soil in Eucalyptus plantation                                                 | Guangxi, China           | KJ463082 KJ462852    |
| **C. parvum**          | CBS 114370; CPC 2423 | Soil in Eucalyptus plantation                                                 | –                        | KJ463081 KJ462851    |
| **C. parvum**          | CBS 138824; CMW 30823 | *E. grandis*                                                              | South Africa             | FJ918514 GQ267405 FJ919565 |
| **C. parvum**          | CBS 136087; CMW 35169; CER 1845 | Soil in Eucalyptus plantation                                                 | Guangdong, China         | KJ462966 KJ463083 KJ462853 |
| **C. parvum**          | CBS 136095; CMW 35413; CER 1904 | Soil in Eucalyptus plantation                                                 | Guangxi, China           | KJ463082 KJ462852    |
| **C. pacifica**        | CBS 109063; CPC 2534; IMI 354528 | Leaf litter                                                               | Hawai, USA                | GQ267213 AY725762 AY725723 |
| **C. papillata**       | CBS 116080; CPC 947 | Soil                                                                       | Amazonas, Brazil         | AF333409 GQ267396 GQ267316 |
| **C. penicilloides**   | CBS 136095; CPC 2445 | Soil in Eucalyptus plantation                                                 | –                        | KJ463081 KJ462851    |
| **C. parvum**          | CBS 110798; CPC 410 | Soil                                                                       | South Africa             | KX784646 KX784583 KX784716 |
| **C. pauciramosa**     | CBS 138824; CMW 30823 | *E. grandis*                                                              | South Africa             | FJ918514 GQ267405 FJ919565 |
| **C. parvum**          | CBS 136087; CMW 35169; CER 1845 | Soil in Eucalyptus plantation                                                 | Guangdong, China         | KJ462966 KJ463083 KJ462853 |
| **C. parvum**          | CBS 136095; CMW 35413; CER 1904 | Soil in Eucalyptus plantation                                                 | Guangxi, China           | KJ463082 KJ462852    |
| Species                  | Isolate nr. | Substrate                  | Locality                          | GenBank accession no. |
|--------------------------|-------------|----------------------------|-----------------------------------|-----------------------|
| C. pseudovata            | CBS 134849  | Soil                       | Serra das Confusões, Piauí        | KM395972 KM396059 KM395885 |
|                          | CBS 134850  | Soil                       | Teresina, Piauí, Brazil           | KM395973 KM396060 KM395886 |
| C. pini                  | CBS 123698  | *Pinus patula*              | Buga, Colombia                    | GQ267224 GQ267436 GQ267344 |
|                          | CBS 125253  | *P. patula*                 | Buga, Colombia                    | GQ267225 GQ267437 GQ267345 |
| C. polizi                | CBS 125270; CMW 7804 | Callistemon citrinus      | Messina, Sicily, Italy            | FJ972417 GQ267461 FJ972486 |
|                          | CBS 125271; CMW 10151 | *Arbutus unedo*           | Catania, Sicily, Italy            | FJ972418 GQ267462 FJ972487 |
| C. plunilateralis         | CBS 111401; CPC 1637 | Soil in Eucalyptus plantation | Ecuador                           | KX784548 KX784586 KX784719 |
| C. pluriramosa           | CBS 136976; CMW 31440; CERC 1774 | Soil in Eucalyptus plantation | Fangchenggang, Guangxi, China     | KJ462995 KJ463112 KJ462882 |
| C. propagincola          | CBS 134815; LPF220 | *Eucalyptus sp.*          | Santana, Pará, Brazil             | KM395963 KM396040 KM395866 |
|                          | CBS 134816; LPF222 | *Eucalyptus sp.*          | Santana, Pará, Brazil             | KM395964 KM396041 KM395867 |
| C. pseudobrassicae       | CBS 134661; LPF280 | Soil in Eucalyptus plantation | Santana, Pará, Brazil             | KM395963 KM396022 KM395848 |
|                          | CBS 134662; LPF280 | Soil in Eucalyptus plantation | Santana, Pará, Brazil             | KM395963 KM396023 KM395849 |
| C. pseudocerciana        | CBS 134823  | *Eucalyptus sp.*           | Santana, Pará, Brazil             | KM395961 KM396048 KM395874 |
| C. pseudocystina         | CBS 134824  | *Eucalyptus seedling*       | Santana, Pará, Brazil             | KM395962 KM396049 KM395875 |
| C. pseudofiocrotinii     | CBS 127195; CMW 27209 | *E. dunnii*               | Fujian, China                     | HQ285789 – HQ285816 |
|                          | CBS 127196; CMW 27213 | *E. dunnii*               | Fujian, China                     | HQ285789 – HQ285817 |
| C. pseudoeucadoriae      | CBS 111402; CPC 1639 | Soil in Eucalyptus plantation | Ecuador                           | KX784542 KX784589 KX784723 |
|                          | CBS 111412; CPC 1648 | Soil                       | Ecuador                           | DQ190601 KX784590 KX784724 |
| C. pseudogordosii        | CBS 134818  | *Azadirachta indica*       | Viçosa, Minas Gerais, Brazil      | KM395905 KM395991 KM395817 |
|                          | CBS 134819  | *A. indica*                | Viçosa, Minas Gerais, Brazil      | KM395906 KM395992 KM395818 |
| C. pseudokyotensis       | CBS 137332; CMW 31439; CERC 1774 | Soil in Eucalyptus plantation | Fangchenggang, Guangxi, China     | KJ462994 KJ463111 KJ462881 |
| C. pseudometrosideri     | CBS 134844  | *Eucalyptus sp.*           | Açailândia, Maranhão, Brazil      | KM395908 KM395994 KM395820 |
| C. pseudomexicana        | CBS 134845  | Soil                       | Maceió, Alagoas, Brazil           | KM395909 KM395995 KM395821 |
| C. pseudonevicaudata     | CBS 114417; CPC 10926 | *Buxus sempervirens*      | West Auckland, New Zealand        | GQ267214 GQ267409 GQ267325 |
|                          | CBS 116251; CPC 3399 | *B. sempervirens*        | New Zealand                       | AF449455 KM396000 KM395826 |
| C. pseudopteridis        | CBS 163.28; IMI 299579 | *Washingtonia robusta*   | USA                               | – KM396076 KM395902 |
| C. pseudopretreatudi     | CBS 123694; CMW 25310 | *Eucalyptus hybrid cutting* | Guangdong, China                  | FJ918504 GQ267411 FJ918541 |
|                          | CBS 123696; CMW 25292 | *Eucalyptus hybrid cutting* | Guangdong, China                  | FJ918505 GQ267410 FJ918542 |
| C. pseudoscoparia        | CBS 125255; CMW 15216 | *E. grandis*              | Pichinchá, Ecuador                | GQ267227 GQ267439 GQ267347 |
|                          | CBS 125256; CMW 15216 | *E. grandis*              | Pichinchá, Ecuador                | GQ267228 GQ267440 GQ267348 |
| C. pseudospathiphylly    | CBS 109165; CPC 1623 | Soil                      | Ecuador                           | FJ918513 GQ267412 FJ918562 |
| C. pseudospathulata      | CBS 134840  | Soil                       | Araponga, Minas Gerais, Brazil    | KM395982 KM396069 KM395895 |
| C. pseudospathulata      | CBS 134841  | Soil                       | Araponga, Minas Gerais, Brazil    | KM395983 KM396070 KM395896 |
| C. pseudoximalensis      | CBS 110923; CPC 941 | Soil                      | Mexico                            | KX784563 – KX784725 |
|                          | CBS 110924; CPC 942 | Soil                      | Mexico                            | KX784564 – KX784726 |
| C. pseudovesaita         | CBS 134674; LPF267 | Soil in Eucalyptus plantation | Santana, Pará, Brazil             | KM395945 KM396032 KM395858 |
|                          | CBS 134675; LPF285 | Soil in Eucalyptus plantation | Santana, Pará, Brazil             | KM395946 KM396033 KM395859 |
| C. pteridis              | CBS 111793; ATCC 34395; CPC 2372 | *Arachnoides adiantiformis* | USA                               | DQ190578 GQ267413 FJ918563 |
|                          | CBS 111871; CPC 2443 | *Pinus sp.*               | Spain                             | DQ190579 GQ267414 FJ918564 |
| C. putrimosma            | CBS 111449; CPC 1951 | *Eucalyptus cutting*      | Brazil                            | KX784566 KX784591 KX784728 |
|                          | CBS 111470; CPC 1940 | Soil                      | Brazil                            | KX784567 KX784592 KX784729 |
|                          | CBS 111477; CPC 1928 | Soil                      | Brazil                            | KX784568 KX784593 KX784730 |
|                          | CBS 116076; CPC 604 | *Eucalyptus cutting*      | Brazil                            | GQ421776 – GQ421792 |

