NEW *Ravenelia* SPECIES ON LEGUMINOUS HOSTS FROM THE BRAZILIAN CERRADO

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ABSTRACT

Four new *Ravenelia* species were described on native leguminous hosts from the Brazilian Cerrado, as follows: *Ravenelia cerradensis* sp. nov., *R. chapadensis* sp. nov., *R. mineirosensis* sp. nov. and *R. emaensis* sp. nov. on *Chamaecrista clausenii* var. *cyclophylla*, *Chamaecriista conferta* var. *virgata*, *Anadenanthera colubrina* var. *colubrina*, and on *Anadenanthera* sp., respectively.

Key words: taxonomy, biodiversity, rust fungi, tropical fungi.

RESUMO

Novas espécies de *Ravenelia* sobre leguminosas do Cerrado brasileiro

Quatro espécies novas de *Ravenelia* foram descritas em leguminosas do Cerrado brasileiro, a saber: *Ravenelia cerradensis* sp. nov., *R. chapadensis* sp. nov., *R. mineirosensis* sp. nov. e *R. emaensis* sp. nov. sobre *Chamaecrista clausenii* var. *cyclophylla*, *Chamaecrista conferta* var. *virgata*, *Anadenanthera colubrina* var. *colubrina* e *Anadenanthera* sp., respectivamente.

INTRODUCTION

Since 1993 the Plant Pathology Department of the University of Brasília started an extensive survey of the fungi associated with the vegetation of the Brazilian savanna, the so-called Brazilian Cerrado (Dianese *et al*., 1997). More than 18,500 specimens of fungi were collected in the Distrito Federal, Minas Gerais, Goiás, South Maranhão, Piauí, and Mato Grosso. Among the host families present in the Cerrado Leguminosae is the largest with 777 species followed by Compositae (Mendonça *et al*. 1998).

Ravenelia Berk. species are known exclusively on legumes and mostly from tropical regions (Cummins, 1978; Cummins & Hiratsuka, 1983; Hennen *et al*., 1982; Hennen & Cummins, 1990). On Cerrado an leguminous hosts, 167 fungal species were recorded comprising 61 Uredinales, which included 19 *Ravenelia* species (Hennen *et al*., 1982; Dianese *et al*., 1997).

Recently, a group of new *Ravenelia* species were described infecting leguminous hosts from the Cerrado (Hennen & Cummins, 1990; Dianese *et al*. 1993). However, a wider survey remains to be done. The objective of the present work was to taxonomically study the collections of *Ravenelia* species deposited in the Mycological Reference Collection of the University of Brasília (CMRUnB). The new taxa found are here described and illustrated.

MATERIALS AND METHODS

Leaflets of selected native leguminous from the Cerrado were collected. Each sample was prepared, numbered, registered and deposited in the Mycological Reference Collection of the University of Brasília (Herbarium UB, Mycological Collection). Slides containing squash preparations of fungal fruiting bodies or sections made by freezing microtome were used for the morphological studies and microphotography. In most cases the samples were stained with lacto-glycerol-cotton blue or glycerol-KOH-phloxine B and the slides sealed with nail polish.

Pieces of leaflets with one or more lesions showing representative samples of uredia and/or telia were examined using a scanning electron microscope (SEM) after being fixed in sodium caccodylate buffer, pH 7.4, 0.1M, containing 2% glutaraldehyde, for at least 24 h. Then followed five washes using the same buffer solution as before treatment with 1% osmium tetroxide (OsO_4) in cacodylate buffer at 4 ° C for 4 h. The samples were again washed five times with buffer solution before being dehydrated in an aqueous series with increasing acetone concentrations from 15, 30, 50, 75 and

[1] Portion of the Doctor's thesis of the senior author

100% of acetone for 15 min in each concentration. Leaflet pieces were then dried at the critical point before being covered with a thin layer of gold in a sputter coater for 140 seconds. Finally, the samples were observed and photographed in a Jeol SEM model JSM 840-AE (Japan).

RESULTS AND DISCUSSION

New *Ravenelia* species were found on *Chamaecrista clausenii* (Benth.) H.S. Irwin. & Barneby var. *cyclophylla* (H.S. Irwin. & Barneby) H.S. Irwin. & Barneby, *C. conferta* (Benth.) H.S. Irwin. & Barneby var. *virgata* H.S. Irwin. & Barneby, on *Anadenanthera colubrina* (Vell.) Brenan var. *colubrina*, and on *Anadenanthera* sp. The descriptions of the new taxa are shown in the following sections.

TAXONOMY

1. *Ravenelia cerradensis* Rezende & Dianese sp. nov. (Figures 1. A-D; 2. A-F)

Spermogonia et *aecia* ignota. *Uredinia* (0,2–) 0,3 (–0,4) x (0,1–) 0,2 (–0,3) mm, amphigena, palido brunnea, paraphysata. *Paraphyses urediniorum* himeniales vel peripherales, 50 x 16 µm, cylindricae cum apicibus globosis vel ovoideis (18-20 µm diam.). *Urediniosporae* (20–) 24 (–29) µm longae x (19–) 23 (–29) µm latae, echinulatae, palido flavae; *poris germinationis*, 6-12, dispersis; *parietis* (0,8–) 1,5 (–2,0) µm crassis. *Telia* amphigena, (0,20–) 0,28 (–0,38 x (0,13–) 0,20 (–0,32) mm, subepidermalia, erumpentia, atro-brunnea, uniseriata vel biseriata circa parvis gallis disposita, paraphysata. *Paraphyses teliorum* idem ac paraphyses urediniorum, plerumque hymeniales. *Capitula teliosporarum* composita, palido-brunnea, subconidea, (60) 66 (80–) x (61–) 68 (–75) µm, laevia, paginis strobilinis; *cellulae centrales* 10, (52–) 57 (–60) x (45–) 52 (56–) µm; *cellulae marginales* 10-12, (20–) 31 (–40) x (17–) 21 (–27) µm. *Cystae* 8–10, (15–) 21 (–25) x (15–) 21 (–27) µm, hyalinae, uniseriatae, pendentes, globosae vel ovoideae. *Pedicelli* persistentes, 4–6 filis hyphalis composita.

