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Phylogeny and taxonomy of the scab and spot anthracnose fungus *Elsinoë* (*Myriangiales*, *Dothideomycetes*)

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Abstract: Species of *Elsinoë* are phytopathogens causing scab and spot anthracnose on many plants, including some economically important crops such as avocado, citrus, grapevines, and ornamentals such as poinsettias, field crops and woody hosts. Disease symptoms are often easily recognisable, and referred to as signature-bearing diseases, for the cork-like appearance of older infected tissues with scab-like appearance. In some *Elsinoë*-host associations the resulting symptoms are better described as spot anthracnose. Additionally the infected plants may also show mild to severe distortions of infected organs. Isolation of *Elsinoë* in pure culture can be very challenging and examination of specimens collected in the field is often frustrating because of the lack of fertile structures. Current criteria for species recognition and host specificity in *Elsinoë* are unclear due to overlapping morphological characteristics, and the lack of molecular and pathogenicity data. In the present study we revised the taxonomy of *Elsinoë* based on DNA sequence and morphological data derived from 119 isolates, representing 67 host genera from 17 countries, including 64 ex-type cultures. Combined analyses of ITS, LSU, *rpb2* and *TEF1-α* DNA sequence data were used to reconstruct the backbone phylogeny of the genus *Elsinoë*. Based on the single nomenclature for fungi, 26 new combinations are proposed in *Elsinoë* for species that were originally described in *Sphaceloma*. A total of 13 species are epitypified with notes on their taxonomy and phylogeny. A further eight new species are introduced, leading to a total of 75 *Elsinoë* species supported by molecular data in the present study. For the most part species of *Elsinoë* appear to be host specific, although the majority of the species treated are known only from a few isolates, and further collections and pathogenicity studies will be required to reconfirm this conclusion.

Key words: anthracnose, molecular phylogeny, scab disease, *Sphaceloma*, taxonomy.

Taxonomic novelties: New species: *Elsinoë asclepiadea* Fan, R.W. Barreto & Crous, *E. citricola* Fan, R.W. Barreto & Crous, *E. embeliae* Thirum. & Naras., *E. euphorbiae* Fan & Crous, *E. fici-caricae* Wani & Thirum., *E. genipae-americanae* Fan & Crous, *E. jasminicola* Fan & Crous, *E. salicina* Fan & Crous; **New combinations:** *E. abutilonis* (Bitanc. & Jenkins) Fan & Crous, *E. anacardii* (Wani & Thirum.) Fan & Crous, *E. banksiicola* (Pascoe & Crous) Fan & Crous, *E. barleriicola* (Wani & Thirum.) Fan & Crous, *E. bidentis* (Bitanc. & Jenkins) Fan & Crous, *E. coryli* (Vegh & M. Bourgeois) Fan & Crous, *E. fagarae* (Bitanc. & Jenkins) Fan & Crous, *E. flacourtiae* (Thirum. & Naras.) Fan & Crous, *E. genipae* (Bitanc.) Fan & Crous, *E. glycines* (Kurata & Kurib.) Fan & Crous, *E. hederae* (Bitanc. & Jenkins) Fan & Crous, *E. ichnocarpi* (Thirum. & Naras.) Fan & Crous, *E. krugii* (Bitanc. & Jenkins) Fan, R.W. Barreto & Crous, *E. lagoa-santensis* (Bitanc. & Jenkins) Fan & Crous, *E. lippiae* (R.C. Baines & Cummins) Fan & Crous, *E. menthae* (Jenkins) Fan & Crous, *E. pongamiae* (Wani & Thirum.) Fan & Crous, *E. populi* (Sacc.) Fan & Crous, *Elsinoë rhois* (Bitanc. & Jenkins) Fan & Crous, *E. ricini* (Jenkins & C.C. Cheo) Fan & Crous, *E. semecarpi* (Wani & Thirum.) Fan & Crous, *E. sesseae* (Bitanc. & Jenkins) Fan & Crous, *E. sicula* (Ciccar.) Fan & Crous, *E. tectificae* (Cheew. & Crous) Fan & Crous, *E. terminaliae* (Bitanc.) Fan & Crous, *E. violae* (Massey & Jenkins) Fan & Crous; **Epitypifications (basionyms):** *Aulographum ledi* Peck, *Elsinoë brasiliensis* Bitanc. & Jenkins, *Elsinoë erythrinae* Sivan. & L.D. Gómez, *Elsinoë mimosae* Viégas, *Elsinoë rosarum* Jenkins & Bitanc., *Elsinoë solidaginis* Jenkins & Ukkelberg, *Elsinoë verbenae* Bitanc. & Jenkins, *Plectodiscella veneta* Burkh., *Sphaceloma glycines* Kurata & Kurib., *Sphaceloma krugii* Bitanc. & Jenkins, *Sphaceloma menthae* Jenkins, *Sphaceloma pongamiae* Wani & Thirum., *Sphaceloma terminaliae* Bitanc.

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INTRODUCTION

All members of the genus *Elsinoë* (*Myriangiales*, *Ascomycota*) are specialised plant parasites causing diseases on many plant hosts, including some economically important crops such as avocado, cassava, citrus, grapevines, ornamentals such as poinsettias, field crops and woody hosts. Many species cause "signature-bearing diseases" easily recognised for their symptom-marker cork-like necrotic tissues. These are often raised, exhibiting cracks, and hence are referred to as scabs. In other *Elsinoë*-host associations the symptoms that result from infection are different and are often called anthracnose (such as in infected grapevines) (Barrus & Horsfall 1928, Jenkins 1947, Farr *et al.* 1989, Pan 1994, Phillips 1994, Gottwald 1995). Nevertheless the use of this name for a plant disease caused by *Elsinoë* is somewhat confusing because of its much broader use for diseases caused by *Colletotrichum*. Spot anthracnose was an alternative name recommended by Jenkins (1947). Some hosts develop severe distortions of infected organs, such as stem elongation in cassava, or twisting of infected stems of *Bidens* spp. (Guatimosim *et al.* 2015). In the case of the cassava pathogen production of Gibberellin-A4 was demonstrated independently by Rademacher & Graebe (1979), and Zeigler *et al.* (1980), suggesting the involvement of plant growth hormone analogues produced by the fungus in other *Elsinoë*-plant associations. Although scab symptoms are easily recognised,

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Studies in Mycology

Fig. 1. Disease symptoms associated with *Elsinoë* spp. **A.** *Anacardium* sp. **B.** *Melia azedarach*. **C.** *Lobelia fistulosa*. **D.** *Alternanthera phyloxeroides*. **E.** *Hovenia* sp.

examination of specimens collected in the field is often frustrating because of the lack of fertile structures. In addition, isolation of *Elsinoë* in pure culture can be very challenging because of their slow growth and resulting cultures easily becoming overgrown by contaminants. Although many species of the scab fungus have been described under *Elsinoë* or *Sphaceloma*, only a few cause important diseases (Holliday 1980). Economically important diseases include avocado scab caused by *E. perseae*, citrus scab caused by *E. fawcettii* and *E. australis*, bean scab caused by *E. canavaliae* and *E. phaseoli*, grape spot anthracnose caused by *E. ampelina*, and cassava superelongation caused by "*Sphaceloma manihoticola*" (Jenkins 1925, Shear 1929, Jenkins 1931, Bruner & Jenkins 1933, Bitancourt & Jenkins 1936a, b, Boedijn 1961, Tan *et al.* 1996) (Fig. 1). In many cases the main impact is on the appearance of the harvested product, and its market acceptability rather than on crop productivity (Swart *et al.* 2001). On the positive side, several *Elsinoë* species cause devastating diseases on important agricultural and environmental weeds and are beneficial species in this regard. Some examples are the scab fungi attacking alligator weed (*Alternanthera philoxeroides*), giant sensitive plant (*Mimosa diplotricha*), beggar tick (*Bidens pilosa*) (Guatimosim *et al.* 2015), and wild poinsettia (*Euphorbia heterophylla*) (Barreto & Evans 1998, Nechet *et al.* 2004).

The order *Myriangiales* has two accepted families, namely *Elsinoaceae* and *Myriangiaceae*, which represent a sister group to *Dothideales*, the type order of the *Dothideomycetes* (Li *et al.* 2011, Hyde *et al.* 2013, Dissanayake *et al.* 2014, Jayawardena *et al.* 2014). They generally have crustose to pulvinate, irregular ascostromata, in which the scattered asci are irregularly arranged in individual locules. Ascospores are hyaline to brown, transversely septate or muriform, which are irregularly arranged and liberated only by the breakup of the stromatal layers above them (Kirk *et al.* 2008, Hyde *et al.* 2013). Asexual morphs of *Elsinoaceae* are acervular coelomycetous fungi with polyphialidic conidiogenous cells, such as the *Sphaceloma* asexual morph of *Elsinoë* in the present study (Jenkins 1932b, Kirk *et al.* 2008). Since the *Myriangiales* was introduced by Starbäck (1899), its classification has undergone several changes. Frederick & Frederick (1947) placed four families in this order (*Dothioraceae*, *Elsinoaceae*, *Myriangiaceae* and *Pseudosphaeriaceae*). von Arx (1963) originally reduced the *Myriangiales* to include the *Myriangiaceae* and *Saccardiaceae*, but later circumscribed the order to include a single family, *Myriangiaceae* (von Arx & Müller 1975). Subsequent treatments by other workers again saw an increase in the number of families, with Barr (1979) originally recognising seven, and later five (Eriksson & Hawksworth 1986, Barr 1987). The first multigene phylogenetic treatment was published by Schoch *et al.* (2006), who placed two families (*Elsinoaceae* and *Myriangiaceae*) in *Myriangiales*, with sister groups being delineated in subsequent studies (Tsuneda *et al.* 2008, Schoch *et al.* 2009). Kirk *et al.* (2008) included three families (*Cookellaceae*, *Elsinoaceae* and *Myriangiaceae*), while Lumbsch & Huhndorf (2010) accepted only *Elsinoaceae* and *Myriangiaceae*, and treated *Cookellaceae* as *incertae sedis* in *Dothideomycetes*, a conclusion that was supported by Hyde *et al.* (2013).

The *Elsinoaceae* was proposed by Saccardo & Trotter (1913) after the invalid "*Elsinoëen*" was introduced by von Höhnel (1909) as a separate family from *Myriangiaceae*, because of habitat and morphological characters. Woronichin (1914) treated this family as a synonym of *Plectodiscellaceae* based on a single species *Plectodiscella piri*, which he found occurring on the leaves of apple and pear. Jenkins (1932a) regarded *Elsinoë* as valid name, and Frederick & Frederick (1947) placed *Elsinoaceae* in the *Myriangiales*. However, von Arx & Müller (1975) placed *Elsinoë*, the type genus of the *Elsinoaceae*, in the *Myriangiaceae* according to the immersed or erumpent, pulvinate or irregular ascostromata, and being restricted to foliar pathogens causing scab disease. Based on observations of their restricted hosts, Barr (1979, 1987) and Eriksson (1981) suggested that *Elsinoaceae* and *Myriangiaceae* should be maintained as two separate families in the *Myriangiales*.

The genus *Elsinoë* was introduced by Raciborski (1900) with descriptions of three species (*E. antidesmae, E. canavaliae* and *E. menispermacearum*). It is characterised by forming scab-like lesions with pseudoascostromata containing three to eight bitunicate asci inside each locule. Asci are saccate to globose with eight hyaline, oblong or fusiform, septate ascospores (Fig. 2). The asexual morph is the acervular coelomycetous *Sphaceloma*, which has polyphialidic conidiogenous cells and hyaline, ellipsoid, aseptate conidia. Jenkins (1932a) treated *Plectodiscella* as a synonym of *Elsinoë* and proposed a connection between *Sphaceloma* and the sexual morph *Elsinoë*, supported by later studies using molecular data (Swart *et al.* 2001). More than 140 species epithets named *Elsinoë* and more than 160 epithets of *Sphaceloma* asexual species have been recorded in Index Fungorum and MycoBank, with an estimated 48 species of *Elsinoë* and 52 species of *Sphaceloma* in Kirk *et al.* (2008). Morphological characteristics of *Elsinoë* species are difficult to

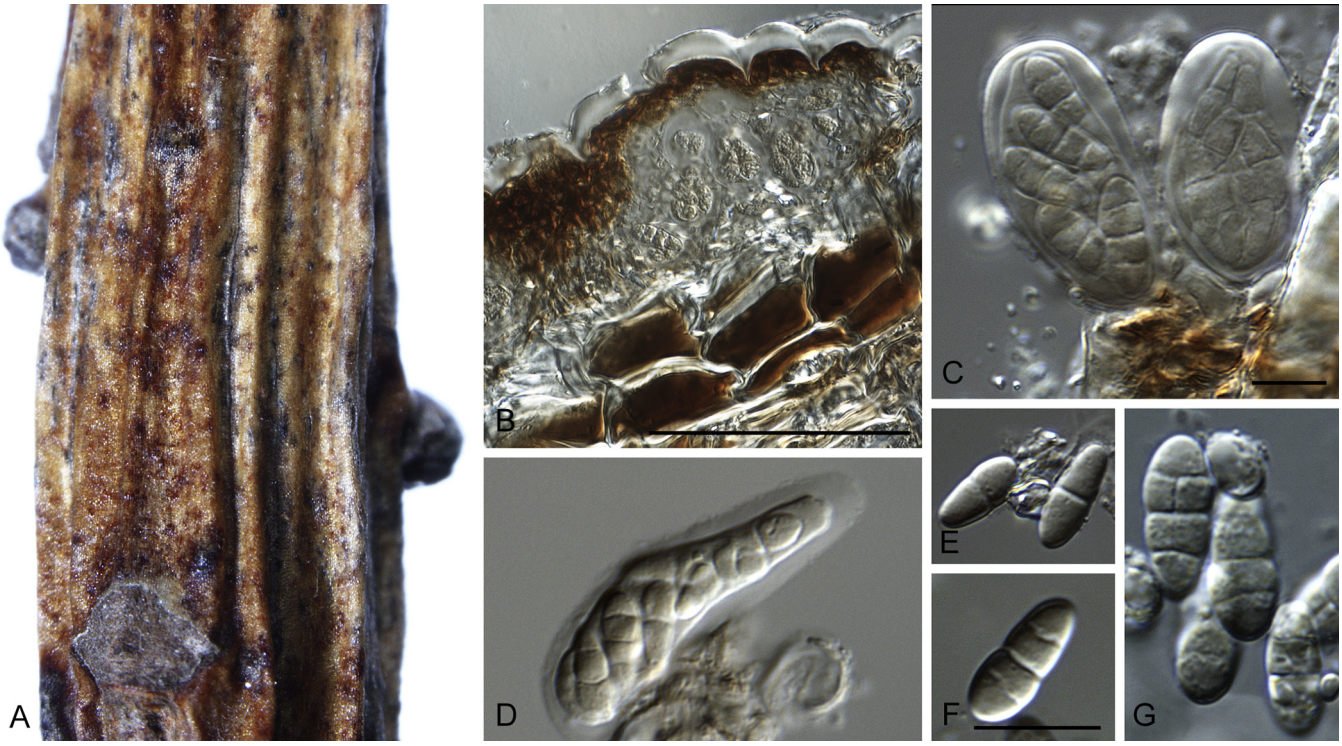

Fig. 2. *Elsinoë fecunda*. **A.** Symptomatic stem. **B.** Subcuticular ascoma. **C, D.** Asci. **E–G.** Ascospores. Scale bars = 10 µm.

observe, as the sexual morph is uncommon in nature, and the frequently observed asexual *Sphaceloma* morph is usually morphologically conserved. Molecular tools have therefore become increasingly important in resolving the connections between different stages of the lifecycle, and the interpretation of morphological variation (Cheewangkoon *et al.* 2009). Swart *et al.* (2001) delineated six *Elsinoë* species associated with scab disease of *Proteaceae* from Australia, California (USA), South Africa, and Zimbabwe, and proposed three new species supported by ITS rDNA sequence data. Similar studies were conducted to describe *Elsinoë* species associated with other plant hosts (Summerell *et al.* 2006, Everett *et al.* 2011, Crous *et al.* 2015b, 2016). In their phylogeny of the genus, Jayawardena *et al.* (2014) included 12 *Elsinoë* species based on multi-gene data available in GenBank at the time. Ex-type sequence data is, however, available for only a few species. The far majority of the *Elsinoë* species described to date will therefore need to be recollected and epitypified. To facilitate species recognition in *Elsinoë* therefore, a phylogenetic backbone would first have to be established. The objectives of the present study were (i) to clarify species boundaries among *Elsinoë* isolates from various host genera distributed over 17 countries; (ii) to provide a multi-gene phylogeny for the genus *Elsinoë* based on a large set of well-identified cultures deposited in the CBS culture collection, supplemented by freshly collected specimens; (iii) to link *Elsinoë* names to their *Sphaceloma* asexual morphs; and (iv) to try and elucidate host specificity or the relationship between *Elsinoë* species and their respective host plants.

MATERIAL AND METHODS

Isolates

One hundred and nineteen *Elsinoë* isolates from 67 host genera representing 17 countries, including 64 ex-type isolates were included in this study (Table 1). The majority of the isolates were obtained from the Westerdijk Fungal Biodiversity Institute, Utrecht, The Netherlands (CBS) (Table 1), while freshly collected specimens were placed in the working collection of Pedro Crous (CPC) housed at the Westerdijk Institute. Freeze-dried isolates were revived in 2 mL malt/peptone (50 %/50 %) and subsequently transferred to 2 % malt extract agar (MEA; Crous *et al.* 2009), and incubated at 22 °C under a natural day-night cycle. For fresh specimens, single-conidial isolates were obtained using techniques from Crous *et al.* (1991). Additionally, an effort was conducted by R.W. Barreto to recollect scab fungi described in the past in Brazil allowing for epitypification of taxa lacking pure cultures. Surveys were concentrated in the State of São Paulo (from which most taxa described by A. Bitancourt and A. E. Jenkins were collected) but also included other south-eastern and southern Brazilian states, mostly in 2010 but with *ad hoc* collections continuing in later years.

DNA isolation, amplification and sequencing

Genomic DNA was extracted using the Wizard® Genomic DNA Purification Kit (Promega, Madison, WI, USA) following the manufacturer's instructions, from fungal mycelium growing on MEA. The ITS region was amplified with the primers ITS5 and ITS4 (White *et al.* 1990), the LSU region with the primers LR0R (Rehner & Samuels 1994) and LR5 (Vilgalys & Hester 1990), the *rpb2* region with primers RPB2-5F2 (Sung *et al.* 2007) and fRPB2-7cR (Liu *et al.* 1999), and the *TEF1-α* gene with the primers elongation-1-F and elongation-1-R (Hyun *et al.* 2001, 2009). The PCR mixture for the all regions consisted of 1 µL genomic DNA, 3 mM $MgCl_2$, 20 µM of each dNTP, 0.2 µM of each primer and 0.25 U BIOTAQ DNA polymerase (Bioline). Conditions for PCR of ITS and LSU genes constituted an initial denaturation step of 2 min at 95 °C, followed by 35 cycles of 30 s at 95 °C, 30 s at 48 °C and 1 min at 72 °C, and a final denaturation step of 8 min at 72 °C, while the *TEF1-α* gene was performed as described by

Table 1. Strains of *Elsinoë* used in this study and their GenBank accession numbers.

Species	Culture accession number(s)	Host	Country	GenBank accession numbers			
				ITS	LSU	*rpb2*	*TEF1-α*
Elsinoë abutilonis	CBS 510.50^{T}	*Callianthe striata* (syn. *Abutilon striatum*)	Brazil	KX887185	KX886949	KX887068	KX886831
E. ampelina	CBS 208.25	*Vitis vinifera*	Brazil	KX887186	KX886950	KX887069	KX886832
E. anacardii	CBS 211.63	*Annona squamosa*	India	KX887187	KX886951	KX887070	KX886833
	CBS 404.63	*Rosa* sp.	India	KX887188	KX886952	KX887071	KX886834
	CBS 470.62^{T}	*Anacardium occidentale*	India	KX887189	KX886953	KX887072	KX886835
E. annonae	CBS 228.64	*Annona* sp.	USA	KX887190	KX886954	KX887073	KX886836
E. arachidis	CBS 511.50^{T}	*Arachis hypogaea*	Brazil	KX887191	KX886955	KX887074	KX886837
	CPC 18529 = RWB 1135	*A. repens*	Brazil	KX887192	KX886956	KX887075	KX886838
	CPC 18533 = RWB 1159	*A. repens*	Brazil	KX887193	KX886957	KX887076	KX886839
E. arrudai	CBS 220.50^{T}	*Tournefortia breviflora*	Brazil	KX887194	KX886958	KX887077	KX886840
E. asclepiadea^{N}	CPC 18544^{T} = RWB 1202 = CBS 141937	*Asclepias mellodora* (syn. *A. curassavica*)	Brazil	KX887195	KX886959	KX887078	KX886841
E. australis^{E}	CBS 229.64	*Citrus aurantiifolia*	Brazil	KX887196	KX886960	KX887079	KX886842
	CBS 230.64	*C. aurantium*	Argentina	KX887197	KX886961	KX887080	KX886843
	CBS 314.32^{T}	*C. aurantium*	Brazil	KX887198	KX886962	KX887081	KX886844
E. banksiicola	CBS 113734^{T} = CPC 1508 = CPC 1510	*Banksia prionote*	Australia	KX887199	KX886963	KX887082	KX886845
E. barleriicola	CBS 471.62^{T} = ATCC 14658	*Barleria gibsonii*	India	KX887200	KX886964	KX887083	KX886846
E. bidentis	CBS 512.50^{T}	*Bidens pilosa*	Brazil	KX887201	KX886965	KX887084	KX886847
	CPC 18526 = RWB 1127	*B. segetum*	Brazil	KX887202	KX886966	KX887085	KX886848
	CPC 18586 = RWB 1280	*B. segetum*	Brazil	KX887203	KX886967	KX887086	KX886849
E. brasiliensis	CPC 18528 = RWB 1133	*Chamaesyce hyssopifolia*	Brazil	KX887204	N/A	KX887087	KX886850
E. caleae	CBS 221.50^{T}	*Calea pinnatifida*	Brazil	KX887205	KX886968	KX887088	KX886851
E. centrolobii	CBS 222.50^{T}	*Centrolobium robustum*	Brazil	KX887206	KX886969	KX887089	KX886852
E. citricola^{N}	CPC 18535^{T} = RWB 1175	*C. limonia*	Brazil	KX887207	KX886970	KX887090	KX886853
	CPC 18570 = RWB 1253	*C. limonia*	Brazil	KX887208	KX886971	KX887091	KX886854
E. coryli	CBS 275.76^{T}	*Corylus avellana*	France	KX887209	KX886972	KX887092	KX886855
E. diospyri	CBS 223.50^{T}	*Diospyros kaki*	Brazil	KX887210	KX886973	KX887093	KX886856
E. embeliae	CBS 472.62^{T}	*Embelia ribes*	India	KX887211	KX886974	N/A	KX886857
E. erythrinae^{E}	CPC 18530 = RWB 1138	*Erythrina* sp.	Brazil	KX887212	KX886975	KX887094	KX886858
	CPC 18540 = RWB 1192	*Erythrina* sp.	Brazil	KX887213	KX886976	KX887095	KX886859
	CPC 18542^{T} = RWB 1196	*Erythrina* sp.	Brazil	KX887214	KX886977	KX887096	KX886860
E. eucalypticola	CBS 124765^{T} = CPC 13318	*Eucalyptus* sp.	Australia	KX887215	KX886978	KX887097	KX886861
E. eucalyptorum	CBS 120084^{T} = CPC 13052	*E. propinqua*	Australia	KX887216	KX886979	KX887098	KX886862
E. euphorbiae ^{N}	CBS 401.63^{T}	*Euphorbia parviflora* (syn. *Euphorbia pilulifera*)	India	KX887217	KX886980	KX887099	KX886863
E. fagarae	CBS 514.50^{T}	*Fagara riedelianum*	Brazil	KX887218	KX886981	KX887100	KX886864
E. fawcettii	CBS 139.25^{T}	*Citrus* sp.	USA	KX887219	KX886982	KX887101	KX886865
	CBS 231.64	*C. aurantiifolia*	USA	KX887220	KX886983	KX887102	KX886866
	CBS 232.64	*C. limon*	USA	KX887221	KX886984	KX887103	KX886867
	CBS 233.64	*C. aurantium*	Panama	KX887222	KX886985	KX887104	KX886868
E. fici	CBS 515.50	*Ficus luschnathiana*	Brazil	KX887223	KX886986	KX887105	KX886869
E. fici-caricae^{N}	CBS 473.62^{T} = ATCC 14652	*F. carica*	India	KX887224	KX886987	KX887106	KX886870
E. flacourtiae	CBS 474.62^{T} = ATCC 14654	*Flacourtia sepiaria*	India	KX887225	KX886988	KX887107	KX886871
E. freyliniae	CBS 128204^{T} = CPC 18335	*Freylinia lanceolata*	South Africa	KX887226	KX886989	KX887108	KX886872
E. genipae	CBS 342.39^{T}	*Genipa americana*	Brazil	KX887227	KX886990	KX887109	KX886873
E. genipae-americanae^{N}	CBS 516.50^{T}	*G. americana*	Brazil	KX887228	KX886991	KX887110	KX886874
E. glycines^{E}	CBS 389.64^{T}	*Glycine soja*	Japan	KX887229	KX886992	KX887111	KX886875
	CBS 390.64	*G. soja*	Japan	KX887230	KX886993	KX887112	KX886876
E. hederae	CBS 517.50^{T}	*Hedera helix*	Brazil	KX887231	KX886994	KX887113	KX886877
E. ichnocarpi	CBS 475.62^{T} = ATCC 14655	*Ichnocarpus frutescens*	India	KX887232	KX886995	KX887114	KX886878
E. jasminae	CBS 224.50^{T}	*Jasminum sambac*	Brazil	KX887233	KX886996	KX887115	KX886879
E. jasminicola^{N}	CBS 212.63^{T}	*J. malabaricum*	India	KX887234	KX886997	N/A	KX886880

Table 1. (Continued).