(continued on next page)
| Species               | Isolate nr.  | Substrate                        | Locality                  | GenBank accession no. |
|----------------------|--------------|----------------------------------|---------------------------|-----------------------|
|                      |              | tub2 | cmdA | tefl |                      |                      |
| C. queenslandica     | CBS 112146;  |      |      |      | E. urophylla          | Australia             | AF398935             | GQ267415             | FJ918543             |
|                      | CPC 3213     |      |      |      |                      |                       | AF389834             | GQ267416             | FJ918544             |
| C. quinqueramosa      | CBS 134654;  | Soil in Eucalyptus plantation    | Monte Dourado, Pará, Brazil | KM395942             | KM396029             | KM395855             |
|                      | LPF065       |      |      |      |                      |                       | KM395943             | KM396030             | KM395856             |
| C. reteaudii         | CBS 112143;  |      |      |      | E. camaldulensis      | Vietnam                | GQ240642             | GQ267418             | FJ918536             |
|                      | CPC 3200     |      |      |      |                      |                       | AF398933             | GQ267417             | FJ918537             |
| C. robigophila       | CBS 134652   | Eucalyptus sp.                    | Açaílândia, Maranhão, Brazil | KM395937             | KM396024             | KM395850             |
| C. rumohrae          | CBS 134655;  |      |      |      | R. adiantiformis      | Vietnam                | KM395938             | KM396025             | KM395851             |
|                      | LPF281       |      |      |      |                      |                       | AF232873             | GQ267419             | FJ918550             |
| C. seminaria         | CBS 136631;  | E. urophylla × E. grandis        | CERC Nursery, Zhanjiang, Guangdong, China | KJ462997             | KJ463114             | KJ462884             |
|                      | CMW 31449;   | clone seedling leaf              |                           |                       |                      |                       |                      |                      |
|                      | CERC 1784    |      |      |      |                      |                       |                       |                      |                      |
| C. silvicola         | CBS 134356   | Soil                              | Araponga, Minas Gerais, Brazil | KM395975             | KM396062             | KM395868             |
| C. sphaeropendunculata | CBS 136081; | Soil in Eucalyptus plantation    |                               | KM395978             | KM396065             | KM395858             |
|                      | CMW 31390;   |      |      |      |                      |                       | KM395978             | KM396065             | KM395859             |
|                      | CERC 1725    |      |      |      |                      |                       | KM395977             | KM396062             | KM395868             |
| C. spathulata        | CBS 555.92   | E. viminalis                      | Brazil                     | AF308463             | GQ267426             | FJ918554             |
| C. spathiphylli      | CBS 136632;  | E. urophylla × E. grandis        | CERC Nursery, Zhanjiang, Guangdong, China | KJ462998             | KJ463115             | KJ462885             |
|                      | CMW 31450;   | clone seedling leaf              |                           |                       |                      |                       |                      |                      |
|                      | CERC 1785    |      |      |      |                      |                       |                       |                      |                      |
| C. spathiphylli      | CBS 114540;  | Spathiphyllum sp.                | Switzerland                | AF348214             | GQ267424             | GQ267330             |
|                      | ATCC 44730;  |      |      |      |                      |                       |                       |                      |                      |
|                      | CPC 2378     |      |      |      |                      |                       |                       |                      |                      |
| C. sphaeropendunculata | CBS 115639; | Soil                              |                               | KM396055             | KM396062             | KM395856             |
|                      | CPC 1148     |      |      |      |                      |                       | KM396056             | KM396062             | KM395857             |
| C. stipitata         | CBS 112513;  | Eucalyptus sp.                    | Colombia                   | KX784661             | KX784596             | KX784734             |
|                      | CPC 3851     |      |      |      |                      |                       | KX784662             | KX784595             | KX784733             |
| C. sulawesiensis     | CBS 125253;  | Eucalyptus sp.                    | Sulawesi, Indonesia        | GQ267220             | GQ267432             | GQ267340             |
|                      | CMW 14879    |      |      |      |                      |                       | GQ267222             | GQ267434             | GQ267342             |
| C. sumatrensis       | CBS 112289;  | Soil                              | Sumatra, Indonesia         | AY725649             | AY725771             | AY725733             |
|                      | CPC 4518     |      |      |      |                      |                       | AY725651             | AY725773             | AY725735             |
| C. syzygiicola       | CBS 112934;  | S. aromaticum                     | Indonesia                  | KX784662             | KX784597             | KX784735             |
|                      | CPC 4516     |      |      |      |                      |                       | KX784663             | –                    | KX784736             |
| C. terrae-reginae    | CBS 112151;  | E. urophylla                      | Queensland, Australia      | FJ918506             | GQ267451             | FJ918545             |
|                      | CPC 3202     |      |      |      |                      |                       | FJ918507             | GQ267452             | FJ918546             |
| C. terrestris        | CBS 136642;  | Soil in Eucalyptus plantation    | Guangdong, China           | KJ463004             | KJ463121             | KJ462891             |
|                      | CMW 35180;   |      |      |      |                      |                       | KJ463003             | KJ463120             | KJ462890             |
|                      | CERC 1856    |      |      |      |                      |                       | KJ463003             | KJ463120             | KJ462890             |
| C. terricola         | CBS 136643;  | Soil in Eucalyptus plantation    | Guangdong, China           | KJ463004             | KJ463121             | KJ462891             |
|                      | CMW 35364;   |      |      |      |                      |                       | KJ463005             | KJ463122             | KJ462892             |
|                      | CERC 1868    |      |      |      |                      |                       | KJ463005             | KJ463122             | KJ462892             |
| C. tetraramosa       | CBS 136635;  | E. urophylla × E. grandis        | CERC Nursery, Zhanjiang, Guangdong, China | KJ463011             | KJ463128             | KJ462898             |
|                      | CMW 31474;   | clone seedling leaf              |                           |                       |                      |                      |                      |                      |
|                      | CERC 1809    |      |      |      |                      |                       |                       |                      |                      |
| C. tropicalis        | CBS 116247;  | Eucalyptus sp.                    | Brazil                     | KX784668             | –                    | KX784741             |
|                      | CPC 3583     |      |      |      |                      |                       | KX784666             | –                    | KX784742             |
| C. tropicalis        | CBS 116248;  | Soil in Eucalyptus plantation    | Brazil                     | KX784666             | –                    | KX784741             |
|                      | CPC 3536     |      |      |      |                      |                       | KX784666             | –                    | KX784742             |
Table 1. (Continued).

| Species | Isolate nr. | Substrate | Locality | GenBank accession no. |
|---------|-------------|-----------|----------|----------------------|
| C. turangicola | CBS 136077; CMW 31411; CERC 1746 | Soil in Eucalyptus plantation | Fangchenggang, Guangxi, China | KJ463013 – KJ462900 |
| C. tunisiana | CBS 130356 | Catlistemon sp. | Tunisia | JN607277 – JN607292 |
| C. unisepata | CBS 413.67; CPC 2391; IMI 299577 | Paphiopedulum callosum | Celle, Germany | GQ267208 GQ267379 GQ267307 |
| C. uxmalensis | CBS 110919; CPC 928 | Soil | Mexico | KX784637 – KX784707 |
| C. variabilis | CBS 110825; CPC 945 | Soil | Mexico | KX784638 – KX784707 |
| C. venezuelana | CBS 111052; CPC 1183 | | Venezuela | KX784671 KX784601 KX784744 |
| Ca. zuluensis | CBS 125268 | E. grandis | South Africa | FJ972414 FJ972459 FJ972483 |
| Calonectria sp. | CBS 111423; CPC 1650 | | Ecuador | KX784673 KX784630 KX784746 |
| | CBS 111465; CPC 1902 | Soil | Brazil | DQ190607 KX784584 KX784717 |
| | CBS 111706; CPC 1636 | Soil | Ecuador | KX784674 KX784604 KX784747 |
| | CBS 112152; CPC 3203 | E. camaldulensis | Vietnam | KX784672 KX784602 KX784745 |
| | CBS 112753; CPC 4225 | | Indonesia | KX784687 KX784598 KX784740 |
| | CBS 113496; CPC 3155 | | | KX784675 KX784605 KX784748 |
| | CBS 113627; CPC 3232 | | | KX784676 KX784606 KX784749 |
| | CBS 114164; CPC 1634 | | Ecuador | KX784677 KX784607 KX784750 |
| | CBS 114691; CPC 2472; AR 2574 | | Canada | KX784678 KX784608 KX784751 |
| | CBS 114755; CPC 1403 | E. tereticornis | Brazil | KX784670 KX784600 KX784743 |
| | CBS 116108; CPC 726 | Soil | Colombia | KX784647 KX784585 KX784718 |
| | CBS 116249; CPC 3533 | Eucalyptus sp. | Brazil | KX784679 KX784609 KX784752 |
| | CBS 116265; CPC 3552 | Eucalyptus sp. | Brazil | KX784680 KX784610 KX784753 |
| | CBS 116305; CPC 3890 | Eucalyptus sp. | Brazil | KX784634 KX784576 KX784704 |
| | CBS 116319; CPC 3761 | Eucalyptus sp. | Brazil | KX784635 KX784577 KX784705 |
| Curvicladiella cignea | CBS 109167; CPC 1595; MUCL 40269 | Leaf litter | French Guiana | KM232002 KM231287 KM231667 |

1 AR: Amy Y. Rossman working collection; ATCC: American Type Culture Collection, Virginia, USA; CBS: Centraalbureau voor Schimmelcultures, Utrecht, The Netherlands; CERC: China Eucalypt Research Centre, Zhanjiang, Guangdong Province, China; CMW: culture collection of the Forestry and Agricultural Biotechnology Institute (FABI), University of Pretoria, Pretoria, South Africa; CPC: Pedro Crous working collection housed at CBS; IMI: International Mycological Institute, CIAT-Bioscience, Egham, Bakeham Lane, UK; LPF: Laboratorio de Patología Florestal, Universidade Federal de Viçosa, Viçosa, Brazil; MUCL: Mycothèque, Laboratoire de Mycologie Systématique et Appliquée, l'Université, Louvain-la-Neuve, Belgium; UFV: Universidade Federal de Viçosa, Viçosa, Brazil. Isolates obtained during the survey indicated in grey blocks.

2 tub2 = β-tubulin, cmdA = calmodulin, tef1 = translation elongation factor 1-alpha. Ex-type isolates indicated in bold. Sequences generated in this study indicated in italics.

characters, of which 507 were constant, 198 parsimony-uninformative and 975 parsimony-informative. The MP analysis yielded 1000 trees (TL = 6988; CI = 0.344; RI = 0.867; RC = 0.298) and a single best ML tree with -lnL = -32198.651254 which is presented in Fig. 1. The BI lasted for 10 M generations, and the consensus tree, with posterior probabilities, was calculated from 15 002 trees left after 5 000 trees were discarded as the ‘burn-in’ phase. In the phylogenetic tree (Fig. 1) the previously unnamed *Calonectria* species resolved in 21 distinct clades that were either well or strongly supported and 17 single lineages, each representing probable novel phylogenetic taxa.

**Taxonomy**

Based on phylogenetic inference supported by morphological observations, numerous *Calonectria* isolates included in this study represent novel species. No sexual morphs were observed for any of the novel taxa described below, even after 6 wk of incubation at room temperature. Fifteen of the lineages (CBS 111423, CBS 111468, CBS 111706, CBS 112152, CBS 112753, CBS 113496, CBS 113627, CBS 114164, CBS 114691, CBS 114755, CBS 116108, CBS 116249, CBS 116265, CBS 116305, CBS 116319) identified based on phylogenetic inference are not provided with names because they form part of a separate study.
Fig. 1. The ML consensus tree inferred from the combined cmdA, tef1 and tub2 sequence alignments. Thickened lines indicate branches present in the ML, MP and Bayesian consensus trees. Branches with ML-BS & MP-BS = 100 % and PP = 1.00 are in blue. Branches with ML-BS & MP-BS ≥ 75 % and PP ≥ 0.95 are in red. Dashed lines indicate branches shortened ×10. The scale bar indicates 0.09 expected changes per site. The tree is rooted to Curvuladiella cignea (CBS 109167). Epi- and ex-type strains are indicated in bold.
Fig. 1. (Continued).
Fig. 1. (Continued).
(Crous et al. in prep.) or more taxa are required to resolve their phylogenetic position.