Holotypus: in foliis vivis *Chamaecristae clauseniorum* var. *cyclophyllae* Irwing & Barneby (= *Cassiae clauseniorum* var. *cyclophyllae*); 4.1 km via Chapada dos Guimarães ad Morro São Gerônimo, Parque Nacional Chapada dos Guimarães, Chapada dos Guimarães, MT; M. Sanchez, nº 2448; 20 V 1997; UB Col. Mycol. 13781.

Spermogonia and *aecia* not observed. *Uredinia* (0,2–) 0,3 (–0,4) x (0,1–) 0,2 (–0,3) mm, amphigenous, light brown, paraphysate. *Paraphyses* hymenial or peripheral, 50 µm long x 4 µm wide, cylindrical with globoid to ovoid tips (18-20 µm diam.) (Figure 1A,B); *Urediniospores* (20–) 24 (–29) µm long x (19–) 23 (–29) µm wide, echinulated, yellowish, with scattered 6–12 germpores, thick walled; walls (0,8–) 1,5 (–2,0) µm thick (Figure 1B,C). *Telia* amphigenous, (0,20–) 0,28 (–0,38 x (0,13–) 0,20 (–0,32) mm, subepidermal, erumpent, dark brown, forming rows around small galls, covered by a thin membrane (Figure 2A,B), paraphysate. *Paraphyses* mostly hymenial similar to uredinial paraphyses (Figure 2D). *Teliospores* compound, light brown, forming teliospore heads, (60–) 66 (80–) x (61–) 68 (–75) µm, smooth, tending to a subconical shape (Figure 2E); *central cells* 10, (52–) 57 (–72) x (45–) 52 (–70) µm, (Figures 2C,E), 8–10 rusty yellow; *marginal cells* (20–) 31 (–40) x (17–) 21 (–27) µm. *Cysts* 8–10, hyaline, uniseriate, hydrophylic, globoid to ovoid (15–) 21 (–25) x (15–) 21 (–27) µm, pendants. *Pedicel* persistent, compound, consisting of 4–6 hyphal strands (Figure 2F).

Several *Cassia sensu lato* (*s.l.*) species are presently accommodated in *Chamaecrista* Moench. and *Senna* Mill. (Lewis, 1987). Thus, when comparing *Ravenelia* species infecting *Chamaecrista* spp. all previous records of the fungus on *Cassia* and *Senna* have to be considered in the discussion.

Sydow & Sydow (1915) described 15 known *Ravenelia* species on *Cassia s.l.* Among them 10 species showed aparaphysate telia. Thus all five remaining paraphysate species [*R. mesillana* Ellis & Barth. (=*R. longiana* Syd. & P. Syd.), *R. spinulosa* Diet. & Holw. var. *papillifera* (Syd. & P. Syd.) Cumm. & J.W. Baxt. (=*R. papillifera* Syd. & P. Syd.), *R. spinulosa* Dietel & Holw., *R. macrocarpa* Syd., and *R. testui* Maubl.] will be discussed because some of the *Cassia* spp. reported as host could now belong in *Chamaecrista*. Among those five species only *R. macrocarpa* which has also been listed in Hennen *et al*. (1982)

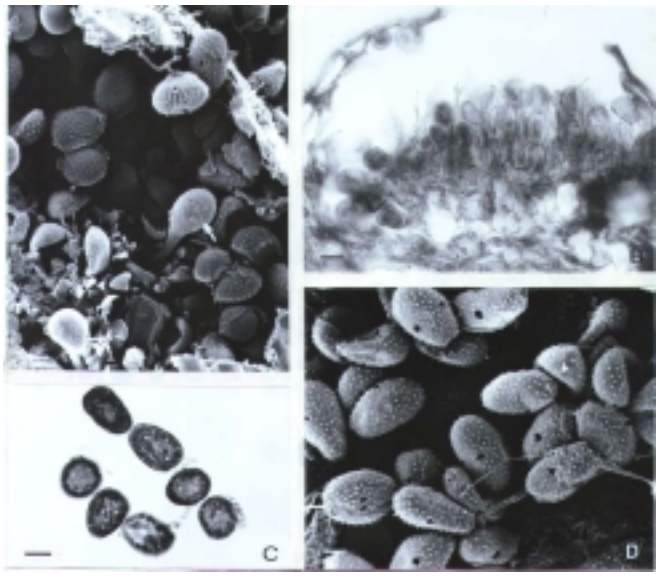

FIG. 1 - *Ravenelia cerradensis* on *Chamaecrista clausenii* var. *cyclophylla*, uredinial phase. A– Uredinia with urediniospores and parahyses (arrow) seen in SEM. B– Section of a paraphysate, subepidermal, erumpent uredinia seen in OM. C– Details of urediniospores showing sparse germ pores and thick wall. D– Echinulate urediniospores, showing germ pores seen in SEM. Bars: A, C = 10 µm; B = 20 µm; and D = 5 µm.

shows teliospores which are not superficially papillate or tuberculate as in this new species. However, *R. macrocarpa* shows subcuticular uredinia instead of subepidermal sori. It also shows teliospore heads with a more elliptical surface reaching a length of 140 µm while *R. cerradensis* sp. nov. shows heads which are more globoid (an average of 66 x 68 µm). *Ravenelia spinulosa* v. *papillifera* has papillate marginal cell, *R. mesillana* forms multiseriate cysts, and showed only paraphysate uredinia. Finally in *R. testui* all of the teliospores are unipapillate not smooth as in the new species. Thus, all five species are different from *R. cerradensis* sp. nov.