Species	Culture accession number(s)	Host	Country	GenBank accession numbers			
				ITS	LSU	*rpb2*	*TEF1-α*
E. krugii[E]	CPC 18531[T] = RWB 1151	*Euphorbia heterophylla*	Brazil	KX887235	KX886998	KX887116	KX886881
	CPC 18537 = RWB 1189	*E. pulcherrima*	Brazil	KX887236	KX886999	KX887117	KX886882
	CPC 18554 = RWB 1228	*E. heterophylla*	Brazil	KX887237	KX887000	KX887118	KX886883
	CPC 18579 = RWB 211	*E. heterophylla*	Brazil	KX887238	KX887001	KX887119	KX886884
E. lagoa-santensis	CBS 518.50[T]	*Byrsonima coccolobifolia*	Brazil	KX887239	KX887002	KX887120	KX886885
E. ledi[E]	CBS 167.33[T]	*Rhododendron neoglandulosum* (syn. *Ledum glandulosum*)	USA	KX887240	KX887003	KX887121	KX886886
E. lepagei	CBS 225.50[T]	*Manilkara zapota* (syn. *Achras sapota*)	N/A	KX887241	KX887004	KX887122	N/A
E. leucospermi	CBS 111207[T] = CPC 1380	*Leucospermum* sp.	South Africa	KX887242	KX887005	KX887123	KX886887
	CBS 111671 = CPC 1504	*Leucospermum* sp.	Australia	KX887243	KX887006	KX887124	KX886888
	CBS 111672 = CPC 1503	*Leucospermum* sp.	Australia	KX887244	KX887007	KX887125	KX886889
	CBS 111673 = CPC 1502	*Leucospermum* sp.	Australia	KX887245	KX887008	KX887126	KX886890
	CBS 112367 = CPC 3699	*Leucospermum cordifolium*	Australia	KX887246	KX887009	KX887127	KX886891
	CBS 115500 = CPC 5236	*Leucospermum* sp.	Spain	KX887247	KX887010	KX887128	KX886892
E. lippiae	CBS 166.40[T]	*Phyla lanceolata* (syn. *Lippia lanceolate*)	USA	KX887248	KX887011	KX887129	KX886893
E. mangiferae	CBS 226.50[T]	*Mangifera foetida* (syn. *M. indica*)	Cuba	KX887249	KX887012	KX887130	KX886894
E. mattiroloanum	CBS 287.64	*Arbutus unedo*	Argentina	KX887250	KX887013	KX887131	KX886895
	CBS 348.36	*A. unedo*	Argentina	KX887251	KX887014	KX887132	KX886896
E. menthae[E]	CBS 321.37	*Mentha piperita*	USA	KX887252	KX887015	KX887133	KX886897
	CBS 322.37[T]	*M. piperita*	USA	KX887253	KX887016	KX887134	KX886898
E. mimosae[E]	CBS 141943 = CPC 18518	*Mimosa invisa*	Ecuador	KX887254	KX887017	KX887135	KX886899
	CPC 19478[T]	*M. invisa*	Brazil	KX887255	KX887018	KX887136	KX886900
E. oleae	CBS 227.59[T]	*Olea europaea*	Italy	KX887256	KX887019	KX887137	KX886901
E. othonnae	CBS 139910[T] = CPC 24853	*Othonna quinquedentata*	South Africa	N/A	N/A	N/A	N/A
E. perseae	CBS 288.64	*Persea americana*	Brazil	KX887257	KX887020	KX887138	KX886902
	CBS 406.34[T]	*P. americana*	USA	KX887258	KX887021	KX887139	KX886903
E. phaseoli	CBS 149.95	*Phaseolus vulgaris*	South Africa	KX887259	KX887022	KX887140	KX886904
	CBS 150.95	*P. vulgaris*	South Africa	KX887260	KX887023	KX887141	KX886905
	CBS 151.95	*P. vulgaris*	Malawi	KX887261	KX887024	KX887142	KX886906
	CBS 152.95	*P. vulgaris*	Malawi	KX887262	KX887025	KX887143	KX886907
	CBS 165.31[T]	*P. lunatus*	Cuba	KX887263	KX887026	KX887144	KX886908
	CBS 234.64	*P. lunatus*	Cuba	KX887264	KX887027	KX887145	KX886909
	CBS 113062 = CPC 4697	N/A	N/A	KX887265	KX887028	KX887146	KX886910
	CBS 113066 = CPC 4694	N/A	N/A	KX887266	KX887029	KX887147	KX886911
E. piri	CBS 163.29	*Pyrus communis*	N/A	KX887267	KX887030	KX887148	KX886912
	CBS 179.82	*Malus sylvestris*	New Zealand	KX887268	KX887031	KX887149	KX886913
E. pitangae	CBS 227.50[T]	*Eugenia pitanga*	Brazil	KX887269	KX887032	KX887150	KX886914
E. poinsettiae	CBS 109333	*E. pulcherrima*	Guatemala	KX887270	KX887033	KX887151	KX886915
	CBS 109334	*E. pulcherrima*	Guatemala	KX887271	KX887034	KX887152	KX886916
E. pongamiae[E]	CBS 402.63[T]	*Pongamia pinnata*	India	KX887272	KX887035	KX887153	KX886917
E. populi	CBS 289.64	*Populus deltoides* subsp. *deltoides* (syn. *P. serotine*)	Argentina	KX887273	KX887036	KX887154	KX886918
	CBS 290.64	*P. deltoides* subsp. *deltoides* (syn. *P. serotine*)	Argentina	KX887274	KX887037	KX887155	KX886919
E. proteae	CPC 1349[T]	*Protea cynaroides*	South Africa	N/A	N/A	N/A	N/A
E. protearum	CBS 113618[T]	*Protea* sp.	Zimbabwe	KX887275	KX887038	KX887156	KX886920
E. punicae	CPC 19968	*Punica granatum*	South Africa	KX887276	KX887039	KX887157	KX886921
E. quercus-ilicis	CBS 232.61[T]	*Quercus ilex*	Italy	KX887277	KX887040	N/A	KX886922
Elsinoë randii	CBS 170.38[T]	*Carya* sp.	Brazil	KX887278	KX887041	KX887158	KX886923
	CBS 171.38[T]	*Carya* sp.	Brazil	KX887279	KX887042	KX887159	KX886924
E. rhois	CBS 519.50[T]	*Toxicodendron vernix* (syn. *Rhus vernix*)	Brazil	KX887280	KX887043	KX887160	KX886925
E. ricini	CBS 403.63 = ATCC 15030	*Ricinus communis*	India	KX887281	KX887044	KX887161	KX886926

(*continued on next page*)

Table 1. (Continued).

Species	Culture accession number(s)	Host	Country	GenBank accession numbers			
				ITS	LSU	*rpb2*	*TEF1-α*
E. rosarum[E]	CBS 150.27	*Rosa* sp.	N/A	KX887282	KX887045	KX887162	KX886927
	CBS 212.33[T]	*Rosa* sp.	USA	KX887283	KX887046	KX887163	KX886928
	CBS 213.33	*Rosa* sp.	USA	KX887284	KX887047	KX887164	KX886929
	CBS 235.64	*Rosa* sp.	USA	KX887285	KX887048	KX887165	KX886930
E. salicina[N]	CPC 17824[T]	*Salix* sp.	USA	KX887286	KX887049	KX887166	KX886931
E. semecarpi	CBS 477.62[T] = ATCC 14657	*Melanochyla caesia* (syn. *Semecarpus anacardium*)	India	KX887287	KX887050	KX887167	KX886932
E. sesseae	CPC 18549 = RWB 1219	*Cestrum laevigatum?*	Brazil	KX887288	KX887051	KX887168	KX886933
E. sicula	CBS 398.59[T]	*Prunus amygdalus*	Italy	KX887289	KX887052	KX887169	KX886934
E. solidaginis[E]	CBS 191.37[T]	*Solidago fistulosa*	USA	KX887290	KX887053	KX887170	KX886935
Elsinoë sp.	CBS 128.14	N/A	N/A	KX887291	KX887054	KX887171	KX886936
E. tectificae	CBS 124777[T] = CPC 14594	*E. tectifera*	Australia	KX887292	KX887055	KX887172	KX886937
E. terminaliae[E]	CBS 343.39[T]	*Terminalia catappa*	Brazil	KX887293	KX887056	KX887173	N/A
	CPC 18538	*T. catapa*	Brazil	KX887294	KX887057	KX887174	KX886938
E. theae	CBS 228.50[T]	*Camellia sinensis* (syn. *Thea sinensis*)	Brazil	KX887295	KX887058	KX887175	KX886939
E. tiliae	CBS 350.73 = ATCC 24510	*Tilia cordata*	New Zealand	KX887296	KX887059	KX887176	KX886940
E. veneta[E]	CBS 164.29[T] = ATCC 1833	*Rubus* sp.	N/A	KX887297	KX887060	KX887177	KX886941
E. verbenae[E]	CPC 18561[T] = RWB 1232	*Verbena bonariensis*	Brazil	KX887298	KX887061	KX887178	KX886942
	CPC 18563	*V. bonariensis*	Brazil	KX887299	KX887062	KX887179	KX886943
E. violae	CBS 294.38	N/A	USA	KX887300	KX887063	KX887180	KX886944
	CBS 333.29	*Symphoricarpos albus* var. *laevigatus*	N/A	KX887301	KX887064	KX887181	KX886945
	CBS 336.35[T]	*Viola* sp.	USA	KX887302	KX887065	KX887182	KX886946
E. zizyphi	CBS 378.62[T] = ATCC 14656	*Zizyphus rugosa*	India	KX887303	KX887066	KX887183	KX886947
Myriangium hispanicum	CBS 247.33	*Acer monspessulanum*	N/A	KX887304	KX887067	KX887184	KX886948

T: ex-type strain; N: new species; E: epitype designated in this study.

Hyun *et al.* (2009). For the *rpb2* amplification, the amplification consisted of 5 cycles of 45 s at 95 °C, 45 s at 56 °C and 2 min at 72 °C, then 5 cycles with a 53 °C annealing temperature and 30 cycles with a 50 °C annealing temperature. The PCR products were sequenced in two directions using the PCR primers and the BigDye Terminator v. 3.1 Cycle Sequencing Kit (Applied Biosystems, Foster City, CA, USA), and performed with an ABI Prism 3730xl DNA Analyzer (Applied Biosystems) according to the manufacturer's instructions.

Phylogenetic analyses

DNA sequences generated by each primer combination were used to obtain consensus sequences using SeqMan v. 7.1.0 in the DNASTAR Lasergene core suite software (DNASTAR Inc., Madison, WI, USA). Sequences were aligned using MAFFT v. 6 (Katoh & Standley 2013) and edited manually using MEGA v. 6.0 (Tamura *et al.* 2013). A partition homogeneity test (PHT) with heuristic search and 1 000 homogeneity replicates was performed using PAUP v. 4.0b10 to test the discrepancy among the ITS, LSU, *rpb2* and *TEF1-α* sequence datasets in reconstructing phylogenetic trees. A maximum parsimony (MP) analysis was performed using PAUP v. 4.0b10 with a heuristic search option of 1 000 random-addition sequences with a tree bisection and reconnection (TBR) branch swapping algorithm (Swofford 2003). The branches of zero length were collapsed and all equally most parsimonious trees were saved. Other parsimony scores such as tree length (TL), consistency index (CI), retention index (RI) and rescaled consistency (RC) were calculated (Swofford 2003).

MrModeltest v. 2.3 was used to estimate the best nucleotide substitution model settings for each gene (Posada & Crandall 1998). Bayesian inference (BI) was performed based on the optimised model for each individual DNA dataset from the results of the MrModeltest, using a Markov Chain Monte Carlo (MCMC) algorithm in MrBayes v. 3.1.2 (Ronquist & Huelsenbeck 2003). Two MCMC chains were run from random trees for 1 000 M generations and stopped when average standard deviation of split frequencies fell below 0.01. Trees were saved each 1 000 generations. The first 25 % of trees were discarded as the burn-in phase of each analysis, and the posterior probabilities (BPP) were calculated to assess the remaining trees (Rannala & Yang 1996). The branch support from the MP analysis was evaluated with a bootstrapping (BS) method of 1 000 replicates (Hillis & Bull 1993). *Myriangium hispanicum* (CBS 347.33) was selected as outgroup in all analyses. Phylograms were viewed using FigTree v. 1.3.1 (Rambaut & Drummond 2010). Novel sequences generated in the current study were deposited in GenBank (Table 1) and the aligned matrices used for phylogenetic analyses were maintained in TreeBASE (www.treebase.org; accession number: S19904).

Morphology

Descriptions of the sexual morph are based on host material, while those of the asexual morph are based on sporulating

cultures (Fig. 3). Colonies were subcultured onto MEA, oatmeal agar (OA), potato dextrose agar (PDA), synthetic nutrient-poor agar (SNA), and tap water agar (WA) (Crous *et al.* 2009). Cultures were incubated at moderate temperatures (22 °C) under a 12 h near-ultraviolet (NUV) light (360 nm), 12 h dark cycle for 3 wk to induce sporulation. Structures were mounted in clear lactic acid, and 50 measurements determined per structure, with extremes of conidial measurements given in parentheses. Colony diameters were measured and the colony colours described after 3 wk according to the colour charts of Rayner (1970). Microscopic photographs were captured using a Nikon Eclipse 80i microscope equipped with a Nikon digital sight DS-Ri2 high definition colour camera, using differential interference contrast (DIC) illumination and the Nikon software NIS-Elements D Package v. 3.00. Adobe Bridge CS v. 6 and Adobe Photoshop CS v. 5 were used for the manual editing. Nomenclatural novelties and descriptions were deposited in MycoBank (Crous *et al.* 2004).

RESULTS

Phylogenetic analyses

The final combined alignment contained 119 *Elsinoë* ingroup strains with a total of 2 532 characters including gaps (617 characters for ITS, 744 for LSU, 751 for *rpb2* and 422 for *TEF1-α*), of which 1 624 characters are constant, 221 variable characters are parsimony-uninformative and 687 characters are variable and parsimony-informative. MP analyses generated one tree, which is presented in Fig. 4 (TL = 4 885, CI = 0.305, RI = 0.815, RC = 0.248). For BI analyses, the general time reversible model with inverse gamma rates (GTR + I + G) was determined to be the best for the ITS, LSU and *TEF1-α* loci by MrModeltest, while the most appropriate model for the *rpb2* locus was Hasegawa–Kishino–Yano with inverse gamma rates model (HKY + I + G). The unique site patterns were 934 (276 for ITS, 96 for LSU, 397 for *rpb2* and 165 for *TEF1-α*). The MP bootstrap supports (BS) equal to or above 70 % are shown in branches in Fig. 4. The branches with significant Bayesian posterior probabilities (BPP) equal to or above 0.95 are shown in the phylogram.

Taxonomy

At the onset of this study, it was estimated that *Elsinoë* contained approximately 48 species, and *Sphaceloma* 52 (Kirk *et al.* 2008). After phylogenetic analyses and morphological examination of 119 isolates, we now recognise 75 species (Table 1), of which eight are newly described, 13 are epitypified, and 26 species names are suggested as new combinations based on the single nomenclature initiative (Wingfield *et al.* 2012, Crous *et al.* 2015a). All strains proposed as new species and for epitypification based on the multi-gene phylogeny were studied morphologically. Type details and notes on the host range and geographic distribution of previously described species are also included.

Elsinoaceae Höhn. ex Sacc. & Trotter, Syll. Fung. (Abellini) 22: 584. 1913.

Type genus: *Elsinoë* Racib., Parasit. Alg. Pilze Java's (Jakarta) 1: 14. 1900.

Elsinoë Racib., Parasit. Alg. Pilze Java's (Jakarta) 1: 14. 1900.

Synonym: *Sphaceloma* de Bary, Ann. Oenol. 4: 165. 1874.

Additional synonyms in MycoBank.

Plant pathogenic, causing scab, leaf and fruit spot and anthracnose disease. *Ascostromata* solitary, aggregated, or gregarious, wart-like, or as small distinctively coloured elevations, or pulvinate, immersed to semi-immersed, globose to subglobose, white, pale yellow or brown, soft, multi-loculate, locules scattered in upper part of ascostromata, cells of ascostromata comprising pseudoparenchymatous cells of *textura globulosa* to *angularis*. *Locules* with few to numerous asci inside each locule, ostiolate. *Ostiole* minute, periphyses absent. *Asci* 8-spored, bitunicate, fissitunicate, saccate to globose, with a minute pedicel, and ocular chamber. *Ascospores* irregularly arranged, oblong or fusiform with slightly acutely rounded ends, with 2–3 transverse septa, hyaline, smooth-walled, lacking a sheath. *Sphaceloma* asexual morph: *Acervuli* or *sporodochia* subepidermal, pseudoparenchymatous. *Conidiophores* hyaline to pale-brown, polyphialidic. *Conidiogenous cells* formed directly from the upper cells of the pseudoparenchyma, mono- to polyphialidic, integrated or discrete, determinate, hyaline to pale brown, without visible periclinal thickening. *Conidia* hyaline, smooth, aseptate, ellipsoidal, guttulate (adapted from Hyde *et al.* 2013).

Elsinoë abutilonis (Bitanc. & Jenkins) Fan & Crous, **comb. nov.** MycoBank MB818107.

Basionym: *Sphaceloma abutilonis* Bitanc. & Jenkins, Arq. Inst. Biol., São Paulo 20: 2. 1950.

Material examined: **Brazil**, São Paulo, from *Callianthe striata* (syn. *Abutilon striatum*), Dec. 1937, M. Kramer, deposited by A.A. Bitancourt (**ex-type** culture CBS 510.50 = IB 2807).

Notes: *Elsinoë abutilonis* was described by (Bitancourt & Jenkins 1950) causing scab disease on leaves and branches of *Abutilon striatum* in São Paulo, Brazil. Information on the original description is limited to a symptom description with acervuli referred to as "invisible" and conidia as "not seen". If not for the ex-type culture being available and now confirmed to belong to a true and distinct species of *Elsinoë*, this species should have been regarded as doubtful. The LSU region fails to distinguish *E. australis* strains CBS 229.64 and 230.64 from *E. abutilonis*.

Elsinoë ampelina Shear, Phytopathology 19: 677. 1929. Fig. 5.

Synonyms: *Sphaceloma ampelinum* de Bary, Ann. Oenol. 4: 165. 1874.

Ramularia ampelophaga Pass., Boln Comiz. Agr. Parmense 9: 125. 1876.

Gloeosporium ampelophagum (Pass.) Sacc., Michelia 1(no. 2): 217. 1878.

Material examined: **Brazil**, from *Vitis vinifera*, A.E. Jenkins (culture CBS 208.25).

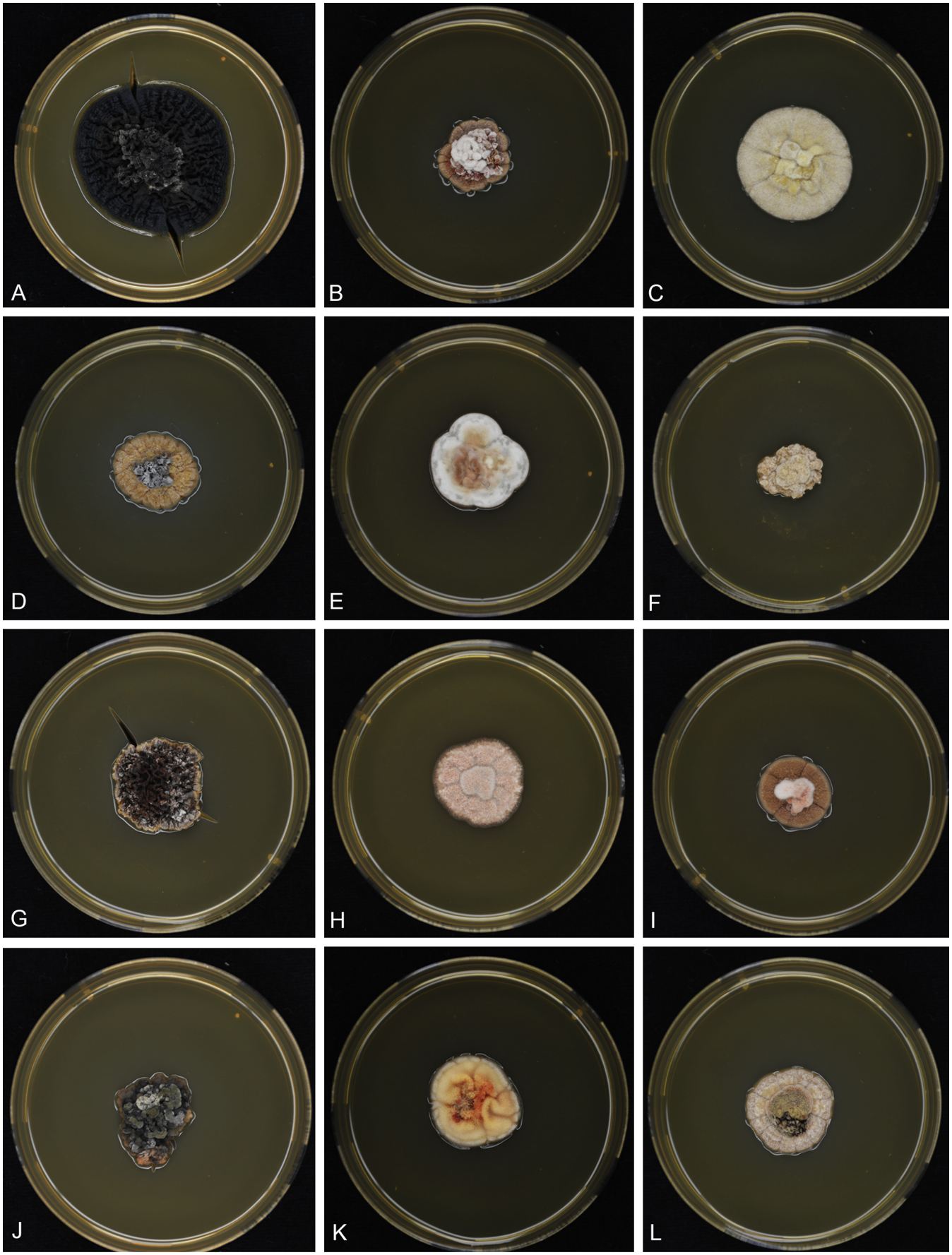

Fig. 3. Colonies of *Elsinoë* spp. on MEA after 3 wk. **A.** *E. australis* (CBS 314.32). **B.** *E. euphorbiae* (CBS 401.63). **C.** *E. genipae-americanae* (CBS 516.50). **D.** *E. glycines* (CBS 389.64). **E.** *E. jasminicola* (CBS 212.63). **F.** *E. ledi* (CBS 167.33). **G.** *E. menthae* (CBS 322.37)). **H.** *E. pongamiae* (CBS 402.63). **I.** *E. rosarum* (CBS 212.33). **J.** *E. solidaginis* (CBS 191.37). **K.** *E. veneta* (CBS 164.29). **L.** *E. verbenae* (CPC 18561).

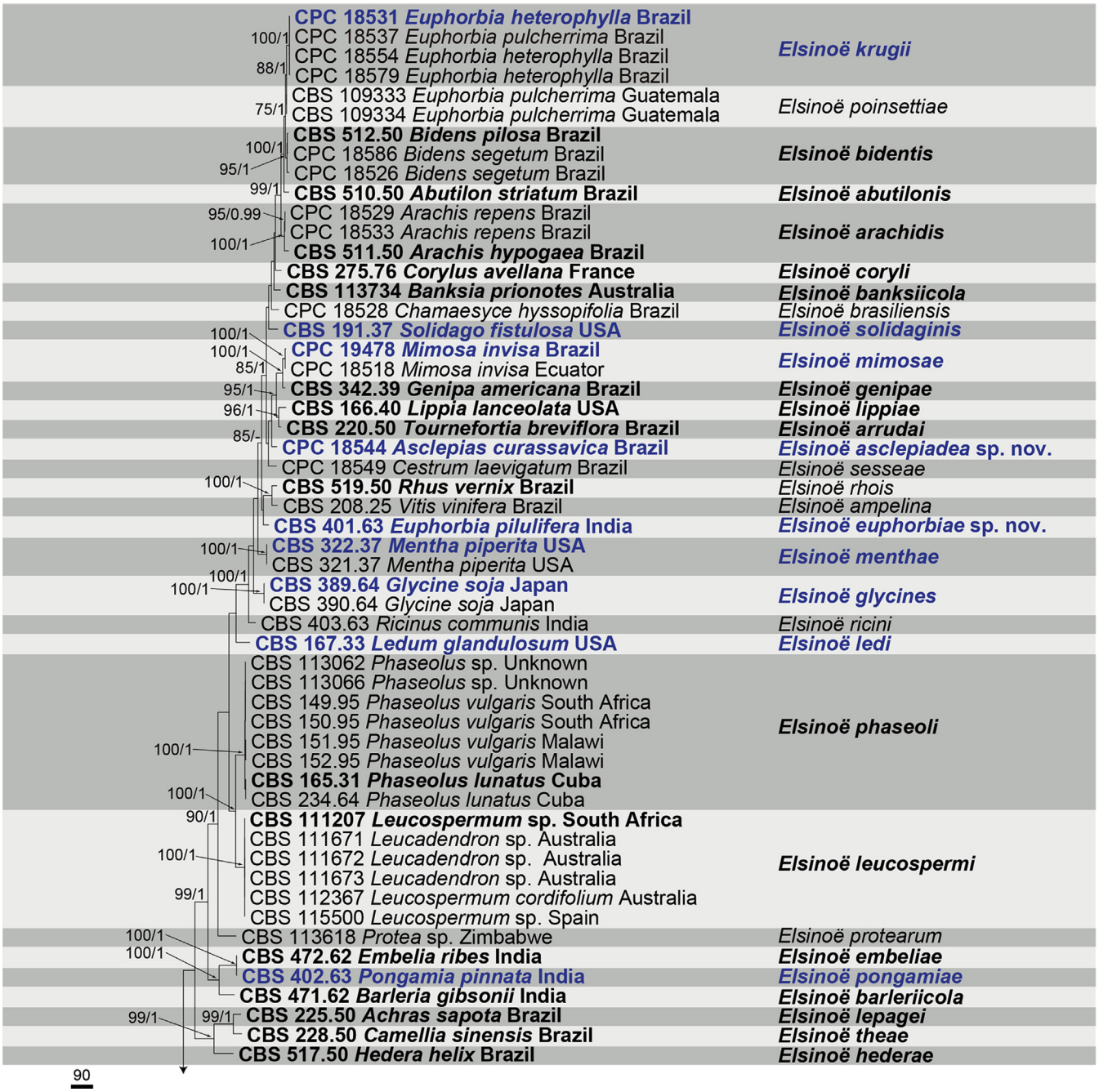

Fig. 4. Maximum parsimony (MP) phylogram of *Elsinoë* based on a combined matrix of ITS, LSU, *rpb2* and *TEF1-α* genes. MP bootstrap support values above 73 % and posterior probabilities above 0.93 from BI are shown at the first and second positions at the nodes. The scale bar represents 90 nucleotide changes. Ex-type strains are in bold. New species and ex-epitypes are in blue.

Notes: This fungus was commonly known as the causal agent of grapevine anthracnose [or grapevine spot anthracnose – as recommended by Jenkins (1947)], which appeared to be of European origin and causes heavy losses in various grape-growing countries throughout the world, requiring chemical control – particularly where grapes are grown under humid conditions (de Bary 1874, Shear 1929, Amorim & Kuniyuki 2005, Poolsawat *et al.* 2010, Carisse & Morissette-Thomas 2013). de Bary (1874) described this species as *Sphaceloma ampelinum*, and Shear (1929) described the sexual morph as *Elsinoë ampelina*, having hyaline, 3-septate ascospores, 15–16 × 4–4.5 µm. This pathogen has been reported worldwide, but requires fresh collections to facilitate epitypification (on *Vitis vinifera*, Western Europe).

Elsinoë anacardii (Wani & Thirum.) Fan & Crous, **comb. nov.** MycoBank MB818108.

Basionym: *Sphaceloma anacardii* Wani & Thirum., Sydowia 23: 253. 1970.

Materials examined: **India**, Lonavla, from *Anacardium occidentale*, Oct. 1958, M.J. Thirumalachar (**ex-type** culture CBS 470.62 = HACC 136 = IMI 092309); Shindewadi, from *Annona squamosa*, Dec. 1960, M.J. Thirumalachar (culture CBS 211.63 = ATCC 15027 = IMI 100600); Poona, Agricultural College, from *Rosa* sp., Jan. 1961, M.J. Thirumalachar (culture CBS 404.63 = ATCC 15031 = IMI 100605).

