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INTRODUCTION

The order Hypocreales (Hypocreomycetidae, Sordariomycetes, Pezizomycotina, Ascomycota) includes approximately 2700 fungal species from 240 genera, which are divided over eight families (Kirk et al. 2008, Crous et al. 2014), with some genera still classified as incertae sedis (Lumbsch & Huhndorf 2007). Members of this order are globally found in various environments and are of great importance to agriculture and medicine. They have been extensively exploited in industrial and commercial applications (Rossman 1996). These fungi are generally characterised by the production of lightly to brightly coloured, ostiolate, perithecial ascomata, containing uniloculate ascii with hyaline ascospores; asexual morphs, the form most frequently encountered in nature, are multielose and phialidic (Rogerson 2014), with some genera regarded as incertae sedis (incertae sedis: L. Lombard, l.lombard@cbs.knaw.nl; P.W. Crous, p.crous@cbs.knaw.nl)

Generic concepts in Nectriaceae

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Abstract: The ascomycete family Nectriaceae (Hypocreales) includes numerous important plant and human pathogens, as well as several species used extensively in industrial and commercial applications as biodegraders and biocontrol agents. Members of the family are unified by phenotypic characters such as uniloculate ascomata that are yellow, orange-red to purple, and with phialidic asexual morphs. The generic concepts in Nectriaceae are poorly defined, since DNA sequence data have not been available for many of these genera. To address this issue we performed a multi-gene phylogenetic analysis using partial sequences for the 28S large subunit (LSU) nrDNA, the internal transcribed spacer region and intervening 5.8S rRNA gene (ITS), the large subunit of the ATP citrate lyase (acl1), the RNA polymerase II largest subunit (rpb1), RNA polymerase II second largest subunit (rpb2), o-actin (act), -tubulin (tub62), calmodulin (cmdA), histone H3 (his3), and translation elongation factor 1-alpha (lef1) gene regions for available type and representative strains representing known genera in Nectriaceae, including several genera for which no sequence data were previously available. Supported by morphological observations, the data resolved 47 genera in the Nectriaceae. We re-evaluated the status of several genera, which resulted in the introduction of six new genera to accommodate species that were initially classified based solely on morphological characters. Several generic names are proposed for synonymy based on the abolishment of dual nomenclature. Additionally, a new family is introduced for two genera that were previously accommodated in the Nectriaceae.

Key words: Generic concepts, Nectriaceae, Phylogeny, Taxonomy.

TAXONOMIC NOVELTIES: NEW FAMILY: Tlachidialesceae L. Lombard & Crous; NEW GENERA: Aquanectria L. Lombard & Crous, Bisifusarium L. Lombard, Crous & W. Gams, Coccinonectria L. Lombard & Crous, Paracremonium L. Lombard & Crous, Rectifusarium L. Lombard & Crous, Xenoacremonium L. Lombard & Crous, X. ipomoeae L. Lombard, Crous, X. monilifera (Mart.) L. Lombard & Crous; NEW SPECIES: Marainnseae humicola L. Lombard & Crous, Neocosmospora rubicola L. Lombard & Crous, Parasexualum infatum L. Lombard & Crous, P. contagium L. Lombard & Crous, Pseudonectria falcicola L. Lombard & Crous, Rectifusarium robiniun L. Lombard & Crous, Xenoacremonium falcatus L. Lombard & Crous, X. nectrioides (Wollenw.) L. Lombard & Crous, X. penzigii (Schroers, Summerbell & O'Donnell) L. Lombard & Crous, X. delphinoides (Schroers, Summerbell, O'Donnell & Lampr.) L. Lombard & Crous, B. dimerum (Penz.) L. Lombard & Crous, B. domesticum (Fr.) L. Lombard & Crous, B. lunatum (Ellis & Everh.) L. Lombard & Crous, B. neocardioides (Wollenw.) L. Lombard & Crous, B. penniseta (Schroers, Summerbell & O'Donnell) L. Lombard & Crous, Calonectria candidalabra (Viejas) Rossman, L. Lombard & Crous, C. clyndrospora (Ellis & Everh.) Rossman, L. Lombard & Crous, Clonostachys apocyni (Peck) Rossman, L. Lombard, Crous & W. Gams, C. aurantia (Penz. & Sacc.) Rossman, L. Lombard & Crous, C. blumenaviae (Rehm) Rossmann, L. Lombard & Crous, C. gibberosa (Schroers) Rossmann, L. Lombard & Crous, C. manihotis (Rick) Rossman, L. Lombard & Crous, C. parva (Schroers) Rossmann, L. Lombard & Crous, C. tonduzi (Spec.) Rossmann, L. Lombard & Crous, C. tornata (Hohn.) Rossman, L. Lombard & Crous, Coccinonectria pachysandricola (B.O. Dodge) Rossman, L. Lombard & Crous, C. rubicola (Schroers, Summerbell & O'Donnell) L. Lombard & Crous, C. tonduzii (Schroers) Rossman, L. Lombard & Crous, C. parva (Schroers) Rossmann, L. Lombard & Crous, C. tonduzi (Spec.) Rossmann, L. Lombard & Crous, X. penicillioides (Schroers, Summerbell & O'Donnell) L. Lombard & Crous, X. falcatus (Wollenw.) L. Lombard & Crous, X. neocardioides (Wollenw.) L. Lombard & Crous, X. penzigii (Schroers, Summerbell & O'Donnell) L. Lombard & Crous, X. delphinoides (Schroers, Summerbell, O'Donnell & Lampr.) L. Lombard & Crous, B. dimerum (Penz.) L. Lombard & Crous, B. domesticum (Fr.) L. Lombard & Crous, B. lunatum (Ellis & Everh.) L. Lombard & Crous, B. neocardioides (Wollenw.) L. Lombard & Crous, X. penzigii (Schroers, Summerbell & O'Donnell) L. Lombard & Crous, X. delphinoides (Schroers, Summerbell, O'Donnell & Lampr.) L. Lombard & Crous.
**Materials and Methods**

**Isolates**

Fungal strains were obtained from the culture collection of the CBS-KNAW Fungal Biodiversity Centre (CBS), Utrecht, The Netherlands and the working collection of Pedro W. Crous housed at the CBS (Table 1).

**DNA isolation, amplification and analyses**

Total genomic DNA was extracted from 7-d-old single-conidial cultures growing on 2 % (w/v) malt extract agar (MEA) using the method of Damm et al. (2008). Partial gene sequences were determined for the 28S large subunit (LSU) rDNA, the internal transcribed spacer region and intervening 5.8S rRNA gene (ITS), the large subunit of the ATP citrate lyase (act1), the RNA polymerase II largest subunit (rpb1), RNA polymerase II second largest subunit (rpb2), β-tubulin (tub2), histone H3 (his3), translation elongation factor 1-alpha (tef1), calmodulin (cmdA) and α-actin (act) using the primers and PCR protocols listed in Table 2. Integrity of the sequences was ensured by sequencing the amplicons in both directions using the same primer pairs as were used for amplification. A consensus sequence for each locus was assembled in MEGA v. 6 (Tamura et al. 2013) and additional sequences were obtained from GenBank (Table 1). Subsequent alignments for each locus were generated in MAFFT v. 7 (Katoh & Standley 2013) and manually corrected where necessary. Phylogenetic congruency of the 10 loci was tested using a 70 % reciprocal bootstrap criterion (Mason-Gamer & Kellogg 1996).

Phylogenetic analyses were based on Bayesian inference (BI) and Maximum Likelihood (ML). For both analyses, the evolutionary model for each partition was determined using MrModeltest (Nylander 2004) and incorporated into the analyses. For the BI analysis, the software package BEAST v. 8.0 (Drummond et al. 2012) was used. The phylogenetic relationships were estimated by performing six independent repetitions of 100 M generations each, with sampling at every 1,000th generation. The Yule speciation algorithm with GTR substitution model and a lognormal uncorrelated relaxed clock were selected for the data. LogCombiner v. 8.0 (from the BEAST package) was used to combine the outputs of six independent runs. The resulting trees were summarised using Tree Annotator v. 1.8.0 (from the BEAST package) using the maximum clade credibility option. FigTree v. 1.4 was used to visualise the final tree.

The ML analysis was performed 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 a second 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. All novel sequences generated in this study were deposited in GenBank (Table 1) and the alignment(s) and tree(s) in TreeBASE.

**Morphology**

For morphological characterisation, single-conidial isolates were grown on synthetic nutrient-poor agar (SNA, Nirenberg 1981) with sterile toothpickc, filter paper or carnation leaves placed on the surface of the agar. Alternatively, isolates were also plated onto potato dextrose agar (2 % w/v, PDA), oatmeal agar (OA) and malt extract agar (2 % w/v, MEA) (recipes in Crous et al. 2009) to induce sporulation when this failed on SNA. Plates were incubated at room temperature (22–25 °C) under ambient light conditions. Some isolates were incubated at 12 h / 12 h fluorescent light and darkness at 25 °C. Gross morphological characters of the asexual morphs were examined after 7–10 d by mounting fungal structures in clear lactic acid and...
| Species                        | Isolate nr. | Substrate          | Collector/ Depositor | Locality     | GenBank Accession No. |
|-------------------------------|-------------|--------------------|----------------------|--------------|-----------------------|
| "Acremonium cf. curvulum" CBS 100551 | Olea europaea | S. Frisullo         | Italy                | KM231057 KM231223 KM231400 KM231552 KM231818 HQ232031 KM232244 KM232385 KM231949 KM232088 |
| Albonectria rigidiuscula CBS 315.73; ATCC 24367; IMI 137397 | Theobroma cacao | P.S. Liu            | Malaysia             | KM231012 KM231206 KM231383 KM231534 KM231609 KM231677 KM232229 KM232378 KM231938 KM232071 |
| CBS 122570; GJS 01-170         | Bark         | G.J. Samuels        | Cameroon              | HQ897896 KM231205 KM231382 KM231533 HQ897815 KM231676 KM232228 HQ897780 KM231937 KM232070 |
| Allantonectria mitina CBS 474.69; MUCL 14535 | Agave americana | H.A. van der Aa     | Spain                 | KM231080 KM231246 KM231340 KM231592 KM231635 KM231716 KM232269 KM232408 KM231973 - |
| CBS 121121; AR 4391 CBS 125499; TG 2008-02 | Agave americana | G. Cacioli          | Italy                 | KM231081 KM231246 KM231430 KM231533 KM231676 KM232228 KM232378 KM231938 KM232071 |
| Acremonium penicillioides CBS 257.54; ATCC 16261 | Acer sp.      | F.V. Ranzoni        | USA                   | KM230954 KM231110 KM231275 - KM231743 KM231613 KM232135 KM232399 KM231865 KM232000 |
| A. submersus CBS 394.62T | Unknown       | H.J. Hudson         | UK                   | KM230996 KM231190 KM231365 KM231517 JQ434586 JQ434514 KM232212 KM232363 EU926334 EU926400 |
| Atractium crassum CBS 180.31T; NRRL 20894 | Water tap     | H.W. Wollenweber    | Germany               | KM230997 KM231110 KM231366 KM231518 EU926219 JQ434512 KM232213 H987964 EU926286 JQ435431 |
| A. stilbaster CBS 410.67T | Decaying bark | W. Gams             | Germany               | KM230997 KM231110 KM231366 KM231518 EU926219 JQ434512 KM232213 H987964 EU926286 JQ435431 |
| CBS 783.85; KAS 385a          | Stump         | K.A. Seifert & G. Andersson | Sweden         | KM230997 KM231110 KM231366 KM231518 EU926219 JQ434512 KM232213 H987964 EU926286 JQ435431 |
| Biafusarium delphinoides CBS 120718T; CPC 13041 | Hoodia gordonii | S.C. Lamprecht      | South Africa          | KM230994 KM231188 KM231363 KM231515 EU926229 KM231660 KM232210 - EU926296 KM232056 |
| CBS 108944T; NRRL 36140       | Homo sapiens  | H. Ph. Endtz        | The Netherlands        | KM230996 KM231190 KM231365 KM231517 JQ434586 JQ434514 KM232212 KM232363 EU926334 EU926400 |
| B. dimericum CBS 116517; NRRL 29976 | Cheese       | K. O'Donnell        | Switzerland           | KM230997 KM231191 KM231366 KM231518 EU926219 JQ434512 KM232213 H987964 EU926286 JQ435431 |
| B. domesticicum CBS 632.76; BBA 63199; NRRL 20690 | Gymnocalcium dasmii | I. Rummland        | Germany               | KM230997 KM231191 KM231366 KM231518 EU926219 JQ434512 KM232213 H987964 EU926286 JQ435431 |
| B. lunatum CBS 176.31T; NRRL 20689 | Soil         | H.W. Wollenweber    | Honduras              | KM230997 KM231187 KM231362 KM231514 EU926245 KM231659 KM232209 H987721 EU926312 KM232057 |
| B. nectrioides CBS 317.34T; NRRL 22109 | Fagus sylvatica | J. Ehrlich          | UK                    | KM230995 KM231189 KM231364 KM231516 KM231795 KM231861 KM232211 KM232362 EU926324 EU926390 |
| Calonectria brassicae CBS 111869; CPC 2409; PC 551197 | Argyreia sp. | K.B. Boedijn & J. Reitsma | Java             | KM230964 GQ280454 GQ267382 DQ190720 GQ280576 GQ280968 KM232181 KM232308 FJ918567 AF232857 |
| CBS 190.50T; CPC 2482; IMI 299389 | Solarium tuberosum | K.B. Boedijn & J. Reitsma | Java             | KM230964 GQ280454 GQ267382 DQ190720 GQ280576 GQ280968 KM232181 KM232308 FJ918567 AF232857 |

(continued on next page)
| Species            | Isolate nr. | Substrate      | Collector/Depositor | Locality       | GenBank Accession No. |
|--------------------|-------------|----------------|---------------------|----------------|-----------------------|
| C. naviculata      | CBS 101121; CMW 30974 | Leaf litter    | R.F. Castañoeda     | Brazil         | KM230966 GQ280478 GQ267399 GQ267252 GQ280600 GQ280722 KM232182 KM232309 GQ267317 GQ267211 |
| Calostilbe striispora | CBS 133491  |                | C. Lechat           | French Guiana  | – KM231162 KM231355 – KM231789 KM231653 KM232204 KM232381 KM231918 KM232048 |
| “C. striispora”   | CBS 122.39  | Erythrina glaucə | R.E.D. Baker        | Trinidad and Tobago | KM231102 – – – – KM231655 KM231735 KM232290 KM232431 KM231991 KM232125 |
| Campylocarpon fasiculare | CBS 112613; CPC 3970 | Vitis sp.     | F. Halleen          | South Africa  | KM231026 HM352881 KM231297 JF375502 AY677301 HM364313 HM364331 KM232322 JF375691 AY677221 |
| C. pseudofuscasciule | CBS 112679; CPC 5472 | Vitis vinifera | F. Halleen          | South Africa  | KM231027 HM352882 KM231298 JF375503 AY677306 HM364314 HM364332 KM232323 JF375692 AY677214 |
| Chaetopsina acutispora | CBS 667.92T | Forest litter  | A. Rambeli         | Africa         | KM230976 KM231164 KM231337 KM231494 KM231771 KM231636 KM232187 – KM231901 KM232029 |
| C. chaetopsinaecatenulatae | CBS 608.92; GJS 77-21; ATCC 56205 | Beilschmiedia tawa | G.J. Samuels       | New Zealand   | HQ897847 – – – – HQ897798 KM231638 – HQ897709 KM231903 KM232031 |
| C. fulva           | CBS 142.56; IMI 062199 | Cedrus deodara | A. Rambeli         | Italy          | KM230977 KM231165 KM231338 KM231495 KM231772 KM231637 KM232188 – KM231902 KM232030 |
| Ciliciopodium brevipes | CBS 691.83  | Fagus sylvatica | G.S. de Hoog       | The Netherlands| – KM231266 KM231451 – KM231856 KM231736 KM232291 KM232432 KM231992 KM232126 |
| C. hyalatum       | CBS 106.13T | Soil           | W. Daszewski        | Switzerland    | KM231103 KM231267 – KM231606 KM231857 KM231737 KM232292 KM232433 KM231993 – |
| Coccoconetria pachysandricola | CBS 501.63; BBA 808; CCT 4699 | Pachysandra terminalis | R. Schneider     | Germany        | KM230979 KM231167 KM231340 KM231497 KM231774 KM231640 KM232190 KM232350 KM231905 KM232033 |
| C. hyalinum       | CBS 476.92; PD 92/1036 | Pachysandra terminalis | The Netherlands    | – KM230980 KM231168 – KM231498 KM231775 KM231641 KM232191 – KM231906 KM232034 |
| C. ruscii         | CBS 128674; AR 4592 | Pachysandra terminalis | P. Brown          | USA            | KM230981 JF383512 KM231341 KM231499 JF382658 JF382715 JF383271 KM232351 JF382544 JF382909 |
| C. repens         | CBS 126108T | Rhusus aculeatusC. Lechat | France            | – KM230978 KM231166 KM231339 KM231496 KM231773 KM231639 KM232349 KM231904 KM232032 |
| Corallomyces elegans | CBS 275.60  | Musa sapientium | Zaire              | – KM231237 – KM231567 KM231628 KM231710 – KM232393 KM231963 KM232100 |
| C. repens         | CBS 358.49  | Carica papaya  | K.B. Boedijn & J. Reijsma | Java           | KM231063 KC479740 – KM231565 KC479756 KM231708 KM232258 KM232391 KM231961 KC479785 |
| C. cymosa         | CBS 118.84; IMI 101072 | Soil           | O.S. Peries        | Sri Lanka      | KM231064 KC479738 – KM231566 KC479755 KM231709 KM232259 KM232392 KM231962 KC479784 |
| Corallonectria jatrophae | CBS 913.96; GJS 96-18 | Unknown tree   | G.J. Samuels       | Puerto Rico    | KM230951 KC479744 KM231273 KM231457 KC479758 KM231611 KM232132 KM232298 KM232186 KC479787 |
| Cosmospora anii   | CBS 748.69TT | Hypoxylon sp.  | W. Gams            | Germany        | HQ897725 KM231224 KM231401 KM231553 KM231819 KM231694 KM232245 HQ897882 KM231950 KM232089 |
| C. coccinea      | CBS 341.70T | Inonotus nodulosus | W. Gams            | Germany        | HQ897913 KM231221 KM231398 KM231550 HQ897827 KM231692 KM232242 HQ897777 KM231947 KM232086 |
| C. cymosa         | CBS 762.69T | Inonotus radiatus | W. Gams            | Germany        | HQ897914 KM231222 KM231399 KM231551 HQ897828 KM231693 KM232243 HQ897778 KM231948 KM232087 |
| Species                  | Isolate nr. | Substrate         | Collector/Depositor | Locality    | GenBank Accession No. |
|-------------------------|-------------|-------------------|--------------------|-------------|----------------------|
|                         |             |                   |                    | acl1        | act                  |
|                         |             |                   |                    | cmdA        | his3                 |
|                         |             |                   |                    | ITS         | LSU                  |
|                         |             |                   |                    | rpb1        | rpb2                 |
|                         |             |                   |                    | tef1        | tub2                 |
| **Cosmospora sp.**      | CBS 101915; GJS 83-159 | Lichen           | G.J. Samuels       | New Zealand | KM231058 KM231225    |
|                         |             |                   |                    |            | KM231402 KM231554    |
|                         |             |                   |                    |            | KM231820 KM231695    |
|                         |             |                   |                    |            | KM232246 KM232386    |
|                         |             |                   |                    |            | KM231951 KM232090    |
| **Curvicladiella cignea** | CBS 101411; MUCL 40268 | Decaying seed  | C. Decock         | French Guiana | KM230967 KM231120    |
|                         |             |                   |                    |            | KM231285 KM231459    |
|                         |             |                   |                    |            | KM231744 JQ666075    |
|                         |             |                   |                    |            | KM232141 KM232310    |
|                         |             |                   |                    |            | KM231866 KM232001    |
| **Cyanonecrtia buxi**   | CBS 130.97; | Buxus sempervirens | H.-J. Schroers     | France      | HM626622 KM231210    |
|                         | CBS 125511; HJS 1398 |                   |                    |            | KM231388 KM231539    |
|                         |             |                   |                    |            | KM231811 KM231679    |
|                         |             |                   |                    |            | KM232233 HM626690    |
|                         |             |                   |                    |            | HQ728150 KM232075    |
| **C. cyanostoma**       | CBS 101734; GJS 98-127 | Buxus sempervirens | G.J. Samuels & F. Candoussau | France | HQ897895 GQ505961 |
|                         |             |                   |                    |            | KM231387 KM231538    |
|                         |             |                   |                    |            | FJ474076 HM626661    |
|                         |             |                   |                    |            | GQ506017 HQ897759    |
| **Cylindrium aeruginosum** | CBS 683.83 | Fagus sylvatica | G.S. de Hoog | The Netherlands | – KM231265 KM231450 |
|                         |             |                   |                    |            | KM231854 KM231734    |
|                         |             |                   |                    |            | KM232430 KM231990    |
| **C. elongatum**        | CBS 685.83A | Fagus sp.        | G.S. de Hoog       | The Netherlands | – KM231264 KM231448 |
|                         |             |                   |                    |            | KM231852 KM231732    |
|                         |             |                   |                    |            | KM232428 KM231988    |
|                         | CBS 115974  |                   | G. Verkley        | The Netherlands | KM231101 – KM231449 |
|                         |             |                   |                    |            | KM231605 KM231733    |
| **Cylindrocarposylist gregarius** | CBS 101072 | Hytlogrops palliatus | R. Kirschner | Germany | KM231021 KM231127 |
|                         |             |                   |                    |            | KM231292 KM231747    |
|                         |             |                   |                    |            | KM231604 KM232231    |
| **C. lageniformis**     | CBS 101073  | Pinus sylvestris | R. Kirschner       | Germany     | KM231022 KM231128    |
|                         |             |                   |                    |            | KM231293 KM231465    |
|                         |             |                   |                    |            | KM231748 JQ666084    |
| **C. parva**            | CBS 11074   | Picea abies       | R. Kirschner       | Germany     | KM231020 KM231126    |
|                         |             |                   |                    |            | KM231291 KM231746    |
| **Cylindrocladiella camelliae** | CPC 234; PPRI 3990; IMI 346845 | Eucalyptus grandis | P.W. Crous | South Africa | KM230959 KM231115 |
|                         |             |                   |                    |            | KM231280 AY793509    |
|                         |             |                   |                    |            | AF208952 JN096249    |
| **C. lageniformis**     | CPC 340.92; PPRI 4448; UFV 115 | Eucalyptus sp.  | A.C. Afenas       | Brazil      | KM230958 KM231114    |
|                         |             |                   |                    |            | KM231279 AY793520    |
| **C. parva**            | CBS 114524; ATCC 28272; CPC 2370 | Telopea speciosissima | H.J. Boesewinkel | New Zealand | KM230960 KM231116    |
|                         |             |                   |                    |            | KM231281 AY793526    |
| **Cylindrocladurn album** | CBS 301.83; ATCC 48642; CPC 2370 | Fucus distichus | R.C. Summerbell | Canada | KM231046 KM231152 |
|                         |             |                   |                    |            | KM231322 KM231484    |
| **C. hubeiense**        | CBS 129.97  | Viscum album      | W. Gams           | France      | KM231048 KM231154    |
|                         |             |                   |                    |            | KM231324 KM231486    |
| **Dactylenecoria alcacerensis** | CBS 129087; CPC 19172 | Vitis vinifera | A. Cabral & H. Oliveira | Portugal | KM231054 KM231158 |
|                         |             |                   |                    |            | KM231330 JF735630    |
| **D. estremocensis**    | CBS 129085; CPC 19170 | Vitis vinifera | C. Rego & T. Nascimento | Portugal | KM231052 KM231156 |
|                         |             |                   |                    |            | KM231328 JF735617    |
|                         |             |                   |                    |            | JF735320 KM231630    |
| **(continued on next page)** |             |                   |                    |            | KM232174 KM232345    |
|                         |             |                   |                    |            | JF735807 JF735448    |
| Species | Isolate nr. | Substrate | Collector/Depositor | Locality | GenBank Accession No. |
|---------|-------------|-----------|---------------------|----------|----------------------|
| D. macrodidyma | CBS 112615; CPC 3978 | Vitis vinifera | F. Halleen | South Africa | acl1 KM231055; act KM352883; cmdA KM231331; his3 JF753647; ITS AY677290; LSU HM364315; rpb1 HM364333; rpb2 JF268710; teF JF268750; tub2 AY677233 |
| D. novozelandica | CBS 113552; CPC 5713 | Vitis vinifera | R. Borftigjoli | New Zealand | acl1 KM231053; act KM231157; cmdA KM231329; his3 JF753633; ITS JF753534; LSU –; rpb1 KM23177; rpb2 KM232346; teF JF735822; tub2 AY677237 |
| D. torresensis | CBS 129086; CPC 19171 | Vitis vinifera | A. Cabral | Portugal | acl1 KM231056; act KM231159; cmdA KM231332; his3 JF753681; ITS JF753562; LSU KM231631; rpb1 KM23177; rpb2 KM232347; teF JF735870; tub2 JF735492 |
| Dialonectria episphaeria | CBS 125494; TG 2006-11 | Unknown Ascomycete | T. Grafenhan | Canada | acl1 HQ897892; act KM231227; cmdA KM231404; his3 KM231556; ITS HQ897811; LSU KM231697; rpb1 KM232248; rpb2 HQ897756; teF KM231953; tub2 KM232092 |
| D. ulevolea | CBS 125493; TG 2007-56 | Unknown Ascomycete | T. Grafenhan | USA | acl1 HQ897918; act KM231226; cmdA KM231403; his3 KM231555; ITS KM231696; rpb1 KM232247; rpb2 HQ897782; teF KM231952; tub2 KM232091 |
| Dematiocladium celtidis | CBS 115994; T. Celtis tala | N. Allegrucci | Argentina | acl1 KM230952; act KM231108; cmdA KM231274; his3 –; ITS AY793430; LSU AY793438; rpb1 KM232133; rpb2 –; teF –; tub2 – |
| Falcocladium multivesiculatum | CBS 120386; PREM 51541; CPC 13207 | Leaf litter | S.F. Silveira | Brazil | acl1 KM231099; act KM231262; cmdA –; his3 –; ITS –; LSU –; rpb1 –; rpb2 –; teF –; tub2 – |
| F. sphaeropedunculatum | CBS 111292; CPC 1448 | Leaf litter | P.W. Crous | Brazil | acl1 –; act –; cmdA –; his3 –; ITS –; LSU –; rpb1 –; rpb2 –; teF –; tub2 – |
| F. thailandicum | CBS 121717; CPC 13489 | Eucalyptus camaldulensis | W. Himan | Thailand | acl1 KM231098; act KM231261; cmdA –; his3 –; ITS –; LSU –; rpb1 –; rpb2 –; teF –; tub2 – |
| Fusarium circinatum | CBS 405.97; BBA 69720; DAOM 225113; MRC 7541; NRRL 25331 | Pinus radiata | J. Cornell | USA | acl1 KM231017; act KM231215; cmdA KM231393; his3 KM231544; ITS U61677; LSU AY249397; rpb1 JX171510; rpb2 JX171623; teF KM231943; tub2 KM232080 |
| F. proliferatum | CBS 189.38; IMI 035108; MUCL 1129 | Avena sativa | B.L. Chona | India | acl1 KM231019; act KM231217; cmdA KM231395; his3 KM231546; ITS KM231816; LSU KM231685; rpb1 KM232238; rpb2 KM232384; teF –; tub2 KM232082 |
| F. sambucinum | CBS 146.95; BBA 64226 | S. tuberosum | H.I. Nirenberg | UK | acl1 KM231015; act KM231213; cmdA KM231391; his3 KM231542; ITS KM231813; LSU KM231682; rpb1 KM232235; rpb2 KM232381; teF KM231941; tub2 KM232078 |
| F. subluratum | CBS 189.34; BBA 62431; NRRL 13384 | Soil | O.A. Reinking | Costa Rica | acl1 HQ897916; act KM231211; cmdA KM231389; his3 KM231540; ITS HQ897830; LSU KM231680; rpb1 HQ897780; rpb2 KM232390; teF –; tub2 KM232076 |
| F. venenatum | CBS 458.93; BBA 64537; NRRL 26228 | Winter wheat | H.I. Nirenberg | Austria | acl1 KM231016; act KM231214; cmdA KM231392; his3 KM231543; ITS KM231814; LSU KM231683; rpb1 KM232236; rpb2 KM232382; teF KM231942; tub2 KM232079 |
| F. verrucosa | CBS 102163; GJS 84-426 | Bamboo | G.J. Samuels | Venezuela | acl1 HQ897920; act KM231212; cmdA KM231390; his3 KM231541; ITS KM231812; LSU KM231681; rpb1 KM232234; rpb2 HQ897784; teF KM231940; tub2 KM232077 |
| Fusicolla aqueductuum | CBS 837.85; BBA 64559; NRRL 20865 | Plug in water tap | H.I. Nirenberg | Germany | acl1 HQ897880; act –; cmdA –; his3 –; ITS –; LSU –; rpb1 –; rpb2 –; teF –; tub2 – |
| Species                        | Isolate nr. ¹ | Substrate                  | Collector/ Depositor | Locality       | GenBank Accession No.² |
|-------------------------------|---------------|----------------------------|----------------------|-----------------|------------------------|
| *F. matuoii*                  | CBS 581.78; ATCC 18694; NRRL 20427 | Albizzia julibrissin | T. Matuo           | Japan           | HQ897858 KM231228 KM231405 KM231557 KM231822 KM231698 KM232249 KM2319720 KM231954 KM232093 |
| *F. violacea*                 | CBS 634.76;² BBA 62461; NRRL 20896 | Quadraspidiotus perniciosus | W. Gerlach         | Iran            | KM231059 KM231229 KM231407 KM231558 KM231824 KM231700 KM232251 KM231969 KM232095 |
| *Geojaysia celatécola*        | CBS 125502;³ TG 2008-32 | Celtis occidentalis | T. Grafenhan       | Canada          | H0M26625 KM231209 KM231386 KM231537 HM266657 HM266669 KM232232 HM266685 HM266683 KM232074 |
| *G. citricum*                 | CBS 125549;⁴ HJS 1372 | Buxus sempervirens | H.-J. Schroers     | Slovenia        | HM26636 KM231208 KM231385 KM231536 KM231810 KM231678 KM232231 KM26679 HM266643 KM232073 |
| *G. desmazieri*               | CBS 125507; TG 2007-87 | Buxus sempervirens | T. Grafenhan       | Spain           | HM26633 KM231207 KM231384 KM231535 HM266651 HM266663 KM232230 HM266675 HQ281146 KM232072 |
| *Glosopeletrichium bubulum*   | CBS 242.62;⁵ ATCC 22228; IFO 9325; IMI 096357; MUCL 18575; NRRL 2899; QM 9007 | Soil               | L.J. Wickerham    | USA             | KM230962 KM231118 KM231283 F513326 DQ377831 AY489732 AY489964 EF469114 KM231982 DQ377831 |
| *G. cylindrosporum*           | CBS 902.70;⁶ ATCC 22229; IFO 9326; IMI 155704; MUCL 18576; NRRL 2899; QM 9007 | Soil               | C. Klinsukont     | Thailand        | KM230963 KM231119 KM231284 F513353 DQ366705 JQ666077 KM231992 DQ377841 |
| *G. longibrachium*            | CBS 126571;⁷ MUCL 46903 | Leaf litter         | C. Decock & V. Robert | French Guiana | KM230961 KM231117 KM231282 F513367 DQ278422 KM231686 KM232178 KM232305 F513435 DQ377835 |
| *Gliocladopsis irregularis*   | CBS 755.97;⁸ CPC 718 | Soil               | A.C. Alfenas       | Indonesia       | KM230957 KM231113 KM231278 JQ666023 AF209977 JQ666082 KM232138 KM232302 F513449 JQ666133 |
| *G. pseudoaennis*             | CBS 116074;⁹ CPC 706 | Soil               | M.J. Wingfield     | China           | KM230956 KM231112 KM231277 JQ666030 AF209851 JQ666080 KM232137 KM232301 JQ666099 JQ666140 |
| *G. sagariensis*              | CBS 199.55²° | Soil               | S.B. Saksena       | India           | KM230955 KM231111 KM231276 JQ666031 JQ666063 JQ666078 KM232136 KM232300 JQ666106 JQ666141 |
| *Hyalocta nolinae*            | CBS 109837¹ | Nolina micrantha   | A.W. Ramaley       | USA             | KM231092 KM231265 KM231442 KM231600 KM231846 KM231726 KM232279 KM232422 JQ666107 – |
| *Ilyonectria capensis*        | CBS 132815¹ | Protea sp.         | K. Beuzdienhout    | South Africa    | – – KM231319 JX231135 JX231151 KM519908 KM232171 KM232336 JX231119 JX231103 |
| *I. destructans*              | CBS 119606; GJS 85-39 | Metrosideros sp.     | G.J. Samuels       | New Zealand     | – KM231315 KM231321 JF235505 JF235260 KM2315910 KM232173 KM232338 JF735694 JF373537 |
| *I. leucospermi*              | CBS 264.65 | Cyclamen persicum  | L. Nilsson         | Sweden          | – KM231148 KM231317 JF735506 AY767273 KM519927 KM232169 KM232344 JF735695 AY7677256 |
| *I. leucoperstii*              | CBS 132809 | Leucospermum sp.   | K. Beuzdienhout    | South Africa    | – KM231150 KM231320 JX311145 JX311161 KM519017 KM232172 KM232337 JX311229 JX311311 |
| *I. lindendri*                | CBS 117527 | Vitis vinifera     | C. Rego            | Portugal        | – KM231149 KM231318 JF735509 D1Q718165 KM519992 KM232170 KM232335 JF735698 D1Q718172 |
| *Lecteria colletotrichoides*   | CBS 109728 | Medicago sativa    | C. Eken            | Turkey          | KM231100 KM231263 KM231447 KM231604 KM231851 KM231731 KM232288 KM232427 KM321107 KM232121 |
| *Macroconia leptosphaeria*    | CBS 717.74 | Stroma of Pyrenomycte | W. Gams           | France          | KM231062 KM231236 KM231414 KM231564 KM231827 KM231707 KM232257 KM232390 JF735695 KM232099 |
| *CBS 100001*                  | Urlica doica | L. Rommelaars     | The Netherlands    | –              | H0M897891 KM231234 KM231412 KM231562 H0M897810 KM231705 KM232255 H0M897755 KM231959 KM232097 |
| *CBS 112770*                  | Cucurbitania laburni | W. Gams           | Austria           | –              | KM231061 KM231235 KM231413 KM231563 KM231826 KM231706 KM232256 KM232589 KM232190 KM232098 |
| Species | Isolate nr. 1 | Substrate | Collector/Depositor | Locality | GenBank Accession No. 2 |
|---------|---------------|-----------|---------------------|----------|------------------------|
| M. papilionacearum | CBS 125495; DAOM 238119; TG 2007-03 | Black ascomycete on Fabaceae | T. Gafrenhan | USA | HQ897912 KM231233 KM231561 HX897626 KM231704 KM232254 HX897776 KM231958 KM232096 |
| Mariannaea campytopora | CBS 209.73; IMI 168965 | Soil | E. Jansen | The Netherlands | KM231032 KM231134 KM231303 KM231473 AY624202 – KM232147 KM232326 KM231875 AY624245 |
| M. catenulatae | CBS 120801 | Decaying wood | W. Gams | Germany | KM231031 KM231133 KM231302 KM231472 KM231753 KM231618 KM232151 KM232325 KM231878 KM232010 |
| M. humicola | CBS 491.92; ATCC 56204 | Wood | G.J. Samuels | Venezuela | KM231030 KM231132 KM231301 KM231471 KM231752 KM231617 KM232150 – KM231877 KM232009 |
| M. pinicola | CBS 740.95; CCT 4534 | Soil | S. Baldini | Brazil | KM231034 KM231136 KM231305 KM231475 KM231755 KM231619 KM232153 KM232328 KM231880 KM232012 |
| M. punicea | CBS 745.88; CTR 71-199 | Pinus sp. | C.T. Rogerson | Venezuela | KM231033 KM231135 KM231304 KM231474 KM231754 – KM232152 KM232327 KM231879 KM232011 |
| M. samuelsii | CBS 239.56 | Soil | J. Meyer | Zaire | KM231028 – KM231299 KM231469 AY624201 JF415981 KM232148 AY624244 |
| M. punicea | CBS 105.66 | Soil | J.H. van Emden | The Netherlands | KM231029 KM231131 KM231300 KM231470 KM231751 KM231616 KM232149 KM232324 JF416021 KM232008 |
| M. sambulatai | CBS 746.88; CTR 71-13 | Bark | C.T. Rogerson | Jamaica | KM231036 KM231138 KM231307 KM231477 KM231757 KM231621 KM232155 KM232330 KM231882 KM232014 |
| Microcera coccophila | CBS 310.34; NRRL 13962 | Scale insect | H.W. Wollenweber | Italy | HQ897843 KM231232 KM231410 KM231560 HQ897794 KM231703 JX171462 HQ897705 JF740692 – |
| M. larvarum | CBS 738.79; BBA 62239; MUCL 19033; NRRL 20473 | Quadrupadiotus perniciosus | W. Gerlach | Iran | KM231060 KM231230 KM231408 KM231559 KM231825 KM231701 KM232252 KM232387 KM231957 – |
| M. rubra | CBS 638.76; BBA 62460; NRRL 20475 | Quadrupadiotus perniciosus | W. Gerlach & D. Ershad | Iran | HQ897903 KM231231 KM231409 EU860073 HQ897820 KM231702 KM232253 HQ897787 JF740696 EU860019 |
| Nalanthamala psidii | CBS 116952; AR 4095 | Padium guajava | Y-F. Yen | Taiwan | KM231073 KM231245 KM231423 KM231576 AY684836 AY684837 KM232268 KM232401 KM231972 AY684838 |
| N. vermoesenii | CBS 230.48; ATCC 10522; IMI 040231; MUCL 7584; NRRL 1752 | Citrus medica | H.S. Fawoett | Spain | KM231071 KM231243 KM231421 KM231574 AY554212 AY554263 KM232266 KM232399 KM231970 AY554231 |
| Nectria balansae | CBS 110893; MUCL 9504 | Arecaceae | P. Bourge | – | KM231072 KM231244 KM231422 KM231575 AY554214 AY554266 KM232267 KM232400 KM231971 AY554233 |
| N. rubra | CBS 123351; AR 4446 | Coronil sp. | C. Lechat | France | KM231079 QS050977 KM231429 KM231582 HM484552 QS059996 QS060026 KM232407 HM484525 HM484607 |
| N. rubra | CBS 125119; GJS 86-117 | Woody vine | G.J. Samuels | French Guiana | KM231078 JF832486 KM231426 KM231581 HM484857 HM484868 HM484871 KM232406 HM484848 HM484874 |
| N. rubra | CBS 129349; AR 4635 | Twigs | W.Y. Zhuang & X.M. Zhang | China | KM231077 JF832485 KM231427 KM231580 JF832653 JF832711 JF832790 KM232405 JF832522 JF832908 |
| Species                     | Isolate nr. | Substrate          | Collector/Depositor | Locality       | GenBank Accession No.2 |
|----------------------------|-------------|-------------------|---------------------|----------------|------------------------|
| *N. cinnabarina*            | CBS 125165; AR 4477; CLL 7152 | Aesculus sp.      | C. Lechat           | France        | KM231074 HM484503 KM231424 KM231577 HM484548 HM484562 HM484577 KM232402 KM484527 HM484606 |
| "N. dacryocarpa"            | CBS 121.87; GJS 85-185 | Tree fern         | G.J. Samuels        | Sulawesi      | KM231097 KM231259 KM231587 KM231650 KM231670 KM232284 |
|                            | CBS 113532   | Pithya cupressina  | S. Ryman & O. Constantinescu | Sweden       | KM231094 KM231257 KM231444 KM231601 KM231684 KM231728 KM232281 KM232424 KM232194 KM232118 |
| *N. mariae*                 | CBS 125294; CLL 7187 | Buxus sempervirens | C. Lechat           | France        | KM231076 JF832499 KM231426 KM231579 JF832629 JF832684 JF832789 KM232404 JF832542 JF832899 |
| *N. nigrescens*            | CBS 125148; AR 4211 | Wood               | A.Y. Rossman        | USA           | KM231075 KM231425 KM231578 KM484707 KM484720 KM484781 KM232403 KM484672 KM484806 |
| *Neocosmospora ambrosia*   | CBS 571.94; BBA 65390 | Camellia sinensis | H.I. Nirenberg      | India         | KM231003 KM231198 KM231373 KM231668 KM232220 KM232368 KM231929 KM232063 |
| *N. haematococca*          | CBS 101573   | Passiflora edulis  | C.F. Hill           | New Zealand   | KM231000 KM231195 KM231370 KM231522 KM231798 KM231665 KM232217 KM232365 KM231927 KM232060 |
|                            | CBS 119600; GJS 02-90 | Dying tree        | G.J. Samuels        | Sri Lanka     | KM230999 KM231194 KM231369 KM231521 KM231797 KM231664 KM232216 KM231926 KM232059 |
|                            | CBS 123669; NRRL 45880 |               |                     |               |            |
| *N. illudens*               | CBS 119605; GJS 85-37 | Metrosideros sp.  | G.J. Samuels        | New Zealand   | KM231009 KM231202 KM231379 KM231530 KM231806 KM231673 KM232225 KM232374 KM231935 KM232068 |
|                            | CBS 126406; GJS 85-67 | Bark               | G.J. Samuels        | New Zealand   | KM231008 JF832443 KM231378 KM231529 JF832660 JF832762 JF832837 KM232373 KM231934 JF832841 |
| *N. phaseoli*              | CBS 265.50   | Phaseolus sp.      | W.C. Snyder         | USA           | KM231010 KM231203 KM231380 KM231531 KM231807 KM231674 KM232226 KM232375 HE647964 HE648035 |
|                            | CBS 102428; HIS 0332 | Bark               | G.J. Samuels        | Australia     | KM231011 KM231204 KM231381 KM231532 KM231808 KM231675 KM232227 KM232376 KM231936 KM232069 |
| *N. ramosa*                | CBS 509.63; IMU 410 | Air                | A.C. Batista        | Brazil        | KM231004 KM231199 KM231374 KM231525 KM231802 KM231669 KM232221 KM232369 KM231930 KM232064 |
|                            | CBS 320.73; ATCC 24396; IMI 131652; NRRL 22107 | Soil               | M.M. Musa           | Sudan         | KM231001 KM231196 KM231371 KM231523 KM231799 KM231666 KM232218 KM232386 DG247551 KM232061 |
|                            | CBS 101018; ATCC 16238; IFO 7591 | Soil               | A. Zazzerini        | Italy         | KM231002 KM231197 KM231372 KM231524 KM231800 KM231667 KM232219 KM232367 KM231928 KM232062 |
| *N. vasinfecta*            | CBS 325.54; ATCC 32363; IMI 251387 | Arachis hypogaea   | M.A. de Freitas     | Guinea        | KM231007 KM231377 KM231528 KM231605 KM231672 KM232224 KM232372 KM231933 KM232067 |
|                            | CBS 517.71; IMI 302626 | Soil               | P. Rama Rao         | India         | KM231006 KM231201 KM231376 KM231527 KM231604 KM231671 KM232223 KM232371 KM231932 KM232066 |
| *Neonectria candida*        | CBS 151.29; IMI 113894; MUCL 28083 | Malus sylvestris   | H.W. Wollenweber    | UK            | KM231044 KM231146 KM231315 JF735602 AY677291 HM042436 KM232168 DQ789792 DQ789723 DQ789863 |