Furthermore, Hennen *et al*. (1982) mentioned *R. faceta* H.S. Jacks. & Holw. another species with paraphysate sori on *Cassia* in Brazil. However, this species differs from *R. cerradensis* due to smaller (45–60 µm) tuberculated teliospores.

More recently Hennen & Cummins (1990) described 15 *Ravenelia* species being ten from Brazil. Among those, two were found on *Senna* species (*R. densifera* Henn. & Cumm. and *R. eminens* Henn. & Cumm.) both with aparaphysate telia and producing highly tuberculate teliospores. The other species in Hennen & Cummins (1990) were found on hosts not related to *Cassia s.l.* all of them showing major differences from the new species and thus do not require a comparison with *R. cerradensis* sp. nov. This is also the case of the following species collected in Brazil: *R. corbuloides* Henn. & Cumm., *R. geminipora* Henn. & Cumm., *R. lata* Henn. & Cumm., *R. pernigra* Henn. & Cumm., *R. septata* Henn. & Cumm., *R. spiralis* Henn. & Cumm., *R. tessellata* Henn. & Cumm., and *R. tortuosa* Henn. & Cumm.

Based on the discussion above it becomes clear that the specimen described belongs to a new *Ravenelia* species, now designated *R. cerradensis* sp. nov.

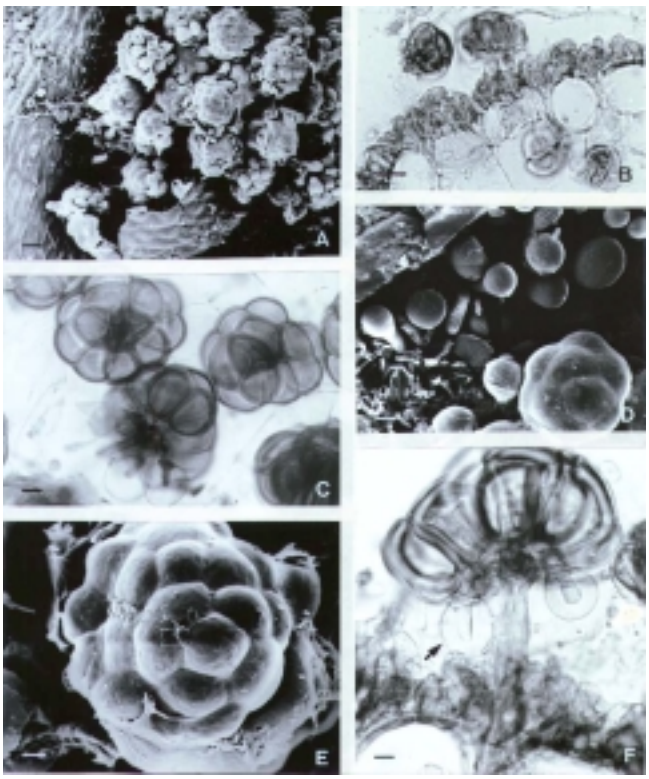

FIG. 2 - *Ravenelia cerradensis* on *Chamaecrista clausenii* var. *cyclophylla*, telial phase. A– Subepidermal, erumpent telium, showing teliospore heads with ondulate surface, seen on SEM. B– Section of a telium showing teliospore heads. C– Teliospore heads with hygroscopic cysts. D– A teliospore head and clavate telial paraphyses, seen on SEM. E– Upper surface of a teliospore head. F– Section through a teliospore head showing individual cell components, pendent cysts (arrow) and compound hyphalic pedicel. (Bars: A, B = 20 µm; C, D = 10 µm; E, F = 5 µm).

***2. Ravenelia chapadensis* Rezende & Dianese, sp. nov. (Figures 3 A-F; 4. A-F)**

Spermogonia et *aecia* ignota. *Uredinia* parva**,** (30–) 50 (–75) x (28–) 35 (–50) µm, amphigena, subepidermalia, erumpentia, palido brunnea, aliquando teliosporae formantes, paraphysata. *Paraphyses* hymeniales, abundantes, cylindricae vel clavatae, usque ad 50 µm longis x 5 µm diam; *Urediniosporae* rubiginoso flavae, obovoideae vel ovoideae, (23–) 27 (–30) x (16–) 20 (–23) µm, parietibus crassis*; poris germinationis* 8-12, dispersis; *parietes* 2–2,5 µm crassi. *Telia* amphigena, subepidermalia, erumpentia, parva, (38–) 59 (–100) x (–25) 40 (–63) µm. (Figure 2E). *Capitula teliosporarum* composita, hemisphaerica vel subconoidea, pedicellata, palido-brunnea, (101–) 131 (–144) x (94–) 107 (–139) µm, 6-12 cellulis diametro constituta; pagina capitulorum irregularis foveatis vel foveolatis; parietibus 2-3 µm crassis; *cellulae centrales* 8-10, (15–) 24 (–39) x (13–) 18 (–29) µm diam, cylindricae, perimetris paginarum hexagonalis; *cellulae marginales* 8-12, (30–) 35 (–40) x (13–) 18 (–29) µm, cylindricae, perimetris paginarum retangularis, basibus cum lamina cellularum intercalaris connectis. *Cellulae intercalares* 8-12, cylindricae vel leviter clavatae, (8–) 12 (–14) x (5–) 7 (–8) µm, basibus cellularum marginalium cystae et pedicelli connectis. *Cystae* 25-30, (18-) 24 (17-)(-28), pendentes vel semipendentes, cellulis intercalaribus connectis. *Pedicelli* (40-) 80 (-120) x (12-) 20 (-22) µm, multihyphalici, ex 8-10 fili hyphalici compositi, semipersistentes, ad apicem cellulis intercalaribus connecti.

Holotypus: in foliis vivis *Chamaecristae decumbentes* (Benth.) H.S. Irwin. & Barneby: prope Parque Nacional da Chapada dos Veadeiros, GO, M. Sanchez nº. 259, 17 X 1994, UB Col. Mycol. 6669.