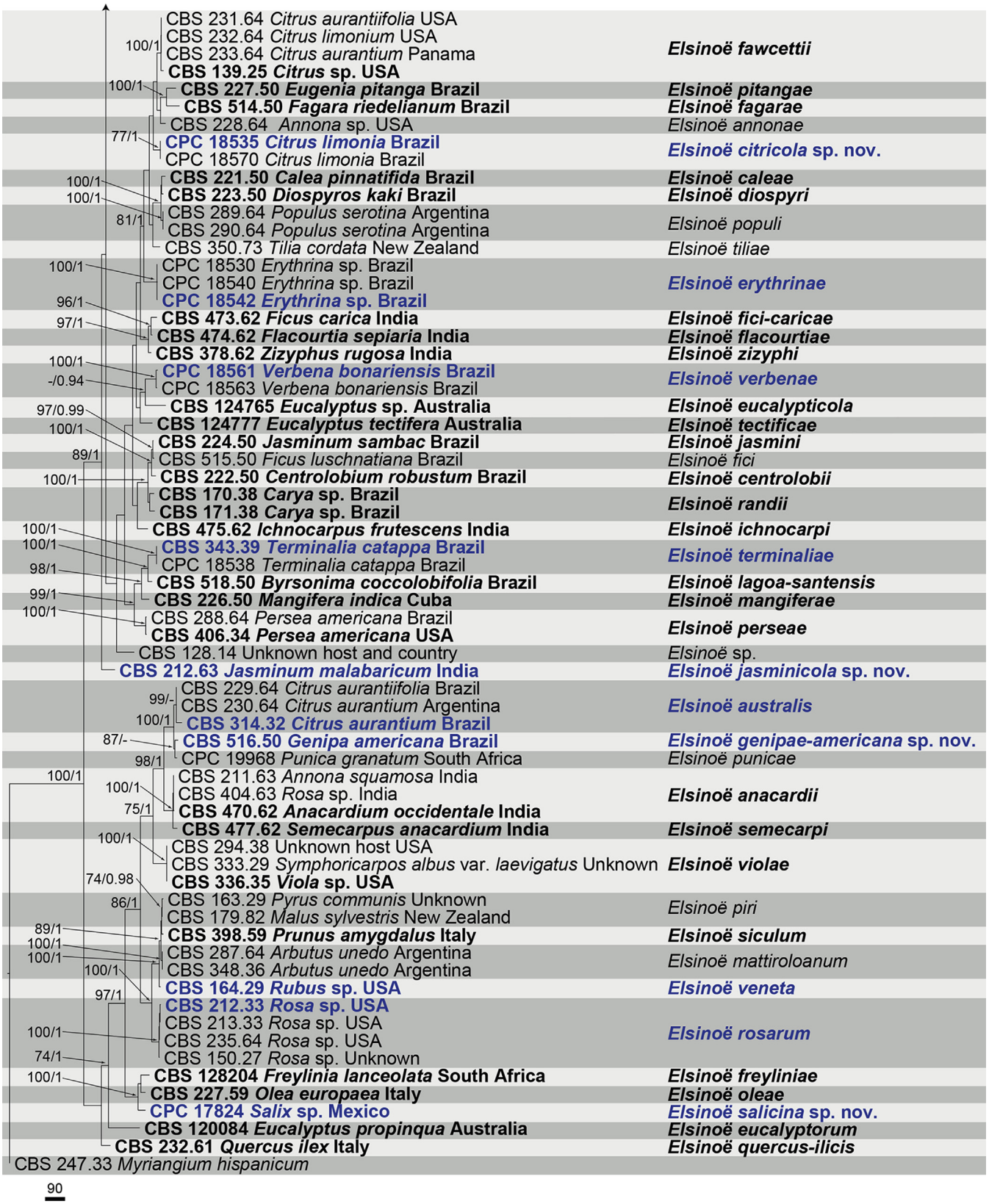

Fig. 4. (Continued).

Notes: *Elsinoë anacardii* was described on cashew in India by Wani & Thirumalachar (1969a, 1970) as causing anthrancnose spots on leaves and also on young shoots and fleshy peduncles that coalesce with age turning into scabs. Symptoms include numerous greyish white leaf spots on the lower leaf surface, 0.5–2 mm diam. Acervuli dark reddish-brown, circular to oblong, intraepidermal, appearing subcuticular when erumpent, 19–31 × 26–67 µm. The cultural characteristics on PDA of this fungus are quite distinct from the usual appearance of *Elsinoë* colonies, having cottony white aerial mycelium on the surface, and green mycelium on the reverse side of the plate. The fact that the isolates studied here originate from completely distinct host families, suggests that there could have been some confusion during the culturing and subsequent deposit of these

Fig. 5. Disease symptoms of *E. ampelina* on *Vitis vinifera*.

cultures. This matter can only be resolved based on fresh collections, as it appears highly unlikely that the same species could cause disease on these diverse hosts. The ITS, *rpb2* and *TEF1-α* regions fail to distinguish *E. anacardii* and *E. semecarpi*.

Elsinoë annonae Bitanc. & Jenkins, Proc. Amer Sci. Congr. Wash. 1940: 157. 1942 (1940).

Material examined: **USA**, from *Annona* sp., C.A. Salemink (culture CBS 228.64).

Notes: *Elsinoë annonae* is known to cause spot anthracnose and leaf spots of *Annona* spp. in São Paulo, Brazil. This fungus is characterised by globose to pyriform asci (20 µm diam), and hyaline, 3-septate ascospores (12–15 × 5–8 µm) (Bitancourt & Jenkins 1940a).

Elsinoë arachidis (Bitanc. & Jenkins) Rossman & W.C. Allen, IMA Fungus 7: 3. 2016. Fig. 6.

Fig. 6. Disease symptoms of *E. arachidis* on *Arachis hypogaea*.

Synonym: *Sphaceloma arachidis* Bitanc. & Jenkins, Arq. Inst. Biol., São Paulo 11: 45: 1940.

Materials examined: **Brazil**, São Paulo, from *Arachis hypogaea*, 18 Jan. 1937, A.A. Bitancourt (**ex-type** culture CBS 511.50 = IB 2371); Minas Gerais, Brumadinho, Inhotim, from *Arachis repens*, Dec. 2010, R.W. Barreto (specimen CBS H-22794, culture CPC 18529 = RWB 1135); São Paulo, Limeira, Flora Natureza, Road Piracicaba-Limeira, Km 8, from *Arachis repens*, Dec. 2010, R.W. Barreto (specimen CBS H-22795, culture CPC 18533 = RWB 1159).

Notes: *Elsinoë arachidis* causes scab on leaves, petioles and stems, and distortions of organs of *Arachis hypogaea* in São Paulo, Brazil. Bitancourt & Jenkins (1940b) described this fungus as "forming yellow, stomatic acervuli bearing pyriform conidiophore aggregates, conidiophores globose to pyriform, conidia elongate to cylindrical, 12–20 × 3–4 µm, and also producing abundant 1 µm diam microconidia. In culture (PDA) colonies are slow-growing, compact, convoluted, light vinaceous fawn with darker areas sometimes black and humid margins." On *A. repens* lesions are common on petioles and stems, starting as darkened depressions that turn into corky and typical small scabs with age. The LSU region fails to distinguish *E. arachidis*, *E. bidentis*, *E. euphorbiae*, *E. genipae*, *E. krugii*, *E. mimosae*, *E. poinsettiae*, *E. sesseae* and *E. fawcettii* strain CBS 139.25.

Elsinoë arrudai Bitanc. & Jenkins, Arq. Inst. Biol., São Paulo 12: 8. 1941.

Material examined: **Brazil**, São Paulo, Tieté, from *Tournefortia breviflora*, Oct. 1937, A.A. Bitancourt (**ex-isotype** culture CBS 220.50 = IB 2777).

Notes: *Elsinoë arrudai* is known to cause leaf spots and scab of *Tournefortia breviflora* in São Paulo, Brazil. Symptoms include numerous leaf spots, round or irregular, protruding, often amphigenous, or even perforated, 0.4–2 mm diam. The disease affects leaves, petioles and stems and develops into typical scab symptoms. This fungus is characterised by minute ascostromata bearing few globose asci (21–24 × 19–24 µm) and hyaline, 3-septate ascospores (11–13 × 5 µm) (Bitancourt & Jenkins 1941). The authors also included information on colonies formed in pure culture (PDA): slow-growing, compact, convolute, radially sulcate or not, olive or russet vinaceous.

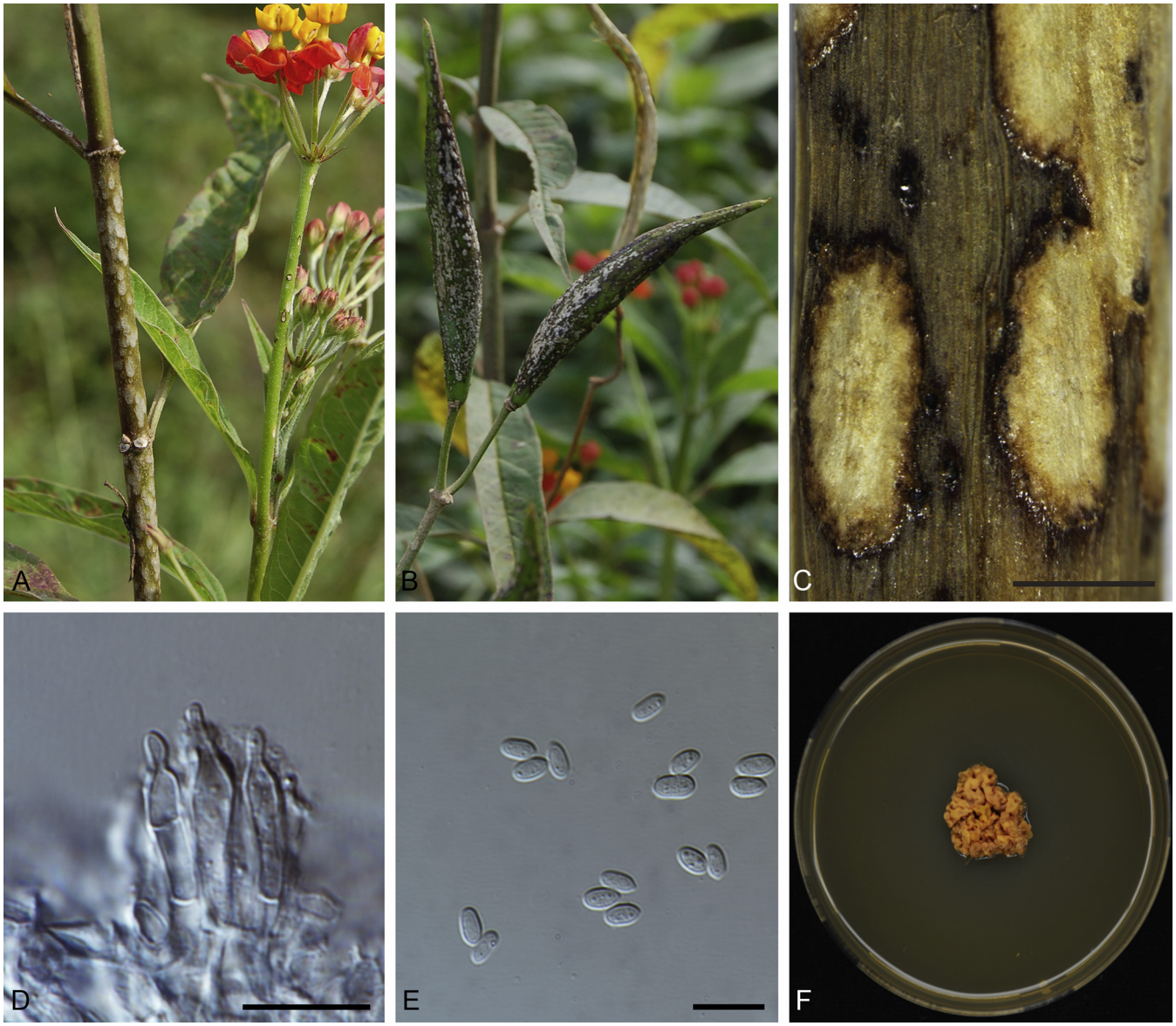

Fig. 7. *Elsinoë asclepiadea* (CPC 18544). **A–C.** Disease symptoms on *Asclepias mellodora*. **D.** Conidiophores. **E.** Conidia. **F.** Colony on MEA after 3 wk. Scale bars: C = 1 mm, D–E = 10 µm.

Elsinoë asclepiadea Fan, R.W. Barreto & Crous, **sp. nov.** MycoBank MB818109. Fig. 7.

Etymology: Named after the host genus from which it was collected, *Asclepias*.

Lesions on branches, petioles, fruits and leaves along veins, occasionally spreading to the lamina, elliptical to irregular, raised and purplish brown at margins and greyish centrally, coalescing and developing typical scab symptoms on older infected areas, occasionally leading to the distortion of affected organ, defoliation and death of severely infected stems. *In culture*: *Conidiophores* subcylindrical, hyaline, verruculose, ampulliform to doliiform, 0–3-septate, 10–18 × 2–3 µm. *Conidiogenous cells* enteroblastic, polyphialidic, with 1–3 integrated loci, hyaline, verruculose, ampulliform to doliiform, 5–15 × 2–3 µm. *Conidia* hyaline, granular, aseptate, ellipsoid, apex obtuse, sometimes constricting at base to a subtruncate locus, (4–)4.5–6(–6.5) × (2–)2.5–3.5(–4) µm.

Culture characteristics: Cultures on MEA, slow-growing (9–12 mm diam after 23 d), raised, cerebriform, compressing and cracking the medium, some pilose aerial mycelium centrally and over other parts of the colony, gelatinous clumps and mucilaginous drops abundant centrally, cinnamon with paler whitish periphery; reverse umber with many cracks in medium visible; colonies composed of a combination of thin-walled hyaline hyphae and dark pseudoparenchyma with muriform chlamydospores; sporulation abundant.

Material examined: **Brazil**, Rio de Janeiro, Carmo, Road Carmo-Sumidouro, next to bridge at boundary between municipalities of Sumidouro and Carmo, from *Asclepias mellodora* (= *A. curassavica*), Dec. 2010, R.W. Barreto (**holotype** CBS H-22745, **ex-holotype** culture CPC 18544 = RWB 1202 = CBS 141937).

Notes: Isolate CPC 18544 was initially identified as "*Sphaceloma asclepiadis*", which is characterised by yellowish, fusiform conidia, 10–15 × 3–4 µm, based on the type material from *Asclepias curassavica* in Brazil (Bitancourt & Jenkins 1949). However, morphological examination of the freshly collected isolate (CPC 18544) indicated that it could be distinguished from "*Sphaceloma asclepiadis*" by having smaller, ovoid conidia, 4–6.5 × 2–3.5 µm.

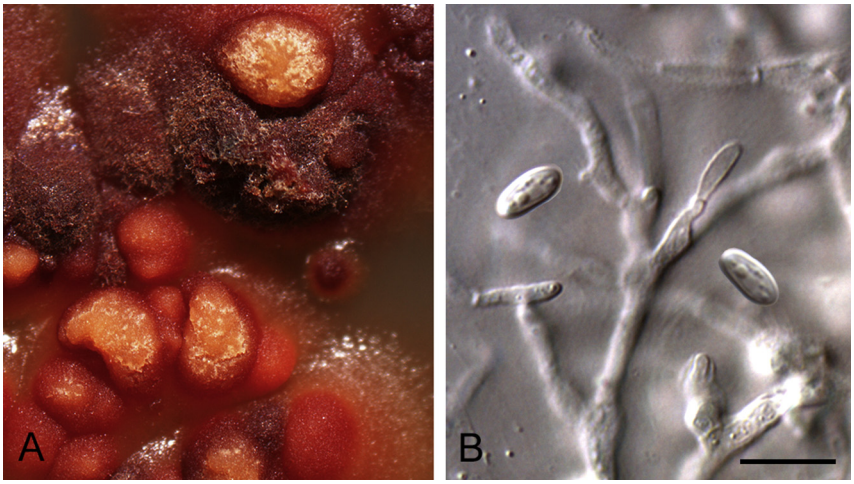

Fig. 8. *Elsinoë banksiicola* (CBS 113734). **A.** Colony on PDA. **B.** Conidiogenous cells and conidia. Scale bars = 10 µm.

The morphological distinction, even if unsupported by molecular analysis, is regarded here as sufficient to allow the proposal of the new species *E. asclepiadea*. Nevertheless, recollecting *S. asclepiadis* and obtaining pure cultures of this fungus would be useful to allow further confirmation of their distinction even if occurring on the same host species.

Elsinoë australis Bitanc. & Jenkins, Mycologia 28: 491. 1936. Fig. 3A.

Synonyms: *Sphaceloma australis* Bitanc. & Jenkins, Mycologia 28: 491. 1936.

Sphaceloma fawcettii var. *viscosum* Jenkins, Phytopathology 23: 538. 1933.

Materials examined: **Argentina**, Tucuman, from *Citrus aurantium*, deposited by C.A. Salemink (culture CBS 230.64). **Brazil**, from *Citrus aurantium*, A.E. Jenkins (culture **ex-isotype** of *Sphaceloma fawcettii* var. *viscosum*, CBS 314.32); Limeira, from *Citrus aurantiifolia*, dep. by C.A. Salemink (culture CBS 229.64).

Notes: This fungus was originally described from *Citrus sinensis* in Brazil, causing a disease known as sweet orange fruit scab, with globose to obclavate asci, and 2–4 celled ascospores, 12–20 × 4–8 µm (Bitancourt & Jenkins 1936a, b). It was also found to be similar to *Elsinoë fawcettii* but differentiating morphological characters were found, including well-developed globose ascostromata, and longer ascospores as well as different host circumscriptions (Bitancourt & Jenkins 1936a). Colonies on MEA are irregular, erumpent, folded, surface dark grey to black, with smooth margins and sparse white to grey aerial mycelium; 25–35 mm diam after 3 wk; sterile. The culture CBS 314.32, which was isolated from *Citrus* in Brazil and deposited as "*Sphaceloma fawcettii* var. *viscosum*", grouped in the same clade with *E. australis* based on all four loci, instead of in the *Elsinoë fawcettii* clade as expected, and is recognised here as a synonym of *E. australis*. *Elsinoë australis* remains restricted to Australia, Bolivia, Brazil and Ethiopia (nt.ars-grin.gov/fungaldatabases/) and is of economic relevance because of affecting the appearance of sweet orange for the fresh fruit market and because quarantine issues prevent exportation of such fruits from countries such as Brazil. The ITS region fails to distinguish *E. australis*, *E. genipae-americanae* and *E. punicae* and should therefore not be used as barcode for species identification of this important pathogen. The LSU region fails to distinguish *E. flacourtiae*, *E. theae* and *E. australis* strain CBS 314.32; it also does not distinguish *E. australis* strains CBS 229.64 and 230.64 from *E. abutilonis*.

Elsinoë banksiicola (Pascoe & Crous) Fan & Crous, **comb. nov.** MycoBank MB818110. Fig. 8.

Basionym: *Sphaceloma banksiicola* Pascoe & Crous, Fungal Planet No. 14. 2007.

Material examined: **Australia**, Victoria, Longford, on leaves and stems of *Banksia prionotes*, 5 Aug. 1996, D. Tricks & A. Ziehrl, isol. & dep. by P.W. Crous (**holotype** CBS H-19926, **ex-type** culture CBS 113734 = CPC 1508 = CPC 1510).

Notes: *Elsinoë banksiicola* is known to cause visible brown amphigenous spots on *Banksia* leaves, up to 8 mm diam, sometimes also occurring on stems of *Banksia prionotes* in Victoria, Australia. *Conidia* hyaline, aseptate, ellipsoid, (4–)8–9(–10) × (2.5–)3–4 µm *in vitro* (Pascoe *et al.* 2007). Only one other species of *Elsinoë* is known from *Banksia*, namely *E. banksiae*. The two species are easily distinguished based on their symptomatology, morphology and cultural characteristics.

Elsinoë barleriicola (Wani & Thirum.) Fan & Crous, **comb. nov.** MycoBank MB818111.

Basionym: *Sphaceloma barleriicola* Wani & Thirum., Sydowia 23: 257. 1970.

Material examined: **India**, Mahabaleshwar, from *Barleria gibsonii*, Mar. 1958, M.J. Thirumalachar (**ex-type** culture CBS 471.62 = ATCC 14658 = HACC 137 = IMI 092310).

Notes: *Elsinoë barleriicola* is known to cause leaf and stem spots of *Barleria gibsonii* in India. Acervuli are dark brown to brownish red, ellipsoid to pyriform, intraepidermal, erumpent, 10–24 × 30–62 µm. Colonies on PDA are deep red on the surface, and reddish brown in reverse (Wani & Thirumalachar 1970).

Fig. 9. A–C. Disease symptoms of *E. bidentis* on *Bidens segetum.*

Elsinoë bidentis (Bitanc. & Jenkins) Fan & Crous, **comb. nov.** MycoBank MB818112. Fig. 9.

Basionym: *Sphaceloma bidentis* Bitanc. & Jenkins, Arq. Inst. Biol., São Paulo 20: 5. 1950.

Materials examined: **Brazil**, from *Bidens pilosa*, Jan. 1937, A.A. Bitancourt (**ex-type** culture CBS 512.50 = IB 2384); Rio de Janeiro, Nova Friburgo, Riograndina, from *Bidens segetum*, Dec. 2010, R.W. Barreto (culture CPC 18526 = RWB 1127); São Paulo, Campos do Jordão, Belvedere near the entrance of Campos do Jordão, from *Bidens segetum*, Dec. 2010, R.W. Barreto (specimen CBS H-22796, culture CPC 18586 = RWB 1280).

Notes: *Elsinoë bidentis* is known to infect leaves and stems on *Bidens pilosa*, *B. segetum* and *B. subalternans* in Brazil (Guatimosim *et al.* 2015). Symptoms include dark, irregular or elongated lesions, 0.5–2 mm diam on leaves; numerous coalescing spots slightly protruding, 0.2–0.6 mm diam on stems. Acervuli dark, slightly protruding, 15–50 µm diam (Bitancourt & Jenkins 1950). The description provided in the original publication is rather incomplete and based on a seemingly sterile specimen. The fungus was recently recollected by Guatimosim *et al.* (2015) who provided a complete description, quoted below: "*Lesions* on leaves and stems: on leaves, mostly along secondary veins, hypophyllous, depressed, irregular, 0.4–2.2 mm diam, leading to disintegration and flecking of host tissue, pale grey in centre; on stems, typical scab symptoms with numerous rounded to irregular warts, with russet vinaceous brown halos, and vinaceous centre, slightly wrinkly. Depending on intensity, leading to distortions of growing stems that may become sinuous or twisted and accompanied by defoliation and die-back of organs above infected areas. Internal mycelium septate, branched in acute angles, 2–3 µm diam, with some enlarged rounded cells, hyaline, smooth, often producing chlamydospores. *Acervuli* almost indistinct, erumpent, localised over a hyaline pseudoparenchyma, formed by 2–3 layers of swollen, irregular cells, 30–100 µm diam. *Conidiogenous cells* ampulliform, with an acute apex, 7 µm, hyaline, smooth. *Conidia* subcylindrical, 3–5(–8) × 2–4 µm, hyaline, smooth. *Culture characteristics*: Very slow-growing (1.3–1.6 cm after 30 d), circular, compressing the medium, aerial mycelium cottony, forming a pink white subiculum, immersed mycelium forming a distinct livid red feathery periphery; reverse dark vinaceous with a distinctly feathery periphery; not sporulating." The LSU region fails to distinguish *E. arachidis*, *E. bidentis*, *E. euphorbiae*, *E. genipae*, *E. krugii*, *E. mimosae*, *E. poinsettiae*, *E. sesseae*, and *E. fawcettii* strain CBS 139.25.

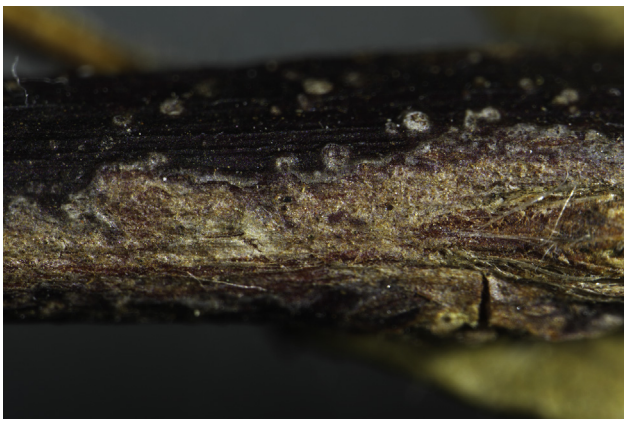

Fig. 10. Disease symptoms of *E. brasiliensis* on stem of *Euphorbia hyssopifolia.*

Elsinoë brasiliensis Bitanc. & Jenkins, Proc. Amer Sci. Congr. Wash. 1940: 160. 1940 (1942). Fig. 10.

Synonyms: *Elsinoë jatrophae* Bitanc. & Jenkins, Arq. Inst. Biol., São Paulo 20: 13. 1950.

Sphaceloma manihoticola Bitanc. & Jenkins, Arq. Inst. Biol., São Paulo 20: 15. 1950.

Materials examined: **Brazil**, Paraíba, Alagoinhas, Agr. Exp. Station, on *Euphorbia brasiliensis* (= *Chamaesyce hyssopifolia*), May 1940, J. Deslandes (**holotype** BPI 679185); Minas Gerais, Barão de Cocais, Road Santa Barbara-Caraça, from *Euphorbia hyssopifolia* (= *C. hyssopifolia*), Dec. 2010, R.W. Barreto (**epitype designated here**, MBT372703, specimen CBS H-22797, **ex-epitype** culture CPC 18528 = RWB 1133 = CBS 141875).

Notes: *Elsinoë brasiliensis* is known to cause leaf spots, petiole and stem cankers or galls on *Euphorbia hyssopifolia* (= *Chamaesyce hyssopifolia*) in Brazil (Bitancourt & Jenkins 1940a). Symptoms include small spots scattered or located at the margin, with a narrow dark border; stem cankers are circular to ellipsoid, elevated with medium to dark brown margin, 4 × 2 mm. This fungus is characterised by globose asci, 17–21 µm diam,

containing eight hyaline, 3-septate ascospores, 12–14 × 5–7 µm (Bitancourt & Jenkins 1940a). The culture CPC 18528 was isolated from the same host in Brazil, and therefore we designate it here as ex-epitype. *In culture*: Colonies raised, ridged, sometimes cracking at folds, cerebriform, compressing and cracking the medium, aerial mycelium absent or sparse, floccose to downy, vinaceous grey centrally with ochreous sectors and purplish grey periphery, with mucilaginous drops; reverse dark purple to ochreous; colonies composed of thick-walled hyphae and yellowish to dark brown pseudoparenchyma; slow growing, 15 mm diam after 23 d; sporulation abundant.

The complex of species reported on *Chamaesyce* spp., *Euphorbia* spp., *Manihot* spp. and related euphorbiaceous genera have been investigated more closely by plant pathologists because of the relevance of the superelongation disease of cassava and the impact of scab on weedy hosts as well as the possibility of weedy and wild members of *Euphorbiaceae* serving as reservoirs for the disease on cassava (Zeigler & Lozano 1983, Barreto & Evans 1998, Alvarez & Molina 2000, Alvarez *et al.*, 2003, Nechet *et al.* 2004). An organised attempt to clarify the identity of the fungus behind superelongation of cassava (Zeigler & Lozano 1983) based on examination of fresh and herbarium specimens, cultural features and cross inoculations of isolates obtained from various *Euphorbiaceae* led to the conclusion that variability and overlap of morphological and cultural characters did not allow for a clear separation of taxa in this complex. Additionally host specificity tended to vary between isolates from a single host and was also inadequate as a basis for species separation. Based on their results these authors proposed that the fungus attacking *C. hyssopifolia* (among other hosts) belonged to *Elsinoë brasiliensis* – a conclusion confirmed with the present multi-gene phylogenetic study (Fig. 4). These authors also accepted *Sphaceloma poinsettiae* as a separate taxon having *Euphorbia heterophylla* and *Eu. pulcherrima* as hosts and considered *Sphaceloma krugii* as its synonym. This is in disagreement with the present study. Here isolates from several of these hosts belonged to separate clades, showing that there are at least four independent species of *Elsinoë* attacking *Chamaesyce* spp., *Euphorbia* spp., and *Manihot* spp.