(continued on next page)
| Species                  | Isolate nr. | Substrate          | Collector/ Depositor | Locality            | GenBank Accession No. |
|--------------------------|-------------|--------------------|----------------------|---------------------|-----------------------|
| *N. lugdunensis*          | CBS 125485; DaOM 235531; TG 2008-07 | Populus fremontii    | T. Graffenhan       | USA                 | HQ897867 KM231145 KM231314 KM231482 KM231762 KM231625 KM232160 HQ897731 KM231887 KM232019 |
| *N. neomacrosora*         | CBS 324.61; DSM 62469 | Abies concolor      | J.A. von Arx        | The Netherlands     | KM231042 KM231144 KM231313 JF735599 JF735312 HM364318 HM364335 DQ789803 HM364335 DQ789875 |
|                          | CBS 198.62; BBA 9628; IMI 113690 | Abies concolor      | W. Gerlach         | Germany             | KM231041 KM231143 KM231312 KM231481 AJ009255 HM364316 KM232167 DQ789795 JF735788 DQ789866 |
| *N. tsugae*               | CBS 788.69 | Tsuga heterophylla | J.E. Bier          | Canada               | HQ897865 KM231147 KM231316 KM231483 KM231763 HQ232146 KM232161 HQ897728 DQ897920 KM232020 |
| Ophiocordyceps triforispora | CBS 314.75; ATCC 28509; DaOM 139482; IMI 166077 | Dead wood          | R.P. Korf          | Jamaica              | – KM231181 KM231354 – KM231788 KM231652 KM232203 – – KM232047 |
| Paracremoneium contagium  | CBS 110348; GJS 01-155 | Homo sapiens       | G.J. Samuels       | Cameroon            | – – KM231442 – – AF543790 AY489669 DQ522457 AF543779 DQ522520 |
| *P. infulatum*            | CBS 485.77; CDC 77-043179 | Homo sapiens       | A.A. Padhye        | India                | KM231065 KM231238 KM231415 KM231568 KM231629 HQ232113 KM232260 KM232394 KM231964 KM232101 |
| Penicillifer bipapillatus | CBS 420.88 | Soil               | O. Rangel          | Colombia             | KM231066 KM231239 KM231416 KM231569 KM231830 KM231711 KM232261 KM232365 KM231965 KM232102 |
| P. dipierltisporus        | CBS 376.59; ATCC 13214; IMI 100713; QM 7720 | Soil               | A.A. Foster        | USA                  | KM230949 KM231106 KM231271 KM231455 KM231741 KM231609 KM232130 KM232296 KM231861 KM231997 |
| *P. penicilliferi*        | CBS 423.88; GJS 87-468 | Unknown            | G.J. Samuels       | Guyana               | KM230947 KM231104 KM231269 KM231453 KM231739 KM231607 KM232128 KM232294 KM231859 KM231995 |
| *P. pulcher*              | CBS 560.67; ATCC 19931; MuCL 11607 | Soil               | J.H. van Emden     | The Netherlands      | KM230950 KM231107 KM231272 KM231456 KM231742 KM231610 KM232131 KM232297 KM231862 KM231998 |
| Pochonia sp.              | CBS 401.70; NRRL 26536 | Myxomycete         | W. Gams            | The Netherlands      | KM231089 KM231252 KM231439 KM231598 KM231843 AF339518 KM232276 KM232419 KM231980 KM232114 |
| *P. pulcher*              | CBS 892.72 | Arcyria sp.        | W. Gams            | The Netherlands      | KM231090 KM231253 KM231440 KM231599 KM231844 KM231724 KM232277 KM232420 KM231981 KM232115 |
| *P. pulcher*              | CBS 634.75 | Myxomycete         | W. Gams            | The Netherlands      | KM231091 KM231254 KM231441 – KM231845 KM231725 KM232278 KM232421 KM231982 KM232116 |
| Pseudonectria buxi        | CBS 324.53 | Buxus sempervirens | J.A. van Arx       | The Netherlands      | KM230984 KM231171 KM231344 KM231502 KM231778 KM232194 KM232353 KM231909 KM232037 |
| “P. coronata”             | CBS 114049; AR 2716 | Buxus sempervirens | R. Lowen           | Spain                | KM230985 KM231172 KM231345 KM231503 KM231779 U17416 AY489670 KM232354 KM231910 KM232038 |
| *P. coronata*             | CBS 696.93 | Buxus sempervirens | F. Candoussau      | France               | KM231086 – KM231437 – KM231840 KM231721 KM232273 KM232416 KM231977 KM232111 |
| Paracremoneium dipierltisporus | CBS 122566; AR 2709 | Buxus sempervirens | A.Y. Rossman       | USA                  | KM230983 KM231170 KM231343 KM231501 KM231777 KM231643 KM232193 – KM231908 KM232036 |
| *P. coronata*             | CBS 123190; CPC 15385 | Buxus sempervirens | S. Trower          | New Zealand          | KM230982 KM231169 KM231342 KM231500 KM231776 KM231642 KM232192 KM232352 KM231907 KM232035 |
| Species                     | Isolate nr.¹ | Substrate                  | Collector/ Depositor | Locality       | GenBank Accession No.² |
|-----------------------------|--------------|-----------------------------|----------------------|-----------------|------------------------|
| *Rectifusarium robinianum*  | CBS 830.85; BBA 64246; NRRL 13953 | Solanum tuberosum | H. Nirenberg | Germany | KM230992 – KM231359 KM231511 KM231793 KM231656 JX171461 JX171575 KM231922 KM232052 |
|                            | CBS 430.91¹; NRRL 25729 | Robinia pseudoacacia | U. Kuchenbäcker | Germany | KM2319707 – KM231360 KM231512 KM231794 KM231657 JX171520 HQ897771 KM231923 KM232053 |
| *R. ventricosum*            | CBS 748.79¹; BBA 62452; NRRL 20846; NRRL 22113 | Soil | W. Gams | Germany | HQ897897 KM231186 KM231361 KM231513 HQ897816 KM231658 KM232208 HQ897781 KM231924 KM232054 |
| *Rodentomyces reticulatus* | CBS 128675; AR 4677; DSM 23301 | Rodent dung | F. Doveri | Italy | KM231096 JF832480 KM231446 KM231603 JF832659 JF832717 KM232283 KM232426 JF832543 JF832910 |
| *Rugonecctria neobalansae* | CBS 125120; GJS 85-219 | Dead tree | G.J. Samuels | Indonesia | KM231023 KM231129 KM231294 KM231466 KM231750 HM364322 KM232146 KM232321 KM231874 HM352869 |
| *R. rugulosa*               | CBS 126565; GJS 09-1245 | Dead tree | Y. Hirooka | Venezuela | KM231024 KM231130 KM231296 KM231468 KM231749 KM231615 KM232145 KM232320 KM231873 KM232007 |
| *Sarcopodium cirinatum*     | CBS 587.92; CCT 5383 | Soil | G. Weber | Costa Rica | – KM231180 KM231353 – KM231787 KM231651 KM232202 KM23360 JF832545 KM232046 |
|                            | CBS 100998; INIFAT C989 | Leaf litter | R.F. Castanieda | Brazil | – KM231179 KM231352 KM231507 KM231786 KM231650 KM232201 KM232359 KM231917 KM232045 |
| *S. cirincetiferum*         | CBS 100251; FMR 6354 | Soil | A.M. Stchigel & M. Caldich | Argentina | KM230988 KM231175 KM231348 KM231580 KM231782 KM231646 KM232197 KM232356 KM231913 KM232041 |
|                            | CBS 100252; FMR 6355 | Soil | A.M. Stchigel & M. Caldich | Argentina | KM230987 KM231174 KM231347 KM231589 KM231781 KM231645 KM232196 KM232355 KM231912 KM232040 |
| *S. flavolanatum*           | CBS 112283 | Theobroma gilieri | H.C. Evans & R.H. Reeder | Ecuador | – KM231178 KM231351 KM231506 KM231785 KM231649 KM232200 KM232358 KM231916 KM232044 |
|                            | CBS 128370 | Decaying wood | W.Y. Zhuang & N. Ye | China | KM230989 KM231177 KM231350 KM231505 KM231784 KM231648 KM232199 KM232357 KM231915 KM232043 |
| *S. macalpinei*             | CBS 115296; HKUCC 8395 | Viburnum odoratissimum | K.D. Hyde | Hong Kong | – KM231176 KM231349 KM231591 KM231783 KM231647 KM232198 – KM231914 KM232042 |
| *S. vanilae*                | CBS 100582; PD 98/8/459-1 | Anthurium sp. | J.W. Veenbaas-Rijks | Ecuador | KM230986 KM231173 KM231346 KM231504 KM231780 HQ232174 KM232195 – KM231911 KM232039 |
| *Saroctadium kiliense*      | CBS 400.52 | Ficus carica | J.M. Waterston | UK | KM231095 KM231258 KM231445 KM231602 KM231649 KM231729 KM232282 KM232425 KM231985 KM232119 |
| *Septofusidium berolinense* | CBS 731.70 | Ficus carica | G.M. Olah | UK | KM231087 KM231250 – KM231584 KM231641 KM231722 KM232274 KM232417 KM231978 KM232112 |
| *S. herbarum*               | CBS 265.58¹; IMI 053581 | Utica dioica | C. Booth | UK | KM231088 KM231251 KM231438 KM231585 KM231642 KM231723 KM232275 KM232418 KM231979 KM232113 |
| *Stachybotrys chartarum*    | CBS 129.13 | – | H.A. Dale | – KM231268 KM231452 KM231588 KM231658 KM231738 KM232293 KM232434 KM231994 KM232127 |

(Generic Concepts in Nectriaceae continued on next page)
| Species                        | Isolate nr. | Substrate       | Collector/ Depositor | Locality         | **GenBank Accession No.** |
|-------------------------------|-------------|-----------------|----------------------|------------------|--------------------------|
| *Stylonectria applanata*      | CBS 125489; TG 2008-24 | Betula sp. | T. Grafenhan | Canada | HQ897873 KM231218 – KM231547 HM364317 KM231689 KM232329 HM364317 KM231944 KM232083 |
| *S. wegeliniana*              | CBS 125490; TG 2009-03 | *Hapalycystis* bicaudata | H. Voglmayr | Austria | HQ897890 KM231219 KM231396 KM231548 KM231817 KM231690 KM232240 HM845454 KM231945 KM232084 |
| *Stylonectria sp.*            | CBS 125491; TG 2007-21 | Unknown Ascomycete | T. Grafenhan | Germany | HQ897915 KM231220 KM231397 KM231549 HM845454 KM231691 KM232241 HM845779 KM231946 KM232085 |
| *Thelemonectria discophora*   | CBS 125153; AR 4324 | *Pinus radiata* | A.Y. Rossman | New Zealand | KM231049 HM352875 KM231327 KM231489 KM364294 KM364307 KM232344 KM231897 KM352860 |
| *T. oïda*                     | CBS 215.67; ATCC 16548; DSM 65220; IMI 116873 | Asparagus officinalis | W. Gerlach | Germany | KM231050 KM352884 KM231325 KM231487 KM364317 KM364334 KM232342 KM231897 KM352860 |
| *T. trachosa*                 | CBS 112467; GJS 92-45; IMI 352560 | Bark | D. Bradford & G.J. Samuels | Scotland | KM231051 KM231155 KM231326 KM231488 KM364317 KM364339 KM232343 KM231896 KM352860 |
| *Thyronectria lamyi*          | CBS 417.89 | *Berberis vulgaris* | H. Schmid | Germany | KM231083 JF832516 KM231434 KM231597 KM231837 KM231718 JF832830 KM232413 JF832850 KM232108 |
| *T. pyrtchochloa*             | CBS 125131; AR 2786 | Acer campestre | A.Y. Rossman | Austria | – KM484512 – KM484545 KM484554 KM484558 KM484541 KM484519 KM484598 |
| *T. quercicola*               | CBS 128976; AR 3805 | Quercus ilex | J. Checa | Spain | – JF832450 KM231433 KM231595 JF832624 JF832743 JF832831 KM232411 JF832851 JF83280 |
| *T. trachosa*                 | CBS 139.89; PD 78/36 | Decaying orchid bulb | G.H. Boerema | The Netherlands | – KM231085 KM231249 KM231436 – KM231839 KM231720 KM232272 KM232415 KM231976 KM232110 |
| *Trichosphaerella ceratophora*| CBS 130.82 | *Agaricus* sp. | E. Müller | Switzerland | KM231093 KM231256 KM231443 KM231586 KM231687 KM232280 KM232423 KM231983 KM232117 |
| *Volutella ciliata*           | CBS 483.61; CCT 5396; MUCL 9659 | Soil | G.L. Baron | Canada | KM230975 KM231163 KM231336 KM231493 KM231770 KM231635 KM231286 – HM364356 KM232028 |
| *V. consors*                  | CBS 139.79; PD 78/36 | Decaying orchid bulb | G.H. Boerema | The Netherlands | HQ897853 KM231161 KM231334 KM231491 KM231768 KM231633 KM232164 HQ897715 KM231899 KM232026 |
| *V. minima*                   | CBS 122767 | Soil | W. Gams | The Netherlands | KM30973 KM231160 KM231333 KM231490 KM231767 KM231632 KM232183 KM231896 KM232025 |
| *V. rosea*                    | CBS 128258 | Soil | P.A. Orput & J.T. Curtis | USA | KM30974 KM231162 KM231335 KM231492 KM231769 KM321634 KM232185 KM232348 KM231900 KM232027 |
| *Xenoacremonium falcatus*     | CBS 400.85; | *Pinus radiata* | J. Reid | New Zealand | KM231068 – KM231418 KM231571 KM231832 HQ232025 KM232263 – KM231967 KM232104 |
| *X. recifei*                  | CBS 137.35; IHEM 4405; MUCL 9696 | Homo sapiens | A.E. de Ara Leão | Brazil | KM231069 KM231241 KM231419 KM231572 KM231633 HM232106 KM232264 KM232397 KM231906 KM232105 |
| *Xenocylindrocladium guianense* | CBS 541.89 | Soil | L. Pfennig | Brazil | KM231070 KM231242 KM231420 KM231573 KM231634 KM232114 KM232265 KM232398 KM231969 KM232106 |
| *Xenocylindrocladium guianense* | CBS 112179; CPC 3496; MUCL 41975 | Plant litter | C. Decock | French Guiana | KM230971 KM231124 KM231289 KM231463 AF317348 JQ666073 KM23166 KM232314 KM231895 AF320197 |
| Species                  | Isolate nr. | Substrate                  | Collector/Depositor                      | Locality  | GenBank Accession No. |
|-------------------------|-------------|----------------------------|------------------------------------------|-----------|-----------------------|
| *X. serpens*            | CBS 128439; MUCL 39315 | Bark                      | G.L. Hennebert                           | Ecuador   | KM230972 KM231125 KM2311290 KM231464 AF220982 KM231688 KM232165 – KM231894 AF320196 |
| *X. subverticillatum*   | CBS 113660T; CPC 3397; MUCL 41834 | Plant litter              | C. Decock & O. Laurence                  | Singapore | KM230970 KM231123 KM231288 KM231462 AF317347 KM231687 – KM232313 KM231893 AF320196 |
| *Xenogloeadiopsis*      | CBS 133814; CPC 19417 | *Eucalyptus*              | P.W. Crous                              | Australia | KM231039 KM231141 KM231310 KM231479 KM231760 KM231623 KM232158 KM232332 KM231885 KM232177 |
| *cypellocarpa*          | CPC 17153    | *Eucalyptus*              | P.W. Crous                              | Australia | KM231040 KM231142 KM231311 KM231480 KM231761 KM231624 KM232159 KM232333 KM231886 KM232176 |
| *X. eucalyptorum*       | CBS 138758; CPC 16271 | *Eucalyptus*              | P.W. Crous                              | South Africa | KM231038 KM231140 KM231309 – KM231759 KM231622 KM232157 KM232331 KM231894 KM232166 |

1 Ex-type and ex-epitype cultures.

1 AR: Collection of A.Y. Rossman; ATCC: American Type Culture Collection, U.S.A.; BBA: Biologische Bundesanstalt für Land- und Forstwirtschaft, Berlin-Dahlem, Germany; CBS: CBS-KNAW Fungal Biodiversity Centre, Utrecht, The Netherlands; CMW: Forestry and Agricultural Biotechnology Institute, University of Pretoria, Pretoria, South Africa; CCT: Colecao de Culturas Tropical, Fundacao Tropical de Pesquisas e Tecnologia "Andre Tosello", Campinas-SP, Brazil; CDC: Centers for Disease Control and Prevention, Atlanta, GA, USA; CLL: C. Lechat collection; CPC: P.W. Crous collection; CTR: C.T. Rogerson collection; DAO: Agriculture and Agri-Food Canada National Mycological Herbarium, Canada; DSM: Deutsche Sammlung von Mikroorganismen und Zellkulturen GmbH, Braunschweig, Germany; FMR: Facultad de Medicina, Reus, Tarragona, Spain; GJS: Gary J. Samuels collection; HJS: Hans-Josef Schroers collection; HKUCC: University of Hong Kong Culture Collection, Department of Ecology and Biodiversity, Hong Kong, China; IFO: Institute for Fermentation, Osaka, Yodogawa-ku, Osaka, Japan; IHEM: Institute of Hygiene and Epidemiology-Mycology Laboratory, Brussels, Belgium; IMI: International Mycological Institute, CABI-Bioscience, Egham, Bagshot, U.K.; IMUR: Institute of Mycology, University of Recife, Recife, Brazil; INIFAT: INIFAT Fungus Collection, Ministerio de Agricultura Habana; KAS: K.A. Seifert collection; MRC: National Research Institute for Nutritional Diseases, Tygerberg, South Africa; MUCL: Mycothèque de l’Université Catholique de Louvain, Belgium; NBRC: NITE Biological Resource Center, Japan; NRRL: Agricultural Research Service Culture Collection, USA; PD: Collection of the Dutch National Plant Protection Organization (NPPO-NL), Wageningen, The Netherlands; PPRI: Plant Protection Research Institute, Pretoria, South Africa; PREM: National collection of Fungi, Agriculture Department, Pretoria, South Africa; QM: Quartermaster Research and Development Center, US Army, Natick, MA, USA; TG: T. Grafenhans collection; UAMH: University of Alberta Mold Herbarium and Culture collection, Edmonton, Canada; UFV: Universidade Federal de Viçosa, Brazil.