**Calonectria amazonica** L. Lombard & Crous, sp. nov. Myco-Bank MB818698. Fig. 2.

**Etymology:** Name refers to the Amazonian region of Brazil where this fungus was collected.

**Macroconidiophores** consist of a stipe bearing a penicillate arrangement of fertile branches, and a stipe extension...
terminating in a vesicle; stipe septate, hyaline, smooth, 75–190 × 6–8 μm; stipe extension septate, straight to flexuous, 180–270 μm long, 4–5 μm wide at the apical septum, terminating in a clavate vesicle, 5–6 μm diam. Conidiogenous apparatus 45–55 μm wide, and 60–80 μm long; primary branches aseptate, 22–32 × 4–6 μm; secondary branches aseptate, 14–24 × 3–5 μm; tertiary branches aseptate, 10–18 × 2–4 μm; quaternary branches aseptate, 10–15 × 3 μm, each terminal branch producing 2–4 phialides; phialides allantoid to elongate doliiform to reniform, hyaline, aseptate, 9–20 × 3–4 μm, apex with minute periclinal thickening and inconspicuous collarette. Macroconidia cylindrical, rounded at both ends, straight to slightly curved, (68–) 74–84(–88) × (4–)4.5–5.5(–6) μm (av. 79 × 5 μm), 1(–3)-septate, lacking a visible abscission scar, held in parallel cylindrical clusters by colourless slime. Mega- and microconidia not observed.

Culture characteristics: Colonies moderately fast growing (40–65 mm diam) on MEA after 7 d at room temperature; surface sienna to sepia with moderate white, wooly aerial mycelium and moderate sporulation on the aerial mycelium and colony surface; reverse sienna to sepia with abundant chlamydospores throughout the medium, forming microsclerotia.

Fig. 2. Calonectria amazonica (ex-type CBS 116250). A. Macroconidiophore. B–C. Conidiogenous apparatus with conidiophore branches and allantoid to elongate doliiform to reniform phialides. D–E. Clavate vesicles. F–G. Macroconidia. Scale bars: A = 50 μm; B–G = 10 μm.
Specimens examined: Brazil. Amazon, from foliar lesion of Eucalyptus tereticornis, 1993, P.W. Crous & A.C. Alfenas (holotype CBS-H22750, culture ex-type CBS 116250 = CPC 3534); ibid., cultures CBS 115486 = CPC 3894.

Notes: Calonectria amazonica resides in the C. pteridis complex. The macroconidia of C. amazonica [(68–74)–84(–88) × (4–) 4.5–5.5(–6) μm (av. 79 × 5 μm)] are slightly smaller than those of C. pteridis and C. pseudopteridis [(50–70–100(–130) × (4–) 5–6 μm (av. 82 × 5.5 μm); Crous 2002, Alfenas et al. 2015], but larger than those of C. amazoniensis, C. lageniformis and C. tropicalis (see below).

Calonectria amazoniensis L. Lombard & Crous, sp. nov. MycoBank MB818699. Fig. 3.

Etymology: Name refers to the Amazonian region of Brazil where this fungus was collected.
Macroconidiophores consist of a stipe bearing a penicillate arrangement of fertile branches, and a stipe extension terminating in a vesicle; stipe septate, hyaline, smooth, 45–240 × 6–9 μm; stipe extension septe, straight to flexuos, 140–280 μm long, 4–5 μm wide at the apical septum, terminating in a clavate vesicle, 5–7 μm diam; lateral stipe extensions (90° to main axis) few, 80–95 μm long, 2–4 μm wide at the apical septum, terminating in clavate vesicles, 2–3 μm diam. Conidiogenous apparatus 30–110 μm wide, and 30–100 μm long; primary branches aseptate, 15–31 × 4–6 μm; secondary branches aseptate, 10–26 × 3–5 μm; tertiary branches aseptate, 9–31 × 3–5 μm; quaternary branches and additional branches (~5) aseptate, 9–18 × 3–5 μm each terminal branch producing 2–4 phialides; phialides elongate doliiform to reniform, hyaline, aseptate, 7–17 × 3–5 μm, apex with minute periclinal thickening and inconspicuous collarette. Macroconidia cylindrical, rounded at both ends, straight, (56–)64–74(–75) × (4–)4.5–5.5(–6) μm (av. 69 × 4 μm), 1-septate, lacking a visible abscission scar, held in parallel cylindrical clusters by colourless slime. Mega- and microconidia not observed.

Culture characteristics: Colonies moderately fast growing (30–60 mm diam) on MEA after 7 d at room temperature; surface cinnamon to brick with sparse, felty, white aerial mycelium and abundant sporulation on the aerial mycelium and colony surface; reverse cinnamon to sepia with abundant chlamydospores throughout the medium, forming microsclerotia.

Specimens examined: Brazil, from soil, Jun. 1998, A.C. Alfenas (holotype CBS-H22752, culture ex-type CBS 111484 = CPC 1924); ibid., culture CBS 111485 = CPC 1929.

Notes: Calonectria brassicicola is a new species in the C. candelabrum complex (Schoch et al. 1999, Lombard et al. 2010a,b, 2015a). The macroconidia of C. brasiliensis [(36–)38–42(–46) × (3–)3.5–4.5(–5) μm (av. 40 × 4 μm)] are smaller than those of its closest phylogenetic neighbours (Fig. 1): C. candelabrum [(45–)58–68(–80) × 4–5(–6) μm (av. 60 × 4.5 μm); Crous 2002], C. eucalypticola [(43–)49–52(–55) × 3–5 μm (av. 50 × 4 μm); Alfenas et al. 2015], C. glabecicola [(45–)50–52(–55) × 3–5 μm (av. 50 × 4 μm); Alfenas et al. 2015], C. metsosideri [(40–)44–46(–51) × 3–5 μm (av. 45 × 4 μm); Alfenas et al. 2013a, 2015], C. pseudometrosideri [(40–)49–52(–60) × (3–)4.5(–5) μm (av. 51 × 4.5 μm); Alfenas et al. 2015] and C. pseudosporoporia [(41–)45–51(–52) × 3–5 μm (av. 48 × 4 μm); Lombard et al. 2010b].
Specimens examined: Indonesia, from soil at Brassica sp., 1990s, M.J. Wingfield (holotype CBS-H22753, culture ex-type CBS 112841 = CPC 4552); ibid., culture CBS 112756 = CPC 4502. New Zealand, substrate unknown, 2001, C.F. Hill, Lynfield 484, culture CBS 112947 = CPC 4668.

Notes: Calonectria brassicicola is similar to C. sumatrensis in having few lateral stipe extensions (Crous et al. 2004b). The macroconidia of C. brassicicola [(36−)39−45(−48) × (4−) 4.5−5.5(−6) μm (av. 42 × 5 μm)] are smaller than those of C. sumatrensis [(45−)55−65(−70) × (4.5−)5(−6) μm (av. 58 × 5 μm); Crous et al. 2004b].

Calonectria brevistipitata L. Lombard & Crous, sp. nov. MycoBank MB818702. Fig. 6.

Etymology: Name refers to the short stipe extensions of the macroconidiophores in this fungus.

Macroconidiophores consist of a stipe bearing a penicillate arrangement of fertile branches, and a stipe extension terminating in a vesicle; stipe septate, hyaline, smooth, 50−210 × 5−12 μm; stipe extension septate, straight to flexuous, 90−135 μm long, 2−5 μm wide at the apical septum, terminating in an fusiform to obpyriform vesicle, 5−8 μm diam; lateral stipe extensions (90° to main axis) abundant, 60−80 μm long, 2−3 μm wide at the apical septum, terminating in broadly clavate vesicles, 2−3 μm diam. Conidiogenous apparatus 45−75 μm wide, and 45−70 μm long; primary branches aseptate, 13−25 × 4−6 μm; secondary branches aseptate, 10−19 × 3−5 μm; tertiary branches aseptate, 8−16 × 3−5 μm; quaternary branches aseptate, 7−11 × 3−4 μm each terminal branch producing 2−6 phialides; phialides elongate doliform to reniform, hyaline, aseptate, 6−11 × 2−4 μm, apex with minute periclinal thickening and inconspicuous collarette. Macroconidia
Fig. 5. Calonectria brassicicola (ex-type CBS 112841). A–C. Macroconidiophores. D–F. Conidiogenous apparatus with lateral stipe extensions and doliiform to reniform phialides. G–J. Sphaero-pedunculate vesicles. K. Macroconidia. Scale bars: A–C = 50 μm; D–K = 10 μm.

Fig. 6. Calonectria brevistipitata (ex-type CBS 115671). A–C. Macroconidiophores. D–E. Conidiogenous apparatus with conidiophore branches and elongate doliiform to reniform phialides. F. Conidiogenous apparatus with lateral stipe extension. G–J. Fusiform to ellipsoid vesicles. K. Macroconidia. Scale bars: A–C = 50 μm; D–K = 10 μm.
cylindrical, rounded at both ends, straight, 29–33(–35) × 3–4 μm (av. 31 × 3.5 μm), 1-septate, lacking a visible abscission scar, held in parallel cylindrical clusters by colourless slime. Mega- and microconidia not observed.

Culture characteristics: Colonies moderately fast growing (40–70 mm diam) on MEA after 7 d at room temperature; surface cinnamon to brick to sienna with abundant, wooly, white to buff aerial mycelium and abundant sporulation on the aerial mycelium and colony surface; reverse cinnamon to sepia with abundant chlamydospores throughout the medium, forming microsclerotia.

**Specimens examined:** Mexico, from soil, Apr. 1994, P.W. Crous (holotype CBS-H22754, culture ex-type CBS 115671 = CPC 949); ibid., cultures CBS 110837 = CPC 913, CBS 110928 = CPC 951.

**Notes:** *Calonectria brevistipitata* is a new species in the *C. candelabrum* complex. The lateral stipe extensions (up to 80 μm long) and macroconidia [29–33(–35) × 3–4 μm (av. 31 × 3.5 μm)] of *C. brevistipitata* are shorter than the lateral stipe extensions (up to 125 μm long) and macroconidia [(35–) 36–40(–43) × (3–)3.5–4.5(–5) μm (av. 38 × 4 μm)] of *C. machaerinae*, the only other species in the *C. candelabrum* complex to produce lateral stipe extensions.