Elsinoë caleae Bitanc. & Jenkins, Arq. Inst. Biol., São Paulo 12: 11. 1941.

Material examined: **Brazil**, São Paulo, Cantareira, from *Calea pinnatifida*, Dec. 1937, A.A. Bitancourt (**ex-isotype** culture CBS 221.50 = IB 2805).

Notes: *Elsinoë caleae* was described by Bitancourt & Jenkins (1941) causing "spots and anthracnose" on leaves and stems of *Calea pinnatifida* in Brazil. On leaves lesions were circular to slightly irregular, amphigenous, 1–2 mm diam; on petioles and stems lesions were small, and slightly elongated, 0.5 × 0.6–2 mm. The fungus was described as having globose to subpyriform asci (21–26 × 21–24 µm), and hyaline, 3-septate (sometimes with longitudinal septa) ascospores (13–17 × 6–8 µm).

Elsinoë centrolobii Bitanc. & Jenkins, Arq. Inst. Biol., São Paulo 19: 98. 1949.

Basionym: *Sphaceloma abutilonis* Bitanc. & Jenkins, Arq. Inst. Biol., São Paulo 20: 2. 1950.

Material examined: **Brazil**, from *Centrolobium robustum*, Feb. 1938, A.A. Bitancourt (**ex-type** culture CBS 222.50 = IB 2858).

Notes: *Elsinoë centrolobii* was described by Bitancourt & Jenkins (1949) causing lesions on leaves of *Centrolobium robustum* in Brazil. Symptoms include small, rounded or slightly irregular leaf spots, torn when larger, causing deformations, 0.1–1.2 mm diam. The fungus was characterised by globose to oblong asci, 22–26 µm diam, and hyaline, 3-septate ascospores (sometimes with a longitudinal septum), 12–15 × 4–6 µm (Bitancourt & Jenkins 1949). The LSU region fails to distinguish *E. centrolobii*, *E. fici*, *E. jasminae*, and *E. randii*.

Elsinoë citricola Fan, R.W. Barreto & Crous, **sp. nov.** MycoBank MB818113. Fig. 11.

Etymology: Named after the host genus from which it was collected, *Citrus*.

Lesions on fruits, leaves and young stems: on fruits areas of scabbed and slightly sunken skin pale brown, up to 2 cm diam, coalescing and forming irregular aggregates of various sizes or irregular rows following a runoff pattern, sometimes associated with a faint yellow periphery on immature fruits, skin at scabbed areas cracking as fruit grows and wounds often invaded secondarily by post-harvest pathogens (particularly *Penicillium* spp.); on leaves amphigenous, extending through the lamina, and forming yellowish pale brown scab, circular to irregular, 0.5–3 mm diam, enlarging and coalescing to form raised, irregular, medium brown lesions, borders raised, brown to dark brown due to the ruptured epidermis, leading to major distortion of affected leaves; young stems also developing small areas of scabbed tissue. *In culture*: *Conidiophores* hyaline, verruculose, ampulliform to doliiform, 0–1-septate, 8–15 × 3–5 µm. *Conidiogenous cells* enteroblastic, polyphialidic, with 1–2 integrated loci, hyaline, verruculose, ampulliform to doliiform, 5–10 × 3–5 µm. *Conidia* hyaline, granular, aseptate, ellipsoid, apex obtuse, sometimes constricting at base to a subtruncate locus, (5.5–)6–8(–9) × (2.5–)3–4(–4.5) µm.

Culture characteristics: Colonies irregular, erumpent, folded, surface apricot, with smooth, irregular margins and sparse white aerial mycelium; 10–15 mm diam after 3 wk; sterile.

Materials examined: **Brazil**, from *Citrus limon*, Dec. 2010, R.W. Barreto (**holotype** CBS H-22746, **ex-type** culture CPC 18535 = RWB 1175 = CBS 141876); Minas Gerais, Viçosa, Piuna, Road Viçosa-Porto Firme, from *Citrus limon*, Dec. 2010, R.W. Barreto (specimen CBS H-22798, culture CPC 18570 = RWB 1253).

Notes: The isolate CPC 18535 was originally identified as "*Sphaceloma fawcettii*". It is, however, genetically distinguished from ex-type strains of *Elsinoë fawcettii* (CBS 139.25) and others (CBS 231.64, CBS 232.64, CBS 233.64), based on four sequenced loci. Morphologically, *E. citricola* is very similar to *E. fawcettii*, and the two species cannot be distinguished based on conidial size alone (5.5–9 × 2.5–4.5 vs. 5–10 × 2–5 µm) (Jenkins 1925). The ITS and LSU regions fail to distinguish *E. citricola* and *E. fawcettii*.

Elsinoë coryli (Vegh & M. Bourgeois) Fan & Crous, **comb. nov.** MycoBank MB818114.

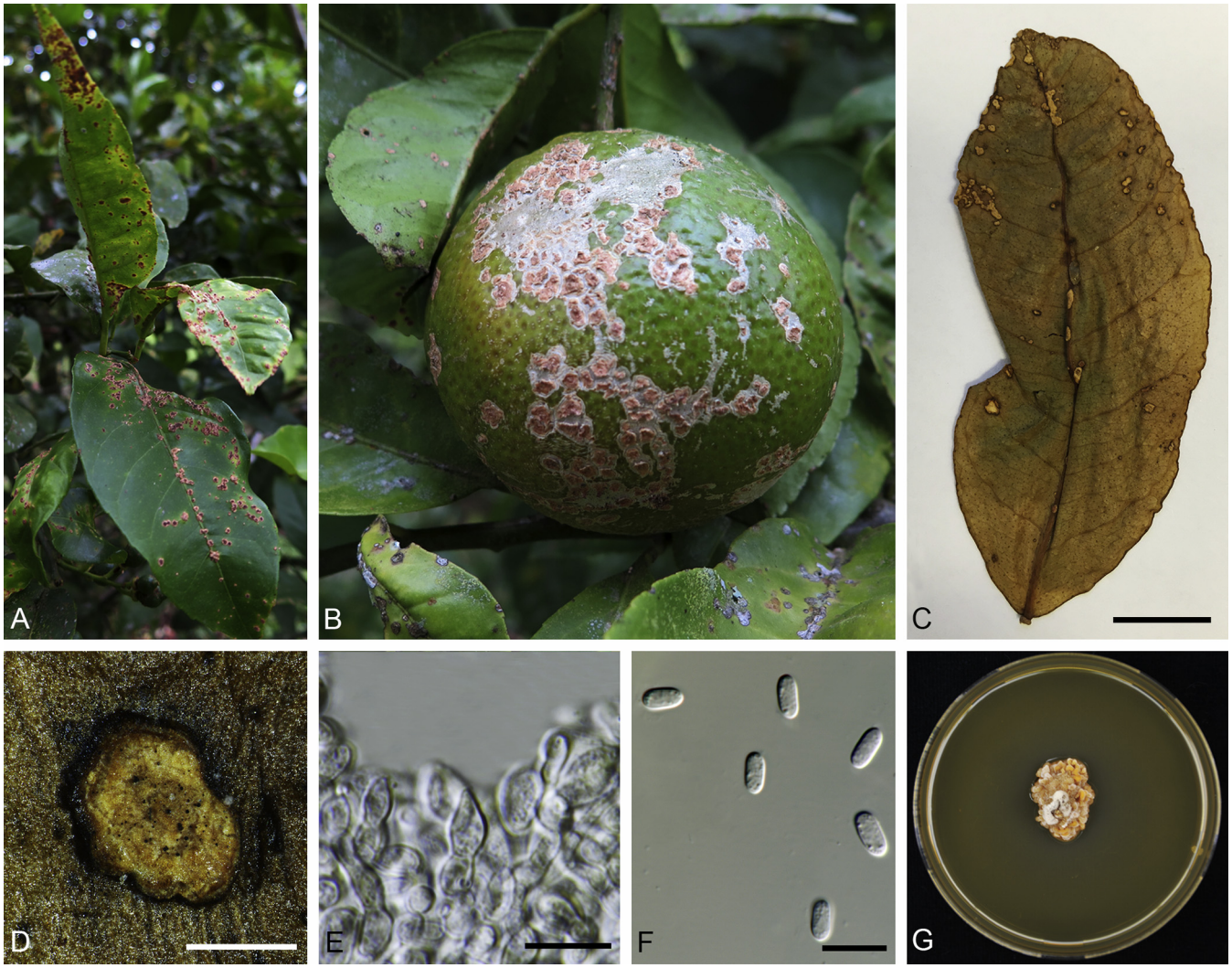

Fig. 11. *Elsinoë citricola* (CPC 18535). **A–D.** Disease symptoms on *Citrus limon*. **E.** Conidiophores. **F.** Conidia. **G.** Colony on MEA after 3 wk. Scale bars: C = 2 cm, D = 1 mm, E–F = 10 µm.

Basionym: *Sphaceloma coryli* Vegh & M. Bourgeois, Revue Mycol., Paris 40: 280. 1976.

Material examined: **France**, Département du Tarn, from *Corylus avellana*, Aug. 1965, I. Végh (**ex-type** culture CBS 275.76).

Notes: *Elsinoë coryli* is known to cause leaf spots of *Corylus avellana* in France. Symptoms include depressed, elongated hypophyllous leaf spots. This fungus is characterised by hyaline, ellipsoid to oblong or subglobose conidia, 1.7–5 × 1.5–3.2 µm (Vegh & Bourgeois 1976).

Elsinoë diospyri Bitanc. & Jenkins, Arq. Inst. Biol., São Paulo 20: 7. 1950.

Material examined: **Brazil**, from *Diospyros kaki*, May 1943, A.A. Bitancourt (**ex-type** culture CBS 223.50 = IB 4621).

Notes: The original description of *Elsinoë diospyri* by Bitancourt & Jenkins (1950) on Japanese persimmon (*Diospyros kaki*) in Brazil includes a description of leaf spots symptoms (but no reference to scaby lesions being formed) which are white in the middle, dark brown or black at the margin, 0.1–0.5 mm diam. The authors also described the sexual morph as characterised by globose asci, 28 µm diam, containing eight hyaline, 1–3-transversally septate ascospores, 8–10 × 4–5 µm. The asexual morph is described as sporodochial, but no conidia were observed. Attempts at recollecting fresh material of the fungus in São Paulo in the context of this work proved unsuccessful.

Elsinoë embeliae Thirum. & Naras., **sp. nov.** MycoBank MB818115.

Etymology: Named after the host genus on which it occurs, *Embelia*.

Elsinoë embeliae differs from the ex-type strain of its closest phylogenetic neighbour *Elsinoë pongamiae* (CBS 402.63) based on LSU positions 593 (–), 607 (T). Positions derived from respective alignments of the separate loci deposited in TreeBASE.

Material examined: **India**, Mahabaleshwar, on leaves and shoots of *Embelia ribes*, 13 Mar. 1958, M.J. Thirumalachar (**holotype** Herb. BPI 681720, **ex-type** culture CBS 472.62 = HACC 130 = IMI 092304).

Notes: The present fungus was originally deposited in CBS as *Sphaceloma embeliae* Thirum. & Naras. in 1962, and a holotype specimen (BPI 681720) in Beltsville, USA. However, we have

Fig. 12. *Elsinoë erythrinae* (CPC 18542). **A**–**B.** Disease symptoms on *Erythrina* sp. **C.** Conidiophores. **D.** Conidia. **E.** Colony on MEA after 3 wk. Scale bars: A = 1 cm, B = 0.5 cm, C–D = 10 µm.

been unable to trace the original publication details of the name, and it appears that the fungus was never published. Because this is a distinct species of *Elsinoë*, the name is herewith validated. The ITS and *TEF1-α* regions fail to distinguish *E. embeliae* and *E. pongamiae*; *rpb2* was not available for comparison.

Elsinoë erythrinae Sivan. & L.D. Gómez, Trans. Br. mycol. Soc. 85: 370. 1985. Fig. 12.

Synonym: *Sphaceloma erythrinae* Bitanc. & Jenkins, Arq. Inst. Biol. São Paulo 20: 9. 1950.

Materials examined: **Brazil**, São Paulo, Cantareira, on leaves and stems of *Erythrina reticulata*, 31 Jan. 1938, E. Ract, USM 90037, IB 2859, IMI 56635, **holotype** of *Sphaceloma erythrinae*; Minas Gerais, Ubá, from *Erythrina* sp., Dec. 2010, R.W. Barreto (**epitype designated here**, MBT372705, specimen CBS H-22799, **ex-epitype** culture CPC 18542 = RWB 1196); Minas Gerais, Brumadinho, Inhotim, from *Erythrina* sp., Dec. 2010, R.W. Barreto (specimen CBS H-22800, culture CPC 18530 = RWB 1138); Rio de Janeiro, Botanic Gardens of Rio de Janeiro – restinga collection, from *Erythrina* sp., Dec. 2010, R.W. Barreto (specimen CBS H-22801, culture CPC 18540 = RWB 1192). **Costa Rica**, Ujarraz, Cartago, on leaves of *Erythrina poeppigiana*, Aug. 1984, L.D. Gomez (**holotype** of *E. erythrinae* IMI 290265).

Notes: *Elsinoë erythrinae* was introduced as the sexual morph of *Sphaceloma erythrinae*, which was described from *Erythrina reticulata* in Brazil (Bitancourt & Jenkins 1950, Sivanesan & Gómez 1985). The culture CPC 18542 was isolated from the same host genus in Brazil, and because it is also morphologically similar, we designate it here as epitype. *Leaf spots* amphigenous, extending through the lamina, without forming prominent scab, circular, separate, 0.5–2 mm diam, forming yellowish, oblong particulates in central white lesions; borders dark brown to black due to the ruptured epidermis. *In culture*: *Conidiophores* hyaline, verruculose, ampulliform to doliiform, 0–1-septate, 10–20 × 3–6 µm. *Conidiogenous cells* enteroblastic, polyphialidic, with 1–3 integrated loci, hyaline, verruculose, ampulliform to doliiform, 7–15 × 3–5 µm. *Conidia* hyaline, granular, aseptate, ellipsoid, apex obtuse, sometimes constricting at base to a subtruncate locus, (5.5–)7–9(–9.5) × (2.5–)3–4(–4.5) µm. Colonies on MEA: slow growing (16 mm diam after 23 d); raised and cerebriform with large cauliflower-like irregular warted protuberances on central area, radially ridged, sometimes cracked along radial folds to expose reddish lower mycelium, partly compressing and cracking the medium, with dense felty aerial mycelium centrally becoming sparser towards the margins with narrow completely immersed border, gelatinous irregular masses or mucilaginous drops formed over colony, slightly pinkish white centrally with lavender sector and amber margins; raising and cracking the medium in reverse, blood coloured with saffron

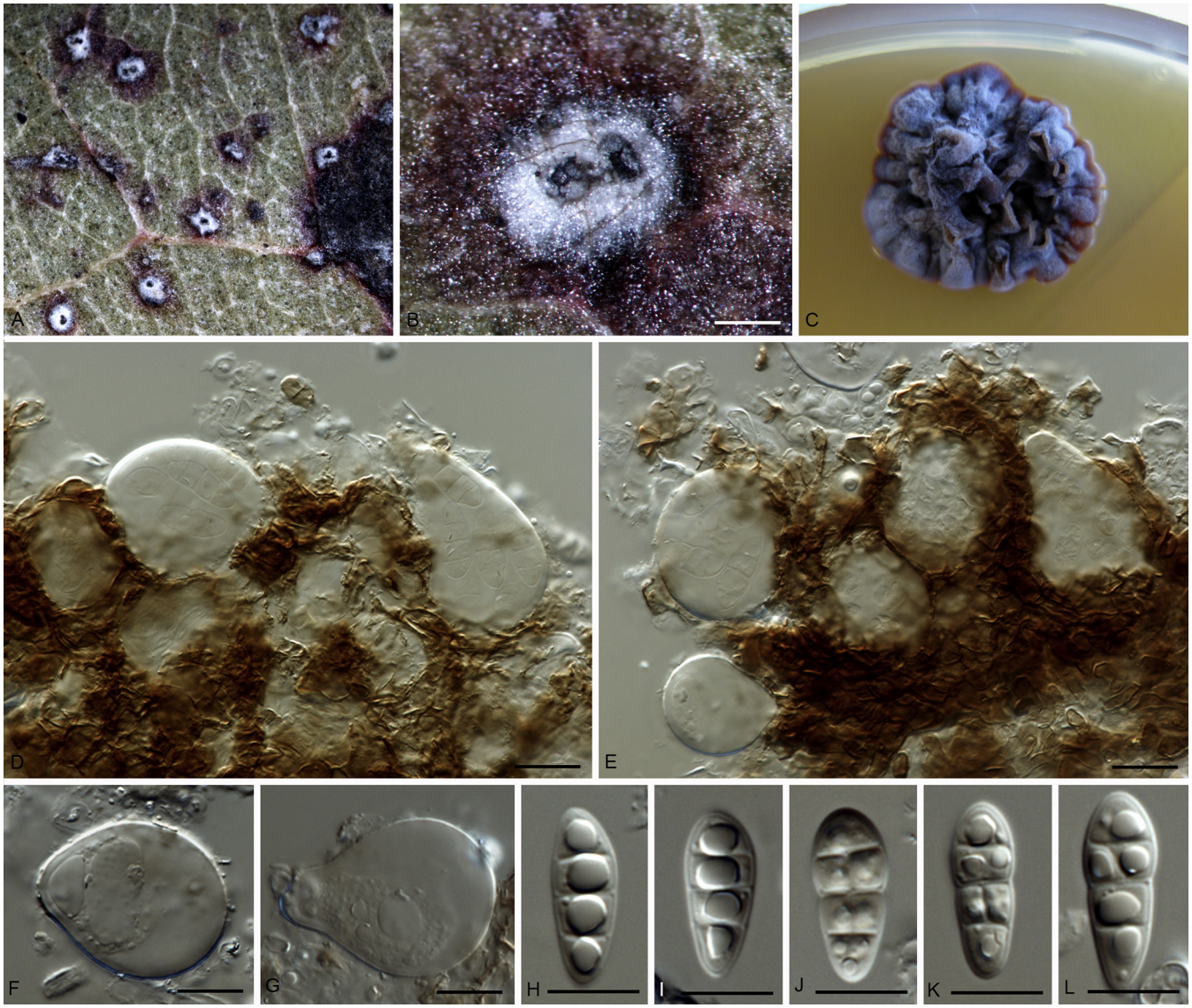

Fig. 13. *Elsinoë eucalypticola* (CBS 124765). **A, B.** Lesions on leaf. **C.** Colony on MEA. **D–G.** Asci. **H–L.** Ascospores. Scale bars: B = 10 mm; D–L = 10 µm.

margins; colonies composed of narrow filiform hyaline hyphae, monilioid pigmented hyphae and pseudoparenchyma; sporulation abundant.

Elsinoë eucalypticola Cheew. & Crous, Persoonia 23: 64. 2009. Fig. 13.

Material examined: **Australia**, Queensland, Cairns, Kuranda Kennedy Highway, from *Eucalyptus* sp., 26 Sep. 2006, P.W. Crous (**holotype** CBS H-20283, **ex-type** culture CBS 124765 = CPC 13318), *ibid*. (cultures CPC 13319, 13320).

Notes: *Elsinoë eucalypticola* is known to cause visible spots on both sides of *Eucalyptus* leaves in Queensland, Australia. *Asci* distributed irregularly throughout the ascostromata, subglobose to broadly obovoid, thick-walled, 8-spored, sessile, hyaline, 30–47 × 24–30 µm. *Ascospores* hyaline to pale brown, broadly ellipsoid with rounded ends, with more prominent taper towards the base, with 4-transverse septa, and 0–3 vertical septa, and sometimes with oblique septa; mostly slightly constricted at the median septum, (16–)17–18(–20) × (6.5–)7–8 µm (Cheewangkoon *et al.* 2009). Other species that have been recorded on *Eucalyptus* include *E. eucalypti*, *E. eucalyptorum* and *E. tectificae*. Ascospores of *E. eucalypticola* (16–20 × 6.5–8 µm) are intermediate in size between those of *E. eucalyptorum* (11–15 × 4–6 µm) (Summerell *et al.* 2006) and *E. eucalypti* (20–28 × 7–8 µm) (Park *et al.* 2000). Both *E. eucalypti* and *E. eucalyptorum* form larger leaf spots than those associated with *E. eucalypticola*.

Elsinoë eucalyptorum Crous & Summerell, Fungal Diversity 23: 332. 2006. Fig. 14.

Material examined: **Australia**, New South Wales, 0.9 km west of Pacific Highway on Middle Brother Road, *ca*. 11 km south of Kew. North Coast NSW, 31 42 38 S 152 42 20 E, Alt: 40 metres; on leaves of *Eucalyptus propinqua*, Feb. 2006, B.A. Summerell (**holotype** CBS H-19746, **ex-type** culture CBS 120084 = CPC 13052).

Notes: *Elsinoë eucalyptorum* is known to cause leaf spots of *Eucalyptus propinqua* in Australia, not extending through the leaf lamina. *Asci* distributed irregularly throughout ascostromata, ovoid to globose, with rounded apex and slightly flattened base, thick-walled, 8-spored, sessile, hyaline, 19–30 × 16–20 µm. *Ascospores* hyaline, smooth, thin-walled, broadly ellipsoidal with rounded ends, with 1(–3) transverse septa, and 1–2 vertical or oblique septa; constricted at median septum, (11–)13–15 × (4–)5(–6) µm (Summerell *et al.* 2006).

Key to *Elsinoë* spp. occurring on *Eucalyptus*[1]

1. Leaf spots absent or ≤1.5 mm..... **2**

1. Leaf spots 2–10 mm diam..... **3**

2. Ascostromata absent, acervuli with conidia 4–4.5 × 2–2.5 µm..... ***E. tectificae***

2. Acervuli absent, ascostromata with ascospores 16–20 × 6.5–8 µm..... ***E. eucalypticola***

3. Ascospores >20 µm long, 20–28 × 7–8 µm..... ***E. eucalypti***

3. Ascospores <20 µm long, 11–15 × 4–6 µm..... ***E. eucalyptorum***

Elsinoë euphorbiae Fan & Crous, **sp. nov.** MycoBank MB818116. Fig. 3B.

Etymology: Named after the host genus from which it was collected, *Euphorbia*.

Elsinoë euphorbiae differs from the ex-type strain of its closest phylogenetic neighbour *Elsinoë rhois* (CBS 519.50) based on alleles in all four loci (positions derived from respective alignments of the separate loci deposited in TreeBASE): ITS positions 107 (C), 170 (G), 381 (C), 175 (A), 176 (T), 190 (T), 193 (C), 197 (C) , 230 (–), 232 (T), 438 (–), 500 (C), 531 (C); LSU positions 303 (C), 391 (C); *rpb2* positions 17 (A), 23 (C), 29 (A), 30 (T), 53 (A), 59 (T), 68 (G), 111 (T), 125 (C), 131 (A), 140 (G), 143 (T), 188 (C), 197 (T), 200 (C), 203 (A), 212 (T), 215 (G), 218 (T), 221 (T), 239 (T), 257 (C), 140 (C), 143 (A), 188 (T), 197 (C), 200 (T), 203 (G), 212 (C), 215 (G), 218 (T), 221 (T), 239 (T), 257 (C), 260 (C), 284 (A), 287 (T), 296 (T), 299 (C), 308 (C), 317 (A), 320 (C), 333 (T), 350 (A), 356 (A), 374 (C), 380 (T), 389 (C), 401 (G), 404 (C), 410 (A), 416 (T), 422 (A), 431 (T), 440 (A), 443 (C), 467 (C), 485 (T), 497 (A), 500 (C), 549 (C), 554 (T), 557 (C), 608 (T), 611 (G), 662 (G), 683 (C), 695 (C), 707 (G), 713 (C), 719 (T), 722 (C), 725 (A); *TEF1-α* positions 14 (C), 149 (A).

Culture characteristics: Colonies irregular, erumpent, folded, surface cinnamon to sepia, with smooth margins and white aerial mycelium in centre; 10–20 mm diam after 3 wk; sterile.

Material examined: **India**, Pimpri, from *Euphorbia parviflora* (= *Euphorbia pilulifera* = *Chamaesyce hirta*), Oct. 1961, M.J. Thirumalachar (**holotype** CBS H-22732, **ex-type** culture CBS 401.63 = ATCC 15028 = IMI 100601).

Notes: Strain CBS 401.63 was initially identified as "*Sphaceloma krugii*" on "*Euphorbia prunifolia* var. *repanda*" (= *E. heterophylla*) in Brazil (Bitancourt & Jenkins 1950). However, a fresh isolate CPC 18531 from the same host genus and location was designed as epitype supported by other isolates (CPC18537, CPC 18554 and CPC 18579) in the current study (see below). Our analyses showed that strain CBS 401.63 grouped in a separate clade from *E. krugii* based on all four loci, supporting our decision to describe it as a new species. The LSU region fails to distinguish *E. arachidis*, *E. bidentis*, *E. euphorbiae*, *E. genipae*, *E. krugii*, *E. mimosae*, *E. poinsettiae*, *E. sesseae*, and *E. fawcettii* strain CBS 139.25.

[1]Species only known from their asexual morphs and not included in this key are *E. eucalyptigena* (on *E. kingsmillii* and *E. pachyphylla*) and *E. preissianae* (on *E. preussiana*) (Crous *et al.* 2016).

Elsinoë fagarae (Bitanc. & Jenkins) Fan & Crous, **comb. nov.** MycoBank MB818117.

Basionym: *Sphaceloma fagarae* Bitanc. & Jenkins, Arq. Inst. Biol., São Paulo 20: 10. 1950.

Material examined: **Brazil**, from *Fagara riedelianum*, Jul. 1938, A.A. Bitancourt (**ex-type** culture CBS 514.50 = IB 2895).

Notes: *Elsinoë fagarae* was originally described causing "spot anthracnose" on leaves and stems of *Fagara* sp. in Brazil (Bitancourt & Jenkins 1950). Symptoms include leaf spots that are round or slightly irregular, with a well-defined protruding margin, strongly depressed in centre, 0.3–0.8 mm diam. This fungus is characterised by yellow, oblong or fusiform conidia, 8–15 × 3 µm.

Elsinoë fawcettii Bitanc. & Jenkins, Phytopathology 26: 394. 1936. Fig. 15.

Synonym: *Sphaceloma fawcettii* Jenkins, Phytopathology 15: 101. 1925.

Materials examined: **USA**, from *Citrus* sp., A.E. Jenkins (**ex-isotype** culture CBS 139.25); from *Citrus aurantifolia*, C.A. Salemink (culture CBS 231.64); Florida, from *Citrus limon*, C.A. Salemink (culture CBS 232.64). **Panama**, Canal Zone, from *Citrus aurantium*, C.A. Salemink (culture CBS 233.64).