2 acl1: large subunit of the ATP citrate lyase; act: a-actin; cmdA: calmodulin; his3: histone H3; ITS: the internal transcribed spacer region and intervening 5.8S nrRNA; LSU: 28S large subunit; rpb1: RNA polymerase II largest subunit; rpb2: RNA polymerase II second largest subunit; tef1: translation elongation factor 1-alpha; tub2: β-tubulin.
Phylogenetic relationships

The multi-gene alignment length was 11 286 bases including gaps, for the 10 gene regions. The phylogenetic analyses included 206 ingroup taxa, with 202 gene regions are indicated in Table 2. The phylogenetic analyses were made at ×1.000 magnification 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 while only extremes are provided for other structures. Colony morphology was assessed using 7-old cultures on MEA, OA and/or PDA and the colour charts of Rayner (1970). All descriptions, illustrations and nomenclatural data were deposited in MycoBank (Crous et al. 2004a).

RESULTS

Phylogenetic relationships

The multi-gene alignment length was 11 286 bases including gaps, for the 10 gene regions. The phylogenetic analyses included 206 ingroup taxa, with Stachybotrys chartarum (CBS 129.13) as an outgroup taxon. The congruence analyses detected one conflict for the placement of Rodontomyces reticulatus (CBS 128675) and Sarocladium kiliense (CBS 400.52), which could not be resolved without excluding both from the analyses. However, as these conflicts only involved the placement of single species, this was ignored and all partitions were combined following the argument of Cunningham (1997) that combining incongruent partitions could increase phylogenetic accuracy. All ambiguously aligned regions were excluded from the analyses (Table 2). The number of polymorphic and parsimony informative sites, and evolutionary model selected for each gene region are indicated in Table 2.

The Bayesian consensus tree confirmed the tree topology obtained from the ML analysis, and therefore only the ML consensus tree with bootstrap support values (BS) and posterior probability values (PP) are indicated for well-supported clades in Figs 1 and 2. Both Figs 1 and 2 represent the same underlying phylogenetic analyses, but are two different representations of the obtained phylogenetic tree with Fig. 1 providing a collapsed leaf overview of the genera and families, and Fig. 2 providing details at strain level. In Fig. 1, 44 well-supported clades (BS ≥ 75%; PP ≥ 0.95) were resolved in the super-clade representing the Nectriaceae. Of these, 33 clades represent established genera with the remaining 11 clades representing possible new genera. Three separate single lineages were also resolved within the Nectriaceae super-clade, representing Corallonectria jatrophae (CBS 913.96), Calostilbe striispora (CBS 133491) and Dematiodiocladium celtidis (CBS 115994).

Several clades, representing genera traditionally classified in the Nectriaceae, resolved in well-supported sister clades (BS ≥ 75%; PP ≥ 0.95) of the Nectriaceae super-clade. Isolates representing the species in the genera Tilachlidium (CBS 363.97 & CBS 505.67) and Septosascus (CBS 265.58 & CBS 731.70), along with an isolate listed as “Pseutonecicia corona” (CBS 696.93), formed a well-supported clade (BS ≥ 75%; PP ≥ 0.95) basal to the Nectriaceae super-clade. Representatives of the genera Aphanocladium (CBS 401.70, CBS 634.75 & CBS 892.72; BS = 100%, PP = 1.0), Ciliocodium (CBS 106.13 & CBS 691.83; BS ≥ 75%, PP ≥ 0.95), Cylindrium (CBS 685.83A, CBS 693.83 & CBS 115974; BS = 100%, PP = 1.0) and Falcocladium (CBS 111292, CBS 121717 & CBS 120386; BS ≥ 75%, PP ≥ 0.95), each formed separate clades outside the Nectriaceae super-clade.

Treatment of genera (Fig. 2)

Based on phylogenetic inference supported by morphological observations, several novel taxa were identified in this study. Recognised clades, as well as novel families, genera and species are described and discussed below. Only generic circumscriptions are provided for known taxa where the descriptions are available in MycoBank, or in recently published scientific papers.
Fig. 1. Maximum Likelihood (ML) consensus tree inferred from the combined 10 genes sequence data set providing a collapsed leaf overview of the genera and families. Thickened branches indicate branches present in both the ML and Bayesian consensus trees. Branches with BS = 100 % and PP = 1.0 are in red. Branches with BS ≥ 75 % and PP ≥ 0.95 are in blue. The tree is rooted to *Stachybotrys chartarum* (CBS 129.13). The arrow indicates the most basal node representing *Nectriaceae*. 
Fig. 2. The ML consensus tree inferred from the combined 10 genes sequence data set. Thickened branches indicate branches present in both the ML and Bayesian consensus trees. Branches with BS = 100 % and PP = 1.0 are in red. Branches with BS ≥ 75 % and PP ≥ 0.95 are in blue. The tree is rooted to Stachybotrys chartarum (CBS 129.13). Clade numbers are provided to the right of the tree and these are used for reference in the Treatment of Genera section. Coloured blocks represent the accepted genera.
Fig. 2. (Continued).

GENERIC CONCEPTS IN NECTRIACEAE

Volutella
- CBS 122767 Volutella minima
- CBS 139.79 Volutella consors
- CBS 128258 Volutella rosea
- CBS 483.61 Volutella ciliata
- CBS 667.92 Chaetopsina acutispora
- CBS 142.56 Chaetopsina fulva
- CBS 608.92 Chaetopsina chaetopsinae-penicillatae
- CBS 126106 Coccinonectria pachysandricola
- CBS 501.63 Coccinonectria pachysandricola
- CBS 128258 Coccinonectria pachysandricola
- CBS 12870 Coccinonectria flavolanatum
- CBS 112263 Coccinonectria flavolanatum
- CBS 100582 Coccinonectria pachysandricola
- CBS 128674 Coccinonectria pachysandricola
- CBS 123190 Pseudonectria foliicola
- CBS 122566 Pseudonectria foliicola
- CBS 532.53 Pseudonectria buxi
- CBS 114049 Pseudonectria buxi
- CBS 100582 Sarcopodium vanillae
- CBS 100252 Sarcopodium circinotetiferum
- CBS 100251 Sarcopodium circinotetiferum
- CBS 115296 Sarcopodium macalpinei
- CBS 128370 Sarcopodium florovanatum
- CBS 112263 Sarcopodium florovanatum
- CBS 100998 Sarcopodium cincinatum
- CBS 537.92 Sarcopodium cincinatum
- CBS 314.75 Ophionectria trichospora
- CBS 109876 Ophionectria trichospora
- CBS 133491 Calostile striispora
- CBS 180.31 Atractium crassum
- CBS 783.85 Atractium stilbaster
- CBS 748.79 Rectifusarium ventricosum
- CBS 176.31 Bisifusarium nectrioides
- CBS 120718 Bisifusarium delphinoides
- CBS 317.34 Bisifusarium penzigii
- CBS 10944 Bisifusarium dimerum
- CBS 117517 Bisifusarium domesticum
- CBS 632.76 Bisifusarium lunatum
- CBS 123669 Neocosmospora haematococca
- CBS 119600 Neocosmospora haematococca
- CBS 101573 Neocosmospora haematococca
- CBS 320.73 Neocosmospora rubicola
- CBS 101018 Neocosmospora rubicola
- CBS 571.94 Neocosmospora ambrosia
- CBS 509.63 Neocosmospora ramosa
- CBS 323.54 Neocosmospora vasinfecta
- CBS 517.71 Neocosmospora vasinfecta
- CBS 562.70 Neocosmospora vasinfecta
- CBS 126406 Neocosmospora illudens
- CBS 119605 Neocosmospora illudens
- CBS 265.50 Neocosmospora phaseoli
- CBS 102429 Neocosmospora phaseoli
- CBS 122570 Albonectria rigidiuscula
- CBS 315.73 Albonectria rigidiuscula
- CBS 125507 Geejayessi desmazieri
- CBS 125549 Geejayessi cicatricum
- CBS 125502 Geejayessi celtidicola
- CBS 101734 Cyanonectria cyanostoma
- CBS 125551 Cyanonectria buxi
- CBS 130.97 Cyanonectria buxi
- CBS 102163 Fusarium verrucosa
- CBS 189.34 Fusarium subluratum
- CBS 146.95 Fusarium sambucinum
- CBS 458.93 Fusarium venenatun
- CBS 405.97 Fusarium cincinatum
- CBS 263.54 Fusarium proliferatum
- CBS 189.38 Fusarium proliferatum

VII

Chaetopsina
- CBS 142.56 Chaetopsina fulva
- CBS 608.92 Chaetopsina chaetopsinae-penicillatae

Coccinonectria
- CBS 128258 Coccinonectria pachysandricola

Pseudonectria
- CBS 532.53 Pseudonectria foliicola
- CBS 114049 Pseudonectria buxi

Sarcopodium
- CBS 133491 Calostile striispora

Ophionectria
- CBS 109876 Ophionectria trichospora
- CBS 133491 Calostile striispora

Atractium
- CBS 180.31 Atractium crassum
- CBS 783.85 Atractium stilbaster

Rectifusarium
- CBS 748.79 Rectifusarium ventricosum

Bisifusarium
- CBS 176.31 Bisifusarium nectrioides
- CBS 120718 Bisifusarium delphinoides
- CBS 317.34 Bisifusarium penzigii
- CBS 10944 Bisifusarium dimerum

Neocosmospora
- CBS 123669 Neocosmospora haematococca
- CBS 119600 Neocosmospora haematococca
- CBS 101573 Neocosmospora haematococca
- CBS 320.73 Neocosmospora rubicola
- CBS 101018 Neocosmospora rubicola

Albonectria
- CBS 315.73 Albonectria rigidiuscula

Geejayessia
- CBS 125507 Geejayessi desmazieri
- CBS 125549 Geejayessi cicatricum
- CBS 125502 Geejayessi celtidicola

Cyanonectria
- CBS 101734 Cyanonectria cyanostoma
- CBS 125551 Cyanonectria buxi
- CBS 130.97 Cyanonectria buxi

Fusarium
- CBS 102163 Fusarium verrucosa
- CBS 189.34 Fusarium subluratum
- CBS 146.95 Fusarium sambucinum
- CBS 458.93 Fusarium venenatun
- CBS 405.97 Fusarium cincinatum
- CBS 263.54 Fusarium proliferatum
- CBS 189.38 Fusarium proliferatum
CBS 125489 Stylonectria applanata
CBS 125490 Stylonectria wegeliniana
CBS 125491 Stylonectria sp.
CBS 341.70 Cosmospora coccinea
CBS 762.69 Cosmospora cymosa
CBS 100551 "Acremonium aff. curvulum"
CBS 748.69 Cosmospora arxii
CBS 101915 "Stylonectria wegeliniana"
CBS 125492 Dialonectria ulveola
CBS 125494 Dialonectria episphearia
CBS 581.78 Fusicolla mauci
CBS 837.85 Fusicolla aquaeductuum
CBS 634.76 Fusicolla violacea
CBS 738.79 Microcera larvarum
CBS 638.76 Microcera rubra
CBS 310.34 Microcera coccpophila
CBS 125495 "Stylonectria wegeliniana"
CBS 125493 Dialonectria ulveola
CBS 125494 Dialonectria episphearia
CBS 358.49 Corallomycetella repens
CBS 118.84 Corallomycetella repens
CBS 275.60 Corallomycetella elegans
CBS 485.77 Paracremonium inflatum
CBS 482.78 Paracremonium inflatum
CBS 110348 Paracremonium contagium
CBS 400.85 Xenoacremonium falcatum
CBS 137.35 Xenoacremonium recifei
CBS 541.88 Xenoacremonium recifei
CBS 230.48 Nalanthamala vermoesenii
CBS 110893 Nalanthamala vermoesenii
CBS 116952 Nalanthamala psidii
CBS 125165 Nectria cinnabaria
CBS 125148 Nectria nigrescens
CBS 125944 Nectria mariae
CBS 125494 Nectria balansae
CBS 125119 Nectria balansae
CBS 123351 Nectria balansae
CBS 121121 Allantonectria milina
CBS 125499 Allantonectria milina
CBS 125131 Thyronectria pyrrochloa
CBS 128976 Thyronectria quercioca
CBS 462.83 Thyronectria sinopica
CBS 417.89 Thyronectria lamyi
CBS 363.97 Tilachlidium brachiatum
CBS 506.67 Tilachlidium brachiatum
CBS 696.93 "Pseudonectria corona"n
CBS 731.70 Septofusidium berolinense
CBS 265.58 Septofusidium herbarum
CBS 401.70 "Aphanocladium album"
CBS 892.72 "Aphanocladium album"
CBS 634.75 "Aphanocladium album"
CBS 108637 Hyaloseta nolinae
CBS 113532 "Nectria dacryocarpia"
CBS 400.52 Sarocladium kilense
CBS 128675 Rodentomyces reticulatus
CBS 121.87 "Nectria dacryocarpia"
CBS 111292 Falcocladium sphaeropedunculatum
CBS 121717 Falcocladium thailandicum
CBS 120386 Falcocladium multivesiculatum
CBS 120386 Falcocladium multivesiculatum
CBS 109728 Lectera colletotrichoides
CBS 685.83A Cylindrium elongatum
CBS 115974 Cylindrium elongatum
CBS 693.83 Cylindrium aeruginosum
CBS 122.39 "Calostilbe striispora"
CBS 691.83 Ciliciopodium brevipes
CBS 108.13 Ciliciopodium hyalinum
CBS 129.13 Stachybotrys chartarum

Fig. 2. (Continued)
Clade I

*Aquanectria* L. Lombard & Crous, *gen. nov.* MycoBank MB810949.

*Etymology*: Name refers to the aquatic niche of these fungi.

Ascomata perithecial, superficial, scattered or aggregated in groups, ovate to subglobose, collapsing laterally when old, brown-orange to orange-red, with papillate ostiolar region. Asci cylindrical to clavate, 8-spored. Ascospores ellipsoid to fusiform, hyaline, 1-septate, with a slight constriction at the septum. Conidiophores in aquatic environment erect, solitary, septate, hyaline, branched, with verticillate penicillus with 1–4 phialides. Phialides cylindrical, tip with periclinal thickening, collarette often tubular, not flared. Conidia filiform, curved to slightly sigmoid, aseptate to 1-septate, hyaline, smooth. Chlamydospores formed intercalary, pale to dark brown, containing a large oil guttule, aggregating to form sclerotia (adapted from Ingold 1942 and Ranzoni 1956).

*Type species*: *Aquanectria penicillioides* (Ingold) L. Lombard & Crous.

*Notes*: The aquatic genus *Aquanectria* is established here to accommodate two fungal species previously treated as members of the genera *Flagellospora* and *Heliscus* (Ingold 1942, Ranzoni 1956, Hudson 1961). Recent studies (Baschien et al. 2013, Duarte et al. 2015) showed that species in the aquatic genus *Flagellospora* belongs to the *Helotiales* based on the type species, *F. curvula*. Furthermore, Lombard et al. (2014b) synonymised the genus *Heliscus*, based on the type species *H. lugdunensis*, under the genus *Neoneectria*. In this study, CBS 257.54 (= *F. penicillioides*) clustered with the ex-type strain (CBS 394.62) of *Heliscus submersus* in a well-supported clade (BS = 100, PP = 1.0) sister to the clade representing the genus *Gliocladiopsis*. Therefore, new combinations are required to accommodate these fungi in the genus *Aquanectria* with *A. penicillioides* as type.

*Aquanectria penicillioides* (Ingold) L. Lombard & Crous, *comb. nov.* MycoBank MB810950. Fig. 3.

*Basionym*: *Flagellospora penicillioides* Ingold, Trans. Brit. Mycol. Soc. 27: 44. 1942.

Material examined: USA, California, Napa County, Green Valley Falls, on decaying leaves of *Acer* sp. submerged in a stream, Dec. 1954, F.V. Ranzoni, culture CBS 257.54.

*Descriptions and illustrations*: Ingold (1942), Ranzoni (1956).

*Aquanectria submersa* (H.J. Huds.) L. Lombard & Crous, *comb. nov.* MycoBank MB810162.

*Basionym*: *Heliscus submersus* H.J. Huds., Trans. Brit. Mycol. Soc. 44: 91. 1961.

Material examined: Jamaica, St. Andrew, Hardwar Gap, on decaying leaves submerged in a stream, 1960, H.J. Hudson, *holotype* IMI 76792 (not seen), culture ex-type CBS 394.62, sterile.)
**Ascomatal state** not known. Setae arising from pseudoparenchymatous cells in a basal stroma, adjacent to cells that give rise to conidiophore stipe, extending beyond the conidiophores; setae unbranched, straight to flexuous, brown, verruculose, thick-walled with basal cell initially smooth, becoming brown with age, tapering from a base which is either rounded and well-defined, or cylindrical and continuous with the cells in the pseudoparenchymatous stroma, to an acutely or subobtusely rounded apex, which is pale brown, thin-walled towards the apex; apical cell sometimes becoming fertile with age, forming an apical penicillate conidiophore. **Conidiophores** consist of a stipe, a penicillate arrangement of fertile branches, and rarely, an extension of the stipe, signifying continued growth and eventual branching of stipe and secondary penicillate conidiophores. **Stipe** septate, hyaline, smooth, brown at the base, arising from tightly arranged pale to medium brown pseudoparenchymous cells in a basal stroma, frequently terminating in a swollen, globose apical cell, giving rise to 1–6 primary branches. **Conidiogenous apparatus** branched (−4), hyaline, smooth, with terminal branches producing 1–6 phialides. **Phialides** elongate doliiform to reniform or subcylindrical, straight to slightly curved, aseptate; apex with minute periclinal thickening and inconspicuous collarette. **Conidia** cylindrical, rounded at both ends, straight, hyaline, 1(−2)-septate, lacking a visible abscission scar, held in parallel clusters by colourless slime. **Chlamydospores** globose, thick-walled, brown, in intercalary chains (adapted from Crous et al. 2005).

**Type species:** *Dematiocladium celtidicola* Allegr. et al., Mycol. Res. 109: 836. 2005. MycoBank MB344508.

**Description and illustrations:** Crous et al. (2005).

**Notes:** *Dematiocladium celtidicola* (ex-type CBS 115994) formed a single lineage basal to the clade representing the genus *Penicillifer* and the single lineage representing *Corallonectria jatrophae*. Recently, Crous et al. (2014) introduced a second species in this genus, *D. celtidicola* from China, which was not available for this study at the time.

**Gliocladiopsis** S.B. Saksena, Mycologia 46: 662. 1954. MycoBank MB8341.

**Ascomata** perithecial, superficial, densely gregarious, seated on a thin basa stroma, obvoid to broadly obpyriform, collapsing laterally when drying, warty, red-brown with a dark red stromatic base, changing to dark red in KOH. **Asci** unitunicate, 8–spored, cylindrical, sessile, with a flattened apex, and a refractive apical apparatus. **Ascospores** uniseriate, overlapping, hyaline, ellipsoidal, smooth, medially 1-septate. **Conidiomata** sporodochial, consisting of numerous aggregated penicillate conidiophores, or reduced to separate penicillate or subverticillate conidiophores. **Conidiophores** monomorphic, penicillate, consisting of a stipe and a penicillate arrangement of fertile branches, rarely dimorphic, penicillate and subverticillate. **Stipe** septate, hyaline, smooth. **Conidiogenous apparatus** with several series of aseptate or 1-septate branches, each terminal branch producing 2–6(−7) phialides. **Phialides** doliiform to cymbiform to cylindrical, hyaline, aseptate, apex with minute periclinal thickening and inconspicuous collarette. **Conidia** cylindrical, rounded...
at both ends, straight to curved, (0–)1-septate, lacking visible ascobiont scars, but frequently with a flattened base, held in fascicles by colourless slime (adapted from Saksgena 1954 and Lombard & Crous 2012).

Type species: Gliocladiopsis sagariensis S.B. Saksgena, Myco- logia 46: 663. 1954. MycoBank MB297822.

Descriptions and illustrations: Saksgena (1954), Crous (2002), Lombard & Crous (2012).

Notes: Representative strains of the genus Gliocladiopsis formed a monophyletic clade (BS = 100 %, PP = 1.0) sister to the clade representing the aquatic genus Aquanectria. Interestingly, these two genera clustered together in a larger clade (BS ≥ 75 %, PP > 0.95), even though they do not share the same ecological niche. Gliocladiopsis species are characteristically soil-borne (Lombard & Crous 2012). The genera do, however, share similar conidiophore morphology.

Penicillifer Emden, Acta Bot. Neerl. 17: 54. 1968. Myco- Bank MB9256.

= Viridispora Samuels & Rossman, Stud. Mycol. 42: 166. 1999.

Ascomata non-stromatic, superficial, globose to pyriform, red, orange-brown, tan, or brown, not reacting or changing to red in KOH, coarsely warted or glabrous. Asci clavate, apex simple. Ascospores green, 1-septate and smooth. Conidiophores erect, solitary, septate, hyaline, unbranched and monophialidic, or with a biverticillate penicillus. Phialides cylindrical, tip with periclinal thickening, collarette often tubular, not flared. Conidia cylindrical to slightly naviculate, 1-septate, hyaline, smooth, with blunt papilla at one or both ends (adapted from Samuels 1989 and Rossman et al. 1999).

Type species: Penicillifer furcatus Emden, Acta Bot. Neerl. 17: 54. 1968. MycoBank MB335703.

Descriptions and illustrations: Samuels (1989), Polishook et al. (1991), Rossman et al. (1999).

Notes: The sexual genus Viridispora was established by Rossman et al. (1999) to accommodate species in the genera Nectria (Samuels 1989, Watanabe 1990) and Neocosmospora (Polishook et al. 1991) that had Penicillifer asexual morphs. Penicillifer was introduced by Emden (1968), typified by P. pulcher, for a fungus isolated from soil in the Netherlands. At present, the genus Viridispora accommodates four species, V. alata (= P. bipapillatus), V. dipartiopsis (= P. furcatus), V. fragariae (= P. fragariae) and V. penicilliferi (= P. macrosporus), each with its own Penicillifer asexual morphs (Samuels 1989, Watanabe 1990, Polishook et al. 1991, Rossman et al. 1999). So far, only P. japonicus (Matsushima 1985) has no associated sexual morph. Because the generic name Penicillifer (1968) is older than Viridispora (1999) for this monophyletic group of fungi (BS = 100 %, PP = 1.0), we propose that the sexual morph, Viridispora, be suppressed in favour of the asexual morph, Penicillifer. A new combination is, however, required for P. furcatus, as the epithet Pseudonectria dipartiopsis (1957) pre-dates that of Penicillifer furcatus (1991) and is provided below.

Penicillifer dipartiopsis (J.H. Miller, Giddens & A.A. Foster) Rossman, L. Lombard & Crous, comb. nov. MycoBank MB810951.

Basionym: Pseudonectria dipartiopsis J.H. Miller, Giddens & A.A. Foster, Mycologia 49: 793. 1957 (1958, as ‘dipartiopsis’).

≡ Neocosmospora dipartiopsis (J.H. Miller, Giddens & A.A. Foster) Samuels & Rossman, Stud. Mycol. 42: 167. 1999.

≡ Viridispora dipartiopsis (J.H. Miller, Giddens & A.A. Foster) Samuels & Rossman, Stud. Mycol. 42: 167. 1999.

≡ Neocosmospora axii Udagawa, Horie & P. Cannon, Sydowia 41: 353. 1989.

≡ Neocosmospora endophytica Polishook, Bills & Rossman, Mycologia 83: 798. 1991.

≡ Penicillifer furcatus Polishook, Bills & Rossman, Mycologia 83: 798. 1991.

Clade II

Cylindrocladiella Boesew., Canad. J. Bot. 60: 2289. 1982. MycoBank MB7869.

= Neocosmospora Crous & C. L. Schoch, Stud. Mycol. 45: 54. 2000.

Ascomata perithecial, superficial, solitary, basa state absent, globose to obpyriform, collapsing laterally when dry, smooth, with several minute, brown setae arising from the perithecial wall surface, red, changing colour in KOH, ostiole consisting of clavate cells, lined with inconspicuous periphyses. Asci unitalicate, 8- spored, cylindrical, sessile, thin-walled, with a flattened apex, and a refractive apical apparatus. Ascospores uniseriate, overlapping, hyaline, ellipsoid to fusoid with obtuse ends, smooth, 1-septate. Conidiospores monomorphic, penicillate, or highlighter (penicillate and subverticillate), mononematous, hyaline. Penicillate conidiospores consist of a stipe, a penicillate arrangement of fertile branches, a stipe extension, and a terminal vesicle. Subverticillate conidiospores consist of a stipe, and one or two series of phialides. Stipe septate, hyaline, smooth. Stipe extensions aseptate, straight, thick-walled, with one basal septum, terminating in a thin-walled vesicle of characteristic shape. Conidigenous apparatus with primary branches aseptate to 1-septate, secondary branches aseptate, terminating in 2–4 phialides. Phialides cylindrical, straight or doliiform to reniform to cymbiform, hyaline, aseptate, apex with minute periclinal thickening and collarette. Conidia cylindrical, rounded at both ends, straight, (0–)1–3-septate, frequently slightly flattened at the base, held in asymmetrical clusters by colourless slime. Chlamydospores brown, thick-walled, more frequently arranged in chains than clusters (adapted from Boesewinkel 1982 and Lombard et al. 2012).

Type species: Cylindrocladiella parva (P.J. Anderson) Boesew., Canad. J. Bot. 60: 2289. 1982.

≡ Cylindrocladium parvum P.J. Anderson, Mass. Agric. Exp. Sta. Bull. 163: 37. 1919.

Descriptions and illustrations: Boesewinkel (1982), Lombard et al. (2012).

Notes: Representative strains of the genus Cylindrocladiella formed a monophyletic clade (BS = 100 %, PP = 1.0), sister to the members of Clade I.