Isotypus: in foliis vivis *Chamaecristae decumbentes* (Benth.) H.S. Irwin. & Barneby: Parque Nacional da Chapada dos Veadeiros, ex agro humido, 2 km ab Alto Paraíso via Parque Nacional, Alto Paraíso, GO, J.C. Dianese nº. 1862, 16 X 1994, UB Col Mycol. 6692.

Spermogonia and *aecia* unknown. *Uredinia* small (30–) 50 (–75) x (28–) 35 (–50) µm, amphigenous, subepidermal in origin, erumpent, light brown, paraphysate, sometimes also

containing teliospores. (Figures 3A,B). *Paraphyses* hymenial, abundant, cylindrical to clavate, up to 50 µm long x 5 µm diam. (Figures 3C,D,E); *Urediniospores* rusty yellow, obovoid to ovoid (23–) 27 (–30) x (16–) 20 (–23) µm, with 8–12 scattered germ pores, thick walled; wall 2–2,5 µm thick (Figure 3F). *Telia* amphigenous, subepidermal, erumpent, paraphysate, small (38–) 59 (–100) x (–25) 40 (–63) µm (Figure 4B). *Teliospore heads* pedicellate, compound, irregular to flat surface, (101–) 131 (–144) x (94–) 107 (–139) µm, 6-12 cells across, irregular, with foveate or lightly pitted surface (Figures 4A,E); with 2–3 µm thick wall; *central cells*, 8–10, cylindrical with an hexagonal superficial profile, (15–) 24 (–39) x (13–) 18 (–29) µm diam.; *marginal cells* 8-12, cylindrical with a rectangular superficial profile (30–) 35 (–40) x (13–) 18 (–29) µm., connected to a layer of 8–12 cylindrical to slightly clavate intercalary cells. *Intercalary cells* (8–) 12 (–14) x (5–) 7 (–8) µm, bearing the marginal cells and connected to the cysts and the pedicels on the lower face (Figures 4C,D,E). *Cysts* 25–30, (18–) 24 (–30) x (17–) 21 (–28) µm, pendent or semipendent, connected to the intercalary cells. *Pedicells* (40–) 80 (-120) x (12–) 20 (–22) µm, multihyphal, with 8–10 hyphal components, semipersistant, connected to the intercalary cells at the top (Figures 4E,F).

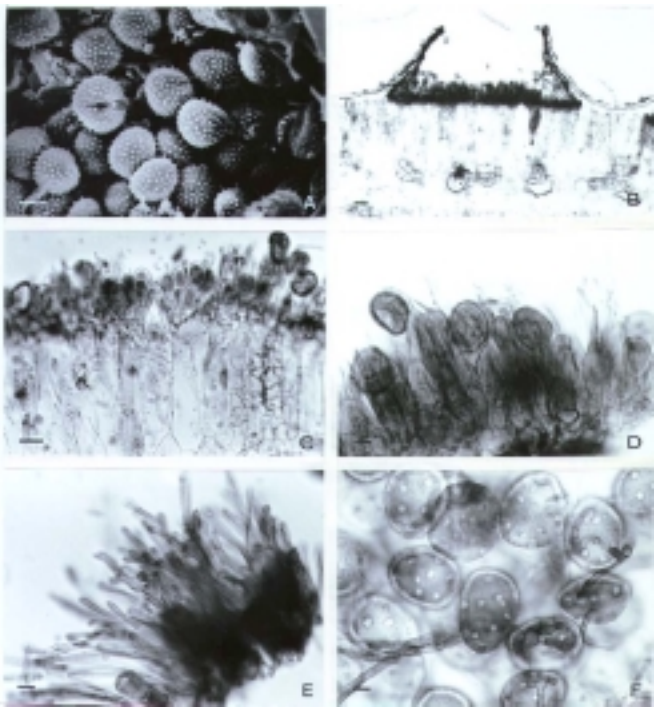

FIG. 3 - *Ravenelia chapadensis* on *Chamaecrista conferta*, uredinial phase. A– A mass of echinulate urediniospores and hymenial paraphyses (arrow). B– Section through an erumpent, subepidermal uredinium. C, D– Detailed view of paraphysate uredinia. E– Cylindrical paraphyses seen on OM. F– Urediniospores showing thick wall and scattered germ pores. Bars: A and D = 10 µm; B = 60 µm; C = 20 µm; E and F = 5 µm.

Other specimens examined: on living leaves of *Chamaecrista conferta* (Benth.) H.S. Irwin. & Barneby var. *virgata* H.S. Irwin. & Barneby; "Parque Nacional da Chapada dos Veadeiros", "Trilha das Cachoeiras", "Alto Paraíso, GO", 15, X, 1994, J.C. Dianese nº. 1828, UB Col. Mycol. 6624; "Estação Ecológica das Águas Emendadas, Planaltina, DF, 14, III, 1995, M. Sanchez nº. 2765, UB Col. Mycol. 14564".

This new species shows all the characteristics of *Ravenelia* such as compound multicellular teliospore heads, containing central and marginal cells, bearing cysts below and showing a multihyphal pedicels. The urediniospores show scattered germ pores. However, the specimen studied also shows an intercalary layer of cells connecting the marginal