Notes: *Elsinoë fawcettii* is commonly known as the causal agent of citrus scab disease, causing heavy losses on *Citrus* worldwide, particularly for the fresh fruit market. Symptoms include lesions that are rough, corky, wart-like, translucent, green or tan at first, becoming brown at the centre, but becoming purplish on fruit. Jenkins (1925) described the asexual morph, *Sphaceloma fawcettii*, as having hyaline, oblong to ellipsoid conidia, 5–10 × 2–5 µm. Bitancourt & Jenkins (1936a) described the sexual morph of this fungus, which is characterised by scattered ascostromata containing globose to ovoid asci, 12–16 µm diam, and hyaline, oblong to ellipsoidal, 1–3 septate ascospores, 10–12 × 5–6 µm. The ITS and LSU regions fail to distinguish *E. citricola* and *E. fawcettii*. In addition, the LSU region fails to distinguish *E. fawcettii* strain CBS 139.25 from *E. arachidis*, *E. bidentis*, *E. euphorbiae*, *E. genipae*, *E. krugii*, *E. mimosae*, *E. poinsettiae*, and *E. sesseae*.

Elsinoë fici Boedijn, Persoonia 2: 70. 1961.

Basionym: *Sphaceloma fici* Thirum., Arq. Inst. Biol., São Paulo 17: 63. 1946.

Material examined: **Brazil**, São Paulo, Cantareira, from *Ficus luschnathiana*, Dec. 1937, A.A. Bitancourt (culture CBS 515.50 = IB 2809).

Notes: *Elsinoë fici* is known to cause leaf spots of *Ficus glomerata* in Java, Indonesia (Boedijn 1961). This fungus is characterised by ovoid to nearly pear-shaped asci, 26–37.5 × 17.5–21.5 µm, containing eight hyaline, ellipsoid to oblong, 3-septate ascospores, 12.5–16 × 4–6 µm, sometimes with a longitudinal septum in one of the middle cells (Boedijn 1961). *Sphaceloma fici* was collected in Mysore, India and

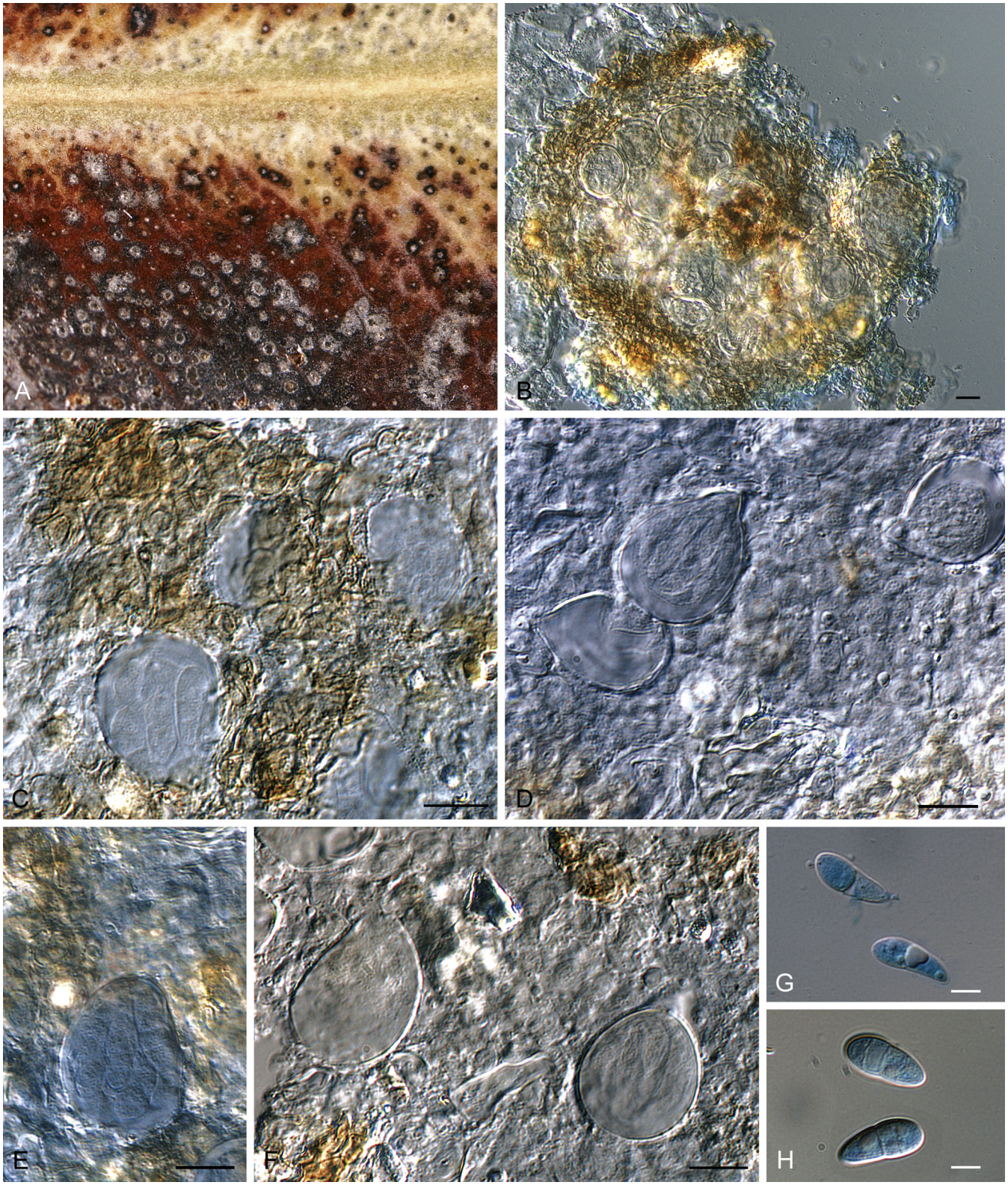

Fig. 14. *Elsinoë eucalyptorum* (CBS 120084). **A.** Leaf spots. **B.** Section through an ascostroma. **C–F.** Asci. **G, H.** Ascospores. Scale bars = 10 µm.

described as: producing irregular leaf spots (2–4 mm diam); acervuli (28–144 × 26–34 µm), conidiophores (15 × 2.4 µm) and conidia not observed. Although treated as synonymous in literature, this has never been proven, and the Brazilian isolate treated here very likely represents a distinct species – a conjecture requiring recollecting the fungus on *F. glomerata* in Java for clarification. The ITS and *TEF1-α* regions fail to distinguish *E. fici* and *E. randii*. The LSU region fails to distinguish *E. centrolobii*, *E. fici*, *E. jasminae*, and *E. randii*.

Elsinoë fici-caricae Wani & Thirum. **sp. nov.** MycoBank MB818118.

Etymology: Named after the host from which it was collected, *Ficus carica*.

Elsinoë fici-caricae differs from the ex-type strain of its closest phylogenetic neighbour *Elsinoë flacourtiae* (CBS 474.62) based on alleles in all four loci (positions derived from respective

Fig. 15. A–D. Disease symptoms of *E. fawcettii* on *Citrus* spp. (Photos credits: Paul Fourie, South Africa).

alignments of the separate loci deposited in TreeBASE): ITS positions 100 (C), 112 (–), 120 (A), 187 (T), 192 (G), 411 (C), 494 (T); LSU positions 36 (A), 41 (T), 74 (T), 94 (T), 107 (A), 371 (C), 372 (T), 378 (T), 383 (T), 388 (A), 408 (C), 411 (G), 427 (T), 432 (T), 444 (T), 537 (T), 563 (A), 568 (T), 649 (A); *rpb2* position 695 (G); *TEF1-α* position 47 (C).

Material examined: **India**, Shindewadi, on *Ficus carica*, 14 Apr. 1957, M.J. Thirumalachar (**holotype** CBS H-22747, **ex-type** culture CBS 473.62 = ATCC 14652 = HACC 128 = IMI 092302).

Notes: An ex-type culture of this species was originally deposited in CBS under the name *Sphaceloma fici-caricae* Wani & Thirum. However, this name does not occur in either Index Fungorum or MycoBank, nor have our colleagues in India been able to locate the name in any of the papers linked to these authors. For this reason, this name is herewith validated in the genus currently accepted for these fungi, *Elsinoë*. The LSU region fails to distinguish *E. fici-caricae*, *E. mattiroloanum*, *E. piri*, and *E. sicula*. The *rpb2* region failed to distinguish *E. genipae*, and *E. mimosae*.

Elsinoë flacourtiae (Thirum. & Naras.) Fan & Crous, **comb. nov.** MycoBank MB818119.

Basionym: *Sphaceloma flacourtiae* Thirum. & Naras., Sydowia 23: 243. 1969.

Material examined: **India**, Maharashtra, Poona, Law College Hill, from *Flacourtia* (= *Flacourtia sepiaria*), Dec. 1959, M.J. Thirumalachar (**ex-type** culture CBS 474.62 = ATCC 14654 = HACC 131 = IMI 092305).

Notes: *Elsinoë flacourtiae* is known to cause scab disease on leaves and tender shoots of *Flacourtia indica* in Maharashtra, India. Symptoms include numerous small spots that are scattered or grouped to form larger patches on leaves; elongated, closely grouped to form crusts by coalescence on young shoots. This fungus is characterised by hyaline, unicellular, ovoid to oblong conidia (1.5–3 µm diam). In culture (PDA), also according to the original description, it produces heaped crustose colonies of ashy white aerial mycelium centrally with deep fawn margins and reddish brown reverse; the colonies are composed of profusely branched mycelium and abundant chlamydospore and "asexual morph fruiting bodies" (Narasimhan *et al.* 1969a). The LSU region fails to distinguish *E. flacourtiae*, *E. theae* and *E. australis* strain CBS 314.32. The *rpb2* region failed to distinguish *E. fici-caricae*, and *E. flacourtiae*.

Elsinoë freyliniae (Crous) Rossman & W.C. Allen, IMA Fungus 7: 3. 2016. Fig. 16.

Basionym: *Sphaceloma freyliniae* Crous, Persoonia 25: 125. 2010.

Material examined: **South Africa**, Western Cape, Cape Town, Kirstenbosch Botanical Garden, from leaves of *Freylinia lanceolata*, 8 May 2010, P.W. Crous (**holotype** CBS H-20485, **ex-type** culture CBS 128204 = CPC 18335); CPC 18336.

Notes: *Elsinoë freyliniae* is known to cause visible spots on leaves of *Freylinia lanceolata* in South Africa, a host that is endemic to this country. This fungus is characterised by hyaline, aseptate, ellipsoidal conidia, (3.5–)4–6(–7) × (2.5–)3–4 µm (Crous & Groenewald 2010). *Elsinoë freyliniae* is presently the only fungus reported on *Freylinia lanceolata* in South Africa (Crous *et al.* 2000, Crous & Groenewald 2010).

Elsinoë genipae (Bitanc.) Fan & Crous, **comb. nov.** MycoBank MB818120.

Basionym: *Sphaceloma genipae* Bitanc., Arq. Inst. Biol., São Paulo 8: 198. 1937.

Material examined: **Brazil**, São Paulo, Cantareira, from *Genipa americana*, Mar. 1935, A.A. Bitancourt (**ex-type** culture CBS 342.39).

Notes: *Elsinoë genipae* is known to cause leaf spots of *Genipa americana* in Brazil. Symptoms include elongated leaf spots, often coalescent, pale brown to reddish, 1–8 mm diam. This fungus is characterised by hyaline, ovoid to globose conidia, 3 × 3–6 µm (Bitancourt 1937). The LSU region fails to distinguish *E. arachidis*, *E. bidentis*, *E. euphorbiae*, *E. genipae*, *E. krugii*, *E. mimosae*, *E. poinsettiae*, *E. sesseae*, and *E. fawcettii* strain CBS 139.25. The *rpb2* region failed to distinguish *E. fici-caricae*, and *E. flacourtiae*.

Elsinoë genipae-americanae Fan & Crous, **sp. nov.** MycoBank MB818121. Fig. 3C.

Fig. 16. *Elsinoë freyliniae* (CBS 128204). **A.** *Freylinia lanceolata.* **B.** Leaf symptoms. **C.** Leaf spot. **D–F.** Conidiogenous cells. **G.** Conidia. Scale bars = 10 µm.

Etymology: Named after the host species from which it was collected, *Genipa americana*.

Elsinoë genipae-americanae differs from its closest relative, *E. punicae* (CPC 19968) based on alleles in all four loci (positions derived from respective alignments of the separate loci deposited in TreeBASE): ITS position 420 (–); LSU positions 383 (C), 466 (T); *rpb2* positions 25 (G), 50 (T), 62 (T), 74 (A), 101 (G), 260 (C), 335 (A), 515 (A), 524 (T), 533 (T), 653 (C), 723 (C), 733 (C), 740 (C); *TEF1-α* positions 5 (T), 71 (T), 110 (T), 134 (T), 233 (T), 359 (G).

Culture characteristics: Colonies erumpent, raised, surface white to pale luteous, with smooth margins and white aerial mycelium; 18–28 mm diam after 3 wk; sterile.

Material examined: **Brazil**, Paraíba state, Manitú, municipality of Bananeiras, from *Genipa americana*, Mar. 1940, A.A. Bitancourt (**holotype** CBS H-22726, **ex-type** culture CBS 516.50 = IB 3700).

Notes: Strain CBS 516.50 was initially identified as "*Sphaceloma genipae*", since it was collected from *Genipa americana*, the same host as *Elsinoë genipae* (Bitancourt 1937). However, the clear phylogenetic distinction between *Elsinoë genipae-americanae* and the ex-type culture of *E. genipae*, as well as all other strains included in this study, resulted in our decision to describe this species as new based on sequence data only. The ITS region fails to distinguish *E. australis*, *E. genipae-americanae* and *E. punicae*.

Elsinoë glycines (Kurata & Kurib.) Fan & Crous, **comb. nov.** MycoBank MB818122. Fig. 3D.

Basionym: *Sphaceloma glycines* Kurata & Kurib., Ann. Phytopath. Soc. Japan 18: 120. 1954.

Culture characteristics: Colonies irregular, erumpent, folded; surface saffron and purplish grey in centre, with smooth margins and sparse white to grey aerial mycelium; 14–18 mm diam after 3 wk; sterile.

Materials examined: **Japan**, Honshu Island, Chūbu, Nagano Prefecture, Naniai-Mura and Imoi-Mura, from *Glycine max* (cultivated soy bean), 29 Sep. 1948, K. Kuribayashi and H. Hurata (**holotype** not found); 24 Sep. 1951, K. Togashi, ex Herb. Inst Yokohama Nat. Univ. 24584, **topotype** designated in Jenkins & Bitancourt (1966) (BPI 910654; SPIB 5690); **lectotype** figs 1–3 from Kurata & Kuribayashi (1954) designated here MBT372709. **Japan**, from *Glycine max* (= *Glycine soja*), H. Kurata (**epitype designated here**, MBT372710, preserved in metabolically inactive state, **ex-epitype** culture CBS 389.64); from *Glycine max*, H. Kurata (culture CBS 390.64).

Notes: *Elsinoë glycines* is a pathogen of soybean (*Glycine* spp.) that was characterised by scab symptoms on leaves, stems and pods. The disease is widely distributed in eastern Asia (China, Korea and Japan), causing severe commercial damage and significant losses to agriculture (Kurata & Kuribayashi 1954, Ford *et al.* 1981, Yum & Park 1989). Kurata & Kuribayashi (1954) describe conidia as being ovoid to oblong-ellipsoidal, biguttulate, hyaline, 4.7–13 × 2.1–5.6 µm. The importance of *E. glycines* for plant quarantine must be highlighted as it is a potential threat to world production of soybean and has remained restricted to the native range of the host species in Asia until now. It should be among the top priorities for plant quarantine detection services in the Americas. The original description of "*Sphaceloma glycines*" (Kurata & Kuribayashi 1954) was from *Glycine max* in Japan, which agrees with the epitype culture CBS 389.64 deposited in CBS (the same host genus and location) designated in the present study.

Fig. 17. Disease symptoms of *E. jasminae* on *Jasminum sambac.*

Elsinoë hederae (Bitanc. & Jenkins) Fan & Crous, **comb. nov.** MycoBank MB818123.

Basionym: *Sphaceloma hederae* Bitanc. & Jenkins, J. Wash. Acad. Sci. 36: 420. 1946.

Material examined: **Brazil**, on *Hedera helix*, Mar. 1943, A.A. Bitancourt (**ex-type** culture CBS 517.50 = ATCC 11183 = IB 4591).

Notes: *Elsinoë hederae* is known to cause leaf spots of *Hedera helix* in Brazil. This fungus can be recognised by small, raised, round to irregular spots with reddish brown margins and greyish white, slightly depressed centres that are later sprinkled with dark fruiting bodies (Jenkins *et al.* 1946). Conidia are oblong, 8–11 × 5–6 µm (Jenkins & Bitancourt 1957).

Elsinoë ichnocarpi (Thirum. & Naras.) Fan & Crous, **comb. nov.** MycoBank MB818124.

Basionym: *Sphaceloma ichnocarpi* Thirum. & Naras., Sydowia 23: 245. 1970.

Material examined: **India**, Maharashtra, Pimpri, Mahendra Hills, from *Ichnocarpus frutescens*, Nov. 1958, M.J. Thirumalachar (**ex-type** culture CBS 475.62 = ATCC 14655 = HACC 132 = IMI 092306).

Notes: *Elsinoë ichnocarpi* is known to infect leaves and petioles of *Ichnocarpus frutescens* in India. Symptoms include spots that are slightly raised, scab-like, leaving a depression on the lower leaf surface, circular to polygonal, greyish white in the centre, with dark brown margin, 30–60 × 15–31 µm. On PDA *E. ichnocarpi* produces colonies of fluffy ashy white aerial mycelium and blood-red in reverse; chains of chlamydospores were common (Wani & Thirumalachar 1970).

Elsinoë jasminae Bitanc. & Jenkins, Arq. Inst. Biol., São Paulo 11: 53. 1940. Fig. 17.

Material examined: **Brazil**, São Paulo, São Sebastião, from *Jasminum sambac*, Jan. 1938, A.A. Bitancourt (**ex-isotype** culture CBS 224.50 = IB 2863).

Notes: *Elsinoë jasminae* is known to cause warting or scab of leaves and stems of *Jasminum sambac* in Brazil. Symptoms include numerous spots, brown, rounded or more often irregular, slightly raised, with flat centre or somewhat depressed, visible on both sides of the leaves, scattered unevenly between the veins, up to 2 mm diam. This fungus is characterised by globose asci, 12–18 µm diam, and 3-septate ascospores, 10–14 × 4–6 µm (Bitancourt & Jenkins 1940b). The LSU region fails to distinguish *E. centrolobii*, *E. fici*, *E. jasminae*, and *E. randii*.

Elsinoë jasminicola Fan & Crous, **sp. nov.** MycoBank MB818125. Fig. 3E.

Etymology: Named after the host species from which it was collected, *Jasminum malabaricum*.

Elsinoë jasminicola differs from the ex-type strain of its close relative *E. jasminae* (CBS 224.50) based on alleles in three loci (positions derived from respective alignments of the separate loci deposited in TreeBASE): ITS positions 32 (T), 42–43 (C), 68 (G), 72 (G), 75 (C), 81 (–), 99 (C), 101 (A), 102 (C), 104 (T), 106 (T), 108 (T), 111–116 (–), 123–147 (–), 169 (G), 171 (A), 176 (C), 179 (–), 181 (–), 185 (C), 188–190 (–), 192–193 (CG), 196–197 (AG), 208 (–), 210 (T), 223–224 (GC), 388 (T), 405 (C), 407 (G), 412 (C), 414 (T), 416–418 (GT–), 424 (C), 427 (T), 430–435 (ATCGGA), 437 (G), 516 (T), 518 (A), 521–522 (CT), 528 (C), 530 (C); LSU positions 34 (C), 111 (C), 115 (C), 297 (C), 316 (C), 325 (C), 336 (A), 340 (C), 343 (C), 348 (C), 372 (C), 378 (T), 383 (C), 398 (C), 430 (C), 464 (C), 489 (G), 491 (C), 545 (C), 560 (C), 599 (C), 670 (A), 680 (A), 682 (A); *TEF1-α* positions 5 (T), 20 (G), 26 (T), 32 (T), 48–50 (CTG), 57(G), 62 (T), 70–120 (GTGAGTAGAATTTGCCTTGGCTTGCCTGACCCGCTCTCTG ATACCTTGCAG), 131 (C), 149 (T), 186 (T), 248 (T), 329 (C), 392 (C).

Culture characteristics: Colonies irregular, raised, surface white to cinnamon, with smooth margins and white aerial mycelium; 16–21 mm diam after 3 wk; sterile.

Material examined: **India**, Khandala, from *Jasminum malabaricum*, Nov. 1959, M.J. Thirumalachar (**holotype** CBS H-22731, **ex-type** culture CBS 212.63 = IMI 100603).

Notes: Isolate CBS 212.63 was initially identified as *Elsinoë jasminae*, which was collected from *Jasminum sambac* in Brazil. However, the new species differs on ITS (82 nt), LSU (20 nt) and *TEF1-α* (64 nt) positions from the ex-type strain of *E. jasminae* (CBS 224.50). It clusters in a separate lineage compared to all other strains included in this study, and therefore we describe this species as new based on phylogenetic analyses.

Elsinoë krugii (Bitanc. & Jenkins) Fan, R.W. Barreto & Crous, **comb. nov.** MycoBank MB818126. Fig. 18.

Basionym: *Sphaceloma krugii* Bitanc. & Jenkins, Arq. Inst. Biol., São Paulo 19: 103. 1949.

Materials examined: **Brazil**, Campinas, on "*Euphorbia prunifolia* var. *repanda*" (= *Eu. heterophylla*), coll. 15 Apr. 1936, H.P. Krug (**holotype** BPI 681889); São Paulo, Águas da Prata, Acesso ao Bairro Cascata, from *Eu. heterophylla*, Dec. 2010, R.W. Barreto (**epitype designated here** MBT372713, specimen CBS H-22803, **ex-epitype** culture CPC 18531 = RWB 1151 = CBS 141877); Rio de Janeiro, Botanic Garden of Rio de Janeiro, from *Eu. pulcherrima*, R.W. Barreto (culture CPC 18537 = RWB 1189); from *Eu. heterophylla*, Dec. 2010, R.W. Barreto (specimen CBS H-22802, culture CPC 18554 = RWB 1228); Minas Gerais, Viçosa, Universidade Federal de Viçosa, Horta Nova, from *Eu.*

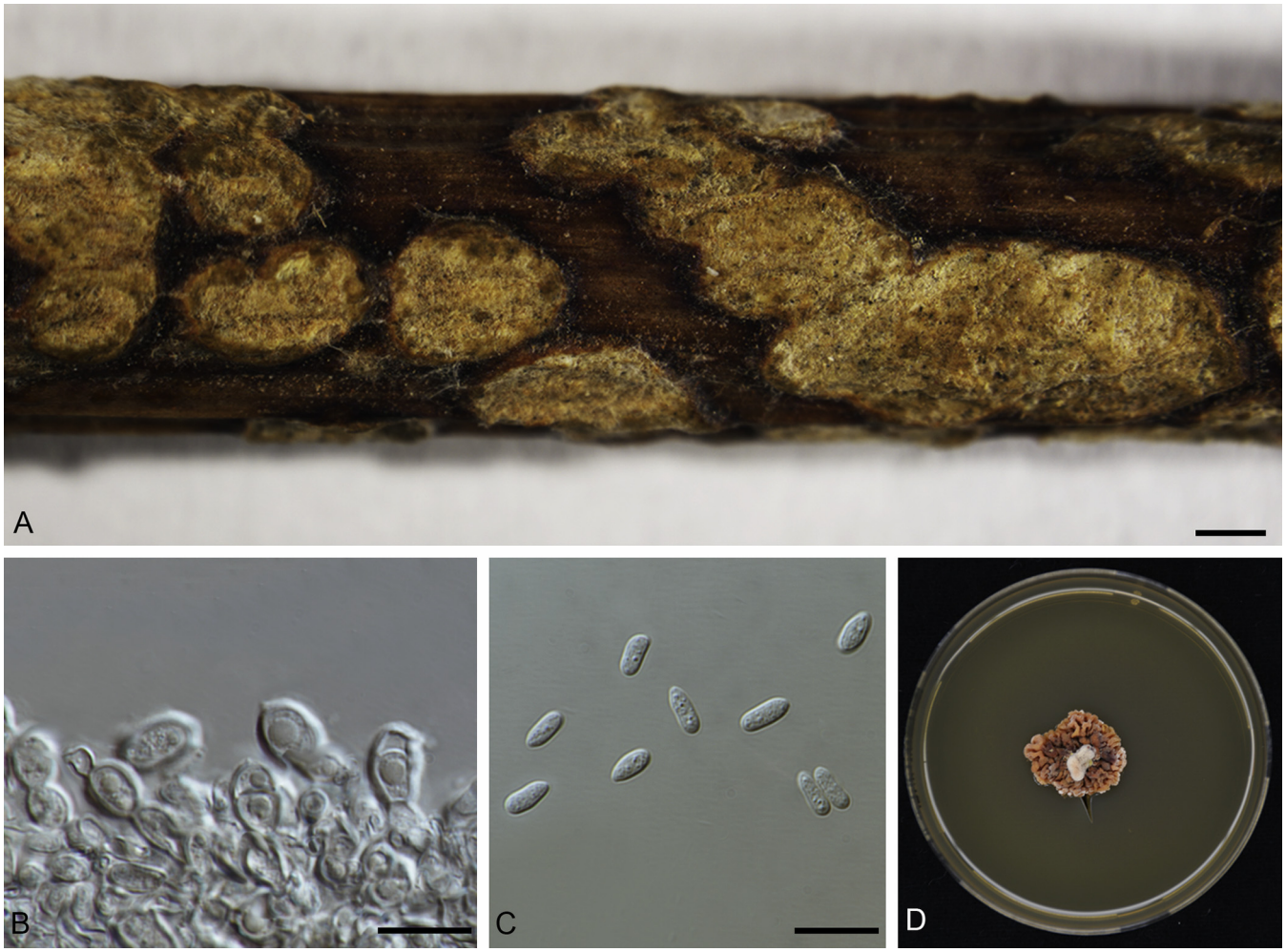

Fig. 18. *Elsinoë krugii* (CPC 18531). **A.** Disease symptoms on *Euphorbia heterophylla*. **B.** Conidiophores. **C.** Conidia. **D.** Colony on MEA after 3 wk. Scale bars: A = 1 mm, B–C = 10 µm.

heterophylla, Dec. 2000, R.W. Barreto (culture CPC 18579 = RWB 211).

Notes: The original description of "*Sphaceloma krugii*" indicated that this fungus was collected from "*Euphorbia prunifolia* var. *repanda*" (= *Eu. heterophylla*) in Brazil, and produced aseptate conidia, 4–6 × 2–4 µm (Bitancourt & Jenkins 1949). The ex-epitype isolate (CPC 18531), was collected from the same host genus and location, and is characterised by aseptate conidia, 4–7 × 2–3.5 µm, which is in agreement with holotype. *In culture*: *Conidiophores* hyaline, verruculose, ampulliform to doliiform, 0–2-septate, 13–30 × 3–6 µm. *Conidiogenous cells* enteroblastic, polyphialidic, with 1–2 integrated loci, hyaline, verruculose, ampulliform to doliiform, 3–8 × 3–6 µm. *Conidia* hyaline, granular, aseptate, ellipsoid to oblong, apex obtuse, sometimes tapering at base to a subtruncate hilum, (4–)5–6.5(–7) × (2–)2.5–3(–3.5) µm. Colonies on MEA are irregular, erumpent, folded, cerebriform; central surface apricot to brown, with smooth, sinuate margins, with sparse aerial mycelium; 12–17 mm diam after 3 wk; sterile. The LSU region fails to distinguish *E. arachidis*, *E. bidentis*, *E. euphorbiae*, *E. genipae*, *E. krugii*, *E. mimosae*, *E. poinsettiae*, *E. sesseae*, and *E. fawcettii* strain CBS 139.25.

Elsinoë lagoa-santensis (Bitanc. & Jenkins) Fan & Crous, **comb. nov.** MycoBank MB818141.