Clade III

Calonectria De Not., Comment. Soc. Crittog. Ital. 2: 477. 1867. MycoBank MB746.
Ascomata perithecial, solitary or in groups, globose to subglobose to ovoid, yellow to orange to red or red-brown to brown, turning darker red to red-brown in KOH, rough-walled; perithecial apex consisting of flattened, thick-walled hyphal elements with rounded tips forming a palisade, discontinuous with warty wall, gradually becoming thinner towards the ostiolar canal, and merging with outer periphyses; perithecial base consisting of dark brown-red, angular cells, merging with an erumpent stroma, cells of the outer wall layer continuing into the pseudoparenchymatous cells of the erumpent stroma. Ascii 8-spored, clavate, tapering to a long thin stalk. Ascospores aggregated in the upper third of the ascus, hyaline, smooth, fusoid with rounded ends, straight to sinuous, un-constricted, or constricted at the septa. **Megaconidiophores** if present, borne on the agar surface or immersed in the agar; stipe extensions mostly absent; co-nidiophores unbranchied, terminating in 1–3 phialides, or sometimes with a single subterminal phialide; phialides straight to curved, cylindrical, seemingly producing a single conidium; periclinal thickening and an inconspicuous, divergent collarette. Rarely visible. **Megaconidia** hyaline, smooth, frequently remaining attached to the phialide, multi-septate, widest in the middle, bent or curved, with a truncated base and rounded apical cell. **Microconidiophores** consist of a stipe, a penicillate arrangement of fertile branches, a stipe extension, and a terminal vesicle; **Macroconidiophores** consist of a stipe, a penicillate arrangement of fertile branches, a stipe extension, and a terminal vesicle; stipe septate, hyaline or slightly pigmented at the base, smooth or finely verruculose; stipe extensions sequestate, straight to flexuous, mostly thin-walled, terminating in a thin-walled vesicle of characteristic shape. **Conidigenous apparatus** with 0–1-septate primary branches; up to eight additional branches, mostly asceptate, each terminal branch producing 1–6 phialides; phialides cylindrical to allantoid, straight to curved, or doliiform to reniform, hyaline, asceptate, apex with minute periclinal thickening and inconspicuous divergent collarette. **Macroconidia** cylindrical, rounded at both ends, straight or curved, widest at the base, middle, or first basal septum, 1- to multi-septate, lacking visible ascission scars, held in parallel cylindrical clusters by colourless slime. **Microconidiophores** consist of a stipe and a penicillate or subverticillate arrangement of fertile branches. Primary branches 0-1-septate, subcylindrical; secondary branches 0–1-septate, terminating in 1–4 phialides; phialides cylindrical, straight to slightly curved, apex with minute periclinal thickening and marginal frill. **Microconidia** cylindrical, straight to curved, rounded at apex, flattened at base, 1(–3)-septate, held in asymmetrical clusters by colourless slime (adapted from Crous 2002).

**Type species:** *Calonectria pyrochroa* (Desm.) Sacc., Michelia 1: 308. 1878.

**Descriptions and illustrations:** Rossman et al. (1999), Crous (2002), Lombard et al. (2010b).

**Notes:** Representative strains of the genus *Calonectria* formed a monophyletic clade (BS = 100 %, PP = 1.0) closely related to the clades representing *Curvicladiella* and *Xenocyndrocladium*, respectively. Based on the ICN for algae, fungi and plants, new combinations are required for *C. morganii* and *C. scoparia* as there are older epithets available for both species.

**Calonectria candelabra** (Viéjas) Rossman, L. Lombard & Crous, comb. nov. *MycoBank* MB810952.

*Basionym:* *Cylindrocladium candelabrum* Viéjas, Bragantia 6: 370. 1946.

- = Calonectria scoparia Ribeiro & Matsuoka, in: Ribeiro, M.Sc. Thesis. Heterotalsism em C. scoparium: 28: 1978 (nom. inval., Art. 29).
- = Calonectria scoparia Peerally, Mycotaxon 40: 341. 1991.

**Calonectria cylindrosora** (Ellis & Everh.) Rossman, L. Lombard & Crous, comb. nov. *MycoBank* MB810953.

*Basionym:* *Diplodium cylindrosorum* Ellis & Everh., Bull. Torrey Bot. Club 27: 58. 1900.

- = Cylindrocladium scoparum Morgan, Bot. Gaz. 17: 191. 1892.
- = Cylindrocladium pithecolobii Petch, Ann. Roy. Bot. Gard. (Peradeniya) 6: 244. 1917.
- = Cylindrocladium ellipticum Aliferi, C.P. Seym. & Sobers, Phytopathology 60: 1213. 1970.
- = Calonectria morganii Crous, Alfenas & M.J. Wingf. *Mycol. Res.* 97: 706. 1993.

**Curvicladiella** Decock & Crous, Stud. Mycol. 55: 225. 2006. *MycoBank* MB500866.

Ascomatal state unknown. *Conidiomata* sporodochial or synnematous, consisting of numerous penicillate conidiophores arising from a stroma of brown, thick-walled chlamydospores. *Conidiophores* consist of a thick-walled, smooth to finely verruculose, septate, pale brown to brown basal stipe, a conidiogenous apparatus and several sterile stipe extensions that have 1(–2) apical and one basal septum; stipe extensions asessiculate, apical cell thick-walled, verruculose, pale brown, prominently curved, tapering towards a bluntly rounded acute apex. *Conidiogenous apparatus* with several hyaline, smooth, subcylindrical, straight to slightly curved conidiophile branches; phialides hyaline, smooth, doliiform to reniform or subcylindrical, apex with minute periclinal thickening, and inconspicuous, flared collarette. *Conidia* cylindrical, septate, lacking a visible abscession scar, held in heads of colourless slime. *Chlamydospores* arranged intercalarly, often aggregating to form microscerotia (adapted from Decock & Crous 1998 and Crous et al. 2006).

**Type species:** *Curvicladiella cignea* Decock & Crous, Stud. Mycol. 55: 225. 2006.

*Descriptions and illustrations:* Decock & Crous (1998), Crous et al. (2006).

**Note:** The monotypic genus *Curvicladiella* formed a well-supported clade (BS = 100 %, PP = 1.0) closely related to the genera *Calonectria* and *Xenocyndrocladium*.

**Gliocephalotrachium** J.J. Ellis & Hesselt., Bull. Torrey Bot. Club 89: 21. 1962. *MycoBank* MB8340.

Ascomata perithecial, superficial, globose to subglobose, scarlet, turning purple in KOH, with a white to pale luteous amorphous coating and hyphal stromatic base. Asci unitunicate, narrowly clavate, 8-spored, with flattened apex and a minute refractive ring. Ascospores hyaline, ellipsoidial, smooth, asceptate.
Conidiophores consisting of a septate, hyaline, pale luteous to pale brown stipe and a penicillate arrangement of fertile branches subtended by septate stipe extensions. Stipe extensions hyaline, septate, terminating in narrowly to broadly clavate vesicles. Conidiogenous apparatus with a series of aseptate, hyaline to pale brown branches, each terminating in 2–8 phialides. Phialides clavate to cylindrical, hyaline, aseptate, constricted at the apex, with minute periclinal thickening. Conidia cylindrical to ellipsoidal, straight to slightly curved, aseptate, accumulating in a white to luteous mucoid mass above the phialides (adapted from Rossman et al. 1993 and Lombard et al. 2014a).

Type species: Gliocephalotrichum bulbilium J.J. Ellis & Hesselt., Bull. Torrey Bot. Club 89: 21. 1962.

Descriptions and illustrations: Rossman et al. (1993), Lombard et al. (2014a).

Notes: Species of Gliocephalotrichum are soil-borne fungi generally associated with post-harvest fruit spoilage of several important tropical fruit crops (Lombard et al. 2014a). Representatives of Gliocephalotrichum clustered in a monophyletic clade (BS ≥ 75 %, PP ≥ 0.95), basal to the clades representing Calonectria, Curvicladiella and Xenocylindrocladium.

Xenocylindrocladium Decock et al., Mycol. Res. 101: 788. 1997. MycoBank MB27788. Fig. 4.

= Xenocalonectria Crous & C.L. Schoch, Stud. Mycol. 45: 50. 2000.

Ascomata perithecial, superficial, solitary or aggregated, globose to subglobose, warted, yellow to red with a dark red stromatic base; ostiolar periphyses hyaline, tubular with rounded ends. Asci unimunicate, 8-spored, cylindrical, with long basal stalks, a flattened apex, and a refractive apical apparatus. Ascospores aggregate in the upper third of the ascus, hyaline, broadly to narrowly ellipsoidal, smooth, medianly 1-septate.
Conidiophores consisting of a stipe, a penicillate arrangement of fertile branches, and an avesiculate stipe extension. Stipe septate, hyaline, smooth; stipe extensions septate, straight to flexuous or sinuous. Conidiogenous apparatus with aseptate or 1-septate primary branches; aseptate secondary, tertiary and quaternary branches, each terminal branch producing 2–6 phialides; phialides doliform to reniform, hyaline, aseptate, apex with minute periclinal thickening and inconspicuous collarette. Conidia cylindrical, rounded at both ends, straight or curved, septate, lacking visible abscission scars, held in parallel cylindrical clusters by slime (adapted from Decock et al. 1997).

Type species: Xenocylindrocladium serpens Decock et al., Mycol. Res. 101: 788. 1997.

Notes: The genus Xenocylindrocladium includes three species described from the tropics, isolated from plant debris (Decock et al. 1997, Crous et al. 2001). At the same time, Decock et al. (1997) introduced the sexual morph of X. serpens as Nectria serpens, which was later transferred to the genus Xenocalonectria by Schoch et al. (2000). Given the name changes required if the genus name Xenocalonectria was used, we propose that the generic name Xenocalonectria be suppressed in favour of Xenocylindrocladium, which also has priority by date and therefore no new combinations are required. Representatives of the genus Xenocylindrocladium formed a monophyletic clade (BS = 100 %, PP = 1.0), closely related to the genera Curvicladiella and Calonectria.

Clade IV

Campylocarpon Halleen et al., Stud. Mycol. 50: 448. 2004. MycoBank MB28858.

Ascomatal state unknown. Asexual state cylindrocarpon-like. Conidiophores arise laterally from single or fasciculate aerial hyphae, carried singularly or aggregated, consisting of a stipe bearing several phialides or a penicillus of irregular branches with terminal branches bearing one or several phialides. Phialides cylindrical or narrowly flask-shaped. Macroconidia cylindrical, typically curved, (1–)3–4(–5)-septate, with minute tapering, obtuse ends, sometimes somewhat more strongly tapering at the base; base with or without an obscure hilum. Microconidia and chlamydospores not observed (adapted from Halleen et al. 2004).

Type species: Campylocarpon fasciculare Schroers et al., Stud. Mycol. 50: 448. 2004.

Description and illustrations: Halleen et al. (2004).

Notes: The monophyletic clade (BS = 100 %, PP = 1.0) representing the asexual genus Campylocarpon is closely related but separate from the clade representing the genus Rugonectria. Both these genera share several morphological characters, such as having cylindrocarpon-like asexual states. Neither is known to produce chlamydospores in culture.

Cylindrocarpostylus R. Kirschner & Oberw., Mycol. Res. 103: 1155. 1999. MycoBank MB28330. Fig. 5.

Ascomatal state unknown. Conidiophores arise from hyphae, consisting of a stipe and penicillate arrangement of fertile branches. Stipe septate, smooth, becoming verruculose with age, initially hyaline, turning yellow to brown. Conidiogenous apparatus with asceptate primary, secondary, tertiary and quaternary branches, each terminal branch producing 2–4 phialides; phialides cylindrical to allantoid, hyaline, aseptate, apex with minute periclinal thickening and inconspicuous collarette. Conidia hyaline, smooth, cylindrical, rounded at both ends, straight or slightly curved, 0–3-septate, lacking visible abscission scars (adapted from Kirschner & Oberwinkler 1999).
Type species: Cylindrocarpostylus gregarius (Bres.) R. Kirschner & Oberw., Mycol. Res. 103: 1155. 1999.
≡ Diplocodiurnium gregarium Bres., Ann. Mycol. 1: 127. 1903.
≡ Cylindrocladium gregarium (Bres.) de Hoog, Persoonia 10: 75. 1978.

Description and illustrations: Kirschner & Oberwinkler (1999).

Note: Representatives of the monotypic genus Cylindrocarpostylus formed a monophyletic clade (BS = 100 %, PP = 1.0), separate from all other members of Clade IV.

Mariannaea G. Arnaud ex Samson, Stud. Mycol. 6: 74. 1974. MycoBank MB8846.

Ascomata perithecial with inconspicuous or absent stroma, solitary, globose with a flat apex, not collapsing or collapsing laterally when pinching dry, pale yellow, orange or brown, not reacting in KOH. Perithecial wall smooth or finely roughened. Asci cylindrical to narrowly clavate, sometimes with an inconspicuous apical ring, 8-spored. Ascospores 1-septate, hyaline, smooth to spinulose. Conidiophores verticillate to penicillate, hyaline, with phialides arising directly from the stipe or forming whorls of metulae on lower parts of the stipe. Stipe hyaline, with phialides arising directly from the stipe or forming whorls of metulae on lower parts of the stipe. Stipe hyaline, with phialides arising directly from the stipe or forming whorls of metulae on lower parts of the stipe. Stipe hyaline, smooth or finely roughened.

Type species: Mariannaea elegans (Corda) Samson, Stud. Mycol. 6: 75. 1974.
≡ Penicillium elegans Corda, Icones Fung. 2: 17. 1838.
≡ Hormodendron elegans (Corda) Bonorden, Handb. Allg. Mykol.: 76. 1851.
≡ Spicaria elegans (Corda) Harz., Bull. Soc. ImpNat. Moscou 44: 238. 1871.
≡ Paecilomyces elegans (Corda) Mason & Hughes apud Hughes, Mycol. Pap. 45: 27. 1951.

Descriptions and illustration: Samson (1974), Gräfenhan et al. (2011).

Note: Unfortunately no culture or sequences of M. elegans were available to be included in this phylogenetic study.

Mariannaea catenulatae (Samuels) L. Lombard & Crous, comb. nov. MycoBank MB810163.

Basionym: Chaetopsis catenulatae Samuels, Mycotaxon 22: 28. 1985.
≡ Nectria chaetosinae-catenulatae Samuels, Mycotaxon 22: 28. 1985.
≡ Cosmospora chaetosinae-catenulatae (Samuels) Rossman & Samuels, Stud. Mycol. 42: 119. 1999.

≡ Chaetopsis catenulatae-caenulatae (Samuels) J. Luo & W.Y. Zhuang, Mycologia 102: 979. 2010.

Description and illustration: Samuels (1985).

Notes: Based on phylogenetic inference in this study, the ex-type culture CBS 491.92, previously known as Chaetopsis catenulatae-caenulatae (Samuels 1985, Luo & Zhuang 2010), clustered in the monophyletic clade (BS ≥ 75 %, PP ≥ 0.95) representing the genus Mariannaea. Therefore, a new combination is provided in the genus Mariannaea. This is the first study to include this ex-type strain in a molecular phylogeny.

Mariannaea pinicola L. Lombard & Crous, nom. nov. MycoBank MB810164.
≡ Nectria pinicola (Samuels & Seifert, Mycotaxon 110: 101. 2009.
≡ Nectria pinicola Samuels & Seifert, Sydowia 43: 257. 1991. (nom. Inval., Art 23.4).

Etymology: Name derived from the plant host Pinus sp., from which it was collected.

Descriptions and illustrations: Samuels & Seifert (1991).

Notes: Gräfenhan et al. (2011) refrained from transferring Nectria pinicola to the genus Mariannaea based on insufficient taxonomic information available at that time. As the use of the same epithet would create a tautonym (Art. 23.4), we choose to provide this species with a new epithet.

Mariannaea humicola L. Lombard & Crous, sp. nov. MycoBank MB810165. Fig. 6.

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

Ascomatal state not observed. Conidiophores arising from the agar surface from aerial hyphae or fascicles, mostly 80–100 μm long, axis 3–7 μm wide, branching verticillately at 2–3 levels, with a terminal whorl of 1–5 phialides, and 1–2 lower nodes of 1–3 phialides, rarely with single phialides. Phialides subulate, sometimes with base slightly swollen, 10–20 μm, 2–4 μm at the broadest part, with periclinal thickening and inconspicuous colarette. Conidia fusiform to ellipsoidal to obovoid, hyaline, smooth, (3–)4 × 2–3 μm (av. 5 × 3 μm), with a distinct hilum at both or at one end. Chlamydospores not seen.

Culture characteristics: Colonies slow growing on MEA, 45–50 mm diam in 14 d at 24 °C. Surface dirty white in the centre becoming tan to sienna towards the margins with dirty white, irregularly distributed tufts of fascicles; aerial mycelium abundant. Reverse chestnut becoming umber at the margins.
Materials examined: Brazil, Sao Paulo, from rhizosphere soil under Araucaria angustifolia, Apr. 1995, S. Baldini (holotype CBS H-21953, culture ex-type CBS 740.95 = CCT 4534). Spain, Canary Islands, La Gomera, on decaying wood of unknown tree, Oct. 1999, R.F. Castaneda, culture CBS 102628 = INIFAT C99/130-2.

Notes: Mariannaea humilica is introduced here for two isolates (CBS 740.95 & CBS 102628), which were listed as “Nectria marianniae” (= M. pinicola) in the CBS collection. Both isolates clustered together in a clade (BS = 100 %, PP = 1.0) separate from the ex-type culture (CBS 754.88) of M. pinicola. The conidia of M. humilica ([3–]4–6 × 2–3 μm (av. 5 ± 3 μm]) are smaller than those of M. pinicola ([5–]9–17) × (2–)2.5–4.5 μm; Samuels & Seift 1991) and no chlamydospores were observed for M. humilica, which are readily formed by M. pinicola (Samuels & Seift 1991).

Rugonectria P. Chaverri & Samuels, Stud. Mycol. 68: 73. 2011. MycoBank MB518563.

Ascomata perithecial, formed on or partially immersed within a stroma, globose to subglobose, warted, orange to red, turning dark red in KOH. Ascii cylindrical to clavate, 8-spored. Ascospores 1-septate, ellipsoidal to oblong, hyaline or sometimes yellow. Asexual state cylindrocarpon-like. Microconidiophores monophialidial or sparsely branched, terminating in cylindrical phialides. Microconidia 0–1-septate, ovoid to cylindrical, with rounded ends, hyaline, lacking a prominent basal hilum. Macroconidiophores irregularly branched or in fascicles, terminating in cylindrical phialides. Macrocandia (3–)5–7(–9)-septate, fusiform, curved, tapering towards the ends with an inconspicuous basal hilum. Chlamydospores absent (adapted from Chaverri et al. 2011).

Type species: Rugonectria rugulosa (Pat. & Gaillard) Samuels et al., Stud. Mycol. 68: 73. 2011.

Notes: When Crous & Kendrick (1994) introduced the asexual genus Xenogliocladiopsis based on X. eucalyptorum, they incorrectly linked it to the Dothidomycete sexual morph Arnaudiella eucalyptorum. Phylogenetic inference in the current study clearly shows that the genus Xenogliocladiopsis belongs to the Nectriaceae, forming a well-supported clade (BS = 100 %, PP = 1.0) basal to Clades I–IV.
Xenogliocladiopsis cypellocarpa L. Lombard & Crous, sp. nov. MycoBank MB810166. Fig. 8.

Etymology: Name derived from the plant host Eucalyptus cypellocarpa, from which it was isolated.

Ascomatal state not observed. Conidiophores hyaline, separate or aggregated in sporodochia, consisting of a stipe bearing a penicillate arrangement of fertile branches, and an avesiculate stipe extension; stipe septate, hyaline, smooth, 19–105 × 4–11 μm; stipe extension septate, straight to flexuous, 70–190 μm long, 2–4 μm wide at the apical septum. Conidiogenous apparatus 70–115 μm wide, and 65–105 μm long; primary branches aseptate, 15–30 × 3–7 μm; secondary branches aseptate, 10–20 × 2–6 μm; tertiary branches aseptate, 7–22 × 2–5 μm; quaternary branches and additional branches (−8) aseptate, 6–15 × 1–4 μm, each terminal branch producing 2–6 phialides; phialides cylindrical to cymbiform, hyaline, aseptate, 8–11 × 1–3 μm, collarette absent. Conidia cylindrical to fusiform, rounded at both ends, straight, 8–10 × 1–2 μm (av. 9 × 1 μm).

Culture characteristics: Colonies moderately fast growing on MEA, 60–80 mm diam after 10 d at 24 °C. Surface white to pale luteous with pale luteous to yellow tuffs of sporodochia forming at the margins; aerial mycelium abundant in the centre becoming immersed towards the margins, with conidiophores forming on the aerial mycelium and on the surface at the margins. Reverse similar in colour.

Material examined: Australia, Northern territories, Darwin, Kurralong Height, on leaves of Eucalyptus cypellocarpa, 25 Apr. 2011, P.W. Crous (holotype CBS H-21951, culture ex-type CBS 133814 = CPC 19417); Queensland, Slaughter Falls, on leaves of Eucalyptus sp., 16 Jul. 2009, P.W. Crous, culture CPC 17153.

Notes: Xenogliocladiopsis cypellocarpa is introduced here as a new species in the genus Xenogliocladiopsis. This species forms shorter stipe extensions (up to 190 μm) than X. eucalyptorum (up to 220 μm), and the conidia of X. cypellocarpa are also slightly smaller than those of X. eucalyptorum (7.5–11 × 1–1.5 μm; Crous & Kendrick 1994).

Clade VI

Cylindrodendrum Bonord., Handb. allg. Mykol.: 98. 1851. MycoBank MB7873.

Ascomatal state unknown. Conidiophores initially as lateral phialides on somatic hyphae, sometimes verticillate, hyaline. Phialides monophialidic, elongate doliiform to reniform to obpyriform, with the terminal part frequently having a swollen tip, apex with minute periclinal thickening and inconspicuous collarette. Conidia cylindrical, rounded at both ends, straight, 0–1-septate, with visible abscission scars (adapted from Lombard et al. 2014b).

Type species: Cylindrodendrum album Bonord., Handb. Allg. Mykol.: 48. 1851.

Description and illustrations: Lombard et al. (2014b).

Notes: Chaverri et al. (2011) suggested that the asexual morphotyped genus Cylindrodendrum could be considered as a synonym of “Cylindrocarpon”. Morphologically however, members of Cylindrodendrum more closely resemble the asexual morphs of fungal species in the genera Atractium, Cosmospora, Dialonecchia, Fusicola, Macroconia and Stylonectria, with the exception of conidium morphology (Gräfenhan et al. 2011). Based on phylogenetic inference, Cylindrodendrum isolates included in this study formed a monophyletic clade (BS = 100 %, PP = 1.0), sister to the monophyletic clade representing Dactylonectria.

Dactylonectria L. Lombard & Crous, Phytopathol. Medit. 53: 348. 2014. MycoBank MB810142.

Ascomata perithecial, superficial, solitary or aggregated in groups, ovoid to obpyriform, dark red, becoming purple-red in
KOH, smooth to finely warted, with papillate apex; without recognisable stroma. Asci clavate to narrowly clavate, 8-spored; apex rounded, with a minutely visible ring. Ascospores ellipsoidal to oblong-ellipsoidal, somewhat tapering towards the ends, medianly septate, smooth to finely warted. Conidiophores simple or aggregated to form sporodochia; simple conidiophores arising laterally or terminally from aerial mycelium, solitary to loosely aggregated, unbranched or sparsely branched, septate, bearing up to three phialides. Phialides monophialidic, more or less cylindrical, tapering slightly in the upper part towards the apex. Macroconidia cylindrical, hyaline, straight to slightly curved, 1–4-septate, apex or apical cell typically slightly bent to one side and minutely beaked, base with visible, centrally located or laterally displaced hilum. Microconidia ellipsoid to ovoid, hyaline, straight, aseptate to 1-septate, with a minutely or clearly laterally displaced hilum. Chlamydospores rarely formed, globose to subglobose, smooth but often appear rough due to deposits, thick-walled, mostly occurring in chains.

Type species: Dactylonectria macrodidyma (Halleen, et al.) Lombard & Crous, Phytopathol. Medit. 53: 352. 2014.
≡ Neonectria macrodidyma Halleen et al., Stud. Mycol. 50: 445. 2004.
≡ Ilyonectria macrodidyma (Halleen et al.) P. Chaverri & C. Salgado, Stud. Mycol. 68: 71. 2011.
≡ Cylindrocarpon macrodidymum Halleen et al., Stud. Mycol. 50: 446. 2004.

Notes: Species in the genus Dactylonectria were initially regarded as members of the genus Ilyonectria. However, phylogenetic studies (Cabral et al. 2012a, Lombard et al. 2014b), showed that the genus Ilyonectria, as originally conceived, was paraphyletic. This led to the introduction of the genus Dactylonectria to accommodate Ilyonectria species isolated from grapevines (Cabral et al. 2012a, Lombard et al. 2014b). The clade representing the genus Dactylonectria (BS = 100 %, PP = 1.0) is monophyletic, and is sister to the clade representing Cylindrocladium. Both clades are distinct from Ilyonectria.
**Ilyonectria** P. Chaverri & C. Salgado, Stud. Mycol. 68: 69. 2011. MycoBank MB518558.

Ascomata perithecial, superficially, solitarily or in groups, loosely attached to substrate, red, turning purple-red in KOH, globose to subglobose, or ovoid to obpyriform with a broadly conical papilla or flattened apex, scaly to slightly warty. Ascii narrowly clavate or cylindrical, 8-spored; apex subtruncate, with a minutely visible ring. Ascomospores ellipsoid, 1-septate, smooth hyaline. Asexual morph cylindrocarpon-like. Conidiophores simple or complex or sporodochial. Simple conidiophores arising laterally or terminally from aerial mycelium, solitarily or loosely aggregated, unbranched or sparsely branched, bearing up to three phialides. Complex conidiophores solitary or aggregated in small sporodochia, repeatedly and irregularly branched. Phialides cylindrical, tapering towards the apex. Microconidia 0–1-septate, oval to ovoid to fusiform to ellipsoid, with a minutely or clearly laterally dissected hilum, formed in heads on solitarily distributed conidiophores or as masses on sporodochia. Macroconidia straight, cylindrical, 1–3 (–4)–septate, with both ends obtusely rounded, base sometimes with a visible, centrally located to laterally displaced hilum, forming flat domes of slimy masses. Chlamydospores globose to subglobose, thick-walled, intercalary or solitarily, initially hyaline, becoming brown with age (adapted from Chaverri et al. 2011).

Type species: *Ilyonectria destructans* (Zinssm.) Rossman, L. Lombard & Crous.

**Description and illustration**: Chaverri et al. (2011).

**Notes**: Representatives of the genus *Ilyonectria* clustered together in a well-supported clade (BS = 100 %, PP = 1.0), distinct from the clades representing *Cylindrocladium* and *Dactylonectria*. Chaverri et al. (2011) applied the epithet ‘radicicola’ (1963) to the type of this genus, whereas the older epithet ‘destructans’ (1918) is available. Therefore, a new combination is provided below for the type species of *Ilyonectria*. Furthermore, a new combination is provided for *Neonectria macroconidialis*, which Cabral et al. (2012a) showed to belong to this genus.

**Ilyonectria destructans** (Zinssm.) Rossman, L. Lombard & Crous, *comb. nov*. MycoBank MB810954.

*Basionym: Ramularia destructans* Zinssm., Phytopathology 8: 570. 1918.

≡ *Cylindrocarpon destructans* (Zinssm.) Scholten, Netherl. J. Plant Path. 70 suppl. (2): 9. 1964.

≡ *Cylindrocarpon radicicola* Wollenw., Fus. Autogr. Del.: 2; 651. 1924.

≡ *Neectria radicicola* Gerlaich & L. Nilsson, Phytopathol. Z. 48: 225. 1963.

≡ *Neonectria radicicola* (Gerlaich & L. Nilsson) Mantir & Samuels, Canad. J. Bot. 79: 339. 2001.

≡ *Ilyonectria radicicola* (Gerlaich & L. Nilsson) P. Chaverri & C. Salgado, Stud. Mycol. 68: 71. 2011.

**Ilyonectria macroconidialis** (Brayford & Samuels) Rossman, L. Lombard & Crous, *comb. nov*. MycoBank MB810955.

*Basionym: Cylindrocarpon macroconidialis* Brayford & Samuels, Mycol. Res. 94: 440. 1990.

≡ *Neectria radicicola var. macroconidialis* Samuels & Brayford, Mycol. Res. 94: 440. 1990.

≡ *Neonectria macroconidialis* (Samuels & Brayford) Seifert, Phytopathology 93: 1541. 2003.

**Neonectria** Wollenw., Ann. Mycol. 15: 52. 1917. MycoBank MB3469.

≡ *Chilonecctria Morelet*, Bull. Soc. Sci. Nat. Archéol. Toulon & Var 178: 6. 1969.

≡ *Heliscus Sacc.*, Michelia 2: 35. 1980.

Ascomata perithecial, solitarily or in groups, seated on an erumpent stroma, red, turning dark red in KOH, smooth to slightly verruculose, 1- to 4-septate, hyaline, becoming pale brown with age. Paraphyses septate when present, slightly constricted at each septum. Conidiophores simple or complex forming sporodochia. Simple conidiophores solitary or loosely aggregated, unbranched or sparsely branched. Complex conidiophores irregularly branched, solitary or aggregated forming sporodochia. Phialides cylindrical, tapers towards the apex. Microconidia 0–1-septate, oval to ovoid to fusiform to ellipsoid, with a minutely or clearly laterally dissected hilum, formed in heads on solitarily distributed conidiophores or as masses on sporodochia. Macroconidia mostly formed by simple conidiophores, hyaline, smooth, ellipsoid to oblong, 0–1-septate. Macroconidia mostly forming complex conidiophores, hyaline, smooth, straight or slightly curved towards the ends, 3–7 (–9)–septate, lacking a scar or basal hilum. Chlamydospores globose to subglobose, hyaline (adapted from Chaverri et al. 2011).

Type species: *Neonectria candida* (Ehrenb.) Rossman, L. Lombard & Crous.

**Description and illustration**: Chaverri et al. (2011).

**Notes**: The genus *Neonectria* is monophyletic, forming a well-supported clade (BS = 100 %, PP = 1.0), distinct from the genera included in Clade VI. A new combination is required for *N. ramulariae* (1917) as there is an older epithet *Fusarium candidum* (1818), available for this species.

**Neonectria candida** (Ehrenb.) Rossman, L. Lombard & Crous, *comb. nov*. MycoBank MB810956.

*Basionym: Fusarium candidum* Ehrenb., Syl. Mycol. Berol: 24. 1818.