**Calonectria cliffordiicola** L. Lombard & Crous, sp. nov. MycoBank MB818703. Fig. 7.

**Etymology:** Name refers to plant host plant genus, *Cliffordia*, from which this fungus was isolated.

**Macroconidiophores** consist of a stipe bearing a penicillate arrangement of fertile branches, and a stipe extension terminating in a vesicle; stipe septate, hyaline, smooth, 65–130 × 7–10 μm; stipe extension septate, straight to flexuous, 127–180 μm long, 4–6 μm wide at the apical septum, terminating in an ellipsoid to

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**Fig. 7.** *Calonectria cliffordiicola* (ex-type CBS 111812). A–C. Macroconidiophores. D–F. Conidiogenous apparatus with conidiophore branches and doliiform to reniform phialides. G–J. Ellipsoid to obpyrifom vesicles. K. Macroconidia. Scale bars: A–C = 50 μm; D–K = 10 μm.
obpyriform vesicle, 7–9 μm diam. Conidiogenous apparatus 57–100 μm wide, and 40–85 μm long; primary branches aseptate, 15–32 × 4–6 μm; secondary branches aseptate, 11–23 × 3–6 μm; tertiary branches aseptate, 7–13 × 3–5 μm; quaternary branches aseptate, 8–13 × 3–4 μm each terminal branch producing 2–6 phialides; phialides doliiform to reniform, hyaline, aseptate, 6–11 × 2–4 μm, apex with minute periclinal thickening and inconspicuous collarette. Macroconidia cylindrical, rounded at both ends, straight, (35–)38–42(–44) × (3–)3.5–4.5(–5) μm (av. 40 × 4 μm), 1-septate, lacking a visible abscission scar, held in parallel cylindrical clusters by colourless slime. Mega- and microconidia not observed.

Culture characteristics: Colonies moderately fast growing (35–65 mm diam) on MEA after 7 d at room temperature; surface cinnamon to brick with sparse, felty, white to buff aerial mycelium and moderate sporulation on the aerial mycelium and colony surface; reverse cinnamon to sepia with abundant chlamydospores throughout the medium, forming microsclerotia.

Specimens examined: South Africa, Western Cape Province, George, from Cliffordia feruginea, 14 Apr. 1996, P.W. Crous (holotype CBS 114458); Stellenbosch, from Prunus avium saplings, 1 May 1999, C. Linde, cultures CBS 111814 = CPC 2617, CBS 111819 = CPC 2604.

Notes: Calonectria cliffordicola is a new species in the C. candelabrum complex (Schoch et al. 1999, Lombard et al. 2010a,b, 2015a). Morphologically, this species shows some overlap with C. brasiliiana, but can be distinguished by its shorter stipe extensions (up to 180 μm) compared to C. brasiliiana (up to 240 μm).

Calonectria ericae L. Lombard & Crous, sp. nov. MycoBank MB818704. Fig. 8.

Etymology: Name refers to host plant genus, Erica, from which this species was isolated.

Macroconidiophores consist of a stipe bearing a penicillate arrangement of fertile branches, and a stipe extension terminating in a vesicle; stipe septate, hyaline, smooth, 40–100 × 6–9 μm; stipe extension septate, straight to flexuous, 105–160 μm long, 3–7 μm wide at the apical septum, terminating in an ellipsoid to obpyriform vesicle, 6–10 μm diam. Conidiogenous apparatus 40–75 μm wide, and 35–70 μm long; primary branches aseptate, 15–23 × 3–5 μm; secondary branches aseptate, 10–19 × 2–6 μm; tertiary branches aseptate, 6–16 × 2–5 μm; quaternary branches aseptate, 6–13 × 2–5 μm each terminal branch producing 2–6 phialides; phialides elongate doliiform to reniform, hyaline, aseptate, 6–11 × 2–4 μm, apex with minute periclinal thickening and inconspicuous collarette. Macroconidia cylindrical, rounded at both ends, straight, (29–)34–40(–42) × (3–)3.5–4.5(–5) μm (av. 37 × 4 μm), 1-septate, lacking a visible abscission scar, held in parallel cylindrical clusters by colourless slime. Mega- and microconidia not observed.

Culture characteristics: Colonies moderately fast growing (40–65 mm diam) on MEA after 7 days at room temperature;
surface cinnamon to brick with sparse, felty, white aerial mycelium and moderate sporulation on the aerial mycelium and colony surface; reverse cinnamon to umber with abundant chlamydo- 
spores throughout the medium, forming microsclerotia.

Specimens examined: USA, California, from Erica capensis, Sep. 1998, S.T. Koike (holotype CBS-H22756, culture ex-type CBS 114458 = CPC 2019); ibid., cultures CBS 114456 = CPC 1984, CBS 114457 = CPC 1985.

Notes: Calonectria ericae is a new species in the C. candelabrum complex. This species produces the smallest macroconidia in the C. candelabrum complex. Kioke et al. (1999) initially identified these isolates as C. pauciramosa based on morphology and mating studies using the C. pauciramosa mating tester strains (Schoch et al. 1999, Lombard et al. 2010a).

Calonectria indonesiana L. Lombard & Crous, sp. nov. MycoBank MB818705. Fig. 9.

Etymology: Name refers to Indonesia, the country where this fungus was collected.

Macroconidiophores consist of a stipe bearing a penicillate arrangement of fertile branches, and a stipe extension terminating in a vesicles; stipe septate, hyaline, smooth, 35–115 × 6–9 μm; stipe extension septate, straight to flex-
uous, 110–130 μm long, 3–5 μm wide at the apical septum, terminating in a sphaeropedunculate vesicle, 8–10 μm diam; lateral stipe extensions (90° to main axis) sparse, 30–50 μm long, 3–4 μm wide at the apical septum, terminating in sphaeropedunculate vesicles, 4–5 μm. Conidiogenous apparatus 40–100 μm wide, and 40–70 μm long; primary branches aseptate, 11–20 × 4–6 μm; secondary branches aseptate, 8–17 × 4–7 μm; tertiary branches aseptate, 9–14 × 3–6 μm; quaternary branches and additional branches (~6) aseptate, 7–12 × 3–5 μm, each terminal branch producing 2–6 phialides; phialides doliiform to reniform, hyaline, aseptate, 7–14 × 3–5 μm, apex with minute periclinal thickening and inconspicuous collarette. Macroconidia cylindrical, rounded at both ends, straight, (38–)40–46(–48) × (3–)4.5–5.5(–6) μm (av. 43 × 5 μm), 1-septate, lacking a visible abscission scar, held in parallel cylindrical clusters by colourless slime. Mega-
and microconidia not observed.

Culture characteristics: Colonies moderately fast growing (50–65 mm diam) on MEA after 7 d at room temperature; surface buff with abundant white to buff, wooly aerial mycelium, and moderate sporulation on the colony surface; reverse sienna, chlamydospores not observed.

Specimens examined: Indonesia, north Sumatera, from soil, 1998, M.J. Wingfield (holotype CBS-H22757, culture ex-type CBS 112936 = CPC 4504); ibid., culture CBS 112826 = CPC 4519.

Notes: Calonectria indonesiana is similar to C. brassicicola and C. sumatrensis in having few lateral stipe extensions (Crous et al. 2004b). Calonectria indonesiana (~6) can be distinguished from

Fig. 9. Calonectria indonesiana (ex-type CBS 112936). A–C. Macroconidiophores. D–E. Conidiogenous apparatus with conidiophore branches and doliiform to reniform phialides. F. Conidiogenous apparatus with lateral stipe extension. G–J. Sphaeropedunculate vesicles. K. Macroconidia. Scale bars: A–C = 50 μm; D–K = 10 μm.
Fig. 10. Calonectria lageniformis (ex-type CBS 111324). A–B. Macroconidiophores. C–E. Conidiogenous apparatus with conidiophore branches and doliiform to reniform phialides. F–I. Lageniformis to ellipsoid vesicles. J. Macroconidia. Scale bars: A–B = 50 μm; C–J = 10 μm.
C. brassicicola (~4) and C. sumatrensis (~3) by the number of branches of the conidiogenous apparatus (Crous et al. 2004b).

Calonectria lageniformis L. Lombard & Crous, sp. nov. MycoBank MB818706. Fig. 10.

Etymology: Name refers to the characteristic lageniform vesicles in this fungus.

Macroconidiophores consist of a stipe bearing a penicillate arrangement of fertile branches, and a stipe extension terminating in a vesicle; stipe septate, hyaline, smooth, 65–220 × 4–9 μm; stipe extension septate, straight to flexuous, 135–185 μm long, 4–6 μm wide at the apical septum, terminating in a lageniform to ellipsoid vesicle, 6–10 μm diam. Conidiogenous apparatus 20–80 μm wide, and 35–60 μm long; primary branches aseptate, 16–28 × 4–6 μm; secondary branches aseptate, 10–18 × 3–6 μm; tertiary branches aseptate, 8–13 × 3–6 μm, each terminal branch producing 2–4 phialides; phialides doliiform to reniform, hyaline, aseptate, 7–11 × 3–4 μm, apex with minute periclinal thickening and inconspicuous collarette. Macroconidia cylindrical, rounded at both ends, straight, (35–)37–43(–45) × (3–)4.5–5.5(–6) μm (av. 40 × 5 μm), 1-aseptate, lacking a visible abscission scar, held in parallel cylindrical clusters by colourless slime. Mega- and microconidia not observed.

Culture characteristics: Colonies fast growing (60–90 mm diam) on MEA after 7 d at room temperature; surface sepia with sparse buff, feltly aerial mycelium and moderate sporulation on the aerial mycelium and colony surface; reverse sepia with abundant chlamydospores throughout the medium, forming microsclerotia.

Specimens examined: Brazil, from leaf lesion on Eucalyptus sp., 1993, P.W. Crous & A.C. Alfenas, culture CBS 112685 = CPC 3418. Mauritius, Rivière Noire, from foliar lesion on Eucalyptus sp., 10 Apr. 1996, H. Smith (holotype CBS-H22758 culture ex-type CBS 111324 = CPC 1473).