Basionym: *Sphaceloma lagoa-santense* Bitanc. & Jenkins, Proc. Amer Sci. Congr. Wash., 1940: 152. 1940 (1942).

Material examined: **Brazil**, on *Byrsonima coccolobifolia*, Feb. 1936, A.A. Bitancourt (**ex-type** culture CBS 518.50 = IB 2863).

Notes: *Elsinoë lagoa-santensis* is known to cause leaf spots of *Byrsonima coccolobifolia* in Brazil. Symptoms include numerous leaf spots, rounded or slight irregular, occurring on any part of the leaf, sometimes grouped or coalescent on upper surface, flat or shallow, black or nearly so with slightly yellowish grey centres, 0.2–4 mm diam. This fungus is characterised by narrowly ellipsoid–fusoid, broadly naviculate, sometimes cylindrical conidia, 11–19 × 4–6 µm (Bitancourt & Jenkins 1940a).

Elsinoë ledi (Peck) Zeller, Phytopathology 21: 965. 1931. Fig. 3F.

Basionym: *Aulographum ledi* Peck, Bull. N.Y. St. Mus. 150: 23. 1911.

Materials examined: **USA**, Michigan, Ingham County, Towan's Swamp, East Lansing, from *Ledum* sp., May 1895, A.B. Cordley (**holotype** 7964 in O.A.C. Herb). **USA**, Oregon, Waconda Beach, on *Rhododendron neoglandulosum* (= *Ledum glandulosum*), Apr. 1931, S.M. Zeller, deposited by A.E. Jenkins

Fig. 19. A–D. Disease symptoms of *E. leucospermi* on *Leucospermum* spp.

(**epitype designated here** MBT372714, preserved in metabolically inactive state, **ex-epitype** culture CBS 167.33).

Notes: *Elsinoë ledi* was formerly treated as *Aulographum ledi* on *Ledum glandulosum* in the USA (Peck 1911). Zeller & Deremiah (1931) examined some older materials and treated it as *Elsinoë ledi* based on its hyaline, subsphaeroid asci scattered in the entostroma with ellipsoid to fusoid, mostly 3-septate ascospores, 12–17.7 × 5–6.5 µm, which are similar to those of *Elsinoë ampelina*. A.E. Jenkins examined the Oregon materials studied here and identified them as *E. ledi* according to Peck's type (Zeller & Deremiah 1931). We therefore designate this collection (CBS 167.33) as epitype, because it agrees well with the original records, having the same host and location. Colonies irregular, erumpent, folded; surface cinnamon, with white aerial mycelium and smooth, sinuate margins; 8–12 mm diam after 3 wk; sterile.

Elsinoë lepagei Bitanc. & Jenkins, Arq. Inst. Biol., São Paulo 12: 5. 1941.

Material examined: **Brazil**, from *Manilkara zapota* (= *Achras sapota*), Mar. 1938, A.A. Bitancourt (**ex-type** culture CBS 225.50 = IB 2904).

Notes: *Elsinoë lepagei* was described causing scab on leaves and branches of *Manilkara zapota* in Brazil (Bitancourt & Jenkins 1941). Symptoms include grey-brown, irregular, prominent, well-defined leaf spots, 0.5–2 mm diam and smaller (0.5–1 mm diam) lesions on stems. This fungus is characterised by globose asci, 16–22 × 12–21 µm, containing eight hyaline, 3-septate ascospores, 10–16 × 4–7 µm (Bitancourt & Jenkins 1941). In culture on PDA (original description): "Colonies slow-growing, compact, convoluted, downy aerial mycelium centrally, viscid marginal area, cinnamon buff."

Elsinoë leucospermi L. Swart & Crous, Mycologia 93: 370. 2001. Fig. 19.

Materials examined: **Australia**, Victoria, Gembrook, from *Leucadendron* sp., Oct. 1996, A. Ziehrl (culture CBS 111671 = CPC 1504), *ibid*. (culture CBS 111672 = CPC 1503, culture CBS 111673 = CPC 1502); Queensland, from *Leucospermum cordifolium*, Mar. 1989, (culture CBS 112367 = CPC 3699). **South Africa**, Western Cape, Betty's Bay, from *Leucospermum* sp., May 1996, P.W. Crous (**ex-type** culture CBS 111207 = CPC 1380). **Spain**, Tenerife, Proteas de Canarias, Apr. 2000, S. Denman (culture CBS 115500).

Notes: *Elsinoë leucospermi* is known to cause leaf spots of *Leucospermum* and *Leucadendron* in Australia, South Africa, USA and Zimbabwe, and also could infect stems of *Serruria* (Swart *et al.* 2001). In Australia, scab disease symptoms have been observed on many genera of *Proteaceae*, including *Banksia*, *Leucadendron*, *Mimetes*, *Protea* and *Serruria* (Forsberg 1993, Pascoe *et al.* 1995, Crous *et al.* 2013). *Elsinoë* is thought to be distributed via asymptomatic nursery material and this has probably occurred on an international scale. *Asci* ovoid to subglobose 16–28 × 13–18 µm. *Ascospores* hyaline, broadly ellipsoid with rounded to obtuse ends, 1–4 transverse, 1–2 vertical septa (oblique septa rare), constricted at the median septum, (10–)12–14(–19) × 4–5 µm. *Conidiomata* acervular, foliicolous but primarily caulicolous, raised, coalescing at maturity, composed of medium brown *textura angularis*, up to 200 µm diam and 1 mm long. *Conidiophores* subcylindrical, pale brown, verruculose, 0–2-septate, 20–30 × 3–6 µm. *Conidiogenous cells* polyphialidic, with 1–2 integrated loci, pale brown, verruculose, ampulliform to doliiform, 10–15 × 3–4 µm. *Conidia* hyaline, granular, aseptate, ellipsoid, with obtuse apex, constricted at the base to a subtruncate hilum, (2–)5–7(–8) × (1–)2.5–3 µm *in vivo*, 5–7 × 2–3 µm *in vitro* (Swart *et al.* 2001).

Elsinoë lippiae (R.C. Baines & Cummins) Fan & Crous, **comb. nov.** MycoBank MB818127.

Basionym: *Sphaceloma lippiae* R.C. Baines & Cummins, Phytopathology 29: 655. 1939.

Material examined: **USA**, on *Phyla lanceolata* (= *Lippia lanceolata*), R.C. Baines (**ex-type** culture CBS 166.40).

Notes: *Elsinoë lippiae* is known to infect *Phyla lanceolata* (previous *Lippia lanceolata*) in the USA. Symptoms include numerous spots on leaves and stems that are scattered or aggregated, centres depressed, buff-coloured, with purple margins (Baines & Cummins 1939).

Elsinoë mangiferae Bitanc. & Jenkins, Arq. Inst. Biol., São Paulo 17: 218. 1946.

Synonym: *Sphaceloma mangiferae* Bitanc. & Jenkins, Arq. Inst. Biol., São Paulo 17: 215. 1946.

Material examined: **Cuba**, Santiago de las Vegas, on *Mangifera foetida* (= *Mangifera indica*), Aug. 1942, A.A. Bitancourt (**ex-type** culture CBS 226.50 = IB 4416).

Notes: *Elsinoë mangiferae* was described by Bitancourt & Jenkins (1946) as the etiological agent of "wart disease" (= scab) of mango (*Mangifera foetida*) in Chile, Cuba and the USA. Symptoms were described in detail in the original description (Bitancourt & Jenkins 1946) – in brief: small leaf spots, greyish pink, rounded to oval, slight elevated, 0.5–15 mm diam; on shoots spots rounded to oval, closely grouped to form larger patches of crusts (scabs), 1–1.5 mm diam. This fungus is characterised by dark reddish brown, ellipsoid to lenticular acervuli, 15–30 × 23–52 µm, and small, hyaline, spherical to ellipsoid conidia, "0–1-septate, frequently in chains, 6–29 × 2–4 µm"; ascostromata pulvinate, 80–160 µm diam and 30–48 µm thick, asci globose, 10–15 µm diam, ascospores 3-septate (sometimes with one longitudinal septum), 10–13 × 4–6 µm; "microconidia" abundant. In culture (on PDA, according to the original description): Colonies raised, thinly convoluted, mostly glabrous, white to grey to pinkish downy aerial mycelium centrally, humid periphery. The situation regarding *E. mangiferae* was later complicated by the publication of Alcorn *et al.* (1999). While studying mango scab in Australia these authors examined samples from Australia and re-examined the type material and concluded that a species of *Denticularia* was involved in both Australian specimens and type material which fitted clearly into the description of the morphology for the asexual morph of the scab fungus included in Bitancourt & Jenkins' publication. It had erect and well developed conidiophores and long conidia and was recognised as a hyphomycetous morph and not close to any "*Sphaceloma* morph". Alcorn *et al.* (1999) proceeded to proposing a new combination *Denticularia mangiferae* for the fungus causing mango scab. Nevertheless, although obtaining pure cultures of the scab fungus from Australia and fulfilling Koch's postulates doubts remain as to which fungus were they actually handling during the inoculation studies. Their culture description is equivalent to that of most *Elsinoë* spp. and they did not manage to produce typical *Denticularia* conidiophores or conidia in culture. The phylogenetic analysis of the type culture leaves no doubt as to the scab fungus on mango correctly belonging to *Elsinoë*. It is reasonable to conjecture that the *Denticularia* found on scabbed tissues is either a saprobe or a mycoparasite that is regularly associated with *E. mangiferae* and led to Bitancourt & Jenkins (1946) producing a mistaken description incorporating the information on *Denticularia* in their holomorph description. Later, while dealing with the complex again Alcorn *et al.* (1999) interpreted correctly the asexual morph present on the specimens as belonging to *Denticularia* but left aside the evidence provided by the description of the sexual morph in Bitancourt & Jenkins (1946) and mistakenly proposed the new combination *Denticularia mangiferae*. One final puzzle is why there was successful completion of Koch's postulates by Alcorn *et al.* (1999) with their *Denticularia* isolate. A possible explanation for that might be that, while attempting to isolate *Denticularia* they have inadvertently obtained a pure culture of *E. mangiferae* to which *Denticularia* was associated and were then capable of reproducing the scab disease when it was used as inoculum. If that proves right, then the *Denticularia* on mango scab still needs to be named. It is interesting to note that during a survey for fungal pathogens to be used for weed biocontrol performed by RWB in Brazil (state of Rio de Janeiro) (Barreto & Evans 1995) a severe scab disease was found on *Mimosa diplotricha* (a major pantropical weed) and the dominating fungus found associated to the symptoms was also identified as a *Denticularia* and, at the time, mistakenly interpreted as the etiological agent of the disease – in fact caused by *Elsinoë mimosae*.

Elsinoë mattiroloanum G. Arnaud & Bitanc., Mycologia 41: 322. 1949.

Synonyms: *Illosporium mattiroloanum* Sacc. & D. Sacc., Syll. fung. (Abellini) 16: 1093. 1902.

Sphaceloma mattiroloanum (Sacc. & D. Sacc.) Jenkins, J. Wash. Acad. Sci. 27: 414. 1937.

Material examined: **Argentina**, Buenos Aires, Moreno, from leaves of *Arbutus unedo*, May 1934, L. Grodsinsky (culture CBS 348.36); on *A. unedo*, C.A. Salemink (culture CBS 287.64).

Notes: *Elsinoë mattiroloanum* is known to cause leaf spots of *Arbutus unedo* in Italy. This fungus is characterised by ellipsoid asci, 30 × 18 µm diam, containing eight hyaline, 1-septate ascospores, 11 × 4 µm. The sexual morph was described from the same leaf spots as that of the asexual morph, and although not proven in culture, was accepted as proof of the sexual-asexual relationship (Arnaud & Bitancourt 1949), for which the new name *Elsinoë mattiroloanum* was introduced. The LSU region fails to distinguish *E. fici-caricae*, *E. mattiroloanum*, *E. piri*, and *E. sicula*.

Elsinoë menthae (Jenkins) Fan & Crous, **comb. nov.** MycoBank MB818128. Fig. 3G.

Basionym: *Sphaceloma menthae* Jenkins, J. Wash. Acad. Sci. 27: 414. 1937.

Materials examined: **USA**, Michigan, from *Mentha* × *piperita*, Aug. 1937, R. Nelson (**holotype** BPI 681964). **USA**, Indiana, on *Mentha piperita*, Aug. 1937, R. Nelson & A.E. Jenkins, dep. A.E. Jenkins (**epitype designated here**, MBT372715, preserved in metabolically inactive state, **ex-epitype** culture CBS 322.37); Indiana, on *Mentha piperita*, R.C. Baines, dep. A.E. Jenkins (culture CBS 321.37).

Notes: "*Sphaceloma menthae*" was originally described causing the disease known as leopard spot on leaves, stems and rootstocks of cultivated *Mentha piperita* in Michigan, USA (Jenkins 1937). Symptoms include circular, oval or irregular spots, black with white centres, up to 5 mm diam. This species is characterised by superficially erumpent acervuli with hyaline, spherical to ellipsoid conidia, 3–8 × 2.5–4 µm (Jenkins 1937). The ex-epitype strain (CBS 322.37) deposited by A.E. Jenkins was isolated from same host in Indiana (USA). Colonies irregular, erumpent, folded, cerebriform, surface brown vinaceous to black, with cinnamon, smooth, sinuate margins and white to grey aerial mycelium; 15–18 mm diam after 3 wk; sterile.

Elsinoë mimosae Viégas, Bragantia 4: 13. 1944. Fig. 20.

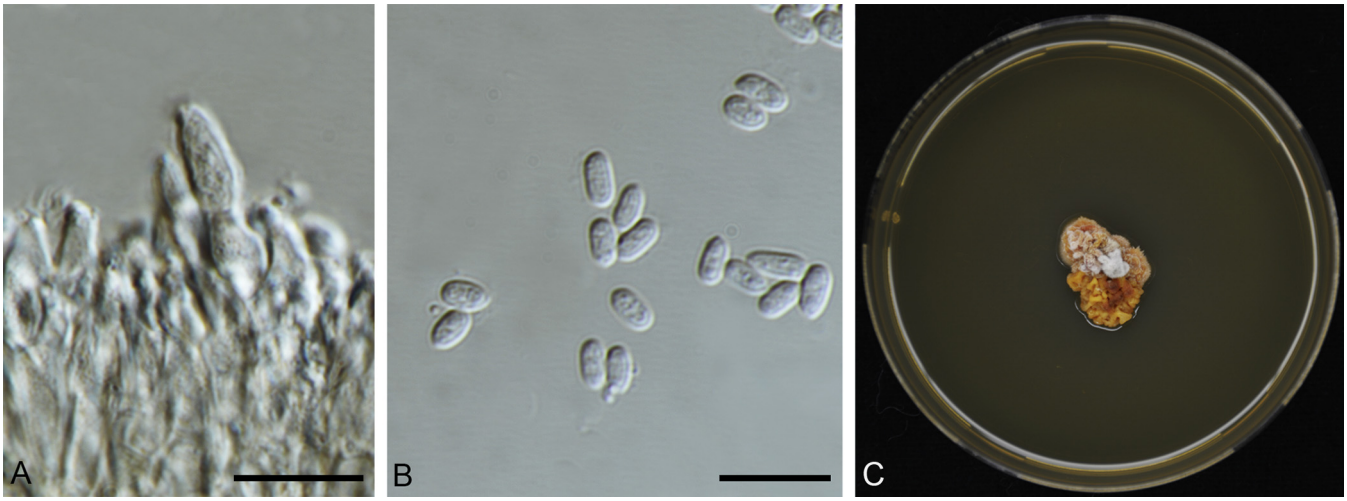

Fig. 20. *Elsinoë mimosae* (CPC 19478). **A.** Conidiophores. **B.** Conidia. **C.** Colony on MEA after 3 wk. Scale bars: A–B = 10 µm.

Materials examined: **Brazil**, São Paulo, Campinas, on *Mimosa* sp., 31 Mar. 1931, H.P. Krug & O. Zagatto (**holotype** Campinas No. 2836); **Brazil**, Rio de Janeiro, Itaguaí, Mazomba, on *Mimosa diplotricha* (= *Mimosa invisa*), Mar. 1999, R.W. Barreto (**epitype designated here** MBT372716, preserved in metabolically inactive state, **ex-epitype** culture CPC 19478 = RWB 154 = CBS 141878). **Ecuador**, Coca, on *Mimosa diplotricha*, Nov. 2000, R.W. Barreto (specimen CBS H-22804, culture CPC 18518 = RWB 224 = CBS 141943).

Notes: *Elsinoë mimosae* was originally recorded on *Mimosa* sp. in Brazil, with globose asci, 18–20 µm diam, distributed irregularly in ascostromata with eight hyaline, muriformly septate, oblong-subovoid ascospores, 8–10 × 4–4.5 µm (Viégas 1944). The strain CPC 19478, which was isolated from the same host in Brazil, is designed here as ex-epitype. *In culture*: *Conidiophores* subcylindrical, hyaline, verruculose, ampulliform to doliiform, 0–1-septate, 8–25 × 2–5 µm. *Conidiogenous cells* enteroblastic, polyphialidic, with 1–2 integrated loci, hyaline, verruculose, ampulliform to doliiform, 8–15 × 2–4 µm. *Conidia* hyaline, granular, aseptate, ellipsoid to oblong, apex obtuse, sometimes tapering towards the base to a subtruncate locus, (3–)3.5–5(–6) × 2–2.5(–3) µm.

Culture characteristics: Colonies, erumpent, folded; central surface brown, with smooth, irregular apricot margins, forming sparse white aerial mycelium; 8–15 mm diam after 3 wk; sterile.

Notes: This fungus causes a severe disease on *M. diplotricha* in South America on habitats ranging from the Ecuadorian Amazon to the highlands of the state of Rio de Janeiro (Brazil). It remains restricted to the neotropics and has clear potential for use as a classical biological control agent against its host (giant sensitive plant), which is a major pantropical weed. The LSU region fails to distinguish *E. arachidis*, *E. bidentis*, *E. euphorbiae*, *E. genipae*, *E. krugii*, *E. mimosae*, *E. poinsettiae*, *E. sesseae*, and *E. fawcettii* strain CBS 139.25. The *rpb2* region failed to distinguish *E. genipae*, and *E. mimosae*.

Elsinoë oleae Ciccar. & Graniti, Arq. Inst. Biol., São Paulo 26: 17. 1959.

Material examined: **Italy**, Catania, Santa Tecla, from leaves of *Olea europaea*, Aug. 1957, A. Graniti (**ex-type** culture CBS 227.59).

Notes: *Elsinoë oleae* is known to cause leaf spots of *Olea europaea* in Italy. Symptoms include prominent, circular, oval or irregular spots that become linear, rugulose, 0.2–2 × 0.1–0.5 mm. This fungus is characterised by hyaline, ovoid asci, 25–30 × 10–14 µm, containing eight hyaline, fusiform, 3-septate ascospores, 12–15 × 3–4 µm. The asexual morph of this fungus has hyaline, ellipsoid, ovoid to subglobose conidia, 2–3.5 × 3–6 µm (Ciccarone & Graniti 1959).

Elsinoë othonnae Crous & A.R. Wood, Persoonia 34: 209. 2015. Fig. 21.

Material examined: **South Africa**, Western Cape Province, Brackenfell, Bracken Nature Reserve, on stems of *Othonna quinquedentata*, 10 May 2014, A.R. Wood (**holotype** CBS H-22239, culture **ex-type** CPC 24853 = CBS 139910); *ibid*. (culture CPC 24954).

Notes: Occurring on stems of *Othonna quinquedentata* in South Africa. Symptoms include circular to subcircular lesions, pale grey-brown with dark red-brown borders, 1–10 mm diam. In culture on SNA: Conidia hyaline, guttulate, smooth, aseptate, ellipsoidal to subcylindrical, apex obtuse, base bluntly rounded to truncate, (5–)6–7 × (2.5–)3(–4) µm *in vitro* (Crous *et al.* 2015b). Because not all genes were successfully amplified, *E. othonnae* was omitted from the final multigene alignment (Table 1).

Elsinoë perseae (Jenkins) Rossman & W.C. Allen, IMA Fungus 7: 3. 2016. Fig. 22.

Basionym: *Sphaceloma perseae* Jenkins, Phytopathology 24: 84. 1934.

Material examined: **Brazil**, Limeira, on *Persea americana*, C.A. Salemink (culture CBS 288.64). **USA**, Florida, Orlando, on *Persea americana*, A.E. Jenkins (**ex-type** culture CBS 406.34).

Notes: *Elsinoë perseae* was originally reported to infect leaves and fruits of *Persea americana* in the USA, causing scab disease. This fungus is characterised by hyaline, ovoid to oblong-ellipsoid, biguttulate conidia, 5–8 × 3–4 µm (Jenkins 1934). Following its initial description, it was broadly recorded in the warmer regions of the American continent (nt.ars-grin.gov/fungaldatabases/) but also in Africa, America, Asia and New

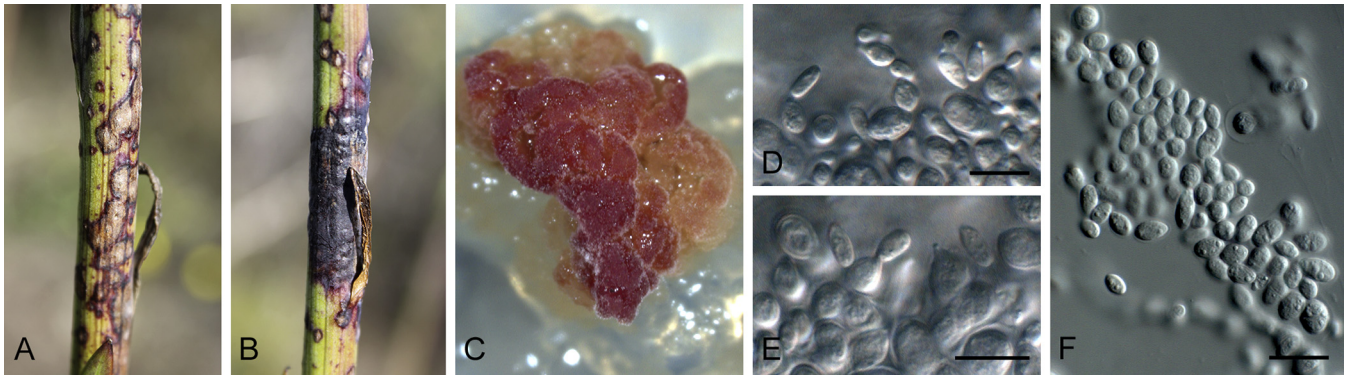

Fig. 21. *Elsinoë othonnae* (CBS 139910). **A, B.** Disease symptoms on stems of *Othonna quinquedentata*. **C.** Colony on PDA. **D–F.** Conidiogenous cells and conidia. Scale bars = 10 µm.

Fig. 22. Disease symptoms of *E. perseae* on *Persea americana*.

Zealand (Hartill 1991, Everett *et al.* 2011). It causes one of the most important diseases of avocado (Piccinini *et al.* 2005).

Elsinoë phaseoli Jenkins, J. Agric. Res. 47: 788. 1933. Fig. 23.

Materials examined: **Cuba**, Wajay, Havana, on *Phaseolus lunatus*, Nov. 1929, C. Aguiar, dep. A.E. Jenkins (**ex-type** culture CBS 165.31 = IMI 303278); on *Phaseolus lunatus*, C.A. Salemink (CBS 234.64 = IMI 303279). **Malawi**, Dedza, on *Phaseolus vulgaris*, Mar. 1994, A. Liebenberg, dep. A.J.L. Phillips (CBS 151.95); Bunda, on *Phaseolus vulgaris*, Mar. 1994, A. Liebenberg, dep. A.J.L. Phillips (CBS 152.95). **South Africa**, KwaZulu-Natal, Greytown, on *Phaseolus vulgaris*, Mar. 1993, A. Liebenberg, dep. A.J.L. Phillips (CBS 149.95); KwaZulu-Natal, Cedara, on *Phaseolus vulgaris* cv. *Helderberg*, Mar. 1993, A. Liebenberg, dep. A.J.L. Phillips (CBS 150.95).

Notes: *Elsinoë phaseoli* is known to cause scab of beans (*Phaseolus lunatus*) in Cuba (Bruner & Jenkins 1933). It has subsequently been reported on *Phaseolus* and *Vigna* in Africa, America and Brazil (Lasca 1978, Phillips 1994). Symptoms include circular lesions on the leaves, occurring on the upper surface of the leaf, 2–3 mm diam; lesions on the stems elongated, white to grey, slightly sunken on green pods, turning red-brown, slightly raised, 2–3 mm diam. This fungus is characterised by ovoid to subglobose asci, 14–22 × 21–27 µm, and hyaline, oblong to ellipsoid ascospores, 10–15 × 4–5 µm, with 2–3 septa (Bruner & Jenkins 1933, Phillips 1994). The conidia are oblong to ellipsoid, 6 × 2 µm (Phillips 1994).

Elsinoë piri (Woron.) Jenkins, J. Agric. Res. 44: 696. 1932.

Basionym: *Plectodiscella piri* Woron., Mykol. Zentbl. 4: 232. 1914.

Materials examined: **New Zealand**, Auckland, from *Malus sylvestris*, Jan. 1982, H.J. Boesewinkel (culture CBS 179.82). **Unknown origin**, from *Pyrus communis*, 1828, A.E. Jenkins (culture CBS 163.29).

Notes: *Elsinoë piri* is known to cause apple and pear spot and anthracnose and is economically important in some organic orchards, but is rarely observed in orchards with a conventional fungicide regime (Scheper *et al.* 2013). It has a worldwide distribution and has been often recorded incorrectly spelled as "*Elsinoë pyri*" (Jenkins 1932a). Symptoms include whitish grey leaf spots with brown margins, having visible dark brown ascostromata in the centre of the spots. Spots on fruits can vary in colour from white to pale yellow brown, to brown in the centre and surrounded by a dark red margin. This fungus is characterised by hyaline conidia, aseptate, 4–6 × 2.5–4 µm, which may be present on acervuli on leaves and fruits (Woronichin 1914, Jenkins 1932a, Jenkins *et al.* 1946, Scheper *et al.* 2013). The LSU region fails to distinguish *E. fici-caricae*, *E. mattiroloanum*, *E. piri*, and *E. sicula*. The *TEF1-α* region fails to distinguish *E. piri*, and *E. sicula*.

Elsinoë pitangae Bitanc. & Jenkins, Arq. Inst. Biol., São Paulo 11: 51. 1940.

Material examined: **Brazil**, São Paulo, Cantareira, on *Eugenia uniflora*, Dec. 1937, A.A. Bitancourt (**ex-type** culture CBS 227.50 = IB 2816).