≡ *Ramularia candida* (Ehrenb.) Wollenw., Phytopathology 1: 220. 1913.

≡ *Cylindrocarpon eichleri* Wollenw., Fus. Autogr. Del.: 461. 1916.

≡ *Fusarium obtususculum* Sacc., Michelia 2: 297. 1881.

≡ *Fusarium oxyxylon* var. *obtususculum* (Sacc.) Cif., Ann. Bot., Roma 16: 221. 1924.

≡ *Cylindrocarpon obtususculum* (Sacc.) U. Braun, Cryptog. Bot. 4: 113. 1993.

≡ *Fusarium eichleri* Bres., Ann. Mycol. 1: 130. 1903.

≡ *Neectria ramulariae* Wollenw., Ann. Mycol. 15: 52. 1917.

≡ *Neectria ramulariae* (Wollenw.) E. Müll., Beltr. Cryptogamenerl. Schweiz 11: 634. 1962.

≡ *Cylindrocarpon magnusianum* Wollenw., Z. Parasitenk. 1: 172. 1928.

**Clade VII**

**Chaetopsina** Rambelli, Atti Accad. Sci. Ist. Bologna, Cl. Sci. Fis., Rendiconti: 5. 1956. MycoBank MB7584.

≡ *Chaetopsinectria* J. Luo & W.Y. Zhuang, Mycologia 102: 979. 2010.

Ascomata perithecial, solitarily, non-stromatic, superficial, obpyriform, with an acute apex, red, becoming dark red in KOH, smooth. Ascii unitunicate, clavate, 8-spored, with a simple apex or an apical ring. Ascospores ellipsoid to fusiform, 1- to 4-septate, hyaline, smooth to striate. Conidiophores erect, setiform, tapering towards acutely rounded apex, mostly flexuous, yellow-
brown, turning red-brown in KOH, fertile in mid region, unbranched, verruculose, thick-walled, base bulbous. Fertile region consisting of irregularly branched dense aggregated conidiogenous cells. Conidiogenous cells ampulliform to lageniform, hyaline, smooth, mononuclear to polyphialidic. Conidia hyaline, smooth, guttulate, subcylindrical, aseptate, apex and base bluntly rounded, base rarely with flattened hilum (adapted from Rambelli 1956 and Luo & Zhuang 2010).

**Type species:** Chaetopsina fulva Rambelli, Atti Accad. Sci. Ist. Bologna, Cl. Sci. Fis. Rendiconti: 5. 1956.

= Nectria chaetopsinae Samuels, Mycotaxon 22: 18. 1985.
= Cosmospora chaetopsinae (Samuels) Rossman & Samuels, Stud. Mycol. 42: 119. 1999.
= Chaetopsinectria chaetopsinae (Samuels) J. Luo & W.Y. Zhuang, Mycologia 102: 979. 2010.

**Descriptions and illustrations:** Rambelli (1956), Samuels (1985), Luo & Zhuang (2010).

**Notes:** Chaetopsinectria, a sexual genus based on Cosmospora chaetopsinae (Samuels 1985), was established by Luo & Zhuang (2010) for a group of fungi having Chaetopsina asexual morphs. We propose that the sexual genus Chaetopsinectria (2010) be suppressed in favour of asexual genus Chaetopsina (1956), which has priority by date and would require no new combinations. The clade representing Chaetopsina (BS ≥ 75 %, PP ≥ 0.95), which includes the type species, C. fulva (ex-type CBS 142.56), is closely related to but separate from the clade representing the genus Volutella. In addition, these two genera do not share any morphological characters.

**Coccinonectria** L. Lombard & Crous, gen. nov. MycoBank MB810176.

**Etymology:** Name refers to the scarlet ascomata produced by these fungi.

Ascomata perithecial, superficial, solitary or aggregated in groups, developing on old sporodochia of volutella-like asexual morphs, subovoid to subglobose, orange to orange-red to carmine red, becoming pink to purple in KOH, initially rough surface due to short, thick-walled setae, with a short papillate ostiole; perithecial wall consists of two regions; inner region composed of thin-walled, flattened, hyaline cells; outer region composed of thick-walled ellipsoid to elongated cells. Setae scattered on surface of the perithecium except at the ostiolar region, hyaline, thick-walled, straight to curved, aseptate, narrowing toward the apex. Ascii uniloculate, clavate, 8-spored, apex simple, truncate with hyaline, thin-walled moniliform paraphyses between the asci. Ascospores narrowly ellipsoid to fusiform, aseptate or medianly septate, slightly constricted at the septum, hyaline, becoming dark yellow with age, finely verrucose. Conidiophores sporodochial, obovate to amber or light russet, with hyaline to lightly coloured aseptate setae. Conidia aseptate, hyaline, guttulate, ellipsoid to fusiform.

**Type species:** Coccinonectria pachysandrlicola (B.O. Dodge) L. Lombard & Crous.

**Notes:** The sexual genus Coccinonectria is established here to accommodate fungal species previously incorrectly treated as members of the genus Pseudonectria (Rossman et al. 1999, Gräfenhan et al. 2011). Coccinonectria is distinguished from Pseudonectria by its orange to scarlet ascomata with short, thick-walled setae extending from the ascomatal surface (Dodge 1944, Rossman et al. 1999). The latter genus is characterised by yellow to greyish yellow-green ascomata with longer setae on the ascomatal surface (Rossman et al. 1999). Phylogenetic inference also shows that the genus Coccinonectria is closely related to the genera Chaetopsina and Volutella, but clearly distinct from the genus Pseudonectria.

**Coccinonectria pachysandrlicola** (B.O. Dodge) L. Lombard & Crous, comb. nov. MycoBank MB810177. **Basionym:** Pseudonectria pachysandrlicola B.O. Dodge, Mycologia 36: 536. 1944.

**Description and illustrations:** Dodge (1944).

**Coccinonectria rusci** (Lechat, Gardiennet & J. Fourn.) L. Lombard & Crous, comb. nov. MycoBank MB810179. **Basionym:** Pseudonectria rusci Lechat et al., Persoonia 32: 297. 2014.

**Description and illustrations:** Crous et al. (2014).

**Note:** Coccinonectria rusci (ex-type CBS 126108) clustered in a monophyletic clade representing the genus Coccinonectria, and therefore a new combination is proposed for this species.

**Pseudonectria** Seaver, Mycologia 1: 48. 1909. MycoBank MB4460. **emend.** L. Lombard & Crous.

= Nectriella Sacc., Michelia 1: 51. 1877.
= Nectriella subgen. Notarisella Sacc., Syll. Fung. 2: 452. 1883.
= Notarisella (Sacc.) Clements & Shear, The genera of Fungi: 280. 1931.

Ascomata perithecial, superficial, solitary, with an inconspicuous basal stroma, globose to pyriform, with a pointed apex, pale yellow to greyish-yellow, not changing in KOH; ascomatal wall smooth, with or without sparse to numerous hyaline to orange periclinal thickening and inconspicuous collarettes. Asci cylindrical to narrowly clavate, 8-spored. Ascospores aseptate, fusiform to ellipsoidal. Conidiophores simple or sporodochial. Simple conidiophores as lateral phialides on somatic hyphae or monochaetal or verticillate, hyaline. Sporodochial conidiophores consist of a stipe and a penicillate arrangement of fertile branches. Conidiogenous apparatus consists of aseptate primary, secondary and rarely tertiary branches with each terminal branch producing 2–4 phialides. Phialides hyaline, cylindrical to allantoid, tapering towards the apex, with obvious periclinal thickening and inconspicuous collarettes. Conidia aseptate, hyaline, fusiform to ellipsoidal. Clamydomo- spores hyaline, globose to subglobose, formed intercalarily in chains (adapted from Rossman et al. 1993, 1999).

**Type species:** Pseudonectria buxi (DC.) Seifert et al., Stud. Mycol. 68: 107. 2011. **Fig. 9.**
= Tubercularia buxi DC., Flora française, Éd. 3 (Paris) 6: 110. 1815.
= Chaetostroma buxi (DC.) Corda, Icon. Fung. 3: 20. 1838.
= Volutella buxi (DC.) Berk., Am. J. Bot. 5: 221. 1888.
= Chaetodochium buxi (DC.) Höhn., Mitt. Bot. Lab. TH Wien 9: 45. 1932.
= Psiloria rosea Berk., The English Flora, Fungi 5-2: 353. 1836.
= Pseudonectria rousseliana (Mont.) Clements & Shear, The genera of Fungi: 280. 1931.
\textbf{Conidiomata} are not observed. \textbf{Conidiophores} simple or sporodochial. Simple conidiophores monochaial or verticillate or as lateral phialides on somatic hyphae; phialides aseptate hyaline, cylindrical to allantoid, 12–35 \( \times \) 2–3 \( \mu \)m. Sporodochial conidiophores without setae, consisting of a stipe and a penicillate arrangement of fertile branches; stipe hyaline, smooth, 0–1-aseptate, 10–25 \( \times \) 2–3 \( \mu \)m. \textbf{Conidiogenous apparatus} 75–95 \( \mu \)m wide, 85–100 \( \mu \)m long; primary branches aseptate, 25–40 \( \times \) 2–4 \( \mu \)m, secondary branches aseptate, 15–20 \( \times \) 2–4 \( \mu \)m, tertiary branches rare, aseptate, 12–15 \( \times \) 2–3 \( \mu \)m, each terminal branch producing 2–4 phialides; phialides hyaline, cylindrical to allantoid, 9–14 \( \times \) 2–4 \( \mu \)m, tapering towards the apex, with obvious periclinal thickening and inconspicuous collarettes. \textbf{Conidia} hyaline, aseptate, fusiform to ellipsoidal, (5–)6.5–7.5(–8) \( \times \) 2–3 \( \mu \)m (av. 7 \( \times \) 3 \( \mu \)m), forming flat domes of pink to salmon slimy masses on the sporodochia. \textbf{Chlamydoconidia} hyaline, globose to subglobose, 35–60 \( \mu \)m diam, formed intercalarily in chains or solitary.

\textbf{Culture characteristics}: Colonies fast growing on MEA, reaching 90 mm in 10 d at 24 °C. Surface white with abundant aerial mycelium, with scattered pink to salmon slimy masses of conidia on sporodochia at the margins. Reverse white.

\textit{Notes}: \textit{Pseudonectria foliicola} can be distinguished from \textit{P. buxi} by the formation of simple conidiophores in the asexual state, something not reported for \textit{P. buxi} (Bezzerra 1963, Rossman \textit{et al.} 1993). Also, no setae were observed surrounding the sporodochia of \textit{P. foliicola}, while setae formation is characteristic of \textit{P. buxi} (Bezzerra 1963, Rossman \textit{et al.} 1993). The conidia of \textit{P. foliicola} are also smaller than those of \textit{P. buxi}, which are 8–12 \( \times \) 2.5–3 \( \mu \)m (Bezzerra 1963).

\textbf{Sarcopodium} Ehrenb. ex Schlecht., Synop. Pl. Crypt. 2: 101. 1824. MycoBank MB97888.

\textit{Sarcopodium} Ehrenb., Syl. Mycol. Berol. 23. 1818.

\textit{Tricholeconium} Corda, Icon. Fung. 1: 17. 1837.

\textit{Cyphina} Sacc., Syl. Fung. 3: 623. 1884.

\textit{Periolopsis} Maire, Ann. Mycol. 11: 357. 1913.

\textit{Actinostilbe} Petch, Ann. Roy. Bot. Gard. (Peradeniya) 3: 9. 327. 1925.

\textit{Kutilakeso} Subram., J. Indian Bot. Soc. 35: 478. 1956.

\textit{Kutilakesopsis} Agnihoth. & Barua, J. Indian Bot. Soc. 36: 308. 1957.

\textit{Lanatonectria} Samuels & Rossman, Stud. Mycol. 42: 137. 1999.

Ascomata perithecial, solitary or in groups, superficial on a minute stroma, on an erumpent, previously conidial stroma, or at the base of a synnema, subglobose to broadly obpyriform, red, turning dark red in KOH, non-papillate or with a minute papilla, with hyaline to yellow hyphal hairs; hairs smooth, spinulose, hooked or straight, septate, thin-walled, arising from the surface of the ascomatal wall and forming around the ascomatal base, sometimes forming a tormentum on the ascomatal surface. \textbf{Asci} clavate to fusiform, 8-spored, apex simple or with a ring. \textbf{Ascospores} ellipsoid to fusiform, 1-septate, hyaline to pale yellow-brown, striate. \textbf{Conidiomata} sporodochial, cupulate to synnematal, superficial. \textbf{Setae} simple, septate, rarely branched, smooth or verruculose, straight or cirrate, brown. \textit{Conidiophores} macronematous, irregularly, verticillate, or penicillately branched, hyaline, smooth. \textit{Phialides} hyaline, smooth, cylindrical or doliform to reniform. \textit{Conidia} aggregated in slimy masses, straight, cylindrical to ellipsoid, hyaline,

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{fig9.png}
\caption{\textit{Pseudonectria buxi} (CBS 324.53). A. Ascomata on the leaf of \textit{Buxus sempervirens}. B–C. Setae on ascomatal surface. D. Asci with ascospores. E–F. Sporodochial conidiophores. G. Conidiogenous apparatus with cylindrical to allantoid phialides. H. Conidia. Scale bars: A = 500 \( \mu \)m; B = 50 \( \mu \)m (apply to F); C = 10 \( \mu \)m (apply to D, G–H); E = 100 \( \mu \)m.}
\end{figure}
0–1-septate (adapted from Sutton 1981 and Rossman et al. 1999).

Type species: Sarcopodium circinatum Ehrenb. ex Schlecht., Synop. Pl. Crypt. 2: 101. 1824.≡ Sarcopodium circinatum Ehrenb., Syl. Mycol. Berol. 12 & 23. 1818.≡ Thelephora circinata (Ehrenb.) Fr., Elenchus Fung. 1: 226. 1828.≡ Corticium circinatum (Ehrenb.) Fr., Epi. Syst. Mycol.: 556. 1838.≡ Hymenochaete circinata (Ehrenb.) Lév., Ann. Sci. Nat., Bot. 5: 133. 1846.

Descriptions and illustrations: Sutton (1981), Rossman et al. (1999).

Notes: Representatives of the genus Sarcopodium formed a monophyletic clade (BS ≥ 75 %, PP ≥ 0.95), closely related to the genus Pseudonectria. Rossman et al. (1999) established the sexual genus Lanatonectria, based on L. flocculenta, for necrotrophic fungi with Actinostilbe asexual morphs. Later, Rossman et al. (2013) proposed that the genus name Lanatonectria be suppressed in favour of Actinostilbe based on priority, as per the ICN (McNeill et al. 2012). However, Sutton (1981) had already synonymised Actinostilbe under the asexual morph genus Sarcopodium. Furthermore, Rossman et al. (2013) synonymised L. flocculenta (= A. macalpinei) under A. flocculenta. Actinostilbe flocculenta should be regarded as a synonym of S. macalpinei as proposed by Sutton (1981). Phylogenetic inference in this study clearly supports the findings of Sutton (1981). Therefore, we regard Actinostilbe as a synonym of Sarcopodium and introduce several new combinations below.

Sarcopodium flavolanatum (Berk. & Broome) L. Lombard & Crous, comb. nov. MycoBank MB810181. Basionym: Nectria flavolanata Berk. & Broome, J. Linn. Soc., Bot. 14: 114. 1873.≡ Actinostilbe flavolanata (Berk. & Broome) Rossman, Samuels & Seifert, IMA Fungus 4: 46. 2013.≡ Nectria radians Penz. & Sacc., Malpighia 11: 510. 1897.≡ Nectria ijiwodensis Penz. & Sacc., Malpighia 11: 512. 1897.≡ Calonectria javanica Penz. & Sacc., Malpighia 11: 508. 1897.≡ Calonectria sulphurella Starbäck, Bih. Kungl. Svenska Vetenskapakad. Handl. 25: 30. 1899.≡ Sphaerostilbe ochracea Pat., in Duss, Enum. Champ. Guadeloupe: 79. 1903.

Sarcopodium mammiforme (Chardón) L. Lombard & Crous, comb. nov. MycoBank MB810182. Basionym: Sphaerostilbe mammiformis Chardón, Sci. Surv. Porto Rico & Virgin Islands 8: 46. 1926.
≡ Nectria mammiformis (Chardón) Samuels, Caldasia 13: 393. 1982.
≡ Lanatonectria mammiformis (Chardón) Samuels & Rossman, Stud. Mycol. 42: 139. 1999.
≡ Actinostilbe mammiformis (Cif.) Seifert & Samuels, Stud. Mycol. 42: 139. 1999.
≡ Stromatographium mammiforme Cif., Sydowia 8: 264. 1954.

≡ Sarcopodium oblongisporum (Y. Nong & W.Y. Zhuang) L. Lombard & Crous, comb. nov. MycoBank MB810183.
Basionym: Lanatonectria oblongispora Y. Nong & W.Y. Zhuang, Fungal Diversity 19: 98. 2005.
≡ Actinostilbe oblongispora (Y. Nong & W.Y. Zhuang) Rossman et al., IMA Fungus 4: 46. 2013.

≡ Sarcopodium raripilum (Penz. & Sacc.) L. Lombard & Crous, comb. nov. MycoBank MB810184.
Basionym: Nectria raripila Penz. & Sacc., Malpighia 15: 228. 1901.
≡ Lanatonectria raripila (Penz. & Sacc.) Samuels & Rossman, Stud. Mycol. 42: 140. 1999.

≡ Volutella ciliata (Alb. & Schw.: Fr.) Fr., Syst. Mycol. 3: 466. 1832.
Type species: Volutella ciliata (Alb. & Schw.: Fr.) Fr., Syst. Mycol. 3: 466. 1832. Fig. 12.

Descriptions and illustrations: Gräfenhan et al. (2011), Luo & Zhuang (2012).

Notes: Representatives of the genus Volutella formed a monophyletic clade (BS ≥ 75 %, PP ≥ 0.95), distinct from the clades representing Coccinonectria and Pseudonectria. Volutella shares several morphological characters of the asexual morph with these genera.

Volutella asiatica (J. Luo, X.M. Zhang & W.Y. Zhuang) L. Lombard & Crous, comb. nov. MycoBank MB810185.
Basionym: Volutellonectria asiatica J. Luo, X.M. Zhang & W.Y. Zhuang, Phytotaxa 44: 5. 2012.

Notes: Luo & Zhuang (2012) established the sexual genus Volutellonectria (Vo.), with Vo. consors as type, and indicated that Volutella (V.) minima represents the asexual morph. However, Gräfenhan et al. (2011) synonymised V. minima under Vo. consors. Additionally, Luo & Zhuang (2012) introduced two more species in the genus Volutellonectria, namely Vo. asiatica as a new species, and Vo. ciliata (= V. ciliata) as a new combination. Given the obscurity of Volutellonectria and the number of name changes that would be required if the use of this name were perpetuated, we propose that the sexual genus Volutellonectria be suppressed in favour of the asexual genus Volutella, which also has priority by date. Therefore only the single new combination proposed in this study is required.

Clade VIII

Atractium Link: Fr., Mag. Ges. naturf. Freunde, Berlin 3: 10. 1809: Fries, Syst. Mycol. 1: xli. 1821. MycoBank MB7291.
Ascomatal state unknown. Conidiophores aggregated into sporodochia or synnemata, non-stromatic. Synnemata determinate, pale brown, composed of a stipe of parallel hyphae and a divergent capitulum of conidiophores giving rise to a slimy conidial mass. Conidiophore branching once or twice monochasial, 2-level verticillate, monoverticillate or irregularly biverticillate. Conidiogenous cells monophialidic, hyaline, subulate with conspicuous periclinal thickening. Conidia (0–1)–5-septate, clavate, obovoid or gently curved, rarely ellipsoidal, with a rounded apical cell, and somewhat conical basal cell, lacking a differentiated foot, forming yellow to orange masses (adapted from Gräfenhan et al. 2011).

Type species: Atractium stilbaster Link, Mag. Ges. naturf. Freunde, Berline 3: 10. 1809.
≡ Fusarium stilbaster (Link) Link, Caroli Linné, Sp. pl. ex. pl. Rite cogn. Gen. Relat. 6: 106. 1825.
≡ Stilbella fusca (Sacc.) Seifert, Stud. Mycol. 27: 77. 1985.
≡ Didymostilbe capillacea Bres. & Sacc., Annls Mycol. 1: 28. 1903.
≡ Didymostilbe obovoidea Matsush. Icon. Microfung. Matsush. Lect.: 60. 1975.

Description and illustrations: Gräfenhan et al. (2011).

Note: Representatives of the genus Atractium formed a monophyletic clade (BS ≥ 75 %, PP ≥ 0.95), closely related to the genera Calostilbe and Ophionectria.

Calostilbe Sacc. & Syd., Syll. Fung. 16: 591. 1902. MycoBank MB758.
≡ Nectria subgen. Phaeonectria Sacc., Syll. Fung. 11: 359. 1895.
≡ Phaeonectria (Sacc.) Sacc. & Trotter, Syll. Fung. 22: 485. 1913.
≡ Calostilbella Höhn., Ber. Deutsch. Bot. Ges. 37: 160. 1919.

Stromata well-developed, originating from a central point, pseudoparenchymatous below the ascomata, giving rise to synnemata, ascomata forming at the base and on rhizoids that arise from the stromata, growing under bark and breaking through at points. Ascomata perithecial, superficial, densely aggregated, ovoid, not collapsing or collapsing laterally when dry, orange, turning sienna in KOH, apical region with acute papilla. Ascomata surface prosenchymatous, walls thickened. Asci clavate, apex simple, base pointed to pedicellate. Ascospores fusiform to ellipsoidal, 1-septate, slightly constricted or not, yellow-brown, coarsely striate, appearing as longitudinal furrows. Asexual morph synnematal, arising throughout the stromata. Hyphae of the synnemata parallel, branched, with the ends of the hyphae at the surface with small “cork screws”, giving the surface a granular-crystalline aspect. Phialides formed in a well-defined, hemispherical cluster, with a swollen, often slightly flared apex at the tip and cylindrical base. Sterile elements interspersed with phialides, straight, smooth, thin-walled, septate. Conidia ellipsoidal, 1-septate, yellow-brown, thick-walled in the centre becoming hyaline and thin-walled at the ends, held in a solitary, brown drop of liquid at the apex (adapted from Rossman et al. 1999).

Type species: Calostilbe striispora (Ellis & Everh.) Seaver, Mycologia 20: 248. 1928.
Antipodium (Pirozynski 1974), known as A. spectabile. Rossman (1977) re-evaluated the generic status of Ophionectria and retained only the type species. Later, Rossman (1983) added O. magniverrucosa to the genus. A second species isolated from Arechae catechu, A. arechae, was added to the genus Antipodium by Matsushima (1980). However, based on the description and illustrations provided, this species should be considered a member of the genus Trichothecium (Summerbell et al. 2011). Since the generic name Ophionectria (1878) has priority over the generic name Antipodium (1974), we recommend that the generic name Ophionectria be protected against Antipodium.

Clade IX

Albonecridia Rossman & Samuels, Stud. Mycol. 42: 105. 1999. MycoBank MB27953.

Ascomata perithecial, solitary or gregarious on a sparse to well-developed stroma, superficial, globose to subglobose to ellipsoidal or ovoid to obovoid, white to pale yellow to pale ochraceous, not changing colour in KOH, warty, with or without a small pointed papilla. Ascii narrowly clavate or broadly clavate to ellipsoidal, 4–8-spored. Ascospores ellipsoidal to long-ellipsoidal or fusiform to long-fusiform, multiseptate, hyaline to yellow-brown, smooth to striate. Conidiophores monopodial, polyphialidic or sporodochial. Microconidia variable in shape, 0–1-septate, hyaline, smooth, with or without a flattened basal papilla, or with or without a poorly developed foot cell. Macroconidia cylindrical to broadly fusiform or long fusiform to clavate, multiseptate, curved, with curved, pointed tip and foot-cell, or distinctly beaked at both ends (adapted from Gerlach & Nirenberg 1982 and Rossman et al. 1999).

Type species: Albonecridia rigidiuscula (Berk. & Broome) Rossman & Samuels, Stud. Mycol. 42: 105. 1999. MycoBank MB27953.

Notes: The sexual genus Albonecridia was introduced by Rossman et al. (1999) to accommodate species with white to pale yellow ascomata associated with Fusarium asexual morphs. Representatives of this genus formed a monophyletic clade (BS = 100 %, PP = 1.0) closely related but separate from the clades representing Cyanonectria, Geejeyessia and Fusarium.

Bisifusarium L. Lombard, Crous & W. Gams, gen. nov. MycoBank MB810226. Fig. 13.
Etyymology: Name refers to the 2-celled macroconidia characteristically formed by these fungi.

Ascomatal state unknown. Conidiophores macronematous, lateral phialidic pegs, simple or sporodochial. Later phialidic pegs arising from superficial or submerged hyphae. Simple conidiophores monophaelial, rarely polyphialidic, cylindrical and slightly tapering towards the apex, or flask-shaped, solitary or aggregated when forming terminally or laterally on hyphae. Sporodochia pionnotal or hemispherical. Pionnotal sporodochia poorly developed, consisting of densely arranged phialides or short supporting cells with whorls of phialides; whorls arising laterally from hyphae or from irregularly branched conidiophores. Hemispherical sporodochia consisting of a core of angular, uniformly thin-walled, hyaline cells bearing cylindrical phialide-subtending cells or monophialides. Microconidia 0(–1)-septate, ellipsoidal and straight or allantoid, broadly lunate to reniform or curved and tapering at both ends, mostly formed by monophaelial conidiophores and lateral phialidic pegs as inconspicuous heads. Macroconidia (0–)1–2(–3)-septate, curved to lunate, with a distal end slightly more bent than the proximal end or with both ends equally bent, both ends tapering, the proximal end typically slightly pedicellate, mostly formed as masses on poorly or well-developed sporodochia. Chlamydospores, if present, globose to subglobose to ellipsoidal, solitary or in chains, sometimes aggregated into sclerotia (adapted from Schroers et al. 2009).

Type species: Bisifusarium dimerum (Penz.) L. Lombard & Crous.

Notes: The genus Bisifusarium is established here to accommodate fusarium-like species previously classified in the genus Fusarium. Species of Bisifusarium can be distinguished from species in Fusarium by their short, (0–)1–2(–3)-septate macroconidia and the formation of lateral phialidic pegs arising from the hyphae (Gerlach & Nirenberg 1982, Schroers et al. 2009), rarely seen in the genus Fusarium. Past phylogenetic studies (Schroers et al. 2009, 'Donnell et al. 2013) showed that species of Bisifusarium (as the Fusarium dimerum species group; Schroers et al. 2009) formed a well-supported monophyletic clade, closely related but separate to “the Fusarium terminal clade” (Geiser et al. 2013). Phylogenetic inference in this study further supports this observation, with representatives of Bisifusarium forming a well-supported clade (BS = 100 %, PP = 1.0) closely related but separate from the clade representing the genus Fusarium.

Bisifusarium biseptatum (Schroers, Summerbell & O’Donnell) L. Lombard & Crous, comb. nov. MycoBank MB810227.

Basionym: Fusarium biseptatum Schroers, Summerbell & O’Donnell, Mycologia 101: 59. 2009. [non Fusarium biseptatum Sawada, Special Publ. Coll. Agric. Natl. Taiwan Univ. 8: 228. 1959, nom. inval.]

Description and illustrations: Schroers et al. (2009).

Bisifusarium delphinoides (Schroers, Summerbell, O’Donnell & Lampr.) L. Lombard & Crous, comb. nov. MycoBank MB810228.
Basionym: Fusarium delphinoides Schroers, Summerbell, O'Donnell & Lampr., Mycologia 101: 57. 2009.

Description and illustrations: Schroers et al. (2009).

Bisifusarium dimerum (Penz.) L. Lombard & Crous, comb. nov. MycoBank MB810229.

Basionym: Fusarium dimerum Penz., Michelia 2: 484. 1882.
- Fusarium pusillum Wollenw., F. Autogr. Del. 2: 550. 1924.
- Fusarium aquaeductuum var. dimerum (Penz.) Raillo, Fungi of the genus Fusarium: 279. 1950.
- Microdochium dimerum (Penz.) Arx, Trans. Brit. Mycol. Soc. 83: 374. 1984.

Bisifusarium domesticum (Fr.) L. Lombard & Crous, comb. nov. MycoBank MB810230.

Basionym: Trichothecium domesticum Fr., Syst. Mycol. 3: 427. 1832.
- Fusarium domesticum (Fr.) Bachm., LWT – Food Sci. Tech. 38: 405. 2005.

Bisifusarium lunatum (Ellis & Everh.) L. Lombard & Crous, comb. nov. MycoBank MB810231.

Basionym: Gloeosporium lunatum Ellis & Everh., Proc. Acad. Nat. Sci. Philadelphia. 43: 82. 1891.
- Fusarium lunatum (Ellis & Everh.) Arx, Verh. Kon. Akad. Wetensch., Afd. Natuurk. 51: 101. 1957.
- Microdochium lunatum (Ellis & Everh.) Arx, Trans. Brit. Mycol. Soc. 83: 374. 1984.
- Fusarium dimerum var. violaceum Wollenw., F. Autogr. Del. 3: 854. 1930.

Bisifusarium nectrioides (Wollenw.) L. Lombard & Crous, comb. et stat. nov. MycoBank MB810232.

Basionym: Fusarium dimerum var. nectrioides Wollenw., F. Autogr. Del. 3: 855. 1930.
- Fusarium nectrioides (Wollenw.) Schroers, Summerbell & O'Donnell, Mycologia 101: 59. 2009.