Note: Calonectria lageniformis is the only species that has lageniform vesicles (Crous 2002, Lombard et al. 2010b, 2015a, Alfenas et al. 2015).

Calonectria machaerinae L. Lombard & Crous, sp. nov. MycoBank MB818707. Fig. 11.

Etymology: Name refers to plant host genus, Machaerina, from which this species was isolated.

Macroconidiophores consist of a stipe bearing a penicillate arrangement of fertile branches, and a stipe extension terminating in a vesicle; stipe septate, hyaline, smooth, 40–115 × 5–10 μm; stipe extension septate, straight to flexuous, 105–170 μm long, 3–5 μm wide at the apical septum, terminating in an ellipsoid to oboviform vesicle, 6–9 μm diam; lateral stipe extensions (90° to main axis) few, 80–125 μm long, 3–5 μm wide at the apical septum, terminating in broadly clavate vesicles, 5–6 μm diam. Conidiogenous apparatus 40–80 μm wide, and 55–90 μm long; primary branches aseptate, 18–28 × 4–6 μm; secondary branches aseptate, 13–23 × 3–6 μm; tertiary branches aseptate, 8–19 × 3–5 μm; quaternary branches and additional branches
(−6) aseptate, 7–15 × 3–5 μm each terminal branch producing 2–6 phialides; phialides doliiform to reniform, hyaline, aseptate, 6–11 × 2–4 μm, apex with minute periclinal thickening and inconspicuous collarette. Macroconidia cylindrical, rounded at both ends, straight, (35–)36–40(−43) × (3–)3.5–4.5(−5) μm (av. 38 × 4 μm), 1-septate, lacking a visible abscission scar, held in parallel cylindrical clusters by colourless slime. Mega- and microconidia not observed.

Culture characteristics: Colonies fast growing (60–85 mm diam) on MEA after 7 d at room temperature; surface cinnamon to brick with sparse, wooly, white aerial mycelium and abundant sporulation on the aerial mycelium and colony surface; reverse cinnamon to umber with abundant chlamydospores throughout the medium, forming microsclerotia.

Specimen examined: New Zealand, Auckland, Auckland University Campus, from foliar lesion of Machaerina sinclairii, 27 Jan. 2008, C.F. Hill (holotype CBS-H22760, culture ex-type CBS 123183 = CPC 15378).

Notes: Calonectria machaerinae is a new species in the C. candelabrum complex. This species, along with C. brevistipitata, are the only two species to produce lateral stipe extensions in the C. candelabrum complex (Schoch et al. 1999, Lombard et al. 2010a,b, 2015a). See note under C. brevistipitata for additional distinguishing characters.

Calonectria multilateralis L. Lombard & Crous, sp. nov. MycoBank MB818708. Fig. 12.

Etymology: Name refers to the multiple lateral stipe extensions on the macroconidiophores of this species.

Macroconidiophores consist of a stipe bearing a penicillate arrangement of fertile branches, and a stipe extension terminating in a vesicle; stipe septate, hyaline, smooth, 25–130 × 4–8 μm; stipe extension septate, straight to flexuous, 135–375 μm long, 5–6 μm wide at the apical septum, terminating in a naviculate vesicle, 6–11 μm diam; lateral stipe extensions (90° to main axis) numerous, 55–100 μm long, 3–5 μm wide at the apical septum, terminating in naviculate vesicles, 4–8 μm. Conidiogenous apparatus 45–95 μm wide, and 30–70 μm long; primary branches aseptate, 10–25 × 3–6 μm; secondary branches aseptate, 6–20 × 3–5 μm; tertiary branches aseptate, 7–15 × 3–5 μm; quaternary branches and additional branches (−7) aseptate, 6–13 × 2–4 μm, each terminal branch
producing 2–6 phialides; phialides doliiform to doliiform to elongate reniform, hyaline, aseptate, 6–12 × 2–4 μm, apex with minute periclinal thickening and inconspicuous collarette. Macroconidia cylindrical, rounded at both ends, straight, (27–)31–35(–38) × 3–4 μm (av. 33 × 3 μm), 1-septate, lacking a visible abscission scar, held in parallel cylindrical clusters by colourless slime. Mega- and microconidia not observed.

Culture characteristics: Colonies forming (55–85 mm diam) on MEA after 7 d at room temperature; surface buff with abundant white, wooly aerial mycelium and abundant sporulation on the colony surface; reverse buff to sienna, chlamydospores not observed.

Specimens examined: Mexico, Uxmal, from soil, Apr. 1994, P.W. Crous (holotype CBS-H22762, culture ex-type CBS 110932 = CPC 957); ibid., cultures CBS 110926 = CPC 947, CBS 110927 = CPC 948, CBS 110931 = CPC 956, CBS 115615 = CPC 915.

Notes: *Calonectria multilateralis* is a new species in the *C. naviculata* complex (Alfenas et al. 2015). The macroconidia of *C. multilateralis* [31–35(–38) × 3–4 μm (av. 33 × 3 μm)] are smaller than those of *C. naviculata* [(40–)42–50 × 3(–4) μm (av. 45 × 3 μm); Crous 2002] and *C. multinaviculata* [(40–)44–49(–52) × (2.5–)3.5(–4) μm (av. 46 × 3.5 μm); Alfenas et al. 2015].

*Calonectria paracolhounii* L. Lombard & Crous, sp. nov. MycoBank MB818709. Fig. 13.

**Etymology:** Name refers to the fact that this species has an asexual morph that is very similar to that of *C. colhounii*.

**Macroconidiophores** consist of a stipe bearing a penicillate arrangement of fertile branches, and a stipe extension terminating in a vesicle; stipe septate, hyaline, smooth, 21–75 × 5–9 μm; stipe extension septate, straight to flexuosus, 82–178 μm long, 3–5 μm wide at the apical septum, terminating in a narrowly clavate vesicle, 3–5 μm diam. Conidiogenous apparatus 31–77 μm wide, and 25–54 μm long; primary branches aseptate, 11–23 × 3–6 μm; secondary branches aseptate, 7–13 × 3–6 μm; tertiary branches aseptate, 7–12 × 2–4 μm, each terminal branch producing 2–6 phialides; phialides elongate doliiform to doliiform to reniform to reniform phialides. *Macroconidia*. Scale bars: A–B = 50 μm; C–G = 10 μm.

Culture characteristics: Colonies moderately fast growing (25–55 mm diam) on MEA after 7 d at room temperature; surface buff to sienna with abundant white to buff, feltly to wooly aerial mycelium and moderate sporulation on the aerial mycelium and colony surface; reverse buff to sienna to umber with abundant chlamydospores throughout the medium, forming microsclerotia.

Specimens examined: USA, substrate unknown, 1990s, A.Y. Rossman (holotype CBS-H22763 culture ex-type CBS 114679 = CPC 24445). *Australia*, fruit of *Annona reticulata*, 1988, D. Hutton, culture CBS 114705 = CPC 2423.

Notes: *Calonectria paracolhounii* is a new species in the *C. colhounii* complex (Lombard et al. 2010b, Chen et al. 2011). The macroconidia of *C. paracolhounii* [(37–)39–43(–45) × 4–5 μm (av. 41 × 5 μm)] are smaller than those of *C. colhounii* [(45–)60–70(–80) × (4–)5(–6) μm (av. 65 × 5 μm); Crous 2002], *C. eucalypti* [(66–)69–75(–80) × (5–)6 μm (av. 72 × 6 μm); Lombard et al. 2010b], *C. fujianensis* [(48–)50–55(–60) × (2.5–)3.5–4.5(–5) μm (av. 52.5 × 4 μm); Chen et al. 2011], *C. monticola* 46–51(–56) × 4–5 μm (av. 49 × 5 μm); Crous et al. 2015b) and *C. pseudocolhounii* [(49–)55–65(–74) × (3.5–)4–5(–5.5) μm (av. 60 × 4.5 μm); Chen et al. 2011], Hutton & Sanewski (1989) initially identified isolate CBS 114705 as *C. colhounii*, associated with leaf and fruit spots of custard apple (*Annona reticulata*). Their identification was based on morphological comparisons, as no DNA sequence data was available for the genus Calonectria at that time.

*Calonectria parva* L. Lombard & Crous, sp. nov. MycoBank MB818710. Fig. 14.

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**Notes:** **Specimens examined:** Mexico, Uxmal, from soil, Apr. 1994, P.W. Crous (holotype CBS-H22762, culture ex-type CBS 110932 = CPC 957); ibid., cultures CBS 110926 = CPC 947, CBS 110927 = CPC 948, CBS 110931 = CPC 956, CBS 115615 = CPC 915.

**Etymology:** Name refers to the fact that this species has an asexual morph that is very similar to that of *C. colhounii*.

**Macroconidiophores** consist of a stipe bearing a penicillate arrangement of fertile branches, and a stipe extension terminating in a vesicle; stipe septate, hyaline, smooth, 21–75 × 5–9 μm; stipe extension septate, straight to flexuosus, 82–178 μm long, 3–5 μm wide at the apical septum, terminating in a narrowly clavate vesicle, 3–5 μm diam. Conidiogenous apparatus 31–77 μm wide, and 25–54 μm long; primary branches aseptate, 11–23 × 3–6 μm; secondary branches aseptate, 7–13 × 3–6 μm; tertiary branches aseptate, 7–12 × 2–4 μm, each terminal branch producing 2–6 phialides; phialides elongate doliiform to doliiform to reniform to reniform phialides. *Macroconidia*. Scale bars: A–B = 50 μm; C–G = 10 μm.

Culture characteristics: Colonies forming (55–85 mm diam) on MEA after 7 d at room temperature; surface buff with abundant white, wooly aerial mycelium and abundant sporulation on the colony surface; reverse buff to sienna, chlamydospores not observed.

Specimens examined: Mexico, Uxmal, from soil, Apr. 1994, P.W. Crous (holotype CBS-H22762, culture ex-type CBS 110932 = CPC 957); ibid., cultures CBS 110926 = CPC 947, CBS 110927 = CPC 948, CBS 110931 = CPC 956, CBS 115615 = CPC 915.

Notes: *Calonectria multilateralis* is a new species in the *C. naviculata* complex (Alfenas et al. 2015). The macroconidia of *C. multilateralis* [31–35(–38) × 3–4 μm (av. 33 × 3 μm)] are smaller than those of *C. naviculata* [(40–)42–50 × 3(–4) μm (av. 45 × 3 μm); Crous 2002] and *C. multinaviculata* [(40–)44–49(–52) × (2.5–)3.5(–4) μm (av. 46 × 3.5 μm); Alfenas et al. 2015].
**Etymology:** Name refers to the small macroconidiophores in this fungus.