Notes: *Elsinoë pitangae* is known to cause lesions (referred to as anthracnose in the original description) on leaves and branches of *Eugenia uniflora* – a native Brazilian myrtaceous fruit crop

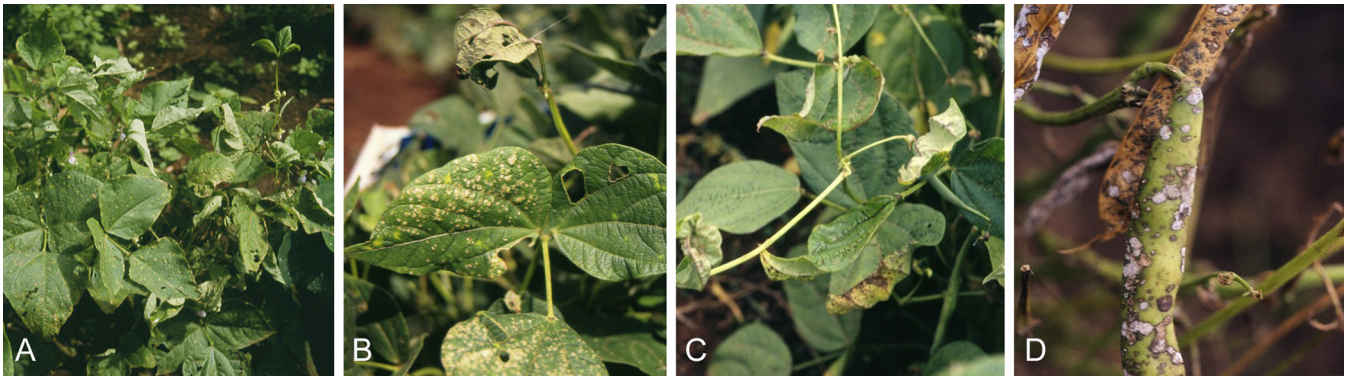

Fig. 23. A–D. Disease symptoms of *E. phaseoli* on *Phaseolus*. (Photos credits: Deidre Fourie, South Africa).

Fig. 24. A–B. Disease symptoms of *E. poinsettiae* on leaves and stem of *Euphorbia*.

(pitangueira) – in São Paulo, Brazil. Symptoms include small spots, round, scattered, amphigenous, depressed, and perforated, occasionally in the centre with protruding edges, 0.2–2 mm diam. This fungus is characterised by globose to ovoid asci, 18–21 × 14–18 µm, and hyaline, 1–3-septate ascospores, 14–20 × 4–6 µm (Bitancourt & Jenkins 1940b). Cultures were briefly described by Bitancourt & Jenkins (1940b) on PDA as: slow-growing, compact, convoluted, black to dull purplish black with some short downy, whitish aerial mycelium.

Elsinoë poinsettiae (Jenkins & Rühle) Rossman & W.C. Allen, IMA Fungus 7: 3. 2016. Fig. 24.

Basionym: *Sphaceloma poinsettiae* Jenkins & Rühle, Proc. Biol. Soc. Wash. 55: 83. 1942.

Materials examined: **Guatemala**, on stem lesion of *Euphorbia pulcherrima*, Oct. 2000, M.E. Palm (culture CBS 109333 = MEP 1503), *ibid*. (culture CBS 109334 = MEP 1504).

Notes: *Elsinoë poinsettiae* was originally described from infected leaves and branches of *Euphorbia pulcherrima* var. *plenissima* in Florida, USA (Jenkins & Rühle 1942). Scab disease of this host was subsequently found in Brazil, Guatemala, Jamaica and Puerto Rico (Rubin 1961, Wehlburg 1968). *Elsinoë poinsettiae* may cause economic losses in ornamental poinsettia nurseries. The name *S. poinsettiae* has been mistakenly used for the fungus causing scab on wild poinsettia (*E. heterophylla*) which was studied in detail as a potential biocontrol agent to be used against this major weed (Nechet *et al.* 2004). The phylogenetic analysis has shown that all isolates attacking *E. heterophylla* in fact belong to *E. krugii*. Conversely, *E. pulcherrima* appeared as a host of *E. krugii*, as revealed by the results of the molecular identification of isolate CPC 18537, a surprising result since the host-range evaluations of Nechet *et al.* (2004) of isolates of *Sphaceloma* obtained from *E. heterophylla* (then seemingly mistakenly identified as *S. poinsettiae*) involving 37 plant species, including *E. pulcherrima* – among several members of the *Euphorbiaceae* – resulted only in the infection of *E. heterophylla*. It is known that there is variation in host range between different populations within species of *Elsinoë* infecting *Euphorbiaceae*. In order to better clarify the situation for *Elsinoë* attacking euphorbiaceous hosts a novel round of studies involving cross inoculations of a range of isolates from different hosts in the family following the lead of Zeigler & Lozano (1983), but supported by the results of the present molecular evaluation of these taxa and utilising modern tools for population studies is needed. The LSU region fails to distinguish *E. arachidis*, *E. bidentis*, *E. euphorbiae*, *E. genipae*, *E. krugii*, *E. mimosae*, *E. poinsettiae*, *E. sesseae*, and *E. fawcettii* strain CBS 139.25.

Elsinoë pongamiae (Wani & Thirum.) Fan & Crous, **comb. nov.** MycoBank MB818129. Fig. 3H.

Basionym: *Sphaceloma pongamiae* Wani & Thirum., Sydowia 24: 319. 1970.

Materials examined: **India**, Vithalwadi, Poona, on *Pongamia pinnata*, 2 Jan. 1958, D.D. Wani. (**holotype** BPI 682603);Vithalwadi near Poona, on *Pongamia pinnata*, Feb. 1960, M.J. Thirumalachar (**epitype designated here**, MBT372717, preserved in metabolically inactive state, **ex-epitype** culture CBS 402.63 = ATCC 15026).

Notes: *Elsinoë pongamiae* was originally described as "*Sphaceloma pongamiae*" on *Pongamia glabrae* in India (Wani & Thirumalachar 1970). Symptoms include small, numerous spots on shoots and pods, often coalescing, forming greyish white crusts (= scab); numerous spots on leaves scattered, less often closely grouped with chalky-white to greyish pink margin, 1–2 mm diam. This fungus is characterised by spherical to ovoid, aseptate conidia, 1.5 × 1.5 µm (Wani & Thirumalachar 1970). The ex-epitype strain deposited at CBS (CBS 402.63) was isolated by the same collector and from the same host genus in India. *In culture*: Colonies circular, raised colonies, surface white to rosy buff, with smooth, sinuate margins and white aerial mycelium; 15–18 mm diam after 3 wk; sterile. The ITS and *TEF1-α* regions fail to distinguish *E. embeliae* and *E. pongamiae*.

Elsinoë populi (Sacc.) Fan & Crous, **comb. nov.** MycoBank MB818130.

Fig. 25. Disease symptoms of *E. proteae* on *Protea cynaroides*.

Basionym: *Hadrotrichum populi* Sacc., Michelia 1: 264. 1878.

Synonym: *Sphaceloma populi* (Sacc.) Jenkins, J. Agric. Res. 44: 694. 1932.

Materials examined: **Argentina**, Minos, on *Populus deltoides* subsp. *deltoides* (= *Populus serotina*), C.A. Salemink (culture CBS 289.64 = ATCC 11181); Minos, from *Populus deltoides* subsp. *deltoides*, C.A. Salemink (culture CBS 290.64).

Notes: *Elsinoë populi* was originally described from infected leaves of *Populus nigra* in Europe, causing scab disease (Jenkins 1932a). This fungus is characterised by hyaline, globose to ovoid conidia, 4–5 × 3 µm (Saccardo 1878, Jenkins 1932a).

Elsinoë proteae Crous & L. Swart, Mycologia 93: 374. 2001. Fig. 25.

Material examined: **South Africa**, Western Cape Province, Harold Porter Botanical Gardens, Betty's bay, on leaves of *P. cynaroides*, 15 Feb. 1996, P.W. Crous (**holotype** PREM 54979, **ex-type** culture CPC 1349).

Notes: Occurring on leaves and petioles of *Protea* spp. in South Africa. It was described by (Swart *et al.* 2001) as follows: Symptoms include circular, raised leaf spots, white-grey with visible black ascostromata on both side of leaves. *Ascospores* hyaline to olivaceous, broadly ellipsoid with rounded ends, with 3–5 transverse, and 1–3 vertical septa; oblique septa sometimes present; mostly slightly constricted at the median septum, (14–)16–17(–20) × (5–)6–7 µm. *Conidia* hyaline, granular, aseptate, ellipsoid, with obtuse apex, and rounded to subtruncate base, (5–)6–7(–8) × 2–3(–4) µm. *In culture*: Colonies irregular, erumpent, folded, with sinuate, smooth margins, rose to red; aerial mycelium sparse, whitish; with diffuse red pigment in the medium. Because not all genes were successfully amplified, *E. proteae* was omitted from the final multigene alignment (Table 1).

Elsinoë protearum (L. Swart & Crous) L. Swart & Crous, CBS Biodiversity Series 13: 250. 2013. Fig. 26.

Basionym: *Sphaceloma protearum* L. Swart & Crous, Mycologia 93: 375. 2001.

Material examined: **Zimbabwe**, Mutare, Gomo Remiti farm, on leaves and stems of *Protea eximia* × *susanne* cv. *Sylvia*, 5 Mar. 1998, L. Swart (**holotype** PREM 56301, **ex-type** culture CBS 113618 = CPC 2037).

Notes: *Elsinoë protearum* is known to cause leaf spots on *Protea* sp. in Australia and Zimbabwe (Swart *et al.* 2001). Ziehrl *et al.* (2000) also demonstrated that *Elsinoë* spp. from South African *Proteaceae* could infect Australian proteaceous genera such as *Banksia* and *Dryandra*, but not *Telopea*, *Grevillea* or *Hakea*. *Symptoms* include circular, reddish leaf spots, erumpent with reddish sporodochia on the necrotic tissue, 5–15 mm diam. *Conidia* hyaline, aseptate, ellipsoid, with obtuse apex, constricted at the base to a subtruncate locus, (3.5–)5–6(–7) × (1.5–)2–2.5 µm *in vivo*. *In culture*: Colonies irregular, erumpent, folded with sinuate, smooth margins, blood red, with diffuse red pigment (Swart *et al.* 2001).

Key to *Elsinoë* species on *Proteaceae*

1 Occurring on *Banksia*..... **2**

1 On other *Proteaceae*..... **3**

2 Leaf spots on *B. serrata*; colonies grey-olivaceous; optimal growth at 15 °C..... ***E. banksiae***

2 Lesions on leaves and veins of *B. prionotes*; colonies blood-red; optimal growth at 20–25 °C..... ***E. banksiicola***

3 Occurring on *Leucadendron*, *Leucospermum* and *Serruria*; ascospores with 1–4 transverse, 1–2 vertical and rarely any oblique septa, (10–)12–14(–19) × 4–5 µm; colonies blood red, optimal growth at 20–25 °C; conidia (2–)5–7(–8) × (1–)2.5–3 µm..... ***E. leucospermi***

3 Occurring on *Protea*..... **4**

4 Leaf spots on mature leaves; ascospores with 3–5 transverse, 1–3 vertical and rarely any oblique septa, (14–)16–17(–20) × (5–)6–7 µm; colonies rose to red with diffusing red pigment; optimal growth at 15–20 °C; *Sphaceloma* morph not observed on host..... ***E. proteae***

4 Shepherd's crook and leaf spot symptoms on juvenile growth flushes, leading to shoot blight; colonies blood-red with slight diffusing red pigment; optimal growth at 20–25 °C; *Elsinoë* morph not observed on host..... ***E. protearum***

4 Leaf spots small black specks on leaves and twigs; ascospores with 1–4 transverse, 1–2 vertical, and rarely any oblique septa, (10–)11.5–12.5(–15) × (4–)4.5–5(–5.5) µm..... ***E. fecunda***

Fig. 26. A–C. Disease symptoms of *E. protearum* on *Protea* sp.

Fig. 27. Disease symptoms of *E. punicae* on *Punica granatum*. (Photo credits: M. Mirabolfathy, Iran).

Elsinoë punicae (Bitanc. & Jenkins) Rossman & W.C. Allen, IMA Fungus 7: 3. 2016. Fig. 27.

Basionym: *Sphaceloma punicae* Bitanc. & Jenkins, Proc. Amer Sci. Congr. Wash. 1940: 163. 1942 (1940).

Material examined: **South Africa**, Western Cape Province, on *Punica granatum* (scab-like lesions on fruit and brown spots on leaves), 12 Mar. 2012, L. Mostert & W. Laubscher (culture CPC 19968).

Notes: *Elsinoë punicae* was originally described from leaf spots of *Punica granatum* in Argentina, and later recorded in Brazil and Italy (Bitancourt & Jenkins 1940a). The violet to blackish purple spots spread to the midrib and veins, becoming paler at the centre upon drying (Bitancourt & Jenkins 1940a). Furthermore, *Sphaceloma punicae* was identified from scab-like lesions from fruit in China (Xiao-Hui *et al.* 2004), and rusty spots on fruit and leaves in India (Jamadar *et al.* 2011). The ITS region fails to distinguish *E. australis*, *E. genipae-americanae* and *E. punicae*.

Elsinoë quercus-ilicis (G. Arnaud) Jenkins & Goid., Arq. Inst. Biol., São Paulo 23: 117. 1956.

Basionym: *Uleomyces quercus-ilicis* G. Arnaud, Annls Sci. Nat. Bot. 7: 687. 1925.

Synonym: *Sphaceloma quercus-ilicis* Martelli & Laviola, Phytopath. Mediterr. 3: 136. 1961.

Material examined: **Italy**, Gargano promontory, on leaves of *Quercus ilex*, G.P. Martelli & C. Laviola (**ex-type** culture of *Sphaceloma quercus-ilicis*, CBS 232.61).

Notes: The specimen information of CBS 232.61, such as host, locality, collection date and collector are the same as those given in the original description of *Sphaceloma quercus-ilicis*, and thus this strain is recognised here as ex-type. Conidia are ovoid to subcylindrical or subfusiform, 10–14 × 5–7 µm (Martelli & Laviola 1961).

Elsinoë randii Jenkins & Bitanc., Phytopathology 28: 77. 1938.

Synonym: *Sphaceloma randii* Jenkins & Bitanc., Arq. Inst. Biol., São Paulo 32: 68. 1965.

Material examined: **Brazil**, São Paulo, Campinas, from *Carya pecan*, A.A. Bitancourt (**ex-isotype** culture CBS 170.38), ibid. (culture CBS 171.38).

Notes: *Elsinoë randii* was described from infected *Carya pecan* in Brazil (Jenkins & Bitancourt 1938). Later it was recorded in Japan and USA but only limited in *Juglandaceae* (Kurosawa & Katsuki 1956, Jenkins & Bitancourt 1965). The ITS and *TEF1-α* regiona fail to distinguish *E. fici* and *E. randii*. The LSU region fails to distinguish *E. centrolobii*, *E. fici*, *E. jasminae*, and *E. randii*.

Elsinoë rhois (Bitanc. & Jenkins) Fan & Crous, **comb. nov.** MycoBank MB818131.

Basionym: *Sphaceloma rhois* Bitanc. & Jenkins, Arq. Inst. Biol., São Paulo 11: 48. 1940.

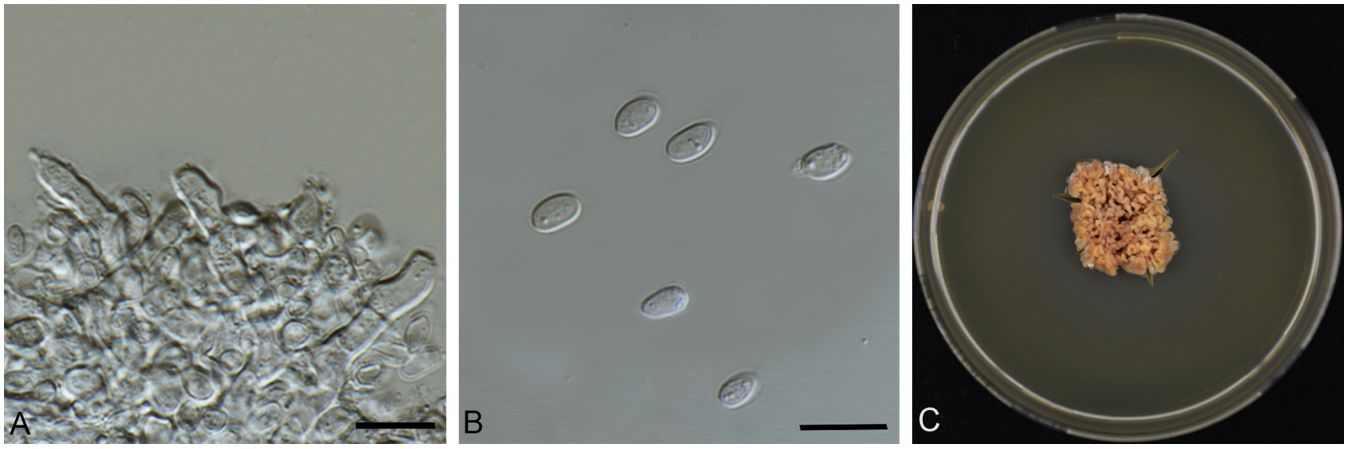

Fig. 28. *Elsinoë salicina* (CPC 17824). **A.** Conidiophores. **B.** Conidia. **C.** Colony on MEA after 3 wk. Scale bars: A–B = 10 µm.

Material examined: **Brazil**, from *Toxicodendron vernix* (= *Rhus vernix*), Dec. 1937, A.A. Bitancourt (**ex-type** culture CBS 519.50 = ATCC 11194 = IB 2802).

Notes: *Elsinoë rhois* is known to infect leaves of *Rhus vernix* (currently *Toxicodendron vernix*) in Brazil. Symptoms include numerous leaf spots, rounded or irregular, often coalescing, amphigenous, depressed, black on upper surface and brown on lower leaf surface, 0.5–3 mm diam. This fungus is characterised by pale yellow, ovoid to cylindrical conidia, 8–16 × 3–6 µm (Bitancourt & Jenkins 1940b).

Elsinoë ricini (Jenkins & C.C. Cheo) Fan & Crous, **comb. nov.** MycoBank MB818132.

Basionym: *Sphaceloma ricini* Jenkins & C.C. Cheo, J. Wash. Acad. Sci. 31: 416. 1941.

Material examined: **India**, Chinchwad, from *Ricinus communis*, Oct. 1959, M.J. Thirumalachar (culture CBS 403.63 = ATCC 15030 = IMI 100604).

Notes: *Elsinoë ricini* was originally known to infect leaves and stems of *Ricinus communis* in Yunnan, China, causing castor bean scab. Symptoms are recognised by numerous leaf spots, globose or subglobose, 2–3 mm diam. This fungus is characterised by oblong, ovoid to ellipsoid conidia, 10–15 × 2.5–4.5 µm (Jenkins & Cheo 1941).

Elsinoë rosarum Jenkins & Bitanc., Mycologia 49: 98. 1957. Fig. 3I.

Synonyms: *Phyllosticta rosarum* Pass., Erb. critt. Ital., Ser. 2, fasc.: no. 1092. 1881.

Sphaceloma rosarum (Pass.) Jenkins, J. Agric. Res. 45: 330. 1932. *Gloeosporium rosarum* (Pass.) Grove, British Stem- and Leaf-Fungi (Coelomycetes) (Cambridge) 2: 224. 1937.

Materials examined: **USA**, Oregon, Washington County, Reedsville, on *Rosa pisocarpa*, 18 May 1944, J. Roaf & C.G. Anderson (**holotype** BPI 681052). **USA**, New York, Ithaca, from *Rosa* sp., 1925, A.E. Jenkins (**epitype designated here** MBT372718, preserved in metabolically inactive state, **ex-epitype** culture CBS 212.33); from *Rosa* sp., 1923, L.M. Massey, dep. A.E. Jenkins (culture CBS 213.33); New York, Ithaca, from *Rosa* sp., C.A. Salemink (culture CBS 235.64). **Unknown origin**, from *Rosa* sp., E.M. Wakefield (culture CBS 150.27).

Notes: Passerini (1881) described this fungus as *Phyllosticta rosarum* causing rose anthracnose in Italy. However, it was confused with similar pathogens, i.e., *Elsinoë veneta* causing bramble anthracnose and *E. piri* associated with apple and pear anthracnose (Jenkins 1932a). Later, Jenkins (1932b) separated them as distinct species according to the three anthracnose diseases that they caused, and treated *Phyllosticta rosarum* as *Sphaceloma rosarum* based on its typical *Sphaceloma* morphology of the asexual morph. Symptoms include dark, purplish black leaf spots with dull livid brown margins, occurring on any part of the leaves, including midrib and veins; lesions on stems are generally circular, or elongate, often dull livid brown, becoming white or ashen, raised, and sometimes depressed at the centre. *Elsinoë rosarum* was originally described from *Rosa* sp. collected in the USA, with hyaline, 1–3 septate ascospores measuring 10–14 × 5–7 µm (Jenkins & Bitancourt 1957). The strain CBS 212.33 deposited in CBS is from the same host genus and location, and thus is designated here as ex-epitype. *In culture*: *Colonies* circular, raised, surface fawn, with smooth margins and white to grey aerial mycelium in centre; 11–15 mm diam after 3 wk; sterile.

Elsinoë salicina Fan & Crous, **sp. nov.** MycoBank MB818133. Fig. 28.

Etymology: Named after the host genus from which it was collected, *Salix* sp.

In culture: *Conidiophores* subcylindrical, hyaline, verruculose, ampulliform to doliiform, 0–2-septate, 10–20 × 4–5 µm. *Conidiogenous cells* enteroblastic, polyphialidic, with 1–3 integrated loci, hyaline, verruculose, ampulliform to doliiform, 8–14 × 4–5 µm. *Conidia* hyaline, granular, aseptate, ellipsoid to oblong, apex obtuse, sometimes constricted at the base to a subtruncate locus, (4.5–)5–6(–6.5) × (25–)3–4.5(–5) µm.

Culture characteristics: Colonies irregular, erumpent, folded, surface apricot, with smooth, irregular apricot margins with few sparse aerial mycelium; 14–20 mm diam after 3 wk; sterile.

Fig. 29. Disease symptoms of *E. sesseae* on *Cestrum laevigatum.*

Material examined: **USA**, Texas, Austin, from *Salix* sp., Aug. 2013, P.W. Crous (**holotype** CBS H-22748, **ex-type** culture CPC 17824).

Notes: *Elsinoë salicina* differs on ITS (25 nt), LSU (3 nt), *rpb2* (33 nt) and *TEF1-α* (18 nt) positions from the closely related species *E. freyliniae* (ex-type culture CBS 128204) and differs on ITS (13 nt), LSU (4 nt), *rpb2* (31 nt) and *TEF1-α* (17 nt) from *E. oleae* (ex-type culture CBS 227.59) included in the current study.

Elsinoë semecarpi (Wani & Thirum.) Fan & Crous, **comb. nov.** MycoBank MB818134.

Basionym: *Sphaceloma semecarpi* Wani & Thirum., Sydowia 23: 255. 1969.

Material examined: **India**, Maharashtra, Poona, Law College, from *Melanochyla caesia* (= *Semecarpus anacardium*), Dec. 1958, M.J. Thirumalachar (**ex-type** culture CBS 477.62 = ATCC 14657 = HACC 135 = IMI 092308).

Note: *Elsinoë semecarpi* was described by Wani & Thirumalachar (1969a) as causing spots on leaves, tender shoots and fruits of *Semecarpus anacardium* (= *Melanochyla caesia*) in India. Symptoms include leaf spots that appear as greyish white crusts (= scabs) in centre with bluish margins, 0.5–5 mm diam, often occurring along midrib and lateral veins or between lateral veins. Slightly raised leaving depression on the lower side of leaves. Lesions on shoots and fruits crustose, greyish white. *Acervuli* were described as numerous, reddish-brown, erumpent 18–39 µm wide but sterile. *In culture*: Colonies raised, crustose, fawn coloured, salmon red reverse; forming abundant microconidia and chlamydospores. The ITS, *rpb2* and *TEF1-α* regions fail to distinguish *E. anacardii* and *E. semecarpi*.

Elsinoë sesseae (Bitanc. & Jenkins) Fan & Crous, **comb. nov.** MycoBank MB818135. Fig. 29.

Basionym: *Sphaceloma sesseae* Bitanc. & Jenkins, Arq. Inst. Biol., São Paulo 20: 18. 1950.

Material examined: **Brazil**, Rio de Janeiro, Seropédica, road Rio-São Paulo, on *Cestrum laevigatum*, Apr. 2010, R.W. Barreto (culture CPC 18549 = RWB 1219).

Note: *Elsinoë sesseae* is known to cause leaf spots of *Sessea brasiliensis* in São Paulo, Brazil. Bitancourt & Jenkins (1950) mentioned scabs on *Cestrum* as "other specimens of *Elsinoaceae* on *Solanaceae* that deserve mentioning" after describing *S. sesseae.* Here the isolate CPC 18549 is tentatively identified as *E. sesseae* but it is acknowledged that this species requires recollection and epitypification. Symptoms include brown, sparse, amphigenous leaf spots that are round to irregular with elevated margins, 0.2–2 mm diam (Bitancourt & Jenkins 1950). The LSU region fails to distinguish *E. arachidis*, *E. bidentis*, *E. euphorbiae*, *E. genipae*, *E. krugii*, *E. mimosae*, *E. poinsettiae*, *E. sesseae*, and *E. fawcettii* strain CBS 139.25.

Elsinoë sicula (Ciccar.) Fan & Crous, **comb. nov.** MycoBank MB818136.

Basionym: *Sphaceloma siculum* Ciccar., Arq. Inst. Biol., São Paulo 26: 14. 1959.

Material examined: **Italy**, Palermo, Piana degli Albanesi, from leaves of *Prunus amygdalus*, Aug. 1957, A. Ciccarone (**ex-type** culture CBS 398.59 = IB 2777).

Notes: *Elsinoë sicula* is known to cause leaf spots of *Prunus amygdalus* in Italy. Symptoms include numerous leaf spots, scattered, grey-violet, 0.5–2 mm diam. This fungus is characterised by hyaline to pale yellow, ellipsoid to ovoid conidia, 3–6.5 × 1.2–3 µm (Ciccarone & Graniti 1959). The LSU region fails to distinguish *E. fici-caricae*, *E. mattiroloanum*, *E. piri*, and *E. sicula*. The *TEF1-α* region fails to distinguish *E. piri*, and *E. sicula*.

Elsinoë solidaginis Jenkins & Ukkelberg, J. Agric. Res. 51: 515. 1935. Fig. 3J.

Materials examined: **USA**, Florida, from *Solidago edisoniana*, 4 Aug. 1934, H.G. Ukkelberg (**holotype** BPI 681061); Georgia, on *Solidago fistulosa*, Nov. 1936, H.G. Ukkelberg, dep. A.E. Jenkins (**epitype designated here** MBT372720, preserved in metabolically inactive state, **ex-epitype** culture CBS 191.37).

Notes: *Elsinoë solidaginis* was originally described from *Solidago chapmanii* in Florida, USA, having 1–2-septate ascospores, 8–13 × 4–5 µm, spherical asci, 15–17 × 15–18 µm, and ovoid, oblong to ellipsoid conidia, 6.5–8.6 × 2.5–4 µm (Bitancourt 1937). The ex-epitype strain CBS 191.37 was collected on *S. fistulosa* growing in the USA. *In culture*: Colonies irregular, erumpent, folded, cerebriform, surface greyish to black, with cinnamon, smooth, sinuate margins and white to grey aerial mycelium; 12–18 mm diam after 3 wk; sterile.

Elsinoë tectificae (Cheew. & Crous) Fan & Crous, **comb. nov.** MycoBank MB818137. Fig. 30.

Basionym: *Sphaceloma tectificae* Cheew. & Crous, Persoonia 23: 79: 2009.