Bisifusarium penzigii (Schroers, Summerbell & O'Donnell) L. Lombard & Crous, comb. nov. MycoBank MB810233.

Basionym: Fusarium penzigii Schroers, Summerbell & O'Donnell, Mycologia 101: 61. 2009.

Cyanonectria Samuels & Chaverri, Mycol. Progress 8: 56. 2009. MycoBank MB537057.

Ascomata perithecial, solitary or aggregated into groups, non-stromatic or on a thin stroma, superficial, globose to subglobose to pyriform, white, yellow, orange, red, bluish purple, bluish black or black, changing colour or not changing colour in KOH, slightly rugose to tuberculate to warted. Ascii narrowly clavate to clavate to cylindrical, 8-spored, with or without an apical ring. Ascospores (0–1)–3–7–(8)–septate, mostly ellipsoidal, hyaline or pale yellow-brown. Conidiophores mono- or polyphialidic or sporodochial. Macroconidia (1–)–5–7–(8)–septate, long-fusiform, with gently curving ends, pedicellate foot cell, with a hooked apical cell. Chlamydospores formed from cells of macroconidia, subglobose, not formed by hyphae.

Type species: Cyanonectria cyanostoma (Sacc. & Flageolet) Samuels & Chaverri, Mycol. Progress 8: 56. 2009.
- Nectria cyanostoma Sacc. & Flageolet, Atti Congr. Bot. Palermo: 53. 1902.
- Fusarium cyanostomum (Sacc. & Flageolet) O'Donnell & Geiser, Phytopathology 103: 404. 2013.

Notes: Samuels et al. (2009) introduced the sexual genus Cyanonectria, based on C. cyanostoma, to accommodate the sexual morphs of an unnamed Fusarium sp., characterised by bicoloured perithecium. Later, Schroers et al. (2011) synonymised F. buxicola under C. buxi, recognising that the genus Cyanonectria formed a strongly supported clade distinct from other sexual genera associated with Fusarium asexual morphs. Phylogenetic inference in this study supports the findings of Samuels et al. (2009) and Schroers et al. (2011) with representatives of Cyanonectria forming a well-supported monophyletic clade (BS = 100 %, PP = 1.0).
Notes: The sexual genus *Geejayessia* was introduced to accommodate fusarium-like species characterised by their broadly ampulliform to broadly ellipsoidal, multicoloured ascomata (*Schooers et al.* 2011), and represents a well-supported monophyletic clade (BS = 100 %, PP = 1.0) distinct from the *Fusarium* clade.

**Type species: Neocosmospora vasinfecta** E.F. Sm., U.S.D.A. Div. Pathol. Bull. 17: 45. 1899. 
≡ Fusarium neocosmosporioides O'Donnell & Geiser, Phytopathology 103: 405. 2013. 
≡ Neocosmospora vasinfecta var. trachefilia E.F. Sm., U.S.D.A. Div. Veg. Pathol. Bull. 17: 45. 1899. 
≡ Neocosmospora vasinfecta var. nivea E.F. Sm., U.S.D.A. Div. Veg. Pathol. Bull. 17: 45. 1899. 
≡ Pseudonectria ornata Bat. & Maia, Anais Soc. Biol. Pernambuco 13: 74. 1955. 
≡ Neocosmospora vasinfecta var. major Rama Rao, Mycospathol. Mycopathol. Appl. 21: 218. 1963. 
≡ Neocosmospora vasinfecta var. conidiifera Kamyschko, Novi Sist. Nizsh. Rast. 2: 115. 1965. 
≡ Neocosmospora ornamentata M.A.F. Barbaso, Garcia de Orta, sér. Est. Argon.: 17. 1965. 
≡ Neocosmospora vasinfecta var. africana (Anx) P.F. Cannon & D. Hawksw., Trans. Brit. Mycol. Soc. 82: 676. 1984.

**Description and illustrations:** Rossman *et al.* (1999), Nalim *et al.* (2011).

Notes: Three generic names, *Haematonecctia* (1999), *Lachnidium* (1891) and *Neocosmospora* (1899) could be applied to this group of fungi (*Rossman et al.* 1999, Summerbell & Schooers 2002). However, the generic name *Lachnidium* is based on a *nomen confundum* (see Madelin 1966 and Kendrick 1974), and can therefore not be used. The genus *Neocosmospora* includes fusarium-like spp. also associated with the sexual genus *Haematonecctia*. *Rossman et al.* (1999) could distinguish these genera based on ascomatal morphology and the reduced asexual morph of *Neocosmospora*. *O'Donnell* (1996) argued that the asexual morphs of *Neocosmospora* are microconidial *Fusarium* spp. that lost the ability to produce macroconidia and sepatate ascosporae. Recent phylogenetetic studies (*Gräfenhan et al.* 2011, *Nalim et al.* 2011, *O'Donnell et al.* 2013), which included representatives of both genera, showed that these genera are congeneric. As the generic name *Neocosmospora* (1899) is older than the generic name...
Haematonectria (1999), the name Neocosmospora takes priority for these fungi. Further support is provided by Nonali et al. (2011) whom stabilised the name Neocrataeococcus through epitypification and provided a new combination for this species under the genus name Neocosmospora (as Neo. haematococcus). Phylogenetic inference in this study supported these findings with the clade representing the sexual genus Neocosmospora being well-supported (BS ≥ 75 %, PP ≥ 0.95). However, as with the genus Fusarium, a monographic study is required to identify all the species belonging to this genus, and therefore only a few new combinations are introduced at this time. The ex-type strain of Haematonectria ramosa (CBS 509.63), the type species of the genus Haematonectria (Batista & Maia 1955) clustered within the Neocosmospora clade, and therefore this genus is regarded as a synonym of Neocosmospora and a new combination is provided. Two isolates listed in the CBS collection as \textit{F. ventricosum} (CBS 320.73 and CBS 101018) also clustered within this clade, separate from other known species, and are therefore described here as new.

**Neocosmospora ambrosia** (Gadd & Loos) L. Lombard & Crous, 
**comb. nov.** MycoBank MB810957.  
**Basionym:** Monacrospium ambrosium Gadd & Loos, Trans. Brit. Mycol. Soc. 30: 13. 1947.  
≡ Fusarium ambrosium (Gadd & Loos) Agnihotri & Nirenberg, Stud. Mycol. 32: 98. 1990.  
≡ Dactylella ambrosia (Gadd & Loos) K.Q. Zhang, X.Z. Liu & L. Cao, Mycosistema 7: 112. 1995.  
≡ Fusarium bugniicortii Brayford, Trans. Brit. Mycol. Soc. 89: 350. 1987.

**Neocosmospora falciformis** (Carrión) L. Lombard & Crous, 
**comb. nov.** MycoBank MB810958.  
**Basionym:** Cephalosporium falciforme Carrión, Mycologia 43: 523. 1951.  
≡ Acremonium falciforme (Carrión) W. Gams, Cephalosporium-artige Schimmelpilze: 139. 1971.  
≡ Fusarium falciforme (Carrión) Summerb. & Schroers, J. Clin. Microbiol. 40: 2872. 2002.

**Neocosmospora illudens** (Berk.) L. Lombard & Crous, 
**comb. nov.** MycoBank MB810959.  
**Basionym:** Nectria illudens Berk., in Hooker, Botany of the Antarctic Voyage II. Flora of New Zealand 7: 203. 1855.  
≡ Cucurbitaria illudens (Berk.) Kuntze, Rev. Gen. Plant. 3: 461. 1898.  
≡ Haematonectria illudens (Berk.) Samuels & Nirenberg, Stud. Mycol. 42: 136. 1999.  
≡ Fusarium illudens C. Booth, The genus Fusarium: 53. 1971.

**Neocosmospora ipomoeae** (Halst.) L. Lombard & Crous, 
**comb. nov.** MycoBank MB810960.  
**Basionym:** Nectria ipomoeae Halst., Rep. New Jersey Agric. Exp. Sta. 12: 281. 1891.  
≡ Cucurbitaria ipomoeae (Halst.) Kuntze, Rev. Gen. Plant. 3: 461. 1898.  
≡ Cronartium ipomoeae (Halst.) Seaver, N. Amer. Flora 3: 22. 1910.  
≡ Hyomyces ipomoeae (Halst.) Wollenw., Phytopathology 3: 34. 1913.  
≡ Haematonectria ipomoeae (Halst.) Samuels & Nirenberg, Stud. Mycol. 42: 136. 1999.  
≡ Fusarium javanicum Koord., Verh. Kon. Ned. Akad. Wetensch., Afd. Natuurk. 13: 247. 1907.  
≡ Hypomyces solani f. cucurbitae W.C. Snyder & H.N. Hansen, Amer. J. Bot. 28: 741. 1941.

**Neocosmospora monilifera** (Berk. & Broome) L. Lombard & Crous, 
**comb. nov.** MycoBank MB810961.  
**Basionym:** Nectria monilifera Berk. & Broome, J. Linn. Soc., Bot. 14: 114. 1875.  
≡ Nectria monilifera (Berk. & Broome) Sacc., Michelia 1: 279. 1878.  
≡ Dialonectria monilifera (Berk. & Broome) Cooke, Grevillea 12: 110. 1884.  
≡ Neoskoecia monilifera (Berk. & Broome) Höhn., Ann. Mycol. 8: 467. 1910.  
≡ Haematonectria monilifera (Berk. & Broome) Samuels & Rossman, Stud. Mycol. 42: 137. 1999.

**Neocosmospora phaseoli** (Burk.) L. Lombard & Crous, 
**comb. nov.** MycoBank MB810962.  
**Basionym:** Fusarium martii f. phaseoli Burk., Mem. Cornell Univ. Agric. Exp. Sta. 26: 1007. 1919.  
≡ Fusarium solani f. phaseoli (Burk.) W.C. Snyder & H.N. Hansen, Amer. J. Bot. 28: 740. 1941.  
≡ Fusarium phaseoli (Burk.) T. Aoki & O’Donnell, Mycologia 95: 671. 2003.

**Neocosmospora plagiarthi** (Dingley) L. Lombard & Crous, 
**comb. nov.** MycoBank MB810963.  
**Basionym:** Nectria plagiarthi Dingley, Trans. Roy. Soc. New Zealand 79: 196. 1951.  
≡ Fusarium plagiarthi (Dingley) O’Donnell & Geiser, Phytopathology 103: 404. 2013.

**Neocosmospora ramosa** (Bat. & H. Maia) L. Lombard & Crous, 
**comb. nov.** MycoBank MB810242.  
**Basionym:** Hyalofoorea ramosa Bat. & H. Maia, Anais Soc. Biol. Pernambuco 13: 155. 1955.

**Neocosmospora rubicola** L. Lombard & Crous, 
**sp. nov.** MycoBank MB810243. Fig. 14.

**Etyymology:** Name derived from the plant host Rubus idaeus, from which it was collected.

Ascomatal state not observed. Conidiophores mononematous, simple, unbranched or aggregated into sporodochia. Mononematous conidiophores 13–129 μm long, 3–7 μm at the base, hyaline, aseptate or septate, terminating in a single phialide or a penicillate or verticillate arrangement of 2–4 phialides; single phialides 17–60 × 3–5 μm, cylindrical, tapering towards the apex, with periclinal thickening and slightly flared collarette; penicillate or verticillate phialides, 13–43 × 3–4 μm, cylindrical to allantoid, tapering towards the apex, with periclinal thickening and slightly flared collarette. Sporodochial conidiophores irregularly branched, sometimes slightly stipitate; sporodochial phialides cylindrical to allantoid, tapering towards the apex, 11–25 × 3–4 μm, with periclinal thickening, with or without slightly flared collarette. Microconidia mostly produced by mononematous conidiophores, 0–1(–2)-septate; 0-septate microconidia ellipsoidal to fusiform or obvoid, (8–)9–13–19 × (2–)3–4(–5) μm (av. 11 × 4 μm); 1-septate microconidia, ellipsoidal to fusiform, straight to slightly curved, apex acutely rounded, base sometimes flattened (13–)15–20(–22) × (3–)4–6 μm (av. 18 × 5 μm); 2-septate microconidia rarely formed, ellipsoidal to fusiform, straight to slightly curved, 20–22(–24) × 4–6 μm (av. 22 × 5 μm). Macroconidia 3–5-septate, cylindrical, straight or curving at both ends, beaked at both ends: 3-septate macroconidia (27–)32–44(–47) × 4–6 μm (av. 38 × 5 μm); 4-septate macroconidia (35–)38–48(–53) × 4–6 μm (av. 43 × 5 μm); 5-septate macroconidia (44–)45–49(–51) × 5–6 μm (av. 47 × 5 μm). Chlamydospores not observed.

**Culture characteristics:** Colony on PDA reaching 35–40 mm after 7 d at 24 °C, forming abundant white to pale luteous aerial...
mycelium, arranged in concentric rings, richly sporulating on the aerial mycelium; reverse concolorous. On SNA with sterile carnation leaf pieces, aerial mycelium absent, mononematous conidiophores arising on the surface of the agar; white sporodochia formed abundantly on the surface of the carnation leaf pieces.

Materials examined: Italy, on Rubus idaeus, Jun. 1998, A. Zazzerini (holotype CBS H-21949, culture ex-type CBS 101018); Sudan, isolated from soil, Feb. 1973, M.M. Musa, culture CBS 320.73 = ATCC 24395 = IMI 131652 = NRRL 22107 = NRRL 22122.

Notes: Neocosmospora rubicola is described here as a new species in the genus Neocosmospora. Sequence comparisons on the FUSARIUM-ID (http://isolate.fusariumdb.org; O'Donnell et al. 2010) and Fusarium MLST (http://www.cbs.knaw.nl/fusarium; O'Donnell et al. 2012) databases were inconclusive, identifying both isolates (CBS 101018 & CBS 320.73) as part of the F. solani complex only.

Neocosmospora solani (Mart.) L. Lombard & Crous, comb. nov. MycoBank MB810964.

Basionym: Fusisporium solani Mart., Die Kartoffel-Epidemie der letzten Jahre oder die Stockfäule und Räude der Kartoffeln: 20. 1842.

≡ Fusarium solani (Mart.) Sacc. Michelia 2: 296. 1881.
≡ Fusarium martii Appel & Wollwe. Arb. Kaiserl. Biol. Anst. Ld-u. Forstw. 8: 83. 1910.
≡ Fusarium striatum Sherb., Mem. Cornell Univ. Agric. Exp. Sta. 6: 255. 1915. (See Index Fungorum (www.indexfungorum.org) and MycoBank (www.mycobank.org) for more synonyms).

Note: Nalim et al. (2011) concluded that Neocosmospora solani (= F. solani) is not congeneric with Neo. haematococca (= Haematonectria haematococca) and therefore a new combination is provided here.

Neocosmospora termitum (Höhn.) L. Lombard & Crous, comb. nov. MycoBank MB810965.

Basionym: Neosko Fitzgeraldia termitum Höhn., Sitzungsber. Akad. Wiss. Wien, Math.-Naturwiss. Kl. 117: 998. 1908.
≡ Haematonectria termitum (Höhn.) Samuels & Rossman, Stud. Mycol. 42: 137. 1999.

Neocosmospora tucumaniae (T. Aoki, O'Donnell, Yos. Homma & Lattanzi) L. Lombard & Crous, comb. nov. MycoBank MB810966.

Basionym: Fusarium tucumaniae T. Aoki, O'Donnell, Yos. Homma & Lattanzi, Mycologia 95: 664. 2003.

Neocosmospora virguliformis (O'Donnell & T. Aoki) L. Lombard & Crous, comb. nov. MycoBank MB810967.

Basionym: Fusarium virguliforme O'Donnell & T. Aoki, Mycologia 95: 667. 2003.
**Rectifusarium** L. Lombard, Crous & W. Gams, *gen. nov.* MycoBank MB810252.

*Etyymology:* Name refers to the erect, acremonium-like conidiophores characteristic of these fungi.

Ascomata perithelial, aggregated in groups, dark red, smooth-walled, globose to subglobose, with a papillate ostiolar region, ringed by a short collar of hyphal tips, smooth. *Asci* clavate, 8-spored, with a rounded apex containing a refractive apical ring. Ascospores ellipsoidal, 1-septate, constricted at the septum, verrucose, light brown. *Conidiophores* simple, mononematous, straight to flexuous, hyaline, septate, unbranched or rarely branched, terminating in a single phialide. *Phialides* cylindrical, tapering towards the apex, with periclinal thickening and flared collarettes. Sporodochia not formed. *Microconidia* rare, ellipsoidal to fusiform, 0–1–septate, hyaline, verruculose, globose to subglobose, (22–28 × 6–3 μm) (av. 14 × 3 μm). Macroconidia (1–)3–septate, straight or slightly curved, fusiform to ellipsoidal, (22–)25–31(–33) × 5–7 μm (av. 28 × 6 μm), with rounded apex and flattened basal cell. *Chlamydospores* hyaline, forming laterally or terminally, globose to subglobose (adapted from Gerlach & Nirenberg 1982).

**Type species:** *Rectifusarium ventricosum* (Appel & Wollenw.) L. Lombard & Crous.

*Notes:* The genus *Rectifusarium* is established here to include the fusarium-like species previously treated as *F. ventricosum*. Wollenweber (1913) established the section *Ventricosum* to accommodate *F. ventricosum*, recognising this *Fusarium* sp. as unique in the genus in having no sporodochia. Phylogenetic inference in this study showed that representatives of this group of fungi formed a distinct well-supported clade (BS = 100 %, PP = 1.0), basal to the other clades included in Clade IX.

**Rectifusarium robinianum** L. Lombard & Crous, *sp. nov.* MycoBank MB810258. Fig. 15.

*Etyymology:* Name derived from the plant host *Robinia pseudoacacia*, from which it was isolated.

Ascomata perithelial, aggregated in groups, dark red, smooth-walled, globose to subglobose, with a papillate ostiolar region, ringed by a short collar of hyphal tips, smooth. *Asci* clavate, 8-spored, with a rounded apex containing a refractive apical ring. Ascospores ellipsoidal, 1-septate, constricted at the septum, verrucose, light brown. *Conidiophores* simple, mononematous, straight to flexuous, hyaline, septate, unbranched or rarely branched, terminating in a single phialide. *Phialides* cylindrical, tapering towards the apex, with periclinal thickening and flared collarettes. Sporodochia not formed. *Microconidia* rare, ellipsoidal to fusiform, 0–1–septate, hyaline, verruculose, globose to subglobose, 6–10 μm diam, forming laterally or terminally.

**Culture characteristics:** Colony on PDA reaching 90 mm after 7 d at 24 °C, forming abundant white to pale luteous aerial mycelium, richly sporulating on the aerial mycelium; reverse concolorous.

Materials examined: **Germany,** Köln, on twig of *Robinia pseudoacacia*, May 1991, U. Kuchenbaecker (holotype CBS H-21948, culture ex-type CBS 430.91 = NRRL 25729); Berlin, from *Solanum tuberosum*, Dec. 1985, H. Nirenberg, culture CBS 830.85 = BBA 64246 = NRRL 13953.

**Note:** *Rectifusarium robinianum* can be distinguished from *R. ventricosum* by its smaller macroconidia and rarely branching acremonium-like conidiophores.

**Rectifusarium ventricosum** (Appel & Wollenw.) L. Lombard & Crous, *comb. nov.* MycoBank MB810253. Fig. 16.

*Basionym:* *Fusarium ventricosum* Appel & Wollenw., *Phytopathology* 3: 32. 1913.

≡ *Fusarium solani* var. *ventricosum* (Appel & Wollenw.) Joffe, Plant and Soil 38: 440. 1973.

≡ *Fusarium cuneiforme* Sherb., *Mem. Cornell Univ. Agric. Exp. Sta.* 6: 129. 1915.

*Materials examined:* **Germany,** Berlin, on tuber of *Solanum tuberosum*, Oct. 1909, H.W. Wollenweber [holotype B 700021849 (as *Fusarium argillaceum*)]; (epitope designated here: Germany, Kiel, from soil in wheat field, Dec. 1979, W. Gerlach, epitope CBS H-21947, MycoBank MB198380, culture ex-epitope CBS 748.79 = BBA 62452 = NRRL 20846 = NRRL 22113).

*Notes:* Wollenweber (1917) synonymised *F. ventricosum* and *F. cuneiforme* under *F. argillaceum*. This decision was based on Fückel’s Fungi Rhenani no. 226, which Booth (1971) rejected as a misdetermination of *F. argillaceum* as it did not agree with the description of *Fries* (1832) for *F. argillaceum*. Comparisons of the type material (B 700021849; as *F. argillaceum*) and Wollenweber’s *Fusaria autographice delineate* no. 431 agree with the description and illustrations provided by Booth (1971) for *F. ventricosum* based on the isolate CBS 748.79, and therefore we agree with Booth’s argument that *F. ventricosum* is not synonymous with *F. argillaceum*.

**Clade X**

**Cosmospora** Raben., *Hedwigia* 2: 59. 1862. MycoBank MB1273.

≡ *Crysgluten* Briosi & Farneti, *Alti Is.* Bot. Univ. Lab. Critt. Pavia 8: 117. 1904.

≡ *Dialonecridia* (Sacc.) Cooke, *Grevillea* 12: 109. 1884.

≡ *Nectria* subgen. *Dialonecridia* Sacc., *Syll. Fung.* 2: 490. 1883.

Ascomata perithelial, scattered or gregarious, with inconspicuous or absent stroma, obpyriform with an acute or papillate apex, orange red or bright red, turning dark red in KOH, smooth walled. *Asci* narrowly clavate to cylindrical, with an apical ring, 8-spored. *Ascospores* initially hyaline, becoming yellow brown to reddish brown, 1-septate, becoming tuberculate when mature. *Conidiophores* acremonium-like, consisting of lateral phialides on somatic hyphae, or with one or two levels of monochasial branching, or verticillate, hyaline. *Phialides* monophialidic, cylindrical to subulate to subclavate, hyaline. *Microconidia* ellipsoidal, oblong or clavate or slightly allantoid, aseptate, hyaline, forming slimy heads. *Macroconidia* absent or rare, subcylindrical, curved, slightly narrowing towards each end, apical cell often slightly hooked with a more or less pointed tip, basal cell not or scarcely pedicellate, 3–5-septate, hyaline (adapted from Rossman et al. 1999 and Gräfenhan et al. 2011).

*Type species:* *Cosmospora cocinea* Raben., *Hedwigia* 2: 59. 1862 [non *Nectria cocinea* (Pers.) Fr. 1849].

≡ *Nectria cosmosporas* Ces. & De Not., Comment. Soc. Crittog. Ital. 1: 195. 1863.

≡ *Dialonecridia cosmosporas* (Ces. & De Not.) Moraves, *Česká Mykol.* 8: 92. 1954.

≡ *Verticillium olivaceum* W. Gams, *Cephalosporium-artige Schimmelpilze* 129. 1971.

*Descriptions and illustrations:* Rossman et al. (1999), Gräfenhan et al. (2011).
Notes: Representatives of the genus *Cosmospora* formed a well-supported clade (BS ≥ 75 %, PP ≥ 0.95), which also included representatives of the genus *Dialonectria* (CBS 125493 & CBS 125494; Gräfenhan et al. 2011). Samuels et al. (1991) revised the genus *Dialonectria* (as Nectria subgen. *Dialonectria*) and assigned it to *Cosmospora* sensu Rossman. Gräfenhan et al. (2011) later resurrected the genus *Dialonectria* and restricted its generic concept around the type species, *D. episphaeria*, recognising that this species represents a species complex of at least five phylogenetic lineages. Although the phylogenetic inference in this study supports the findings of Samuels et al. (1991) that *Dialonectria* should be seen as a synonym of *Cosmospora*, we select not to introduce new combinations at present. A monographic study for both genera is required to stabilise the taxonomy of these genera. Furthermore, isolates listed in the CBS collection as “*Acremonium cf. curvulum*” (CBS 100551) and “*Stylonectria wegeliniana*” (CBS 101915) clustered within the *Cosmospora* clade. Both isolates appear to be sterile, and therefore their taxonomic status cannot be determined at present.
**Fusicolla** Bonord., Handb. Allg. Mykol.: 150. 1851. MycoBank MB8294.

Ascomata perithecial, stroma erumpent, fully or partially immersed in a slimy, pale orange sheet of hyphae over the substrate, scattered to gregarious, or in small groups, globose to pyriform with a short acute or disk-like papilla, yellow, pale buff to orange, not changing in KOH, smooth walled. Asci cylindrical to narrowly clavate, with an apical ring, 8-spored. Ascospores hyaline to pale brown, 1-septate, smooth or slightly verrucose when mature. Conidiophores initially as lateral phialides on somatic hyphae, sometimes monochasial, verticillate or penicillate, hyaline. Phialides monophialidic, cylindrical to subulate, hyaline. Microconidia absent or sparse, ellipsoidal to allantoid, aseptate, hyaline. Macroconidia falcate, straight to curved, narrowing towards the ends, apical cell often hooked with a pointed tip, basal cell slightly pedicellate 1–3-septate or 3–5-septate or up to 10-septate, hyaline. Chlamydospores absent to abundant, globose, single, in pairs or chains, sometimes forming in macroconidia (adapted from Gerlach & Nirenberg 1982 and Gräfenhan et al. 2011).

**Type species:** *Fusicolla betae* (Desm.) Bonord. Handb. Allg. Mykol.: 150. 1851.

≡ *Fusisporium betae* Desm., Ann. Sci. Nat., Bot. 19: 436. 1830.
≡ *Fusarium betae* (Desm.) Sacc., Michelia 2: 132. 1880.
≡ *Pionnotes betae* (Desm.) Sacc., Syll. Fung. 4: 726. 1886.
≡ *Pionnotes riziphila var. betae* (Desm.) de Wild. & Durieu, Prodrome de la flore belge 2: 367. 1898.

**Descriptions and illustrations:** Gerlach & Nirenberg (1982), Gräfenhan et al. (2011).

**Notes:** Representatives of the genus *Fusicolla* formed a monophyletic clade (BS = 100 %, PP = 1.0) closely related to but separate from the clades representing the genera *Macroconia* and *Microcera*. Unfortunately, no cultures or sequences of *F. betae* were available to be included in the present study.

*Macroconia* (Wollenw.) Gräfenhan et al., Stud. Mycol. 68: 101. 2011. MycoBank MB519441.

≡ *Nectria* sect. *Macroconia* Wollenw., Angew. Bot. 8: 179. 1926.
Ascomata perithecial, stroma in conspicuous or absent, solitary, subglobose with or without a small apical papilla, orange to carmine red, turning dark red to violet in KOH, sometimes with hyphal hairs arising from the outer wall. Ascii cylindrical to narrowly clavate, with a simple apex, 8-spored. Ascosporae yellowish, 1-septate, smooth, sometimes becoming striate when mature. Conidiophores initially as lateral phialides on somatic hyphae, later monochaetioal to verticillate, hyaline. Phialides monophaellic, cylindrical to subulate, hyaline. Microconidia rare or absent, ellipsoidal to allantoid, hyaline. Macroconidia subcylindrical to curved, apical cell conical or hooked, basal cell mostly conspicuously pedicellate, 3–7(–14)-septate, hyaline. Chlamydaspore absent to rare, globose, single, in pairs or chains in hyphae (adapted from Gräfenhan et al. 2011).

Type species: Macroconia leptosphaeriae (Niessl.) Gräfenhan, & Schroers, Stud. Mycol. 68: 102. 2011.

Type species: Microcera coccophila (Desm.) MycoBank MB5301.

Description and illustrations: Gräfenhan et al. (2011).

Notes: The genus Microcera was raised from species name to genus level by Gräfenhan et al. (2011) for fusarium-like species having large macroconidia and minute perithecia. Phylogenetic inference in this study supports this decision, with representatives of this genus forming a well-supported clade (BS = 100 %, PP = 1.0) closely related to but separate from the genera Fusicollia and Macroconia.

Microcera Desm., Ann. Sci. Nat. Bot. 10: 359. 1848. MycoBank MB8920.

Ascomata perithecial with stroma and/or byssus covering host, solitary or in groups, globose, with a blunt papilla, orange to dark red, turning dark red or violet in KOH, finely roughened. Asci cylindrical to narrowly clavate, with an apical ring, 8-spored. Ascosporae hyaline to pale yellow-brown, 1(–3)-septate, smooth, sometimes becoming tuberculate when mature. Conidiophores as lateral phialides on somatic hyphae, becoming monochaetioal, verticillate to penicillate, hyaline, forming discrete sporodochia or synnemata on the host. Phialides monophaellic, cylindrical to subulate to subclavate, hyaline. Macroconidia pale, orange, pink or bright red in mass, subcylindrical, moderately or conspicuously curved, apical cell often slightly or conspicuously hooked, basal cell scarcely to conspicuously pedicellate, (0–)3–5–(12)-septate, hyaline (adapted from Gräfenhan et al. 2011).

Type species: Microcera coccophila Desm., Ann. Sci. Nat. Bot. 10: 359. 1848.

Notes: The genus Microcera includes fusarium-like species generally regarded as entomogenous fungi associated with scale insects, although they can also be found on other substrates (Gräfenhan et al. 2011). Gräfenhan et al. (2011) resurrected this genus based on DNA sequence data and its ecological association, after Wollenweber & Reinking (1935) placed all Microcera spp. in Fusarium. Our phylogenetic inference supports this decision, as representatives of the genus Microcera clustered in a well-supported clade (BS ≥ 75 %, PP ≥ 0.95) distantly related to Fusarium but closely related to the genera Fusicollia and Macroconia.

Stylonectria Höhn., Sitzungsber. Kaiserl. Akad. Wiss., Math.-Naturwiss. Cl., Abt. 1, 124: 52. 1915. MycoBank MB5301.