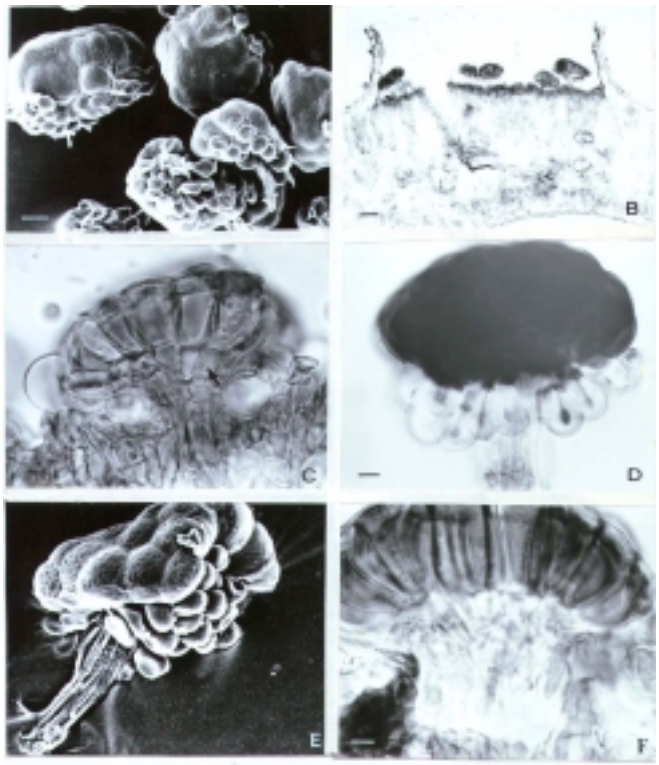

FIG. 4 - *Ravenelia chapadensis* on *Chamaecrista conferta*, telial phase. A–Teliospore heads with large numbers of subjacent semi-adherent cysts seen on SEM. B– Section showing subepidermal condition of a telium. C– Teliospore head showing intercalary cells that compose the compound teliospore with layers of intercalary cells (arrow) forming a layer which connects the teliosporic layer with the cysts and the multihyphal pedicel. D– A teliospore head showing a group of 10 cysts and a multicomponent hyphalic pedicel. E– Details of a teliospore head with wavy surface, showing also cysts and compound pedicel. F– Section of a teliospore head showing individual cells, intercalary layer and cysts. Bars: A = 20 µm; B = 60 µm; C, D, E, F = 10 µm.

cells with the pedicel and the cysts. This is a cell layer and is an attribute of the genus *Kernkampella* Rajendren, specifically pathogenic to Euphorbiaceae (Rajendren, 1970). However, the new species shows teliospores with a foveate surface instead of one that is strongly tuberculate as in *Kernkampella* species. Furthermore, the new species forms urediniopores holoblastically and not in a repetitive manner as in *Kernkampella*.

Thus all specimens here studied belong in the genus *Ravenelia* and due to the intercalary cells shown they surely belong in a very restricted group of species. Thus, *R. chapadensis* sp. nov. with irregularly shaped teliospore heads is clearly different from all paraphysate species already compared to *R. cerradensis* sp. nov. The only species reported as having an intercalary layer of cells separating the spores from the cysts is *R. opaca* Diet. (Dietel, 1895) as indicated by Cummins & Hiratsuka (1983). However, the original descriptions of *R. opaca* included in Sydow & Sydow (1915) and also in Cummins (1978) do not mention the existence of cells between cysts and teliospore. In *R. opaca* telia are very large and may reach 3 mm diam but teliospore heads do not reach 140 µm as in the new species. Finally the teliospores of *R. opaca* have a smooth surface while those of *R. chapadensis* sp. nov. show slight pitting all over their surface. Sydow & Sydow (1915) and Cummins (1978) did not mention uredinia and urediniospores which, however, are always present in this new species. On the other hand spermogonia were not found in *R. chapadensis* sp. nov. but were present in *R. opaca* (Sydow & Sydow, 1915; Cummins, 1978).

Multiseriate abundant (25 to 30 cysts per teliospore head) cysts, the presence of intercalary cells in larger teliospores, are characteristics sufficient to separate *R. chapadensis* sp. nov. from *R. cerradensis* sp. nov.

3 - *Ravenelia mineirosensis* Rezende & Dianese sp. nov. (Figures 5. A-D; 6. A-E)

Etymology: after Mineiros, a city of the State of Goiás close to the site where the type was collected.

Spermogonia et *aecia* ignota. *Uredinia* (33–) 55 (–95) x (33–) 38 (–63) µm, hypophylla, subepidermalia, erumpentia, cinnamomo-brunnea, paraphysata; p*araphyses* 48–52 µm x 4–6 µm, saepe peripherales, cylindricae vel clavatae, aureo-brunneae, apicibus 16-10 x 15-17 µm diam., gobosisis vel obovoideis. *Urediniosporae* (17–) 23 (–28) x (14–) 15 (–18) µm, palido-brunneae, obovoideae vel ellipsoideae, 4-6 poris germinationis dispersis saepe equatoriales vel subequatoriales, parietibus lateralibus 2 µm crassis, parietibus apicalibus 2-3 µm crassis, parietibus basalibus 1.5-2 µm crassis, omnino valde echinulatae; *echinulationes* conicae, 5-7 µm longae. *Telia* (50–) 75 (–100) x (33–) 50 (–70) µm, amphigena, saepe hypophylla, rubinoso-brunnea, subepidermalia, erumpentia, paraphysata. *Paraphyses* similem paraphyses urediniarum, plerumque peripherales,. *Capitula teliosporarum* (85-) 96 (–110) x (86–) 91 (–110) composita, discoidea vel hemisphaerica, pedicellata, palido brunnea, 5-7 cellulis diametro constituta, pagina capitulorum laevia; parietibus 3-4 µm crassis; *cellulae centrales* 4, (15-) 18 (-20) µm diam, perimetris superis cellularum pentagonalis et crassiatis; *cellulae marginales* 6-8, (17-) 22 (-25) µm, cylindricae, perimetris paginarum retangularis, laeviae, basibus cellularum marginales cystae et pedicelli connectis; parietes 3-4 µm crassis. *Cystae* 6-8, saepe 8, (17-) 19 (-20) µm, pendentes. *Pedicelli* 16 x 6 µm, multihyphalici, descidui.

Holotypus: in foliis vivis *Anadenantherae colubrinae* (Vell.) Brenan var. *colubrinae*; "Parque Nacional das Emas", in agro gramineo, Mineiros, GO, 13 IV 1997, M. Sanchez 2657, UB Col. Micol. 14369.