Material examined: **Australia**, Northern Territory, road to Robin Falls, S 14°10′20″, E 131°07′15″ on *Eucalyptus tectifica*, 23

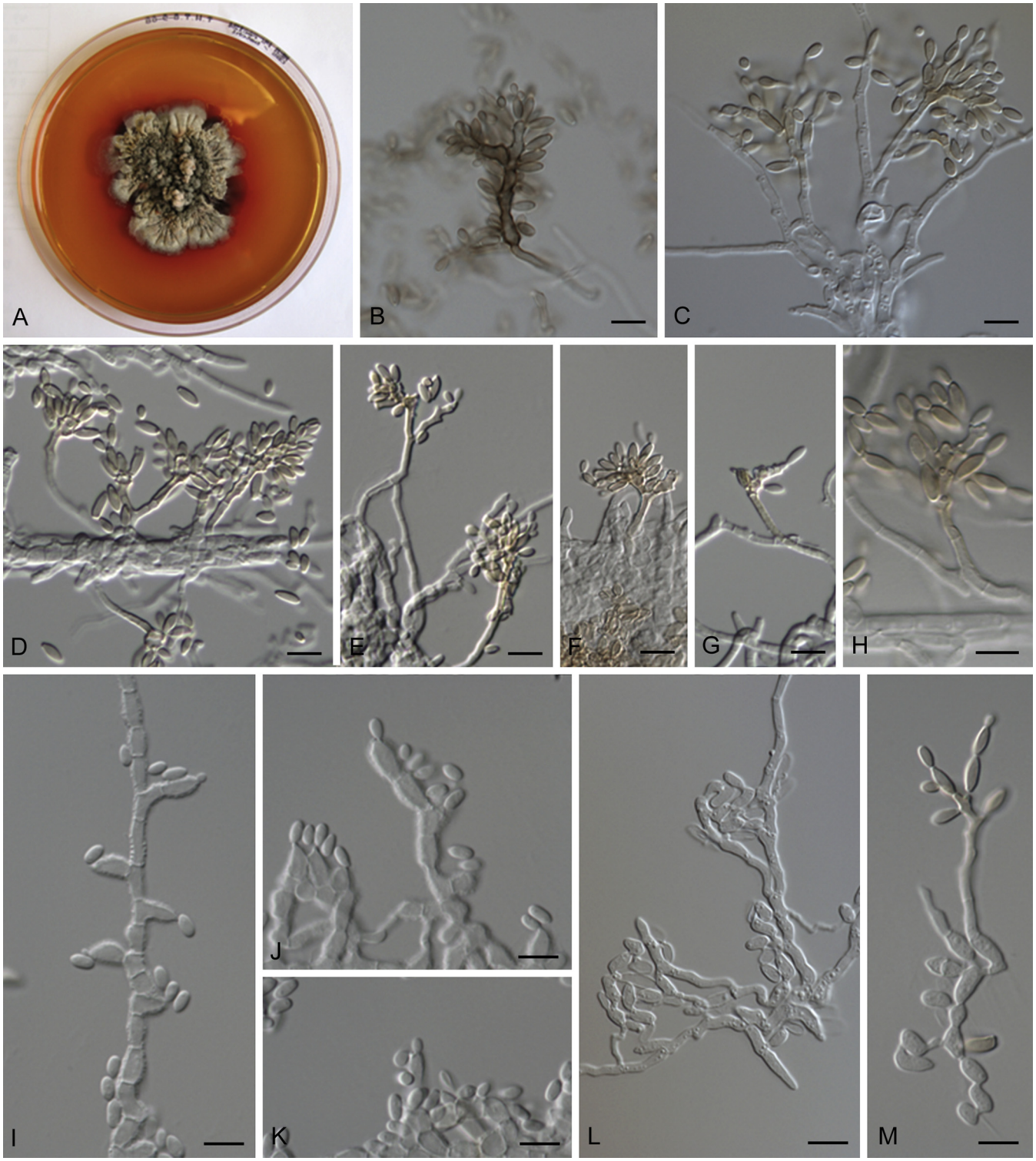

Fig. 30. *Elsinoë tectificae* (CBS 124777). **A.** Colony on MEA. **B–M.** Asexual morph with conidiophores, conidiogenous cells and conidia. Scale bars = 10 µm.

Sep. 2007, coll. B.A. Summerell, isol. & dep. P.W. Crous (**holotype** CBS H-20296, **ex-type** culture CBS 124777 = CPC 14594), *ibid*. (cultures CPC 14595, 14596).

Notes: *Elsinoë tectificae* was described from leaves of *Eucalyptus tectifica* collected in Australia. *Conidiogenous cells* terminal, integrated, smooth to slightly verruculose, thin-walled, straight or geniculate, somewhat swollen to irregular, (7–)15–20(–30) × (3–)4–5(–6) µm, with crowded conidiogenous loci in an apical rachis, denticles $\leq$1 µm high, flat tipped, with minutely thickened and reflective scars, visible as a circle when viewed from directly above, 1–1.3 µm diam. *Conidia* in short, branched chains; ramoconidia cylindrical to ellipsoid, tapering toward both ends, sometimes swollen at the crowded conidiogenous loci, aseptate, thin-walled, smooth to slightly verruculose, pale to medium brown, 7–9(–11) × 2.5–3(–4) µm; hila thickened along the rim, refractive, not darkened; intercalary conidia ellipsoid to fusiform, aseptate, pale to medium brown, 6–8(–9.5) × 2.2–3.3 µm; terminal conidia obovoid, pale brown, paler toward the apex, (2.5–)3.5–5 × 2–2.5 µm. *In culture*: Colonies irregular, centre strongly folded, convoluted, with sparse, pale, orange grey aerial mycelium, turning greenish grey

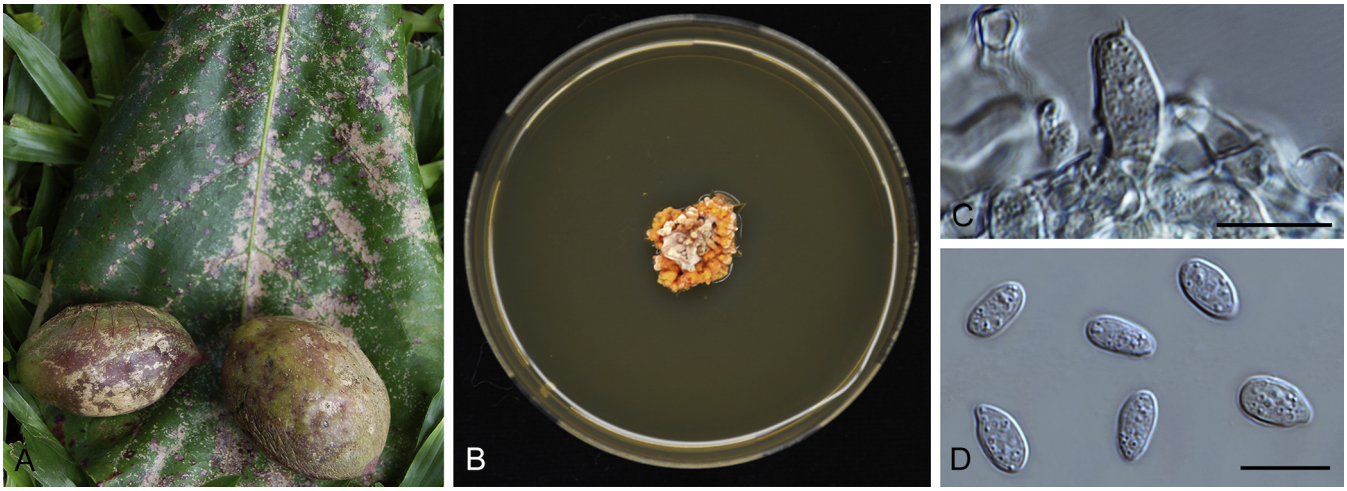

Fig. 31. *Elsinoë terminaliae* (CBS 343.39). **A.** Disease symptoms on *Terminalia catappa*. **B.** Colony on MEA after 3 wk. **C.** Conidiophores. **D.** Conidia. Scale bars: C–D = 10 µm.

and woolly when sporulating; margin feathery, pigmenting the medium with reddish orange diffuse pigment; 15 mm diam after 15 d at 25 °C in the dark (Cheewangkoon *et al.* 2009).

Elsinoë terminaliae (Bitanc.) Fan & Crous, **comb. nov.** MycoBank MB818138. Fig. 31.

Basionym: *Sphaceloma terminaliae* Bitanc., Arq. Inst. Biol., São Paulo 8: 197. 1937.

Materials examined: **Brazil**, São Paulo, Santos, from *Terminalia catappa*, Apr. 1934, H.S. Lepage (**holotype** BPI 683030); Rio de Janeiro, from *Terminalia catappa*, Apr. 1939, A.A. Bitancourt (**epitype designated here** MBT372721, preserved in metabolically inactive state, **ex-epitype** culture CBS 343.39); Rio de Janeiro, Gavea, from *Terminalia catappa*, R.W Barreto (specimen CBS H-22805, culture CPC 18538 = RWB 1190a).

Culture characteristics (based on CPC 18538): raised, cerebriform with numerous minute elevations centrally, convoluted, irregular margins, compressing and cracking the medium at margins, no aerial mycelium, humid, greyish lilac centrally followed by salmon and violet slate areas; reverse complex multiple folds raising and cracking the medium, ochreous with darker areas; colonies composed of thin-walled, hyaline and dark brown monilioid hyphae and brown pseudoparenchyma; 15 mm diam after 23 d; sporulating abundantly.

Notes: This fungus was originally described from *Terminalia catappa* in Brazil, with conidia 10–15 × 4–6 µm (Bitancourt 1937). The strain CBS 343.39 designated here as ex-epitype is from the same collector, host and location, deposited three years after the publication. It agrees well in morphology with the original description, with conidia being aseptate, 8–13 × 4–6 µm. *Symptoms* include numerous small spots, raised, circular to polygonal, ashy-pink, 0.25–2 mm diam, closely grouped to form larger patches. *In culture*: Conidiophores subcylindrical, hyaline, verruculose, ampulliform to doliiform, 0–2-septate, 12–20 × 4–6 µm. *Conidiogenous cells* enteroblastic, polyphialidic, with 1–2 integrated loci, hyaline, verruculose, ampulliform to doliiform, 5–12 × 4–6 µm. *Conidia* hyaline, granular, aseptate, ellipsoid to oblong, apex obtuse, sometimes tapering at base to a subtruncate locus, (8–) 9–12(–13) × 4–5.5(–6) µm.

Elsinoë theae Bitanc. & Jenkins, Arq. Inst. Biol., São Paulo 10: 195. 1939.

Synonyms: *Sphaceloma theae* Kuros., Ann. phytopath. Soc. Japan 9: 130. 1939.

Sphaceloma theae Kuros. ex Bitanc. & Jenkins, Arq. Inst. Biol., São Paulo 20: 18. 1950.

Material examined: **Brazil**, São Paulo, Cantareira, from *Camellia sinensis* (= *Thea sinensis*), Nov. 1938, A.A. Bitancourt (**ex-isotype** culture CBS 228.50 = IB 3061).

Notes: *Elsinoë theae* was known to infect leaves and bracts of *Thea sinensis* (= *Camellia sinensis*) in São Paulo, Brazil. This fungus is characterised by irregular ovoid asci, 14–22 × 12–20 µm, containing eight hyaline, 3-septate ascospores, 10–14 × 3–7 µm (Bitancourt & Jenkins 1939b). The LSU region fails to distinguish *E. flacourtiae*, *E. theae* and *E. australis* strain CBS 314.32.

Elsinoë tiliae Creelman, Mycologia 48: 555. 1956.

Material examined: **New Zealand**, Palmerston North, from leaves of *Tilia cordata*, Nov. 1972, J.C. Muirhead, dep. G.F. Laundon (culture CBS 350.73 = ATCC 24510 = LEV 6783).

Notes: *Elsinoë tiliae* is known to infect branches, fruits, leaves and petioles of *Tilia* spp. in Argentina, Canada and the USA. This fungus is characterised by globose, ovoid or pyriform asci, 19–25 × 17–20 µm, containing eight hyaline, irregularly arranged, obclavate, 3-septate ascospores, 11–16 × 5–6 µm. The asexual morph of this fungus has ovoid conidia, 3.7–6.5 × 1.8–2.5 µm (Creelman 1956).

Elsinoë veneta (Burkh.) Jenkins, J. Agric. Res. 44: 696. 1932. Fig. 3K.

Fig. 32. Disease symptoms of *E. verbenae* on *Verbena bonariensis*.

Basionym: *Plectodiscella veneta* Burkh., Phytopathology 7: 91. 1917.

Materials examined: **USA**, New York, on *Rubus neglectus*, 1914, W.H. Burkholder (**holotype** BPI 681404); from *Rubus* sp., L.K. Jones, dep. A.E. Jenkins (**epitype designated here** MBT372722, preserved in metabolically inactive state, **ex-epitype** culture CBS 164.29 = ATCC 1833).

Notes: *Plectodiscella veneta* was originally introduced as the pathogen causing anthracnose disease of black raspberry (*Rubus idaei* var. *aculeatissimi*, *R. neglecti* and *R. occidentalis*) in Brant, New York, USA, having globose asci, 24–30 µm diam, with eight hyaline, ovoid to ellipsoid, 3-septate ascospores, 18–21 × 6.5–8 µm (Burkholder 1917). Later Jenkins (1932a) allocated this fungus to *Elsinoë*. The ex-epitype culture (CBS 164.29) was isolated from the same host and deposited in CBS by Jenkins. *In culture*: Colonies circular, erumpent, folded, cerebriform, surface rosy buff to apricot, with white, smooth margins and white to rosy buff aerial mycelium; 15–18 mm diam after 3 wk; sterile.

Elsinoë verbenae Bitanc. & Jenkins, Arq. Inst. Biol., São Paulo 12: 9. 1941. Figs 2L, 32.

Materials examined: **Brazil**, São Paulo, Campinas, on *Verbena bonariensis* (Fig. 32), A.P. Viégas & A.S. Costa, 12 Jan. 1939 (**holotype** BPI 681232); São Paulo, Road Itatiaia-Itamonte, near the top of the mountain, from *Verbena bonariensis*, Apr. 2010, R.W. Barreto (**epitype designated here**, MBT372723, specimen CBS H-22806, **ex-epitype** culture CPC 18561 = RWB 1232 = CBS 141879). **Brazil**, Rio de Janeiro, Pirai, Ponte das Laranjeiras, from *Verbena bonariensis*, Apr. 2010, R.W. Barreto (culture CPC 18563 = RWB 1238).

Notes: *Elsinoë verbenae* was originally described as having globose asci, 16 µm diam, with eight hyaline, 3-septate ascospores, 15–16 × 5–7 µm, occurring on *Verbena bonariensis* from Campinas, São Paulo, Brazil (Bitancourt & Jenkins 1941). The ex-epitype culture (CPC 18561) was isolated from same host in Brazil. *In culture*: Colonies circular, erumpent, raised; surface white to salmon and straw to brown vinaceous, with smooth margins and white to grey aerial mycelium; 13–18 mm diam after 3 wk; sterile.

Elsinoë violae (Massey & Jenkins) Fan & Crous, **comb. nov.** MycoBank MB818139.

Basionym: *Sphaceloma violae* Massey & Jenkins, Mem. Cornell University Agric. Exp. Stat. 176: 7. 1935.

Materials examined: **USA**, South Carolina, Summerville, from *Viola* sp., Jan. 1933, H.M. Nichols, dep. A.E. Jenkins (**ex-syntype** culture CBS 336.35); New York, Fishkill, Unknown host, Jun. 1938, A.E. Jenkins (culture CBS 294.38). **Unknown origin**, from *Symphoricarpos albus* var. *laevigatus*, M.F. Barrus (culture CBS 333.29).

Notes: Symptoms include enlarged spots, rounded to elongated, white, buff to grey with dark green margin on the lower surface of leaves. The strains CBS 333.29 and CBS 294.38 were originally described as "*Sphaceloma symphoricarpi*" according to their host (Massey & Jenkins 1935). However, the current phylogeny shows that they cluster with the ex-type culture (CBS 336.35) of *Elsinoë violae*. It is therefore conjectured that labelling problems may have occurred in the past and that strains CBS 333.29 and CBS 294.38 in fact belong to *E. violae*.

Elsinoë zizyphi Thirum. & Naras., Sydowia 23: 249. 1969.

Material examined: **India**, Maharashtra, Poona, Law College, from *Ziziphus rugosa*, Jan. 1959, M.J. Thirumalachar (**ex-type** culture CBS 378.62 = ATCC 14656 = HACC 133 = IMI 092307).

Notes: *Elsinoë zizyphi* was described causing scab disease on *Ziziphus rodundifolia* (= *Ziziphus nummularia*) in India by Narasimhan *et al.* (1969b). Symptoms are recognised by numerous spots, circular to oval, raised, greyish pink depressed centre with blackish brown margin, 0.1–1 mm diam. This fungus is characterised by globose asci containing eight hyaline, muriform, 1–3-septate ascospores, 12–15 × 3–4 µm. The asexual morph of this fungus has spherical to ovoid conidia, 1.5–3 × 1.5–2.5 µm. *In culture*: Colonies raised, cerebriform, brownish red with salmon red reverse.

DISCUSSION

The order *Myriangiales* has two families, *Elsinoaceae* and *Myriangiaceae*, that accommodate two and 10 genera, respectively (Dissanayake *et al.* 2014, Jayawardena *et al.* 2014). The recent revision of *Myriangiaceae* by Dissanayake *et al.* (2014) added six genera to the family based on morphological characteristics (*Ascostratum*, *Butleria*, *Dictyocyclus*, *Hemimyriangium*, *Micularia*, and *Zukaliopsis*). Molecular data from genera in *Myriangiaceae* are still incipient, and only two *Myriangium* species, *M. duriaei* (CBS 260.36) and *M. hispanicum* (CBS 247.33), presently have

SSU, LSU, *rpb2*, and *TEF1-α* sequences available (Jayawardena *et al.* 2014). The same situation appeared to be the case in the *Elsinoaceae*, which was reassessed by Jayawardena *et al.* (2014) who excluded eight genera (*Beelia*, *Butleria*, *Hemimyriangium*, *Hyalotheles*, *Micularia*, *Saccardinula*, *Stephanotheca* and *Xenodium*) and included only *Elsinoë* and *Molleriella* in this family. Prior to the present study, the available molecular dataset for *Elsinoë* (asexual morph *Sphaceloma*) proved to be rather sparse (Swart *et al.* 2001, Summerell *et al.* 2006, Crous *et al.* 2015b, 2016). Different authors have discussed the relationship between *Elsinoaceae* and *Myriangiaceae*, but based on morphological features and phylogenetic analyses, the two families were accepted as distinct within the order *Myriangiales* (Schoch *et al.* 2006, 2009, Lumbsch & Huhndorf 2007, 2010, Boehm *et al.* 2009, Hyde *et al.* 2013, Jayawardena *et al.* 2014).

In accordance with the "One Fungus = One Name" concept, a single name for polymorphic genera has generally followed the rule of choosing the oldest or the most commonly used name with the most species epithets (Hawksworth 2011, Taylor 2011, Rossman *et al.* 2015, 2016). In the case of *Elsinoë*, the younger sexual name *Elsinoë* Racib. (1900) was chosen for protection over that of the older asexual name, *Sphaceloma* de Bary (1874) (Wijayawardene *et al.* 2012, Rossman *et al.* 2015). Therefore, many names in *Sphaceloma* need to be formally recognised in *Elsinoë*, with a first set of 26 *Sphaceloma* species being relocated to *Elsinoë* in the present study.

As is the case with many phytopathogenic genera of *Dothideomycetes*, the most common phylogenetic problem related to *Elsinoë* taxonomy is that many species (e.g. *E. ampelina*, *E. australe*, *E. fawcettii* and *E. perseae*) are based on old specimens without accompanying sequence data (Jenkins 1925, 1932a, b, Bitancourt & Jenkins 1936a). In fact, until 2014 there were only 12 strains available in GenBank for multigene phylogenetic studies (ITS, LSU, *TEF1-α*) (Jayawardena *et al.* 2014). In the first taxonomic phylogenetic study of *Elsinoë*, Swart *et al.* (2001) used ITS sequence data to evaluate the phylogenetic significance of six species from *Proteaceae*. According to the Dictionary of Fungi, Kirk *et al.* (2008) recognised about 50 species in *Elsinoë*, although more than 140 species have been described to date (see Index Fungorum and MycoBank). A significant result of the present study was thus to extend the number of genes used in *Elsinoë* phylogenetic studies, as well as the number of species subjected to DNA analyses.

The taxa investigated in the current study represent the largest collection of *Elsinoë* and *Sphaceloma* strains ever subjected to DNA sequence analysis. A total of 73 single species lineages from 119 *Elsinoë* strains were recognised based on ITS, LSU, *rpb2* and *TEF1-α* sequence data, including eight new species, 13 epitypifications and 26 new combinations (Table 1). During the course of this study it was observed that, although the ITS is a useful locus for distinguishing most species of *Elsinoë* (resolving 61 / 74 (82.4 %) of the species included in the phylogenetic tree), the *rpb2* and *TEF1-α* regions performed much better at species resolution (resolving 65 / 71 (91.5 %) and 64/73 (87.7 %) of the species included in the phylogenetic tree, respectively). Specifically, the *rpb2* and *TEF1-α* regions could distinguish the quarantine pathogen *E. australis* from its closest neighbours. The LSU region was able to distinguish only 51 of the 73 (69.9 %) species included in the phylogenetic tree. The total number of species counted for each of LSU, *rpb2* and *TEF1-α* is slightly lower compared to ITS as species for which the respective gene sequence was missing was excluded from the count. This is of interest for disease diagnosis and quarantine services. The *Elsinoë* species treated were sampled from various plants distributed over 17 countries in different continents including Africa, Asia, Australia, Europe, Latin America and North America. In spite of the limited number of strains per species, the vast majority of *Elsinoë* species studied here appear to be host-specific (Fig. 1).

Phylogenetic studies based on type materials are hampered by the lack of authentic cultures, and thus epitypification from fresh collections is required to create a stable and workable taxonomy. There are several excellent studies on a number of *Sphaceloma* and *Elsinoë* species associated with plant diseases in Brazil, India and the USA (Jenkins 1932a, b, Bitancourt & Jenkins 1936a, Narasimhan *et al.* 1969a, b, Wani & Thirumalachar 1969a, b, c), whereas very few species have any available cultures or DNA data, and thus cannot be included in recent studies of *Elsinoë*. Epitypification of these taxa is urgently required (Cannon *et al.* 2012). Here we designated 13 epitypes based on specimens and cultures deposited at CBS, but no DNA data are presently available for the type species, *E. canavaliae* from *Canavalia gladiata* in Java, Indonesia.

With regard to host associations, species of *Elsinoë* seem to have narrow host ranges, mostly limited to a single host species. Of the 73 species subjected to multi-gene analyses, only four were found to occur on more than one host. These include *E. leucospermi* (from *Leucospermum* and *Leucadendron*; *Proteaceae*), *E. anacardii* [from *Anacardium*, (*Anacardiaceae*) *Annona* (*Annonaceae*) and *Rosa* (*Rosaceae*)], *E. violae* [from *Symphoricarpos* (*Caprifoliaceae*) and *Viola* (*Violaceae*)] and *E. piri* (from *Malus* and *Pyrus*; *Rosaceae*). These unexpectedly broad host-range species need to be recollected and critically re-examined: *E. anacardii* in particular, for having hosts in broadly separate plant families. Each of the other 69 species included in this study is known to occur on only one host species or genus. An unexpected result is that we have no obvious distinct geographic distributions according to the phylogenetic tree obtained, which delineated two main subclades (Fig. 4). One subclade (MP/BPP = 89/1) contains 57 species, including the important phytopathogens *E. ampelina* (on grapevines) and *E. fawcettii* (on citrus). Another subclade (MP/BPP = 97/1) contains 14 species, including *E. australis* (on citrus).

It is clear that the leading mycologists dealing with *Elsinoë* in the mid 20th century (A. Bitancourt and A.E. Jenkins) have considered scab symptoms as a major character for recognising the presence of fungi belonging to *Elsinoë/Sphaceloma*. To the point of having proposed new species based on disease symptoms alone, with no sporulation present on the specimens. Examples are *S. allamandae* and *S. psidii* (Bitancourt & Jenkins 1949), among others. In most instances, nevertheless, when no conidia or ascospores were found, identification had the support of successful isolations resulting in cultures having the appearance commonly found for fungi in this genus – slow growing, raised, often cerebriform or corrugated, dark red, orange or brown colonies. In cases where not even cultures were obtained such species should be regarded as doubtful until fertile specimens and pure cultures are obtained since scab symptoms on plants may arise because of other fungal agents such as *Venturia inaequalis* (apple scab), bacteria such as *Streptomyces sacabies* (potato scab), or arthropod attack.

It is necessary to acknowledge the important legacy of Agesilau A. Bitancourt (Instituto Biológico de São Paulo – Brazil) and Anna E. Jenkins (USDA – USA) (Fig. 33) who have worked and published independently and in cooperation from the 1930s

Fig. 33. Anna E. Jenkins (USDA – USA) and Agesilau A. Bitancourt (Instituto Biológico de São Paulo – Brazil), trailblazers for global *Elsinoë* research.

to the 1960s on the *Elsinoaceae*, and managed to collect and describe a significant proportion of the known species of *Elsinoë/ Sphaceloma.* This wasn't a small feat considering the challenges involved in the collection, observation and isolation of *Elsinoaceae.* Many of the isolates included in the present publication were originally obtained by Bitancourt and Jenkins who cared for depositing their isolates in the CBS, and hence allowed for this work to be accomplished now. The fact that they remained viable after up to 80 yr in preservation underlines the sturdiness of *Elsinoë.* Isolation of these fungi in pure culture has played an important role for confirmation of a suspected scab or spot anthracnose disease as having a *Elsinoë* etiology. It now becomes even more important for the taxonomy of the genus, given the body of DNA sequences available following the present study. Not many publications provide descriptions of procedures for isolating these difficult microfungi, but Bitancourt & Jenkins (1939a) described a "routine procedure" which would be worthy of consideration, particularly, regarding the large number of species successfully isolated by them. Unfortunately, their "routine procedure" was based on single ascospores as starting point. As these are notoriously difficult to find, this method can hardly qualify as "routine".

The procedure for isolation of *Elsinoë* spp. (used by R.W. Barreto) we advise others to use is as follows: a) always start from fresh material (herbarium material has never proven successful); b) under the dissecting microscope select a piece of scab or anthracnose tissue free of saprobes or mycoparasites; c) rub the scab lesion vigorously with cotton wool soaked with 96 % ethanol; d) allow to dry; e) with a sterile sharp scalpel peel the surface of lesion with a shallow tangential cut; f) flame the scalpel blade; g) stab the medium in the plate to cool it down, and make the point of the blade humid and sticky; h) drive the point of the blade into the inner tissue that appeared where the epidermis was pealed and remove a very small fragment of infected tissue; i) transfer it to different demarcated points on a plate containing a routine medium for fungi (MEA, PDA, or MEA with antibiotics); j) prepare several plates (success rate is low); k) follow culture development on plates closely as *Elsinoë* colonies are slow-growing and any contaminants may overgrow the colonies; l) choose dense, pseudostromatic, slow growing colonies arising from the fragments (often honey, orange, reddish or brown, with diffuse pigment in agar) and transfer them to fresh plates or tubes. An alternative method (used by P.W. Crous) is to simply scrape the sterile tissue surface with a scalpel, and make dilution plates (on MEA with antibiotics) of the conidiomata/ascostromata, and later pick up typical *Elsinoë* colonies that become visible after a 2–7 d (viewed with light from below on a dissecting microscope).

In future studies of *Elsinoë*, fresh specimens should be collected to help clarify the species concepts of taxa presently still lacking types linked to multigene DNA data. It is frequently difficult to observe typical sexual structures in many of these taxa represented by old specimens, and strains soon become sterile in culture. Phylogenetically, the relationship between the two main subclades and the position of the type species *Elsinoë canavaliae*, also awaits to be clarified. This epitypification, supplemented by DNA data of related genera such as *Molleriella* and *Myriangium*, will significantly improve our knowledge of the evolutionary relationships within the order.

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