**Macroconidiophores** consist of a stipe bearing a penicillate arrangement of fertile branches, and rarely a stipe extension terminating in a vesicle; stipe septate, hyaline, smooth, 43–149 × 5–7 μm; stipe extension septate, straight to flexuous, 65–95 μm long, 2–4 μm wide at the apical septum, terminating in a narrowly clavate vesicle, 3–5 μm diam. **Conidiogenous apparatus** 18–33 μm wide, and 24–43 μm long; primary branches aseptate, 11–21 × 3–5 μm; secondary branches aseptate, 11–15 × 3–4 μm, each terminal branch producing 2–4 phialides; phialides cylindrical to allantoid, hyaline, aseptate, 9–19 × 3–5 μm, apex with minute periclinal thickening and inconspicuous collarette. **Macroconidia** cylindrical, rounded at both ends, straight, (60–)66–78(–83) × 5–7 μm (av. 72 × 6 μm), (1–)3-septate, lacking a visible abscission scar, held in parallel cylindrical clusters by colourless slime. **Mega- and microconidia** not observed.

**Specimen examined:** South Africa, Mpumalanga, Sabie, D.R. de Wet nursery, from Eucalyptus grandis ramets (roots), 11 May 1990, P.W. Crous (holotype CBS-H22764, culture ex-type CBS 110798 = CPC 410 = PPRI 4001).

**Note:** Calonectria parva can be distinguished from other species in the genus by its relatively small macroconidiophores, which rarely bear a stipe extension.

**Calonectria plurilateralis** L. Lombard & Crous, sp. nov. MycoBank MB818711. Fig. 15.

**Etymology:** Name refers to the multiple lateral stipe extensions on the macroconidiophores of this fungus.

**Macroconidiophores** consist of a stipe bearing a penicillate arrangement of fertile branches, and numerous lateral stipe extensions terminating in vesicles, lacking a central stipe extension; stipe septate, hyaline, smooth, 50–130 × 4–7 μm; stipe extension septate, straight to flexuous, 110–180 μm long, 4–7 μm wide at the apical septum, terminating in obpyriform to ellipsoid vesicles, 7–11 μm diam; lateral stipe extensions (90° to main axis) abundant, 75–105 μm long, 3–6 μm wide at the apical septum, terminating in obpyriform to ellipsoid vesicles, 5–7 μm diam. **Conidiogenous apparatus** 25–80 μm wide, and 25–85 μm long; primary branches aseptate, 11–39 × 2–9 μm; secondary branches aseptate, 7–17 × 3–5 μm; tertiary branches

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**Fig. 14.** Calonectria parva (ex-type CBS 110798). A. Macroconidiophore. B–C. Conidiogenous apparatus with conidiophore branches and cylindrical to allantoid phialides. D–E. Narrowly clavate vesicles. F. Macroconidia. Scale bars = 10 μm.
aseptate, 6–12 × 3–5 μm; quaternary branches aseptate, 8 × 4 μm, each terminal branch producing 2–6 phialides; phialides doliiform to reniform, hyaline, aseptate, 4–11 × 3–4 μm, apex with minute periclinal thickening and inconspicuous colarette. Macroconidia cylindrical, rounded at both ends, straight, (27–)30–38(–41) × (3–)3.5–4.5(–5) μm (av. 34 × 4 μm), 1-septate, lacking a visible abscission scar, held in parallel cylindrical clusters by colourless slime. Mega- and microconidia not observed.

**Culture characteristics:** Colonies fast growing (60–85 mm diam) on MEA after 7 d at room temperature; surface sienna to sepia with moderate white, wooly aerial mycelium and abundant sporulation on the colony surface; reverse sienna to sepia, chlamydospores throughout the medium, forming microsclerotia.

**Specimen examined:** Ecuador, from soil, 20 Jun. 1997, M.J. Wingfield (holotype CBS-H22766, culture ex-type CBS 111401 = CPC 1637).

**Note:** *Calonectria plurilateralis* can be distinguished from other members of the *C. cylindrospora* complex by its numerous lateral stipe extensions.

*Calonectria pseudoecuadoriae* L. Lombard & Crous, sp. nov. MycoBank MB818712. Fig. 16.

**Etymology:** Name refers to the fact that this species has an asexual morph that is very similar to that of *C. ecuadoriae*.

Macroconidiophores consist of a stipe bearing a penicillate arrangement of fertile branches, and a stipe extension terminating in a vesicle; stipe septate, hyaline, smooth, 40–210 × 7–10 μm; stipe extension septate, straight to flexuous, 160–250 μm long, 4–5 μm wide at the apical septum, terminating in a clavate vesicle, 4–7 μm diam. Conidiogenous apparatus 70–105 μm wide, and 50–90 μm long; primary branches aseptate, 18–30 × 5–7 μm; secondary branches...
Fig. 16. Calonectria pseudoeuadoriae (ex-type CBS 111402). A–B. Macroconidiophores. C–E. Conidiogenous apparatus with conidiophore branches and doliform to reniform phialides. F–I. Clavate vesicles. J. Macroconidia. Scale bars: A–B = 50 μm; C–J = 10 μm.
aseptate, 9–22 × 3–7 μm; tertiary branches aseptate, 7–17 × 3–5 μm; quaternary branches and additional branches (–6) aseptate, 7–12 × 3–5 μm, each terminal branch producing 2–6 phialides; phialides doliiform to reniform, hyaline, aseptate, 8–12 × 3–4 μm, apex with minute periclinal thickening and inconspicuous collarette. Macroconidia cylindrical, rounded at both ends, straight, (34–)36–40(–43) × 3–4 (~5) μm (av. 38 × 3.5 μm), 1-septate, lacking a visible abscission scar, held in parallel cylindrical clusters by colourless slime. Mega- and microconidia not observed.

Culture characteristics: Colonies moderately fast growing (30–60 mm diam) on MEA after 7 d at room temperature; surface cinnamon to brick with sparse white, wooly aerial mycelium and abundant sporulation on the aerial mycelium and colony surface; reverse buff to cinnamon with abundant chlamydospores throughout the medium, forming microsclerotia.

Specimens examined: Ecuador, soil, 20 Jun. 1997, M.J. Wingfield (holotype CBS-H22768, culture ex-type CBS 111402 = CPC 1639); ibid., culture CBS 111412 = CPC 1648.

Notes: Calonectria pseudoecuadoriae is morphologically similar to C. ecuadoriae. The macroconidia of C. pseudoecuadoriae [(34–)36–40(–43) × 3–4 (~5) μm (av. 38 × 3.5 μm)] are smaller than those of C. ecuadoriae [(45–)48–55(–65) × (4–)4.5(–5) μm (av. 51 × 4.5 μm); Crous et al. 2006]. Furthermore, C. pseudoecuadoriae has six tiers of branches in its conidiogenous apparatus in comparison to the seven in C. ecuadoriae (Crous et al. 2006), although these differences are relatively minor.

*Calonectria pseudouxmalensis* L. Lombard & Crous, sp. nov. MycoBank MB818713. Fig. 17.
**Etymology:** Name refers to the fact that this species has an asexual morph that is very similar to that of *C. uxmalensis.*

Macroconidiophores consist of a stipe bearing a pennisetate arrangement of fertile branches, and a stipe extension terminating in a vesicle; stipe septate, hyaline, smooth, 30–60 × 6–8 μm; stipe extension septate, straight to flexuous, 100–140 μm long, 4–6 μm wide at the apical septum, terminating in an obpyriform to obpyriform vesicle, 7–9 μm diam. *Conidigenous apparatus* 45–60 μm wide, and 30–90 μm long; primary branches aseptate, 12–34 × 3–6 μm; secondary branches aseptate, 9–21 × 3–6 μm; tertiary branches aseptate, 9–17 × 3–5 μm; quaternary branches aseptate, 4–13 × 3–5 μm each terminal branch producing 2–6 phialides; phialides elon- gate reniform to allantoïd to cylindrical, hyaline, aseptate, 6–15 × 3–5 μm, apex with minute periclinal thickening and inconspicuous collarette. *Macroconidia* cylindrical, rounded at both ends, straight, (35–)40–46(–49) × (4–)4.5–5.5(–6) μm (av. 43 × 5 μm), 1-septate, lacking a visible abscission scar, held in parallel cylindrical clusters by colourless slime. *Mega- and microconidia* not observed.

**Culture characteristics:** Colonies moderately fast growing (35–75 mm diam) on MEA after 7 d at room temperature; surface cinnamon to brown with sparse, wooly, white to buff aërial mycelium and moderate sporulation on the aërial mycelium and colony surface; reverse cinnamon to sepia with abundant chlamydospores throughout the medium, forming microsclerotia.

Specimens examined: **Brazil,** from Eucalyptus cuttings, Jun. 1998, A.C. Alfenas (holotype CBS-H22770, culture ex-type CBS 111449 = CPC 1951); Bahia do Sol, from Eucalyptus cuttings, Apr. 1993, P.W. Crous, culture CBS 116076 = CPC 604; from soil, Jun. 1998, A.C. Alfenas, cultures CBS 111470 = CPC 1940, CBS 111477 = CPC 1928.

**Notes:** *Calonectria putriramosa* is a new species in the *C. candelabrum* complex (Schoch et al. 1999, Lombard et al. 2010a, b, 2015a). The macroconidia of *C. putriramosa* [(35–)40–46(–49) × (4–)4.5–5.5(–6) μm (av. 43 × 5 μm)] are smaller than those of its closest phylogenetic neighbours (see notes under *C. brasiliana*), but slightly larger than those of *C. brasiliana* [(36–)38–42(–46) × (3–)3.5–4.5(–5) μm (av. 40 × 4 μm)].