Isotypus: in foliis vivis *Anadenantherae colubrinae* (Vell.) Brenan var. *colubrinae*; Parque Nacional das Emas, via flumen Jacuba, Mineiros, GO, 11 IV 1997, Pfenning 102, UB Col. Micol. 14258.

Spermogonia and *aecia* unknown. *Uredinia* (33–) 55 (–95) x (33–) 38 (–63) µm hypophyllous, subepidermal, erumpent, cinnamon-brown (Figures 5A,B). *Paraphyses* 48–52 µm long x 4–6 µm wide, clavate with globoid to obovoid tips (16–) 18 (–20) x (15–) 16 (–17) µm, mostly peripheral, golden-brown (Figures 5B,C). *Urediniospores* (17–) 23 (–28) x (14–) 15 (–18) µm, ellipsoid to obovoid, strongly echinulate; *echinulations* conical, 5–7 µm high, with a depressed halo around of the base (Figure 5D); *wall* 2 µm

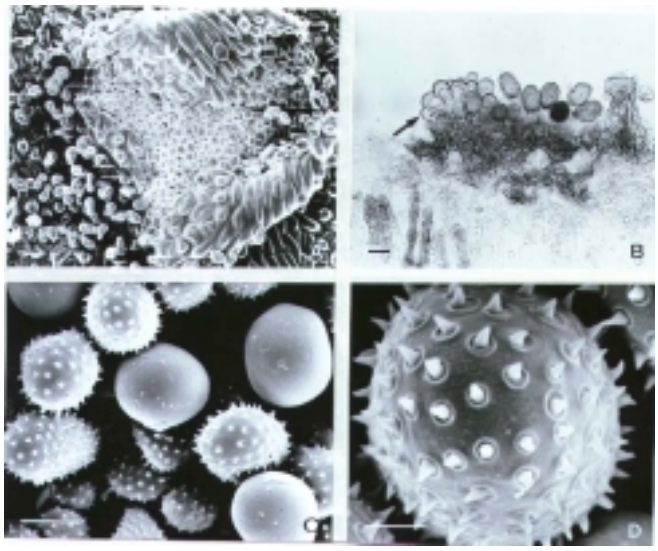

FIG. 5 - *Ravenelia mineirosensis* on *Anadenanthera colubrina* var. *colubrina*, uredinial phase. A–Subepidermal hypophyllous uredinium. B–Section through an uredinium showing peripheral paraphyses (arrow) and urediniospores, with equatorial germ pores. C–Echinulate urediniospores and clavate smooth paraphyses with globose tip. D–Details of an urediniospore seen on SEM with a clear halo around the base of the echinulations. Bars: A, B = 20 µm, C = 10 µm and D = 5 µm.

thick at the sides, 2–3 µm at the spore apex and 1,5–2 µm at the base*; germ pores* 4–6, scattered, mostly equatorial and subequatorial. *Telia* (50–) 75 (–100) x (33–) 50 (–70) µm, amphigenous, mostly hypophyllous, rusty–brown, paraphysate as uredinia; paraphyses mostly peripheral (Figures 6A,B). *Teliospore heads* (85-) 96 (–110) x (86–) 91 (–110) µm, smooth, 5-7 seven cells across; *central cells* 4, pentagonal, (17–) 18 (–20) x (15–) 18 (–20) µm, with prominent lines around each cell; *marginal cells* 6–8 rectangular, smooth, (17–) 22 (–25) µm,; *walls* 3–4 µm thick (Figures 6C,D). *Cysts* 6–8, mostly 8, globoid, (18–) 19 (–20) x (17–) 18 (–20) µm, hygroscopic, pendent (Figure 6E). Pedicels multihyphal, 16 x 6 µm, not persistent.

Several leguminous species belonging in *Piptadenia* Benth. were recombined in *Anadenanthera* Speg. (Lewis, 1987). Thus the *Ravenelia* species previously reported on the *Piptadenia* species were compared with this new species here described because there is no record of a *Ravenelia* species infecting *Anadenanthera*. According to Sydow & Sydow (1915) the *Ravenelia* spp. found on the *Piptanenia* species are: *R. henningsiana* Diet. on *Piptadenia* sp., *R. simplex* Diet. on *P. stipulacea* (Benth.) Ducke. (=*P. communis* Benth.), and *R. cebil* Speg. on *Anadenanthera colubrina* (Vell.) Brenan var. *cebil* (Gris.) Alts. (= *P. macrocarpa* Benth. var. *cebil* (Gris.) Chad. & Hass). Hennen *et al.* (1982) listed *R. henningsiana*, *R. simplex*, and *Uredo vilis* (Syd. & P. Syd.) Baxter (= *R. vilis* Syd. & P. Syd.) (Baxter, 1975; Sydow & Sydow, 1916) as the *Ravenelia* species occurring in Brazil.

The new *Ravenelia* species on *Anadenanthera* was compared with other smoothly-teliospored species found on this host genus and also with those four species parasitic on *Piptadenia* spp (*Ravenelia emaensis* sp. nov. on *Anadenanthera* sp.; *R. simplex* on *P. communis*; *R. henningsiana* on *Piptadenia* sp.; *R. cebil* on *P. macrocarpa* and *Uredo vilis* on *Piptadenia* sp.).

Uredo vitis with two germ pores in its thin-walled urediniospores is not the uredinial phase of *R. mineirosensis* sp. nov. which shows thick-walled spores with 4–6 germ pores. *Ravenelia simplex* clearly differs from *R. mineirosensis* sp. nov. based on size and shape of the teliospores. Neither *R. henningsiana* with epiphyllous aparaphysate telia and uredinia, and tuberculate smaller teliospores, nor *R. sydowiana* with aparaphysate telia can not be confused with the new species. *Ravenelia chacoensis* reported from Argentina (Lindquist, 1946) shows shorter paraphyses (30 µm) and at least seven central cells in the teliospore head, a number much higher than four central cells found in *R. mineirosensis* which forms 52 µm long paraphyses. Finally, *R. cebil* described as another variety of *Anadenanthera colubrina* (= *Piptadenia macrocarpa*) showing 3–5 ovoid cysts and amphigenous uredia is also different from this new fungus which forms 6–8 globoid, cysts and shows only hypophyllous uredinia.