Ascomata perithecial on a thin, white to yellow, hyphal or subicularum-like stroma, gregarious in groups of up to 20, subglobose, pyriform to subcylindrical, with or without broad, circular, flat disc on a venter-like neck, pale yellow, orange-red, orange-brown, or pale to dark red, becoming dark red to purple in KOH, smooth. Ascii cylindrical to clavate, apex simple or with a ring, 8-spored. Ascosporae hyaline or yellow to pale brown, 1-septate, cylindrical to allantoid to ellipsoidal, smooth or tubercullate. Conidiophores initially formed as unbranched phialides on somatic hyphae, sometimes loosely branched, sometimes forming small sporodochia. Phialides monophaellic, cylindrical to subcylindrical, with a distinct collarette. Microconidia sparse, allantoid to lunulate, slightly or strongly curved, aseptate, in slimy heads. Macroconidia orange in mass, subcylindrical or moderately to strongly curved, falcate, 0–1-septate, apex narrower than base, apical cell blunt or hooked, basal cell not or scarcely pedicellate (adapted from Höhn 1915 and Gräfenhan et al. 2011).

Type species: Stylonectria applanata Höhn., Sitzungsber. Kaiserl. Akad. Wiss., Wien, Math.-Naturwiss. Kl., Abt. 1, 124: 52. 1915.

Descriptions and illustration: Höhn (1915), Weese (1916), Gräfenhan et al. (2011).

Notes: Species of Stylonectria are host-specific fungicolous fungi, which Rossman et al. (1999) considered as a synonym of Cosmospora. Phylogenetic inference in this study and Gräfenhan et al. (2011) showed that the genus Stylonectria formed a well-supported clade (BS = 100 %, PP = 1.0) basal to the other genera included in Clade X.

Clade XI

Corallomycetella Henn., Hedwigia 43: 245. 1904. MycoBank MB1237.
Ascomata perichaetial, solitary or gregarious, associated with reddish rhizomorphs or synnemata, obpyriform, orange-red to red, changing to purple in KOH, slightly scurfy, smooth around the ostiole. Ascii clavate to cylindrical, with an apical ring, 8-spored. Ascospores ellipsoidal, 1-septate, constricted at the septum, hyaline to yellow-brown, finely striate. Asexual morph synnematosus. Synnemata solitary or gregarious, 2–5 caespitose, arising laterally or as terminal extension of the rhizomorphs or directly from the substrate, cucurbitaceous, subulate-capitate, cylindrical, slender to robust, straight to curved to sinuous, unbranched or branched, hisrute, pale luteous to luteous, turning red to purple in KOH. Marginal hyphae echinulate to verrucose, pale luteous, turning bright red in KOH, with clavate terminal cells, covering the entire surface of stipe. Conidiophores unbranched, or once simple monochaetal or mononerticate. Phialides cylindrical, terminal, collarettes not flared, periclinal thickening conspicuous. Conidia ellipsoidal, ovoidal with a truncate base, aseptate, smooth, forming white to yellow, subglobose conidial masses (adapted from Rossman et al. 1999 and Herrera et al. 2013b).

**Type species**: *Corallomycetella repens* (Berk. & Broome) Rossman & Samuels, Stud. Mycol. 42: 113. 1999.

- *Sphaerostilbe repens* Berk. & Broome, J. Linn. Soc., Bot. 14: 114. 1875.
- *Corallomycetella hisensis* Henn., Hedwigia 43: 245. 1904.
- *Paracremonium sp. nov.*

**Description and illustrations**: Herrera et al. (2013b).

**Notes**: Species of *Corallomycetella* are tropical fungi characterised by the formation of brightly coloured rhizomorphs of their rhizostilbelliform asexual morphs (Seifert 1985, Rossman et al. 1999, Herrera et al. 2013b). These fungi are associated with rosetting diseases of various woody tropical plant hosts (Rossman et al. 1999, Herrera et al. 2013b). Phylogenetic inference in this study showed that the species of *Corallomycetella* formed a distinct monophyletic clade (BS = 100 %, PP = 1.0).

**Paracremonium** L. Lombard & Crous, gen. nov. MycoBank MB810267.

**Etymology**: Name refers to the acrementum-like morphology of these fungi.

Ascomatal morph not observed. *Mycelium* consisting of hyaline, septate, branched hyphae, sometimes forming sterile coils with conidiophores radiating outwards, hyphal septa inconspicuously swollen. *Conidiophores* arising laterally from somatic hyphae, erect, cylindrical to subcylindrical, unbranched or rarely branched, aseptate or septate, smooth, hyaline. *Conidiogenous cell* terminal, monophiloadetic, hyaline, smooth, elongate-ampulliform or subcylindrical, tapering towards the apex, with periclinal thickening and inconspicuous collarette. *Conidia* aseptate, fusiform to ellipsoidal to cylindrical, straight to slightly or strongly curved, forming slimy heads on the conidiophore.

**Type species**: *Paracremonium inflatum* L. Lombard & Crous.

**Notes**: The genus *Paracremonium* is established here for different strains from a group of fungi previously treated as *Acremonium recifei* (Gams 1971; also see *Xenoacremonium* below). Species of *Paracremonium* are distinguished from other acremonium-like genera by the formation of sterile coils from which conidiophores radiate and having inconspicuously swollen septa in the hyphae. All species in *Paracremonium* are associated with human infections (see below). Phylogenetic inference in this study showed that representatives of this genus formed a monophyletic clade (BS = 100 %, PP = 1.0) closely related but separate from the clades representing *Corallomycetella* and *Xenoacremonium*.

**Paracremonium inflatum** L. Lombard & Crous, sp. nov. MycoBank MB810268. Fig. 17.

**Eymology**: Name refers to the inconspicuous swollen septa of the hyphae formed by this fungus.

**Ascomatal state unknown**. *Mycelium* consisting of hyaline, septate, branched, 2–4 μm diam hyphae, inconspicuously swollen at the hyphal septa, sometimes forming sterile coils with conidiophores radiating outwards. *Conidiophores* arising laterally from somatic hyphae, erect, subcylindrical, unbranched or rarely branched, 0–1-septate, up to 115 μm tall, 2–3 μm diam, hyaline, smooth, terminating in one or two conidiogenous cells. *Conidiogenous cell* terminal, elongate-ampulliform, tapering towards the apex, 20–85 μm × 2–4 μm, apex 1.5–2 μm diam, with prominent periclinal thickening and inconspicuous collarette, hyaline, smooth. *Conidia* formed in heads at apex of conidiogenous cells, aseptate, ellipsoid to fusiform, smooth, slightly to strongly curved, 5–6 × 1–2 μm (av. 5 × 2 μm). *Chlamydospores* not seen.

**Culture characteristics**: Colony on PDA reaching 50–65 mm diam after 7 d at 24 °C; colony consists of semi-immersed aerial mycelium; surface with pink to salmon centre becoming white at the margins; reverse concolorous.

**Materials examined**: India, from a granulomatous lesion on the right hand of a male Homo sapiens, Oct. 1977, A.A. Padhye (holotype CBS H-21946, culture ex-type CBS 485.77 = CDC 77-043179); Colombia, Dep. de Meta, Municipio de Villavicencio, 25 km from road Villavicencio-Acacías, 550 m alt., from soil in maize-field, 18 Feb. 1976, O. Rangel, culture CBS 482.78.

**Paracremonium contagium** L. Lombard & Crous, sp. nov. MycoBank MB810269. Fig. 18.

**Etymology**: Name refers to the ability of this fungus to cause a subcutaneous infection of humans.

**Ascomatal state unknown**. *Mycelium* consisting of hyaline, septate, branched, 2–4 μm diam hyphae, sometimes
inconspicuously swollen at the hyphal septa. Conidiophores arising laterally from somatic hyphae, erect, subcylindrical, unbranched or rarely branched, 0–1-septate, up to 75 μm tall, 1–2 μm diam, hyaline, smooth, terminating in one or two conidiogenous cells. Conidiogenous cells terminal, elongate-ampulliform, tapering towards apex, 25–50 × 2–3 μm, apex 1.5–2 μm diam, with prominent periclinal thickening and inconspicuous collarette, hyaline, smooth. Conidia formed in heads at apex of conidiogenous cells, aseptate, ellipsoidal to fusiform, smooth, slightly to strongly curved, 4–6(–7) × 2–3 μm (av. 5 × 2 μm). Chlamydospores not seen.

Culture characteristics: Colony on PDA reaching 45–50 mm diam after 7 d at 24 °C; colony consists of semi-immersed aerial mycelium; surface with pink to salmon centre becoming white at the margins; reverse apricot in centre becoming salmon to pale pink to white towards the margin.

Material examined: Canada, Ontario, Toronto, from a subcutaneous lesion in the left thigh of a male Homo sapiens, S. Mohan (holotype CBS H-21945, culture ex-type CBS 110348 = UAMH 10141).

Note: Paracremonium contagium can be distinguished from P. inflatum by its shorter conidiophores and the absence of sterile coils from which conidiophores radiate.

Xenoacremonium L. Lombard & Crous, gen. nov.
MycoBank MB810270.

Etymology: Name refers to the acremonium-like morphology of these fungi.

Ascomatal state not observed. Mycelium consisting of hyaline, septate, branched hyphae. Conidiophores either as lateral phialidic pegs or arising laterally from somatic hyphae, erect, cylindrical to subcylindrical, unbranched or rarely branched, aseptate or septate, smooth, hyaline. Conidiogenous cells terminal, monophialidic, hyaline, smooth, elongate-ampulliform or subcylindrical, tapering towards the apex, with periclinal thickening and inconspicuous collarette. Conidia aseptate, fusiform to ellipsoidal to cylindrical, slightly or strongly curved, forming slimy heads on the conidiophore.
Fig. 19. Xenoacremonium falcatus (ex-type CBS 400.85). A, C. Conidiophores arising laterally from somatic hyphae. B. Lateral phialidic pegs. D. Conidia. Scale bars: A = 50 μm; B = 10 μm (apply to C–D).

**Type species:** Xenoacremonium recifei (Leão & Löbo) L. Lombard & Crous.

**Notes:** The genus Xenoacremonium is established here for a group of fungi previously treated as Acremonium recifei (Gams 1971), which includes the ex-type of A. recifei (CBS 137.35). Phylogenetic inference in this study showed that representatives of this genus formed a monophyletic clade (BS = 100 %, PP = 1.0) closely related but separate from the clades representing Corallomycetella and Paracremonium.

**Xenoacremonium falcatus** L. Lombard & Crous, sp. nov. MycoBank MB810271. Fig. 19.

**Etymology:** Name refers to the strongly curved conidia produced by this fungus.

**Ascomatal morph unknown.** Mycelium consisting of hyaline, septate, branched, 2–3 μm diam hyphae. Conidiophores either as lateral phialidic pegs, 2–4 × 1–2 μm, or arising laterally from somatic hyphae, erect, subcylindrical, unbranched or rarely branched, 0–1-septate, up to 80 μm tall, 2–4 μm diam, hyaline, smooth, terminating in one or two conidiogenous cells. **Conidiogenous cells** terminal, elongate-ampulliform, tapering towards apex, 25–80 × 2–3 μm, apex 1–2 μm diam, with prominent periclinal thickening and inconspicuous collarette, hyaline, smooth. **Conidia** formed in heads at apex of conidiogenous cells, aseptate, ellipsoidal to fusiform, 1-septate, slightly constricted at the septum, pale brown to golden-brown, coarsely striate. **Conidiophores** sporodochial or penicillate, stalked, mononematous. **Sporodochia** hyaline, erumpent, hemispherical or flat; cells of well-developed sporodochia angular to globose, forming pseudoparenchymatous tissue, evenly thin-walled. **Phialides** formed singly or in whorls on cylindrical cells that arise from pseudoparenchymatous tissue of sporodochia or in whorls on penicillately branched conidiophores, elongate, widest

**Culture characteristics:** Colony on PDA reaching 55–60 mm diam after 7 d 24 °C; colony consists of semi-immersed aerial mycelium; surface with pale luteous to luteous centre becoming white towards the margins; reverse pale luteous with pale luteous or luteous pigment throughout the medium.

**Material examined:** New Zealand, North Island, Woodhill Forest, Compartment 75, on Pinus radiata, 14 May 1982, J. Reid (holotype CBS H-21944, culture ex-type CBS 400.85).

Fig. 20. Xenoacremonium recifei (ex-type CBS 137.35). A–B. Conidiophores arising laterally from somatic hyphae. C. Conidia. Scale bars: A = 50 μm; B = 10 μm (apply to C).

Notes: The conidia of Xenoacremonium falcatus [4–8(~10) × 1–2 μm (av. 6 × 2 μm)] are slightly larger than those of X. recifei [4–6(~7.5) × 1–2 μm; Gams 1971]. Furthermore, X. falcatus produces lateral phialidic pegs on its somatic hyphae, a feature not observed in this study or reported for X. recifei by Gams (1971).

**Xenoacremonium recifei** (Leão & Löbo) L. Lombard & Crous, comb. nov. MycoBank MB810272. Fig. 20. Basionym: Cephalosporium recifei Leão & Löbo, C.R. Soc. Biol. R. Janeiro: 205, 1934. ≡ Hyalopus recifei (Leão & Löbo) Leão & M.A.J. Barbosa, Sub. Stud. Parasitol. Genero Hyalopus Corda 1838: 39. 1941. ≡ Acremonium recifei (Leão & Löbo) W. Gams, Cephalosporium-artige Schimmelpilze: 133. 1971. = Hyalopus furcatus Bat. & C. Ram., Atlas Inst. Micol. Univ. Recife 4: 290. 1967. = Hyalopus furcatus Bat. & C. Ram., Atlas Inst. Micol. Univ. Recife 4. 290. 1967.

**Material examined:** Brazil, from mycetoma on Homo sapiens, 1934, A.E. de Araújo Leão (culture ex-type CBS 137.35).

**Clade XII**

**Nalanthamala** Subram., J. Indian Bot. Soc. 35: 478. 1956. = Rubrinectria Rossman & Samuels, Stud. Mycol. 42. 1999.

Ascomata perithelial on an erumpent stroma, aggregated in groups, superficial, globose to broadly ovoid or broadly pyriform, with a short, rounded, obtuse papilla, orange-red with orange, rarely green scales, turning dark red in KOH. Asci cylindrical, apex simple or with a small, refractive ring, 8-spored. **Ascospores** broadly ellipsoidal to fusiform, 1-septate, slightly constricted at the septum, pale brown to golden-brown, coarsely striate. **Conidiophores** sporodochial or penicillate, stalked, mononematous. **Sporodochia** hyaline, erumpent, hemispherical or flat; cells of well-developed sporodochia angular to globose, forming pseudoparenchymatous tissue, evenly thin-walled. **Phialides** formed singly or in whorls on cylindrical cells that arise from pseudoparenchymatous tissue of sporodochia or in whorls on penicillately branched conidiophores, elongate, widest
Styloletendraea

Stilbonectria

Scand. 2: 388. 1849.

Macroconidia hyaline, ellipsoid to fusoid, rarely curved, aseptate. Conidia

Micro-

Sphaerostilbe

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Type species: Nalanthamala madreeya Subram., J. Indian Bot. Soc. 35: 478. 1956.

Descriptions and illustrations: Rossman et al. (1999), Schroers et al. (2005).

Notes: Species of Nalanthamala are tropical fungi associated with wilt and blight diseases of various economically important tropical crops (Schroers et al. 2005, Rossman et al. 2013). Representatives of this genus formed a monophyletic clade (BS = 100 %, PP = 1.0) closely related to the clade representing the genus Nectria. Unfortunately cultures or sequences of N. madreeya were not available for the molecular phylogeny.

Nectria (Fr.) Fr., Summa Veg. Scand. 2: 387. 1849.

MycoBank MB3431.

≡ Hypocreaceae. Nectria Fr., Syst. Orbis Veg.: 105. 1825.
≡ Phedodrosphearea Dumort., Commentat. Bot.: 90. 1822.
≡ Sphaerostilbe Tut. & C. Tut., Sel. Fung. Carpol. 1: 130. 1861.
≡ Megalonectria Spec., Anales Soc. Ci. Argent. 12: 217. 1881.
≡ Stilbonectria P. Karst., Hedwigia 28: 194. 1889.
≡ Creonectria Seaver, Mycologia 1: 183. 1909.
≡ Rhodotrich Vain., Ann. Acad. Sci. Fenn. 15: 31. 1921.
≡ Styloletendraea Weese, Mitt. Bot. Inst. Techn. Hochsch. Wien 1: 60. 1924.
≡ Ochraceospora Fiore, Bot. Soc. Naturalisti Napoli 41: 90. 1930.

Ascomata perithelial on or nearly or completely immersed in an erumpent stroma, aggregated in groups, red to bay to sienna, turning bright red to blood red to purple in KOH, subglobose to globose, smooth surface to warted. Asci cylindrical to narrowly clavate or clavate, with an inconspicuous ring, 8-spored. Ascospores ellipsoid, oblong, fusiform, pyriform or allantoid, rounded at both ends, smooth or spinulose, hyaline, straight to slightly curved, up to 4-septate. Conidiophores pycnidial, sporodochial, lateral phialidic pegs or acropleurogenous. Microconidia hyaline, ellipsoid to fusoid, rarely curved, aseptate. Macroconidia hyaline, ellipsoid, oblong, cylindrical to allantoid or subglobose to ellipsoid, 0–1-septate, smooth, straight to slightly curved, rounded at both ends. Chlamydospores rare (adapted from Hirooka et al. 2012).

Type species: Nectria cinnabaria (Tode: Fr.) Fr., Summa Veg. Scand. 2: 388. 1849.

≡ Hypocreaceae. Nectria Fr., Syst. Orbis Veg.: 105. 1825.
≡ Phedodrosphearea Dumort., Commentat. Bot.: 90. 1822.
≡ Sphaerostilbe Tut. & C. Tut., Sel. Fung. Carpol. 1: 130. 1861.
≡ Megalonectria Spec., Anales Soc. Ci. Argent. 12: 217. 1881.
≡ Stilbonectria P. Karst., Hedwigia 28: 194. 1889.
≡ Creonectria Seaver, Mycologia 1: 183. 1909.
≡ Rhodotrich Vain., Ann. Acad. Sci. Fenn. 15: 31. 1921.
≡ Styloletendraea Weese, Mitt. Bot. Inst. Techn. Hochsch. Wien 1: 60. 1924.
≡ Ochraceospora Fiore, Bot. Soc. Naturalisti Napoli 41: 90. 1930.

Ascomata perithelial on or nearly or completely immersed in an erumpent stroma, aggregated in groups, red to bay to sienna, turning bright red to blood red to purple in KOH, subglobose to globose, smooth surface to warted. Asci cylindrical to narrowly clavate or clavate, with an inconspicuous ring, 8-spored. Ascospores ellipsoid, oblong, fusiform, pyriform or allantoid, rounded at both ends, smooth or spinulose, hyaline, straight to slightly curved, up to 4-septate. Conidiophores pycnidial, sporodochial, lateral phialidic pegs or acropleurogenous. Microconidia hyaline, ellipsoid to fusoid, rarely curved, aseptate. Macroconidia hyaline, ellipsoid, oblong, cylindrical to allantoid or subglobose to ellipsoid, 0–1-septate, smooth, straight to slightly curved, rounded at both ends. Chlamydospores rare (adapted from Hirooka et al. 2012).

Type species: Nectria miltina (Mont.) Weese, Ann. Mycol. 8: 464. 1910.

≡ Sphaeria miltina Mont., Explor. Sci. Algérie, Bot. I. 1: 477. 1848.
≡ Nectria miltina (Mont.) Mont., Syll. Genera Sp. Pl. Cryptog.: 225. 1856.
≡ Nectriella miltina (Mont.) Sacc., Michelia 1: 278. 1878.
≡ Allantonectria yuccae Earle, In: Greene, P. Baker. 2: 11. 1901.
≡ Nectriella bacilliforma Traverso & Spessa, Bot. Soc. Brotn. 25: 172. 1910.

Description and illustrations: Hirooka et al. (2012).

Notes: The genus Allantonectria is monotypic based on A. miltina, recently resurrected to generic level by Hirooka et al. (2012) after Rossman et al. (1999) placed the type species in Nectria. Isolates of A. miltina formed a monophyletic clade (BS ≥ 75 %, PP ≥ 0.95) distinct from the Nectria clade, but closely related to the clade representing the genus Thyronectria.

Thyronectria Sacc., Grevillea 4 (no. 29): 21. 1875. MycoBank MB5469.

≡ Pleonectria Sacc., Nuovo Giorn. Bot. Ital. 8: 78. 1876.
≡ Chloronectria Sacc., Michelia 1: 279. 1878.
≡ Nectria subgenus Aponectria Sacc., Michelia 1: 296. 1878.
≡ Aponectria (Sacc.) Sacc., Syll. Fung. 2: 516. 1883.
≡ Mattirolia Berl. & Bres.; Annuaria Soc. Apilarii Tridentini 14: 55. 1889.
≡ Scoleconectria Seaver, Mycologia 1: 197. 1909.
≡ Thyronectriodea Seaver, Mycologia 1: 206. 1909.

Ascomata perithelial, immersed in a stroma or superficial, densely aggregated, subglobose to globose to flask-shaped, apex obtuse, red to amber, turning slightly purple in KOH. Ascii oblong or clavate, with undifferentiated apex or with an inconspicuous ring, 8-spored. Ascospores ellipsoid, fusiform, long-cylindrical to filiform, hyaline, (0–)1-septate, multiseptate to uninucleate, smooth or striate, sometimes budding in the ascus to produce oblong to allantoid, aseptate, hyaline, ascosporidial. On natural substrate asexual morph sometimes pycnidial. Pycnidia co-occurring with ascomata, solitary or aggregated in groups, superficial, subglobose to irregularly discoid to cupulate or

Notes: Hirooka et al. (2012) recently revised Nectria, recognising 29 species within the genus. Representatives of this genus included in this study formed a monophyletic clade (BS ≥ 75 %, PP ≥ 0.95) closely related to the genus Nalanthamala.
elongate and erect, rosy, orange, red, violaceous brown to nearly black. Conidiophores densely packed, simple, irregularly or verticillately branched. Conidia formed on lateral phialidic pegs or cylindrical to subulate phialides, conidial formation enteroblastic. Ascomatal state, asexual morph forming verticillate conidiophores or pycnidia. Conidiophores unbranched or branched, but sometimes densely branched to form sporodochia. Conidiogenous cells monopodial, cylindrical, slightly curved towards the apex. Conidia oblong, ellipsoid, cylindrical or allantoid, hyaline (0–) 1–2-septate, smooth (adapted from Hirooka et al. 2012 and Jaklitsch & Voglmayr 2014).

Type species: Thyronectria rhodochlora (Mont.) Seeler, J. Arnold Arbor. 21: 455. 1940.

≡ Sphaeria rhodochlora Mont., Ann. Sci. Nat., Bot. 1: 307. 1834.
≡ Mattiroia rhodochlora (Mont.) Berl. (as “rhodochlora”), Atti Congr. Bot. Int., (Genova): 574. 1892.
≡ Pleosphaeria rhodochlora (Mont.) Sacc., Syll. Fung. (Abellini) 2: 306. 1883.
≡ Trichosphaeria rhodochlora (Mont.) Sacc., Syll. Fung. (Abellini) 1: 454. 1882.
≡ Pleosphaeria mutabilis Sacc., Syll. Fung. 2: 306. 1883.
≡ Mattiroia mutabilis (Sacc.) Checa, M.N. Blanco & G. Moreno, Mycotaxon 125: 153. 2013.
≡ Strickenia mutabilis (Sacc.) G. Winter, Rabenh. Krypt.-Fl., ed. 2, 1: 288. 1885.
≡ Thyronectria patavina Sacc., Atti Soc. Veneto-Trentino Sci. Nat. 4: 123. 1875.
≡ Nectria patavina (Sacc.) Rosman, Mem. New York Bot. Gard. 49: 260. 1989.
≡ Valsonecctria patavina (Sacc.) Cooke, Grevillea 12: 105. 1884.
≡ Nectria pyrrochlora Auer., (as “pyrrochlora”) in Rabenhorst, Hedwigia 8: 88. 1869.
≡ Calonectria pyrrochlora (Auer.) Sacc., (as “pyrrochlora”) Michelia 1: 251. 1878.
≡ Thyronectria pyrrochlora (Auer.) Sacc., Michelia 2: 325. 1881.
≡ Valsonecctria pyrrochlora (Auer.) Cooke, Grevillea 12: 105. 1884.
≡ Pleosphaeria pyrrochlora (Auer.) G. Winter, Rabenh. Krypt.-Fl. Ed. 2, 1, II. Abt.: Ascomyc.: Gymnoascom. 108. 1884.
≡ Mattiroia pyrrochlora (Auer.) Starbäck, Bih. Kungl. Svenska Vetenskapsakad. Handl. 19: 43. 1894.

Descriptions and illustrations: Hirooka et al. (2012), Jaklitsch & Voglmayr (2014).

Notes: Recently, Hirooka et al. (2012) revised this group of fungi, placing them in the genus Pleonectria, with P. lamyi as type, stating that this generic name was the oldest available name for these fungi. Jaklitsch & Voglmayr (2014), however, argued that the generic name Thyronectria represents the oldest name for these fungi based on phylogenetic inference. Previously, these fungi were incorrectly placed in the fungal family Nectriaceae due to the presence of paraphyses, but have now been shown to belong to the Nectriaceae (Jaklitsch & Voglmayr 2014). Phylogenetic inference in the present study supports this conclusion with representatives of Thyronectria forming a monophyletic clade (BS ≥ 75 %, PP ≥ 0.95) closely related to but separate from the clade representing Aliantonecctria.

Clade XIV

Tilachlidiaceae L. Lombard & Crous, fam. nov. MycoBank MB810273.

Ascomatal state unknown. Conidiophores synnematous or acremonium-like. Synnemata terete, simple to branched, cylindrical, narrowing towards the apex, consisting of bundles of parallel longitudinal, closely compacted hyphae with 1-4 scattered phialides terminating the hyphae of the synnema. Phialides cymbiform to cylindrical, hyaline, aseptate, with obvious collarettes, narrowing towards the apex. Conidia hyaline, fusiform to ellipsoid to subcyllindrical, aseptate becoming 1–3-septate in culture, smooth to finely ornamented, with or without mucoid sheath, formed in chains or agglutinating into large spherical or irregular white clumps. Parasitic or saprobic on living or dead folicolous or entomogenous fungi.

Type genus: Tilachlidiaceae Preuss.

Type species: Tilachlidiaceae brachiatum (Batsch) Petch.

Notes: The fungal family Tilachlidiaceae is introduced here to include species of the synnematous genera Septofusidium and Tilachlidiaceae. Gams (1971) placed the genus Septofusidium in the family Nectriaceae based on morphological characters, whereas the genus Tilachlidiaceae was classified as incertae sedis in the order Hypocreales (Gams 1971). No records could be located where Septofusidium has been treated in a molecular or phylogenetic analysis and neither are there any DNA sequence records available for this genus on NCBI’s GenBank sequence database. Only one record for T. brachiatum (CBS 506.67; HQ232177) could be found on GenBank. Therefore, this study represents the first molecular phylogenetic inference to include Septofusidium. Representatives of both genera clustered together in a well-supported clade (BS ≥ 75 %, PP ≥ 0.95) basal to the clades (Clades I–XIII) representing the family Nectriaceae, supporting the introduction of the new family Tilachlidiaceae.

Tilachlidiaceae Preuss, Linnaea 24: 126. 1851. MycoBank MB10236. Fig. 21.

Ascomatal state unknown. Synnemata cylindrical, simple or branched, narrowing towards the apex, consisting of bundles of parallel, longitudinal, usually closely compacted hyphae. Phialides scattered, hyaline, subulate, gradually narrowing to an acute apex, usually terminating hyphae of the synnema, or as lateral cells of the hyphae, single or in groups. Conidia oblong to ellipsoidal, aseptate, hyaline, smooth, covered by a mucoid layer, aggregating into large spherical or irregular masses.

Type species: Tilachlidiaceae brachiatum (Batsch) Petch, Trans. Brit. Mycol. Soc. 21: 66. 1937.

≡ Clavaria brachiatula Batsch., Elenchus Fung. 1: 233. 1786.
≡ Isaria brachiatula (Batsch) Schum., Enum. Fl. S. Aeth. 2: 443. 1803.
≡ Isaria agaricina Pers., Desp. Meth. Fung.: 111. 1794.
≡ Isaria citrina Pers., Icon. Descr. Fung. Minus Gognit., Lipsiae: 9. 1798.
≡ Isaria intricata Fr., Syst. Mycol. 3: 278. 1839.
≡ Isaria filiformis Wall., Fl. Cryptog. German. 2: 307. 1833.
≡ Tilachlidiaceae pinnatum Preuss, Linnaea 24: 127. 1851.
≡ Corethropsis epimycetes Masssee, J. R. Microbiol. Soc. 5: 1885.
≡ Tilachlidiaceae subulatum A.L. Smith, Trans. Brit. Mycol. Soc. 3: 122. 1908.
≡ Hirsutella ramosa Mains, Mycologia 41: 308. 1949.
≡ Tilachlidiaceae ramosus (Mains) Mains, Mycologia 43: 714. 1952.
≡ Tilachlidiaceae setigerum Malençon, Bull. Soc. Hist. Natr. Afr. N. 44: 148. 1953.

Descriptions and illustrations: Mains (1951), Gams (1971).

Notes: Species of Tilachlidiaceae are saprophytic fungi growing on dried fungi or entomogenous on lepidopterous insects (Petch...
Representatives of the genus *Tilachlidium* formed a monophyletic clade (BS = 100 %, PP = 1.0) closely related to but separate from the clade representing the genus *Septofusidium*.