**Calonectria stipitata** L. Lombard & Crous, sp. nov. MycoBank MB818715. Fig. 19.

**Etymology:** Name refers to the lateral stipe extensions produced by this fungus.

Macroconidiophores consist of a stipe bearing a pennisetate arrangement of fertile branches, and a stipe extension terminating in a vesicle; stipe septate, hyaline, smooth, 40–170 × 5–10 μm; stipe extension septate, straight to flexuous, 145–185 μm long, 4–7 μm wide at the apical seps, terminating in an ellipsoid to obpyriform vesicle, 7–9 μm diam. *Conidigenous apparatus* 45–60 μm wide, and 30–90 μm long; primary branches aseptate, 12–34 × 3–6 μm; secondary branches aseptate, 9–21 × 3–6 μm; tertiary branches aseptate, 9–17 × 3–5 μm; quaternary branches aseptate, 4–13 × 3–5 μm each terminal branch producing 2–6 phialides; phialides elongate reniform to allantoïd to cylindrical, hyaline, aseptate, 6–15 × 3–5 μm, apex with minute periclinal thickening and inconspicuous collarette. *Macroconidia* cylindrical, rounded at both ends, straight, (27–)29–35(–37) × (3–)3.5–4.5(–6) μm (av. 29 × 3 μm)
32 × 4 μm), 1-septate, lacking a visible abscission scar, held in parallel cylindrical clusters by colourless slime. *Mega- and microconidia* not observed.

**Culture characteristics:** Colonies fast growing (60–85 mm diam) on MEA after 7 d at room temperature; surface sienna to sepia with abundant wooly, white aerial mycelium and abundant sporulation on the aerial mycelium and colony surface; reverse sienna to sepia with abundant chlamydospores throughout the medium, forming microsclerotia.

*Specimen examined:* Colombia, from *Eucalyptus* sp., 1990s, M.J. Wingfield (*holotype* CBS-H22771, culture ex-type CBS 112513 = CPC 3851).

*Notes:* *Calonectria stipitata*, like *C. brevistipitata* and *C. machaerinae*, produce lateral stipe extensions, a characteristic.
not usually associated with members of the C. candelabrum complex (Schoch et al. 1999, Lombard et al. 2010a,b, 2015a). The lateral stipe extensions of C. stipitata (up to 135 μm) are longer than those of C. brevistipitata (up to 80 μm) and C. machaerinae (up to 125 μm).

**Calonectria syzygiicola** L. Lombard & Crous, sp. nov. Myco-Bank MB818716. Fig. 20.

**Etymology:** Name refers to the host plant, Syzygium aromaticum from which this fungus was isolated.

**Macroconidiophores** consist of a stipe bearing a penicillate arrangement of fertile branches, and a stipe extension terminating in a vesicle; stipe septate, hyaline, smooth, 30–170 × 4–8 μm; stipe extension septate, straight to flexuous, 65–105 μm long, 3–4 μm wide at the apical septum, terminating in a sphaero-opedunculate vesicle, 4–7 μm diam; lateral stipe extensions (90° to main axis) sparse, 40–50 μm long, 2–3 μm wide at the apical septum, terminating in sphaero-opedunculate vesicles, 3–6 μm diam. **Conidiogenous apparatus** 30–70 μm wide, and 30–45 μm long; primary branches aseptate, 12–21 × 4–6 μm; secondary branches aseptate, 8–14 × 3–5 μm; tertiary branches aseptate, 9–12 × 3–5 μm; quaternary branches aseptate, 8–10 × 2–3 μm, each terminal branch producing 2–6 phialides; phialides doliiform to reniform, hyaline, aseptate, 7–11 × 2–4 μm, apex with minute periclinal thickening and inconspicuous collarette. **Macroconidia** cylindrical, rounded at both ends, straight, (39–) 41–49(–56) × (4–)4.5–5.5(–7) μm (av. 45 × 5 μm); 1-aseptate, lacking a visible abscission scar, held in parallel cylindrical clusters by colourless slime. **Microconidia** not observed.

**Culture characteristics:** Colonies moderately fast growing (45–65 mm diam) on MEA after 7 d at room temperature; surface amber to sienna with abundant woolly, white to buff aerial mycelium, and abundant sporulation on the aerial mycelium and colony surface; reverse sienna with abundant chlamydospores throughout the medium, forming microsclerotia.

Specimens examined: Indonesia, Sumatra, from soil under Syzygium aromaticum, 1998, M.J. Wingfield (holotype CBS-H22772, culture ex-type CBS 112831 = CPC 4511), culture CBS 112827 = CPC 4512.

**Notes:** Calonectria syzygiicola is closely related to C. asiatica (Fig. 1). However, the macroconidia of C. syzygiicola [(39–) 41–49(–56) × (4–)4.5–5.5(–7) μm (av. 45 × 5 μm)] are smaller than those of C. asiatica [(42–)48–55(–65) × (4–)5(–5.5) μm (av. 53 × 5 μm); Crous et al. 2004b].

**Calonectria tereticornis** L. Lombard & Crous, sp. nov. Myco-Bank MB818717. Fig. 21.

**Etymology:** Name refers to the host plant, Eucalyptus tereticornis, from which this fungus was isolated.

**Macroconidiophores** consist of a stipe bearing a penicillate arrangement of fertile branches, and a stipe extension terminating in a vesicle; stipe septate, hyaline, smooth, 70–270 × 6–11 μm; stipe extension septate, straight to flexuous, 140–245 μm long, 3–7 μm wide at the apical septum, terminating in a fusiform to ovoid vesicle, 8–14 μm diam. **Conidiogenous apparatus** 35–65 μm wide, and 45–75 μm long; primary branches aseptate, 18–34 × 4–10 μm; secondary branches aseptate, 11–26 × 3–7 μm, each terminal branch...
producing 2–4 phialides; phialides elongate doliiform to allantoid, hyaline, aseptate, 9–15 × 3–5 μm, apex with minute periclinal thickening and inconspicuous collarette. Macroconidia cylindrical, rounded at both ends, straight, (51–)55–63(–71) × (3–)4.5–5.5(–6) μm (av. 59 × 5 μm), 1-septate, lacking a visible abscission scar, held in parallel cylindrical clusters by colourless slime. Mega- and microconidia not observed.

Culture characteristics: Colonies fast growing (55–75 mm diam) on MEA after 7 d at room temperature; surface cinnamon to sienna with sparse buff to white, wooly aerial mycelium and abundant sporulation on the aerial mycelium and colony surface; reverse sienna to umber with abundant chlamydospores throughout the medium, forming microsclerotia.

Specimens examined: Brazil, Tucurui, from leaves of Eucalyptus tereticornis, 20 Sep. 1996, P.W. Crous (holotype CBS-H22773 culture ex-type CBS 111301 = CPC 1429).

Notes: Calonectria tereticornis is closely related to C. gordoniae and C. ovata (Fig. 1). The macroconidia of C. tereticornis [(51–)55–63(–71) × (3–)4.5–5.5(–6) μm (av. 59 × 5 μm)] are smaller than those of C. gordoniae [(44–)50–70(–80) × (4–)5–6 μm (av. 65 × 5 μm); Crous 2002] and C. ovata [(50–)65–80(–110) × 4–5 (–6) μm (av. 70 × 5 μm); Crous 2002].

**Calonectria terricola** L. Lombard & Crous, sp. nov. MycoBank MB818718. Fig. 22.

Etymology: Name refers to soil, the substrate from which this fungus was isolated.

Macroconidiophores consist of a stipe bearing a penicillate arrangement of fertile branches, and a stipe extension terminating in a vesicle; stipe septate, smooth, 30–100 × 5–9 μm; stipe extension septate, straight to flexuous, 135–175 μm long, 4–5 μm wide at the apical septum, terminating in a fusiform to ovoid vesicle, 8–12 μm diam. Conidiogenous apparatus 30–100 μm wide, and 45–65 μm long; primary branches aseptate, 14–26 × 3–6 μm; secondary branches aseptate, 13–22 × 2–5 μm; tertiary branches aseptate, 15–18 × 4–5 μm, each terminal branch producing 2–4 phialides; phialides elongate doliiform to reniform, hyaline, aseptate, 9–17 × 3–5 μm, apex with minute periclinal thickening and inconspicuous collarette. Macroconidia cylindrical, rounded at...
both ends, straight, (40–)43–49(–53) × (3–)4–5(–6) μm (av. 46 × 4.5 μm), 1-septate, lacking a visible abscission scar, held in parallel cylindrical clusters by colourless slime. Mega- and microconidia not observed.

Culture characteristics: Colonies moderately fast growing (45–65 mm diam) on MEA after 7 d at room temperature; surface brick to sienna with sparse, buff to white, wooly aerial mycelium and moderate sporulation on the aerial mycelium and colony surface; reverse sienna with abundant chlamydospores throughout the medium, forming microsclerotia.

Specimens examined: Brazil, from soil in Eucalyptus plantation, 1996, P.W. Crous (holotype CBS-H22774; culture ex-type CBS 116247 = CPC 3583); ibid., culture CBS 116248 = CPC 3536.

Notes: Calonectria terricola is a new species in the C. pteridis complex. The macroconidia of C. terricola [(40–)43–49(–53) × (3–)4–5(–6) μm (av. 46 × 4.5 μm)] are smaller than those of C. ovata [(50–)65–80(–110) × 4–5 (–6) μm (av. 70 × 5 μm); Crous 2002], C. pseudovata [(55–) 67–70(–80) × (4–)5 (–7) μm (av. 69 × 5 μm); Alfenas et al. 2015] and C. tereticornis [(51–)55–63(–71) × (3–)4.5–5.5(–6) μm (av. 59 × 5 μm)].

Calonectria tropicalis L. Lombard & Crous, sp. nov. MycoBank MB818719. Fig. 23.

Etymology: Name refers to the tropical region in Brazil where this fungus was collected.

Macroconidiophores consist of a stipe bearing a penicillate arrangement of fertile branches, and a stipe extension terminating in a vesicle; stipe septate, hyaline, smooth, 120–210 × 7–8 μm; stipe extension septate, straight to flexuous, 190–270 μm long, 4–6 μm wide at the apical septum,
terminating in a clavate vesicle, 5–6 \( \mu \)m diam. Conidiogenous apparatus 50–70 \( \mu \)m wide, and 60–90 \( \mu \)m long; primary branches aseptate, 20–32 \( \times \) 4–6 \( \mu \)m; secondary branches aseptate, 12–29 \( \times \) 3–6 \( \mu \)m; tertiary branches aseptate, 12–20 \( \times \) 2–4 \( \mu \)m, each terminal branch producing 2–4 phialides; phialides elongate doliiform to reniform, hyaline, aseptate, 10–16 \( \times \) 2–5 \( \mu \)m, apex with minute periclinal thickening and inconspicuous collarette. Macroconidia cylindrical, rounded at both ends, straight to slightly curved, (69–)74–86(–89) \( \times \) (4–)4.5–5.5(–6) \( \mu \)m (av. 80 \( \times \) 5 \( \mu \)m), 1(–3)-septate, lacking a visible abscission scar, held in parallel cylindrical clusters by colourless slime. Mega- and microconidia not observed.