Thus, this discussion leads to the conclusion that the fungus here described belongs to a new species which is designated *R. mineirosensis* sp. nov.

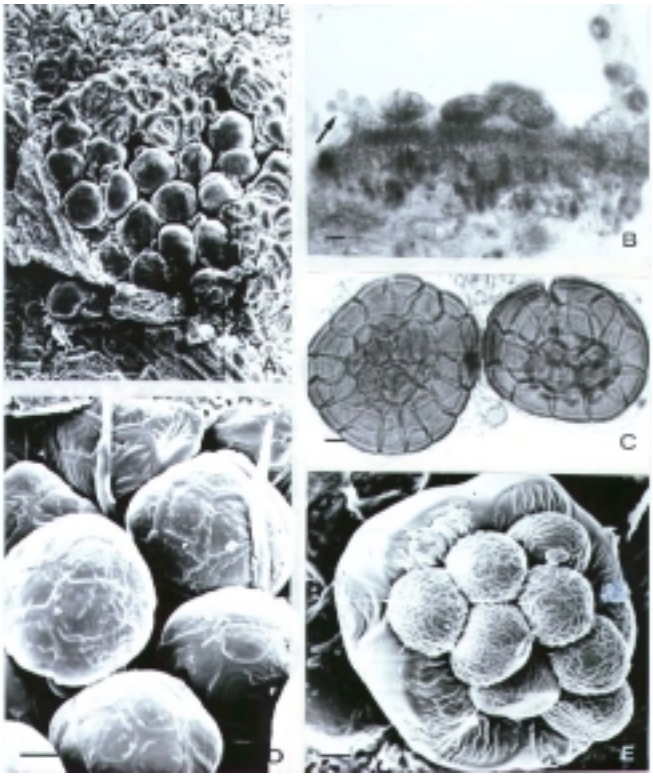

FIG. 6 - *Ravenelia mineirosensis* on *Anadenanthera colubrina* var. *colubrina*, telial phase. A– Erumpent epiphylous telium. B– Section through a telium showing peripheral paraphyses (arrow) and teliospore heads. C– Two smooth teliospore heads, showing central and marginal cells. D– Four teliospore heads, with central cells bound by conspicuous prominent walls. E– Teliospore head with eight pendent cysts. Bars: A = 40 µm; B = 30 µm; C and E = 10 µm, and D = 20 µm.

4 - *Ravenelia emaensis* Rezende & Dianese sp. nov.
(Figures 7. A-E; 8. A-F)

Spermogonia et *aecia* ignota. *Uredinia* (55–) 58 (–62) x (15–) 19 (–22) µm, hypophylla, subepidermalia, erumpentia, cinnamomo-brunnea, paraphysata; *paraphyses* 40–50 µm long, saepe peripherales, clavatae, aureo-brunneae, apicibus globosis vel ovoideis usque ad 7 µm diam. *Urediniosporae* (22–) 27 (–30) x (10–) 13 (–15) µm, palido-brunneae, obovoideae, clavatae vel pyriformes, echinulatae, 2-4 poris germinationis, saepe 3, equatorialibus unizonatis; *echinulationes* cylindricae, 4-5 µm longae. *Telia* (14–) 22 (–24) x (12–) 17 (–24) µm, hypophylla, aliquando urediniosporae formantes, erumpentia, paraphysata, *paraphyses* similem paraphyses urediniarum. *Capitula teliosporarum* (89–) 96 (–110) x (82–) 88 (–110) µm, composita, perimetro irregulari vel circulari, pedicellata, aurantico-brunnea, 6-7 cellulis diametro constituta, pagina capitulorum laevia; parietibus apicalibus 5-6 µm crassis; parietibus lateralibus 0.5-1 µm crassis; *cellulae centrales cells*

9–12, (21–) 23 (–26) x (17–) 19 (–21) µm diam, perimetris superis cellularum hexagonalis; *cellulae marginales* 18-24, (18–) 23 (–27) x (–10) 14 (–17) µm. *Cystae* 18-24, globosae, 18-16 µm diam., hyalinae, appressae. *Pedicelli* 30 x 14 µm, multihyphalici, ex 4-6 fili hyphali compositi, descidui.

Holotypus: in foliis vivis *Anadenantherae* sp., Parque Nacional das Emas, via flumen Jacuba, Mineiros, GO, L. Pfenning no. 102, 12 IV 1997, UB Col. Mycol. 14258.

Spermogonia and *aecia* unknown. *Uredinia* (55–) 58 (–62) x (15–) 19 (–22) µm, hypophyllous, subepidermal, erumpent, cinnamon-brown, paraphysate; *paraphyses* orange-rusty, 40–50 µm long, with ovoid or globose tips, up to 7 µm diameter (Figures 7A,B). *Urediniospores* (22–) 27 (–30) x (10–) 13 (–15) µm, obovoid, clavate to piriform, pale brown, with cylindrical echinulations 4-5 µm long, 2–4 germ pores, often three; *pores* equatorial, unizonate (Figures 7C,D,E). *Telia* (14–) 22 (–24) x (12–) 17 (–24) µm, hypophyllous, sometimes also forming urediniospores, paraphysate (Figures 8A,B,C); *paraphyses* same as those of the uredinia. *Teliospores* compound, multicellular, (89–) 96 (–110) x (82–) 88 (–110) µm, with perimeter irregular or round, 6–7 cells across, smooth, orange-rusty; *central cells* 9–12, with hexagonal perimeter, (21–) 23 (–26) x (17–) 19 (–21) µm; *marginal cells* 18–24, wall 0,5–1,0 µm of thickness at sides and 5–6 µm at the spore top, (18–) 23 (–27) x (–10) 14 (–17) µm, (Figures 8D,E). *Cysts* 18–24 corresponding on number to the marginal cells, 18x16 µm diam., adherent, non hygrophylous, hyaline. *Pedicels* compound, with 4–6 hyphal strings, 30x14 µm, deciduous (Figures 8E,F).