**Septofusidium** W. Gams, Cephalosporium-artige Schimmelpilze: 147. 1971. MycoBank MB9882. Fig. 22.

Ascomatal state unknown. Conidiophores basitonously verticil late, arising laterally from submerged hyphae. Phialides sometimes integrated in septate branches, cylindrical to allantoid, smooth, becoming verrucose, hyaline to yellow. Conidia formed in long divergent chains, cylindrical to fusiform, 0–7-septate, hyaline to yellow, smooth or roughened to verrucose, sometimes with distinct hilum at both ends.

Type species: *Septofusidium elegantulum* (Pidopl.) W. Gams, Cephalosporium-artige Schimmelpilze: 147. 1971. ≡ *Fusidium elegantulum* Pidopl., Mykrobiol. Zh. Kiew 9: 53. 1948.

Descriptions and illustrations: Gams (1971), Samson (1974).

Notes: Species of *Septofusidium* are regarded as parasitic on foliicolous fungi (Gams 1971, Samson 1974). Representatives of this genus formed a monophyletic clade (BS ≥ 75 %, PP ≥ 0.95) within the larger clade representing the new family *Tilachlidiaceae*. Unfortunately sequences or cultures of *S. elegantulum* were not available for study. One isolate (CBS 696.93) listed as “Pseudonectria coronata” in the CBS collection also clustered within the *Tilachlidiaceae* clade. However, this isolate was sterile and analyses of the DNA sequences were inconclusive. Therefore this isolate cannot be identified at present and might be a contaminant of the original culture.

**Clade XV**

This weakly-supported clade includes representatives of the hypocrelean families *Clavicipitaceae* and *Niessliaceae*. The family *Clavicipitaceae* is represented here by isolates previously treated as *Aphanocladium album* (CBS 401.70, CBS 892.72 & CBS 634.75; Gams 1971) which formed a well-supported clade (BS = 100 %, PP = 1.0). Based on the illustration provided by Gams (1971) for CBS 401.70 and confirmed by comparisons of...
DNA sequences on NCBI's GenBank sequence database, these isolates represent unknown species in the genus *Pochonia*. Unfortunately, all three isolates appear to be sterile and are therefore tentatively treated as undetermined species of *Pochonia* pending further investigation. The family *Niessliaceae* is represented by *Hyaloseta nolinae* (CBS 109837) and *Trichosphaera ceratophora* (CBS 130.82). An isolate listed in the CBS collection as “*Nectria dacryocarpa*” (CBS 113532) also clustered within this clade, but is also sterile and no conclusive identification could be made based on DNA sequence comparisons, and is therefore not treated further here.

**Clade XVI**

This weakly-supported clade includes the ex-type of *Rodentomyces reticulatus* (CBS 128675; Doveri et al. 2010) and an authentic strain of *Sarocladium kiliense* (CBS 400.52; Herrera et al. 2013b). The monotypic genus *Rodentomyces* was initially placed in the *Nectriaceae* based on ITS and LSU sequence data (Doveri et al. 2010). However, this was not supported in the phylogenetic inference in this study. Analyses of the individual gene regions used here clustered both *R. reticulatus* and *S. kiliense* as a weakly-supported clade in the *Nectriaceae* (Clades I–XIII) using the tub2, ITS, LSU and tef1 gene regions (results not shown) basal to the *Nectria* clade (Clade XII). The remaining six genes regions used here, however, placed both these isolates at the basal position represented in Figs 1 and 2. At present, the monotypic *Sarocladium* is classified as *incertae sedis* in the order *Hypocreales* (Summerbell et al. 2011, Giraldo et al. 2014), and therefore based on the weak relationship between *R. reticulatus* and *S. kiliense* in this study, both are considered *incertae sedis* pending further investigation. An isolated listed in the CBS collection as “*Nectria dacryocarpa*” (CBS 121.87) also clustered within this clade, but is also sterile and no conclusive identification could be made based on DNA sequence comparisons, and is therefore not treated further here.

**Clade XVII**

*Falcocladium* S.F. Silveira et al., Mycotaxon 50: 447. 1994. MycoBank MB25800.

Ascomatal state unknown. *Conidiophores* sporodochial, synnemat, or penicillate when formed on aerial mycelium, hyaline, solitary or aggregated in groups, arising laterally from somatic hyphae, or from a stroma of thick-walled, red-brown chlamydospores. Stipe extensions hyaline to pale brown, straight to flexu-ous, aseptate, thick-walled, originating from any position on a conidiophore branch, or in the position of a phialide, frequently with more than one occurring in the same conidiogenous apparatus, terminating in an ellipsoidal, sphaeropedunculate or turbinate vesicle. *Conidiogenous apparatus* hyaline, aseptate to multi-septate, consisting of up to three series of branches. *Phialides* hyaline, arising from ends of each terminal branch in groups of 2–6, ampulliform or lageniform to subulate, with inconspicuous collarettes. *Conidia* hyaline, 0(–1)-septate, falcate with acute, short apical and basal appendages (adapted from Crous et al. 1994).

Type species: *Falcocladium multivesiculatum* S.F. Silveira et al., Mycotaxon 50: 448. 1994.

**Descriptions and illustrations:** Crous et al. (1994, 1997, 2007), Somrithipol et al. (2007).

**Notes:** The family *Falcocladaceae* was recently introduced for the genus *Falcocladium* (Jones et al. 2014), which includes four species, namely *F. multivesiculatum* (Crous et al. 1994), *F. sphaeropedunculatum* (Crous et al. 1997), *F. thailandicum* (Crous et al. 2007) and *F. turbinatum* (Somrithipol et al. 2007). Crous et al. (2007) judged the genus to be polyphyletic (but allied with the *Hypocreales*) after the ITS sequence of *F. thailandicum* was included in a phylogenetic analysis of this species with *F. multivesiculatum*, *F. sphaeropedunculatum* and other related sequences downloaded from GenBank. Phylogenetic inference in the present study showed that the ex-type of *F. thailandicum* (CBS 121717) clustered within the monophyletic clade (BS > 75 %, PP ≥ 0.95) representing the genus *Falcocladium*, but distinct from the *Nectriaceae* clade (Clade I–XIII), therefore supporting the introduction of the family *Falcocladaceae*.

**Clade XVIII**

This unsupported clade includes *Lecteola colletotrichoides* (CBS 109728) of the *Plectosphaerellaceae* (*Hypocreomycetidae*, *incertae sedis*, *Sordariomycetes*), representatives of the genera *Cylindrium* and *Ciliocapodium*, and a single isolate (CBS 122.39) listed as “*Calostilbe striispora*” in the CBS collection. Both *Cylindrium* and *Ciliocapodium* are classified in the family *Nectriaceae* by Index Fungorum and MycoBank and limited literature is available for both genera. Phylogenetic inference in this study excluded both genera from *Nectriaceae* and they are therefore considered as *incertae sedis*.

**Untreated or excluded genera**

*Bacillispora* Sv. Nilsson, Bot. Not. 115: 77. 1962. MycoBank MB7304.

Type species: *Bacillispora aquatica* Sv. Nilsson, Botaniska Notiser 115: 77. 1962.

**Descriptions and illustrations:** Nilsson (1962), Iqbal & Bhatti (1980).

**Notes:** *Bacillispora* is an aquatic asexual genus established by Nilsson (1962) with *B. aquatica* as type. Based on the descriptions provided by Nilsson (1962) and Iqbal & Bhatti (1980) (for *B. inflata*), members of this genus closely resemble the asexual morphs of the genera *Neonectria* and *Thelaniaectria*. However, no cultures were available at this time to determine the phylogenetic position of *Bacillispora* in the *Nectriaceae*.

*Peziotrichum* (Sacc.) Lindau, In: Engler & Prantl, Natürl. Pflanzenfam. 1(1): 467. 1900. MycoBank MB9285. [≡ *Botryotrichum* subgenus *Peziotrichum* Sacc., Hedwigia 32: 58. 1893.]

Type species: *Peziotrichum lachnella* (Sacc.) Lindau, In: Engler & Prantl, Natürl. Pflanzenfam. 1(1): 467. 1900. [≡ *Botryotrichum lachnella* Sacc., Hedwigia 32: 58. 1893.]

**Description and illustration:** Subramanian (1971).
Notes: Pezizotríchum is an entomogenous asexual genus, based on P. lachnellae, which was initially linked to Optioneactia coccorum (Petch 1927, Subramanian 1971). Rossman (1977) synonymised O. coccorum under Podonectria coccorum, which belongs to the Tubefilliaceae (Pleosporales, Pleosporomycetidae, Dothideomycetes; Rossman 1987), a genus also linked to the asexual genus Tetractium (Tubefilliaceae, Pleosporales, Pleosporomycetidae, Dothideomycetes; Kodue et al. 2006). Since there are no living cultures available representing Pezizotríchum that would allow for molecular studies, the link of this genus to Podonectria and Tetractium cannot be confirmed. Pezizotríchum could be considered as a member of the Tubefilliaceae, based on the descriptions and illustrations provided by Petch (1927) and Subramanian (1971).

Pleogibberellâ Sacc., In: Berl. & Voglino, Syll. Fung. Addit. 1–4: 217. 1886. MycoBank MB4211.

Type species: Pleogibberella calami (Cooke) Berl. & Voglino, Syll. Fung. Addit. 1–4: 217. 1886 (as “calarmia”).

≡ Gibberella calami Cooke, Grevillea 13: 8. 1864.

Description and illustration: Rossman et al. (1999).

Notes: Rossman et al. (1999) studied the type specimen of Pleogibberella calami, the only species in this genus, and concluded that this genus is most similar to members of the genus Nectria based on the ascomatal wall structure, well-developed stroma and large, muriform ascospores. The type specimen also did not include asexual structures. No living cultures are available to allow this genus to be included in molecular studies.

Pleurocolla Petr., Ann. Mycol. 22: 15. 1924. MycoBank MB9458.

Type species: Pleurocolla tiliae Petr. Ann. Mycol. 22: 15. 1924.

Description and illustration: Diehl (1933).

Notes: No living cultures were available for molecular studies.

Pseudocosmospora C. Herrera & P. Chaverri, Mycologia 105: 1291. 2013. MycoBank MB802432.

Type species: Pseudocosmospora eutypellae C. Herrera & P. Chaverri, Mycologia 105: 1293. 2013.

Description and illustration: Herrera et al. (2013a).

Notes: Representatives of Pseudocosmospora have not been included in this study as no cultures were available to us. Herrera et al. (2013a), however, clearly indicated this sexual genus to form a monophyletic lineage sister to Dialoneactia and Cosmospora.

Stalagmites Thiess. & Syd., Ann. Mycol. 12: 189. 1914. MycoBank MB5182.

Type species: Stalagmites tumefaciens (Syd. & P. Syd.) Thiess. & Syd., Ann. Mycol. 12: 189. 1914.

≡ Dothidea tumefaciens Syd. & P. Syd., Ann. Mycol. 5: 360. 1907.

Description and illustration: Rossman et al. (1999).

Notes: This monotypic genus, based on Stalagmites tumefaciens, is associated with galls on branches of a Serjania sp. Rossman et al. (1999) concluded that this genus belongs in the Nectriaceae based on morphological similarities to the sexual morphs of Fusarium (as Gibberella) and Pleogibberella. No living cultures were available for molecular studies.

DISCUSSION

To our knowledge, this study represents the largest sampling of nectriaceous fungi subjected to multi-locus sequence analyses to date. It provides a broad phylogenetic backbone and framework for future studies of the Nectriaceae. Members of this family are commonly found in various environments, where they play important socio-economic roles in human endeavours in agriculture, industry and medicine. The phylogenetic foundation set in this study will form the basis for further investigation of several genera, and will allow identification of novel taxa in existing and new fungal groups in this family. Although taxonomic issues have been clarified in some genera in this study, it also highlights some taxonomic problems in the Nectriaceae.

Members of the Nectriaceae are pleomorphic fungi, displaying both asexual and sexual morphs during their life cycles. This originally resulted in the separate naming of each fungal morph, providing a considerable challenge to fungal systematics (Cannon & Kirk 2000). The implementation of The International Code of Nomenclature for algae, fungi and plants (ICN; McNeill et al. 2012), stipulating that only one scientific name should be used for a fungal species, resulted in the abolition of dual nomenclature (ICN Art. 59; McNeill et al. 2006, Hawksworth et al. 2011) for pleomorphic fungi. Although selecting the correct generic name for a group of fungi should be based on priority of the oldest generic name, several fungal groups are considered exceptions to this principle based on the need for reasonable nomenclatural stability in fungi of economic or health significance (Rossman et al. 2013). Therefore, Hawksworth (2011, 2012) proposed several criteria to be applied for determining the status of a generic name. These criteria include (1) the number of name changes required, (2) the clarity of the generic concept, (3) the frequency of use of each generic name and (4) the vote of interested members of the scientific community. Applying these criteria, Rossman et al. (2013) proposed the conservation or protection of several generic names in the Nectriaceae. Also following this approach, we propose the conservation or protection of the generic names Penicillifére (<i>Viridíspora</i>), Sarcopódium (<i>Actínostilbe</i> = <i>Lanatonectria</i>) and Xenoyclindrocladum (<i>Xenocalonectria</i>) based on priority of the generic name and the number of name changes required if the alternative generic name is applied. However, the implementation of ICN has already sparked intensive debate, especially where well-established generic names in literature, such as Fusarium <i>s. lat.</i> (Geiser et al. 2013, O’Donnell et al. 2013, Aoki et al. 2014), have now been segregated into more narrowly defined genera, with newly introduced and older generic names being applied for these newly segregated fungal groups (Gräfenhahn et al. 2011, Schroers et al. 2011).
The generic name *Fusarium* is well-embedded in mycological literature, representing the fourth most commonly published fungal name (see Geiser et al. 2013). The segregation of the genus *Fusarium* by Gräfenhan et al. (2011) and Schroers et al. (2011) was therefore met by strong opposition from the general *Fusarium* working community (Geiser et al. 2013, O’Donnell et al. 2013, Aoki et al. 2014), although the genus *Fusarium* s. lat. clearly has internal phylogenetic structure supporting these divisions. A similar debate within the general plant pathological community surrounded the segregation of *Cylindrocarpon* and *Neonectria* into several genera by Chaverri et al. (2011). These changes have ultimately been widely accepted (Cabral et al. 2012a, b, c, Lombard et al. 2013). We therefore choose to retain the generic names *Albonectria*, *Cyanonectria*, *Geejayessia* and *Neocosmospora* as proposed by Gräfenhan et al. (2011), Nalim et al. (2011) and Schroers et al. (2011) for fungal groups previously treated in the genus *Fusarium*. This approach allows for consistency in the taxonomic treatment of genera in the *Nectriaceae*, as several clades, which include important plant pathogens (e.g. Clade III & IV) are shown here to display a similar genetic structure and ecology (e.g. *Cylindrocarpon*, *Dactyloclonectria*, *Ilyonectria* and *Neonectria* on Vitis vinifera; Cabral et al. 2012a, b, Lombard et al. 2013, 2014a, b).

In this study, we were able to resolve 47 genera in the *Nectriaceae*, of which three genera, namely Calostilbe, *Corallonectria* and *Dematociadium*, are represented by single lineages due to the paucity of cultures. For several of these genera there has been little or no DNA sequence data available prior to this study. These genera include *Aquaclonectria*, *Cuvicladelia*, *Cylindrocarpostylus*, *Cylindrocladenum*, *Ophonectria*, *Paracremonium*, *Penicillifer*, *Sarcopodium*, *Septofusidium*, *Tiliacladenum*, *Xenoacremonium*, *Xenocylinodendrum*, and *Xenoglacioldiopsis*. All these genera were shown to form monophyletic clades. New studies will be needed on these groups, especially since two of them, *Paracremonium* and *Xenoacremonium*, represent important human pathogens (Gams 1971). The remaining genera are for the most part regarded as either foliicolous or entomogenous fungi or endophytes and saprobes of mostly woody plant hosts (Ranzoni 1956, Gams 1971, Crous & Kendrick 1994, Kirschner & Oberwinkler 1999, Rossman et al. 1999) which might play an important role in industrial applications in future.

Six new genera, which were previously treated as members of the genera *Acremonium*, *Flagellospora*, *Fusarium* and *Pseudonectria*, are introduced here in the family *Nectriaceae*. Species in the new genus *Coccinonectria* were initially regarded as members of the genus *Pseudonectria* mostly based on plant host association (Rossman et al. 1999, Gräfenhan et al. 2011, Crous et al. 2014). Morphologically, *Coccinonectria* species can be distinguished from *Pseudonectria* by their scarlet ascomata, although their asexual morphs share several morphological features. Phylogenetic inference in this study also supported segregation of *Coccinonectria* from *Pseudonectria*, and therefore two new combinations are made in *Coccinonectria*.

*Bisifusarium*, *Neocosmospora* and *Rectifusarium* were previously treated as members of the genus *Fusarium*. Phylogenetic inference in this study showed that these genera are monophyletic and distinct from each other and *Fusarium*. *Bisifusarium* includes fusarium-like species previously treated as the “*Fusarium dimerum* species complex” (Schroers et al. 2005, Geiser et al. 2013, O’Donnell et al. 2013). They are distinguished by the formation of lateral phialidic pegs, which are not commonly found in *Fusarium*, and by producing 1–2-septate macroconidia. These fungi are mostly isolated from clinical samples (Schroers et al. 2009). Species of *Rectifusarium* are soil-borne fungi and have been isolated from various agricultural crops, but are not regarded as important pathogens or post-harvest pathogens of these crops (Wollenweber 1913, Gerlach & Nirenberg 1982). This genus is distinguished from *Fusarium* by its simple, erect, almost cylindrocarpon-like conidiophores, and the absence of sporodochia. Members of the new genera *Paracremonium* and *Xenoacremonium* were previously treated as *Acremonium rectefici* (Gams 1971, Summerbell et al. 2011), which have been shown to be paraphyletic (Summerbell et al. 2011). Both genera include important human subcutaneous and opportunistic pathogens (Gams 1971, de Hoog et al. 1993). Phylogenetic inference guided the recognition of subtle morphological distinctions between the genera. Species of *Paracremonium* can be distinguished by the formation of sterile coils in culture and their pink to salmon coloured colonies on PDA. *Xenoacremonium* species do not form sterile coils in culture, but readily release a pale luteous to luteous pigment into the growth medium, a phenomenon that is not observed in *Paracremonium*.

A new family, *Tilachlidiaceae*, is introduced here in the order *Hypocreales* for two genera, *Septofusidium* and *Tilachlidiaceae*, previously classified in the family *Nectriaceae*. These genera share several morphological characters and are known to be saprobic or parasitic on other fungi (Pitch 1931, Mains 1951, Gams 1971, Samson 1974). Some species of *Tilachlidiaceae* have been shown to produce important antibiotics (Gottshall et al. 1951, Roberts 1952) as well as novel compounds that are cytotoxic to leukemia cells (Feng et al. 2004), discoveries highlighting the potential for exploitation of these fungi in medical applications.

Comparisons of the phenotypic and ecological characters of genera in the *Nectriaceae* included in this study showed marginal correlations with some of the clades identified in the phylogenetic tree. Genera in Clade I are characterised by their penicillate arrangement of fertile branches but do not all share the same ecological niche. Clade III includes genera that also have a penicillate arrangement of fertile branches but have a sterile stipe extension extending beyond the conidiogenous apparatus and are generally regarded as soil-borne fungi. Clade IV and VI include genera, with the exception of *Cylindrocarpostylus* and *Mariannaea*, having soil-borne cylindrocarpon-like asexual morphs. They are associated with basal rot and canker diseases of their plant hosts. Genera in Clade VII are characterised by their sporodochial asexual morphs with characteristic straight to cirinate setae surrounding the sporodochia. They are associated mostly with leaf and stem blight diseases of plant hosts in the *Buxaceae*. Clade X includes genera with fusarium-like asexual morphs. They are generally pathogens of other fungi or of insects.

The ten gene regions used in this study were chosen based on their extensive use in molecular mycology. They have proved suitable to explore phylogenetic relationships within and between genera in the *Nectriaceae* (Chaverri et al. 2011, Gräfenhan et al. 2011, Hirooka et al. 2012, Lombard et al. 2010a, b, 2012, 2014a, b, Lombard & Crous 2012, Herrera et al. 2013a, b, O’Donnell et al. 2013). Although phylogenetic analyses of the individual gene regions (results not shown) were able to resolve all the genera in the *Nectriaceae* with varying statistical support, none of these gene regions can be considered as the “silver bullet” for the *Nectriaceae*. An illustration of the unreliability of individual
genes is found in the placement of Rodontomyces reticulatus and Sarocladium kiliense within the Nectriaceae clade by tob2, ITS, LSU and tec1, but not by the other six genes studied. The best statistical support for each genus was obtained using rp1 and rpb2, and therefore these loci should be further studied in attempts to determine phylogenetic relationships in the Nectriaceae. However, the ability of these two loci to serve as barcodes for species in these genera still needs to be determined for each genus on an individual basis.

The present study, as mentioned previously, should serve as backbone for future taxonomic studies of genera in the Nectriaceae. More loci need to be identified and screened with an eye to finding a more robust single locus – a process that might be expedited by using whole genome sequences. Presently there is an under-representation of Nectriaceae in the available whole genome sequences (nine genomes; http://genome.jgi.doe.gov). More genomic studies are urgently needed in the Nectriaceae. Our study also highlights the importance of maintaining living cultures in public culture collections, as many of the genera included in this study were subjected to molecular analysis for the first time based on cultures collected at various times in history, while, on the other hand, several recently described taxa were unavailable for inclusion.

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APPENDIX

Recently Rossman et al. (2013) proposed generic names for acceptance or rejection in the families Bionectriaceae, Hypocreaceae and Nectriaceae. In this treatment, Clonostachys was recommended above Bionectria in the Bionectriaceae. Within the Hypocreaceae, Hypomycetes was recommended over Cladobotryum, Sphaerostilbella over Gliciadium, and Trichoderma over Hypocreus. In keeping with these proposals and in line with the International Code of Nomenclature for algae, fungi and plants (ICN; McNeill et al. 2012), new combinations are required in the genera Clonostachys, Hydropisphaera, Nectriopsis (Bionectriaceae), and Sphaerostilbella (Hypocreaceae), which are provided here.

BIONECTRIACEAE

Clonostachys apocyni (Peck) Rossman, L. Lombard & Crous, comb. nov. MycoBank MB810968.
Basionym: Nectria apocyni Peck, Bull. Buffalo Soc. Nat. Sci. 1: 71. 1873.
≡ Clonostachys apocyni (Peck) Kuntze, Rev. Gen. Plant. 3: 460. 1898.
≡ Bionectria apocyni (Peck) Schroers & Samuels, Z. Mykol. 63: 153. 1997.
≡ Nectria rugispora Pat., Bull. Trimestriel Soc. Mycol. France 8: 133. 1892.
≡ Cucurbitaria rugispora (Pat.) Kuntze, Rev. Gen. Plant. 3: 461. 1898.
≡ Nectria cameeolavida Penz. & Sacc., Malpighia 11: 511. 1897.
≡ Dendrodochium macrosporum Sacc. & Ellis, Michelia 2: 580. 1882.
≡ Clonostachys macrosora (Sacc. & Ellis) Schroers & W. Gams, Stud. Mycol. 46: 62. 2001.
≡ Dendrodochium roseomucosum Matsu., Matsuhash. Mycol. Mem. 8: 17. 1995.

Clonostachys aurantia (Penz. & Sacc.) Rossman, L. Lombard & Crous, comb. nov. MycoBank MB810969.
Basionym: Nectria aurantia Penz. & Sacc., Malpighia 11: 509. 1897.
≡ Bionectria aurantia (Penz. & Sacc.) Rossman, Samuels & Lowen, Mycológia 85: 698. 1993.

Clonostachys blumenavieae (Rehm) Rossman, L. Lombard & Crous, comb. nov. MycoBank MB810970.
Basionym: Nectria blumenavieae Rehm, Hedwigia 37: 192. 1898.

Clonostachys gibberosa (Schroers) Rossman, L. Lombard & Crous, comb. nov. MycoBank MB810971.
Basionym: Bionectria gibberosa Schroers, Stud. Mycol. 46: 198. 2001.

Clonostachys manihotis (Rick) Rossman, L. Lombard & Crous, comb. nov. MycoBank MB810972.
Basionym: Nectria manihotis Rick, Ann. Mycol. 8: 458. 1910.

Clonostachys parva (Schroers) Rossman, L. Lombard & Crous, comb. nov. MycoBank MB810973.
Basionym: Bionectria parva Schroers, Stud. Mycol. 46: 143. 2001.

Clonostachys tonduzii (Speg.) Rossman, L. Lombard & Crous, comb. nov. MycoBank MB810974.
Basionym: Bionectria tonduzii Speg., Bol. Acad. Nac. Ci. 579: 563. 1919.
≡ Nectria tonduzii (Speg.) Samuels, Mem. New York Bot. Gard. 48: 22. 1988.

Clonostachys tornata (Höhn.) Rossman, L. Lombard & Crous, comb. nov. MycoBank MB810975.
Basionym: Pseudonectria tornata (Höhn.) Sitzingsber. Akad. Wiss. Wien, Math.-Naturwiss. KI. 118: 1470. 1909.
≡ Bionectria tornata (Höhn.) Schroers, Stud. Mycol. 46: 184. 2001.
≡ Nectria sesquiphialis Samuels, Mem. New York Bot. Gard. 49: 276. 1989.
≡ Sesquiciphialum asymmetricum Samuels, Mem. New York Bot. Gard. 49: 276. 1989.
≡ Clonostachys asymmetrica (Samuels) Schroers, Stud. Mycol. 46: 184. 2001.

Note: The sexual-asexual morph connections for these species in Clonostachys are based on the monograph of Bionectria by Schroers (2001).

Hydropisphaera fusigera (Berk. & Broome) Rossman, L. Lombard & Crous, comb. nov. MycoBank MB810976.
Basionym: Monotospora fusigera Berk. & Broome, J. Linn. Soc., Bot. 14: 99. 1873.
≡ Gliomastix fusigera (Berk. & Broome) C.H. Dickinson, Mycol. Pap. 115: 7. 1968.
≡ Acremonium fusigera (Berk. & Broome) W. Gams, Cephalosporium-artige Schimmelpilze: 94. 1971.
≡ Hydropisphaera bambusicola Lechat, Mycotaxon 111: 96. 2010.

Notes: Lechat et al. (2010) linked the sexual morph Hydropisphaera bambusicola to the asexual morph Gliomastix fusigera.
The epithet of G. fusigera (≡ Monotospora fusigera (1973) is older, therefore takes priority, and the new combination is provided.

**Nectriopsis rexiana** (Sacc.) Rossman, L. Lombard & Crous, **comb. nov.** MycoBank MB810977. **Basionym**: Verticillium nanum subsp. rexianum Sacc., Michelia 2: 577. 1882.

\[=Verticillium niveotestaceum Lindau, Rabenh. Kryptogam.-Fl. Pflze – Fungi imperfect 1: 316. 1905.\]

\[=Hypomyces exigua Pat., Bull. Soc. Mycol. France 18: 180. 1902.\]

\[=Nectriopsis exigua (Pat.) W. Gams, Nematologica 50: 73. 1982.\]

\[=Nectria myxomycetica Samuels, Mem. New York. Bot. Gard. 48: 48. 1988.\]

**HYPOCREACEAE**

**Sphaerostilbella aurifila** (W.R. Gerard) Rossman, L. Lombard & Crous, **comb. nov.** MycoBank MB810979. **Basionym**: Stilbum aurifilium W.R. Gerard, Bull. Torrey Bot. Club. 5: 39. 1874.

\[=Ciliocapnodium aurifilium (W.R. Gerard) Cooke, Grevillea 19: 14. 1890.\]

\[=Dendrostilbella aurifila (W.R. Gerard) Seifert & J.A. Mackinnon, Mycologia 75: 324. 1983.\]

\[=Sphaerostilbella lutea (Henn.) Sacc., Mycologia 16: 85. 1924.\]

\[=Sphaerostilbella lutea (Henn.) Sacc., Syll. Fung. 2: 398. 1905.\]

\[=Stilbum aureonitens (Tul. & C. Tul.) Kuntze, Rev. Gen. Plant. 3: 488. 1898.\]

\[=Nectriopsis aureonitens (Tul. & C. Tul.) Maire, Ann. Mycol. 32: 136. 1934.\]

\[=Sphaerostilbella aureonitens (Tul. & C. Tul.) Petch, J. Bot. 74: 220. 1937.\]

\[=Sphaerostilbella aureonitens (Tul. & C. Tul.) Seifert, Samuels & W. Gams, Stud. Mycol. 27: 145. 1985.\]

**Sphaerostilbella penicillioiides** (Corda) Rossmann, L. Lombard & Crous, **comb. nov.** MycoBank MB810978. **Basionym**: Glicadium penicillioiides Corda, Icon. Fungorum hucusque Cogn. 4: 31. 1840.

\[=Hypomyces auronincens Tul. & C. Tul., Selecta Fungorum Carologiae: Nectrioe- Phacidie- Pezizie 3: 64. 1865.\]

\[=Hypolyssus auronincens (Tul. & C. Tul.) Kuntze, Rev. Gen. Plant. 3: 488. 1898.\]

\[=Nectriopsis auronincens (Tul. & C. Tul.) Maire, Ann. Mycol. 9: 323. 1911.\]

\[=Hyphonoecia auronincens (Tul. & C. Tul.) Petch, J. Bot. 74: 220. 1937.\]

\[=Sphaerostilbella aureonincens (Tul. & C. Tul.) Seifert, Samuels & W. Gams, Stud. Mycol. 27: 145. 1985.\]
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