**Culture characteristics:** Colonies moderately fast growing (45–65 mm diam) on MEA after 7 days at room temperature; surface sienna to sepia with moderate white, wooly aerial mycelium and moderate sporulation on the aerial mycelium and colony surface; reverse sienna to sepia with abundant chlamydospores throughout the medium, forming microsclerotia.

**Specimens examined:** Brazil, Amazon, from foliar lesion of *Eucalyptus* sp., 1993, P.W. Crous & A.C. Alfenas (holotype CBS 116271 = CPC 3559); ibid., cultures CBS 116242 = CPC 3543.

**Notes:** *Calonectria tropicalis* resides in the *C. pteridis* complex. This species can be distinguished from other species in the complex by the smaller numbers of fertile branches in its conidiogenous apparatus.

**Fig. 22.** *Calonectria terricola* (ex-type CBS 116247). A–C. Macroconidiophores. D–F. Conidiogenous apparatus with conidiophore branches and elongate doliiform to reniform phialides. G–J. Fusiform to ovoid vesicles. K. Macroconidia. Scale bars: A–C = 50 \( \mu \)m; D–K = 10 \( \mu \)m.

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**Calonectria uniseptata** Gerlach, Phytopathol. Z. 61: 379. 1968. MycoBank MB327268.

**Specimen examined:** Germany, Celle, from root of Paphiopedilum callosum, May 1967, W. Gerlach, culture ex-type CBS 413.67 = IMI 299577.

**Notes:** Sobers (1972) reduced *C. floridana* and *C. uniseptata* to synonymy with *C. kyotensis* based on their similarities in morphology and pathogenicity. Phylogenetic inference in this study showed that the ex-type of *C. uniseptata* (CBS 413.67; Gerlach 1968) is distinct from *C. kyotensis*. Therefore, *C. uniseptata* is reinstated here as a distinct species of *Calonectria*.

**Calonectria uxmalensis** L. Lombard & Crous, sp. nov. MycoBank MB818720. Fig. 24.

**Etymology:** Name refers to the ancient Maya city Uxmal, Mexico, the locality where this fungus was collected.

**Macroconidiophores** consist of a stipe bearing a penicillate arrangement of fertile branches, and a stipe extension terminating in a vesicle; stipe septate, hyaline, smooth, 35–155 \( \times \) 6–8 \( \mu \)m; stipe extension septate, straight to flexuous, 60–140 \( \mu \)m long, 3–6 \( \mu \)m wide at the apical septum, terminating in a clavate vesicle, 5–6 \( \mu \)m diam. Conidiogenous apparatus 50–70 \( \mu \)m wide, and 60–90 \( \mu \)m long; primary branches aseptate, 20–32 \( \times \) 4–6 \( \mu \)m; secondary branches aseptate, 12–29 \( \times \) 3–6 \( \mu \)m; tertiary branches aseptate, 12–20 \( \times \) 2–4 \( \mu \)m, each terminal branch producing 2–4 phialides; phialides elongate doliiform to reniform, hyaline, aseptate, 10–16 \( \times \) 2–5 \( \mu \)m, apex with minute periclinal thickening and inconspicuous collarette. Macroconidia cylindrical, rounded at both ends, straight to slightly curved, (69–)74–86(–89) \( \times \) (4–)4.5–5.5(–6) \( \mu \)m (av. 80 \( \times \) 5 \( \mu \)m), 1(–3)-septate, lacking a visible abscission scar, held in parallel cylindrical clusters by colourless slime. Mega- and microconidia not observed.
terminating in broadly clavate to obpyriform to ellipsoid vesicles, 5–6 μm diam. Conidiogenous apparatus 30–90 μm wide, and 35–60 μm long; primary branches aseptate, 14–19 × 3–6 μm; secondary branches aseptate, 10–16 × 3–6 μm; tertiary branches aseptate, 7–11 × 3–5 μm; quaternary branches and additional branches (–6) aseptate, 7–11 × 3–5 μm, each terminal branch producing 2–6 phialides; phialides doliiform to reniform, hyaline, aseptate, 8–11 × 2–4 μm, apex with minute periclinal thickening and inconspicuous collarette. Macroconidia cylindrical, rounded at both ends, straight, (26–)
27–33(–35) × 3–4 μm (av. 30 × 3 μm), 1-septate, lacking a visible abscission scar, held in parallel cylindrical clusters by colourless slime. Mega- and microconidia not observed.

Culture characteristics: Colonies fast growing (65–85 mm diam) on MEA after 7 d at room temperature; surface buff to sienna with abundant buff to white, felty to wooly aerial mycelium and moderate sporulation on the aerial mycelium and colony surface; reverse sienna to umber with abundant chlamydospores throughout the medium, forming microsclerotia.

Specimens examined: Mexico, Uxmal, from soil, Apr. 1994, P.W. Crous (holotype CBS-H22761, culture ex-type CBS 110925 = CPC 945); ibid., culture CBS 110919 = CPC 928.

Notes: Calonectria uxmalensis can be distinguished from C. mexicana, C. pseudomexicana and C. tunisiana by its lateral stipe extensions, a characteristic not known for the latter three species (Schoch et al. 1999, Crous 2002, Lombard et al. 2011).

Calonectria venezuelana L. Lombard & Crous, sp. nov. MycoBank MB818721. Fig. 25.

Etymology: Name refers to Venezuela, the country from which this fungus was collected.

Macroconidiophores consist of a stipe bearing a penicillate arrangement of fertile branches, and a stipe extension terminating in a vesicle; stipe septate, hyaline, smooth, 35–100 × 4–8 μm; stipe extension septate, straight to flexuous, 85–190 μm long, 3–6 μm wide at the apical septum, terminating in a fusiform to ovoid to ellipsoidal vesicle, 5–9 μm diam. Conidiogenous apparatus 25–60 μm wide, and 25–65 μm long; primary branches aseptate, 15–30 × 4–8 μm; secondary branches aseptate, 11–24 × 3–5 μm; tertiary branches aseptate, 8–14 × 3–6 μm, each terminal branch producing 2–4 phialides; phialides elongate doliiform to reniform, hyaline, aseptate, 8–17 × 2–5 μm, apex with minute periclinal thickening and inconspicuous collarette. Macroconidia cylindrical, rounded at

Fig. 24. Calonectria uxmalensis (ex-type CBS 110925). A–C. Macroconidiophores with lateral stipe extensions. D–F. Conidiogenous apparatus with conidiophore branches and doliiform to reniform phialides. G–J. Obpyriform to ellipsoidal vesicles. K. Macroconidia. Scale bars: A–C = 50 μm; D–K = 10 μm.
both ends, straight, (48–)54–62(–65) × (4–)4.5–5.5(–7) μm (av. 58 × 5 μm), 1-septate, lacking a visible abscission scar, held in parallel cylindrical clusters by colourless slime. Microconidiophores consists of a stipe and a penicillate or subverticillate arrangement of fertile branches; stipe septate, hyaline, smooth, 25–40 × 3–4 μm; primary branches aseptate, 8–12 × 2–4 μm, terminating in 1–4 phialides that are cylindrical, straight to slightly curved, 7–15 × 2–4 μm, apex with minute periclinal thickening and inconspicuous collarette. Microconidia cylindrical, straight to slightly curved, rounded at the apex and flattened at the base, 16–20(–22) × (2–)2.5–3.5(–4) μm (av. 18 × 3 μm), (0–)1-septate, lacking a visible abscission scar, held in parallel cylindrical clusters by colourless slime. Macroconidia not observed.

Culture characteristics: Colonies fast growing (50–75 mm diam) on MEA after 7 d at room temperature; surface cinnamon to amber with sparse, buff to white, wooly aerial mycelium and abundant sporulation on the aerial mycelium and colony surface; reverse sienna to amber with abundant chlamydospores throughout the medium, forming microsclerotia.

Specimen examined: Venezuela, Acarigua, from soil, 27 Jun. 1995, M.J. Wingfield (holotype CBS-H22778 culture ex-type CBS 111052 = CPC 1183).

Notes: Calonectria venezuelana forms a single lineage closely related to C. eucalypticola (Fig. 1). The macroconidia of C. venezuelana [(48–)54–62(–65) × (4–)4.5–5.5(–7) μm (av. 58 × 5 μm)] are larger than those of C. eucalypticola [(43–)49–52(–55) × 3–5 μm (av. 50 × 4 μm); Alfenas et al. 2015].

DISCUSSION

A collection of isolates stored for many years and tentatively identified as species of Calonectria based on morphology, were shown to represent 24 new species. At the time that they were collected, it would not have been possible to recognise them as novel taxa and this vividly illustrates the power of the DNA-based sequencing tools that are now available to facilitate accurate species recognition. These species emerging from this study were isolated from various substrates collected globally over a 20 year period, and this study therefore highlights the value of the careful storage and maintenance of cultures for further study when appropriate opportunities arise to do so. This paper also highlights the fact that many undescribed species most likely remain hidden in culture collections, requiring a re-evaluation based on DNA sequence comparisons.
Most of the isolates collected in Brazil formed part of the Calonectria syntax imperfecta complex. This complex is the species complex associated with CLB on Eucalyptus spp. propagated commercially as non-natives in plantations. Results of this study have raised the number of species known from Brazil to 55 (Alfenas et al. 2015a, 2015b, 2016). They will also contribute to reducing the impact of, for example, tree pathogens that are resulting in serious losses to planted forests (Wingfield et al. 2015).

When the 24 species newly described in this study were collected, the genus Calonectria had only been peripherally studied. At that time, most species had been described based on their morphological characteristics, which included vesicle shape and conidiominal and macroconidial dimensions and seption (Crous & Wingfield 1994, Crous 2002). However, with a large number of DNA sequences now available from recent taxonomic studies of the genus Calonectria (Lombard et al. 2010b, 2015a, Alfenas et al. 2015), the initial identifications could be either confirmed or corrected. This study, vividly highlights the impact that DNA sequence data have had in providing more accurate identifications of filamentous fungi (Crous et al. 2015a, 2016). Identifications at this level are already impacting substantially on agricultural and forestry practices as well as in the trade in food and fibre products (Crous et al. 2016).

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