Other specimen examined: on living leaves of *Anadenanthera* sp., km 44 on the road to Mineiros from Parque Nacional das Emas, in the right lane near the sign indicating Emaus, Mineiros, Goiás, 12 IV 1997, Pfenning 122, UB Col. Mycol. 14330.

The *Ravenelia* species which showed a closer relationship with this new species were described in Sydow & Sydow (1915), Cummins (1978) and listed by Hennen *et al.* (1982). They show smooth teliospore heads or are either parasitic to *Piptadenia* or to the *Anadenanthera* species.

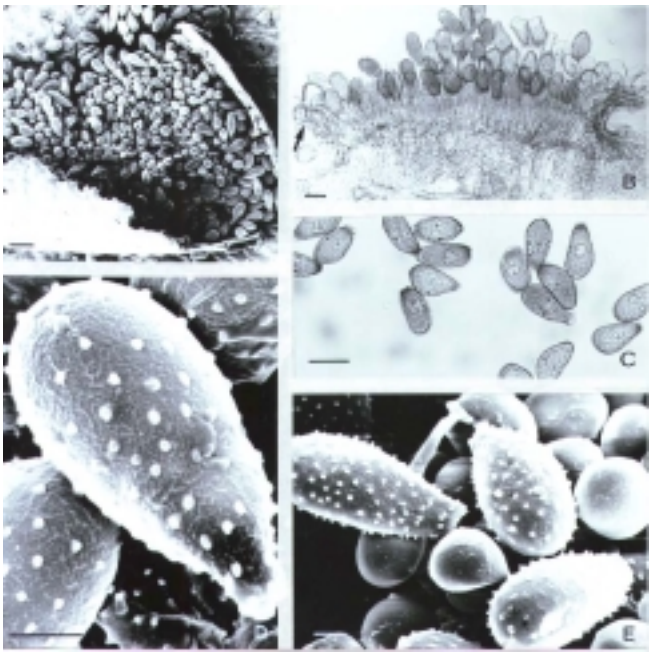

FIG. 7 - *Ravenelia emaensis* on *Anadenanthera* sp., uredinial phase. A– Hyphophyllous subepidermal erumpent uredium. B– Setion through an urediniun showing smooth clavate peripheral paraphyses (arrow) and urediniospores. C– Urediniospores showing equatorial germ pores. D and E– Clavate urediniospores showing cylindrical to verrucose ornaments. Bars: A, B, and C = 20 µm; and E = 5 µm.

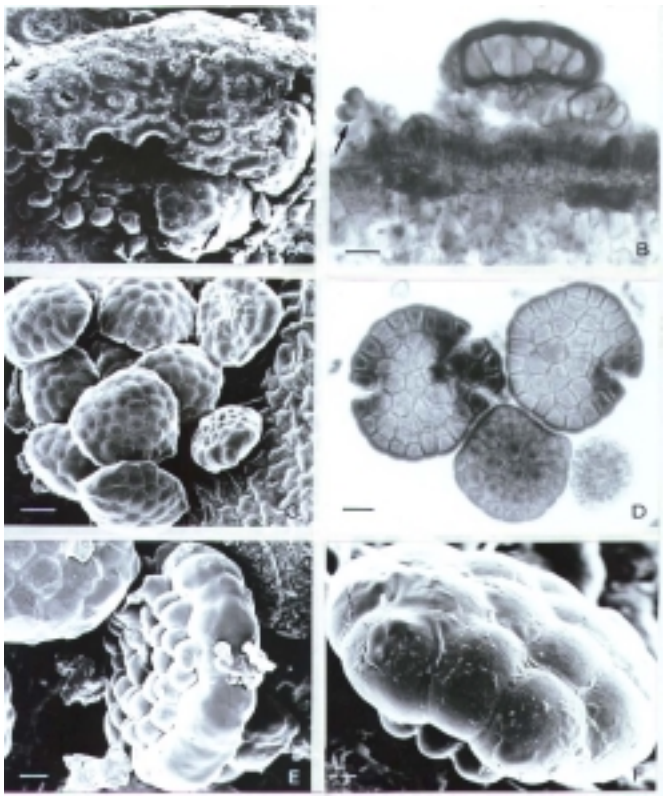

FIG. 8 - *Ravenelia emaensis* on *Anadenanthera* sp., telial phase. A– Hipophyllous subepidermal mixed sorus showing two teliospores (arrow) and several ornamented urediniospores. B– Section through a telium showing a teliospore head with adherent cysts and peripheral paraphyses (arrow). C– A group of teliospore heads. D– Teliospore heads seen on OM showing 10–14 central cells and up to 21 marginal cells. E and F– Details of the teliospore head. Bars: A, B and D = 20 µm; C = 30 µm; E and F = 10 µm.

The new species can be easily separated from all related species (*Ravenelia simplex*; *R. henningsiana*; *R. cebil*; *R. sydowiana*; *R. spegazziniana*; *R. chacoensis*; *Uredo vilis* and *R. mineirosensis*) because of the extremely high number of adherent cysts present in its teliospore heads (18 to 24), and due to the formation of uniquely verrugose instead of echinulate urediniospores. The closest species is *R. sydowiana* with 6-19 pendant cysts which also has just 3-5 central cells found in heads (50-85 µm diam.) which, however, are much smaller than those of *R. emaensis* sp. nov. Dimensional and morphological differences also allow to segregate this new species from *R. mineirosensis* sp. nov. which shows only four central cells in the teliospore heads, a number much lower than the 9-12 cells found in *R. emaensis* sp. nov. For these reasons the specimen studied is considered a new *Ravenelia* species, namely *R. emaensis* sp. nov.

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