

Checklist of the arbuscular mycorrhizal fungi (*Glomeromycota*) in the Brazilian semiarid

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Abstract — Seventy-nine species of arbuscular mycorrhizal fungi (AMF) are reported for the semiarid Caatinga biome of Northeast Brazil. Data are based primarily on research by L.C. Maia and co-workers during the past 20 years. The full checklist is available at www.mycotaxon.com/resources/weblists.html.

Key words — *Glomeromycetes*, symbiosis, biodiversity, taxonomy

Introduction

Arbuscular mycorrhizal fungi (AMF) form symbiotic association with roots of plants, a mutual connection that may have contributed to the evolution and survival of land-plants and fungi for over 400 million years (Smith & Read 1997).

Thaxter (1922) felt that AMF belonged to the *Endogonaceae*. Based on the symbiotic habit, Morton & Benny (1990) placed all AMF into the new order *Glomales* as a monophyletic group. The AMF are now classified in the phylum *Glomeromycota* (Schüßler et al. 2001) with approximately 220 described species.

Fitter (1990) noted that the fundamental ecological importance of AMF fungi requires research of their diversity in various ecosystems, and in discussing the place of AMF community in a given ecosystem, Sanders et al. (1996) questioned whether there is a relationship between which plants are colonized and what effect AMF have upon both plants and the ecosystem. These questions indicate the need for intensive studies and justify a survey of AMF in different ecosystems.

Most investigations of AMF in Brazil pertain to plant crops and not to natural ecosystems (Maia et al. 2006). The review paper by Trufem (1996) on AMF research within the Amazon, Atlantic Rain Forest, and Cerrado, cited the need for studies in the Caatinga and Pampas, two less studied Brazilian biomes. The Caatinga, which covers more than 800,000 km², representing 70% of the Northeast region and ~11% of Brazil (Drummond et al. 2000), is characterized by a hot dry semiarid climate and vegetation with

trees and shrubs (many spiny, some xerophytic) in the *Apocynaceae*, *Bromeliaceae*, *Cactaceae*, *Euphorbiaceae*, and *Leguminosae* (Leal et al. 2003). One recent study (Stürmer & Siqueira 2008) lists only 30 AMF species from the Caatinga biome.

The new records contribute additional data about AMF diversity and a more complete list of AMF species from the Brazilian semiarid Caatinga biome.

Material and methods

Data cited originated from the authors as well as from the Web of Science; student theses and scientific proceedings have also been considered. References consulted include Albuquerque 2008; Freitas 2006; Lemos 2008; Gattai 2006; Goto et al. 2009, 2010; Lima et al. 2007; Maia et al. 2006; Mergulhão 2007; Mergulhão et al. 2007; Morais 2007; Pagano et al. 2007; Silva et al. 2007, 2008; and Souza et al. 2007. Gigasporioid-producing AMF species are classified according to Oehl et al. (2008); earlier synonyms are also listed.

Results

Seventy-nine species were found in the Caatinga, of which seven are new records for Brazil (*Dentiscutata colliculosa*, *Diversispora spurca*, *Glomus arborenses*, *G. pallidum*, *Racocetra intraornata*, *Scutellospora dipurpurens*, *S. pernambucana*) and three (*D. colliculosa*, *R. intraornata*, *S. pernambucana*) have been recently described. This brings the number of known Brazilian AMF to 106 species, including the 99 taxa cited by Stürmer & Siqueira (2008).

Acaulosporaceae

Acaulospora bireticulata F.M. Rothwell & Trappe. Mycotaxon 8: 472. 1979.
Habitat: agrosystems.

Acaulospora delicata C. Walker, C.M. Pfeiffer & Bloss. Mycotaxon 25: 622. 1986.
Habitat: agrosystems, natural and impacted caatinga (mining).

Acaulospora denticulata Sieverd. & S. Toro. Angewandte Botanik 61: 217. 1987.
Habitat: natural caatinga.

Acaulospora elegans Trappe & Gerd. Mycologia Memoir 5:34. 1974.
Habitat: agrosystems.

Acaulospora excavata Ingleby & C.Walker. Mycotaxon 50: 100. 1994.
Habitat: agrosystems, natural and impacted caatinga (mining).

- Acaulospora foveata* Trappe & Janos. Mycotaxon 15: 516. 1982.
Habitat: agrosystems and natural caatinga.
- Acaulospora koskei* Błaszk. Mycological Research 99: 237. 1995.
Habitat: natural caatinga.
- Acaulospora lacunosa* J.B. Morton. Mycologia 78: 643. 1986.
Habitat: natural caatinga.
- Acaulospora laevis* Gerd. & Trappe. Mycologia Memoir 5: 33. 1974.
Habitat: agrosystems.
- Acaulospora longula* Spain & N.C. Schenck. Mycologia 76: 689. 1984.
Habitat: agrosystems and natural caatinga.
- Acaulospora mellea* Spain & N.C. Schenck. Mycologia 76: 690–691. 1984.
Habitat: agrosystems, natural and impacted caatinga (mining).
- Acaulospora morrowiae* Spain & N.C. Schenck. Mycologia 76: 692. 1984.
Habitat: agrosystems and natural caatinga.
- Acaulospora rehmi* Sieverd. & S. Toro. Angewandte Botanik 61: 219. 1987.
Habitat: agrosystems, natural and impacted caatinga (mining).
- Acaulospora scrobiculata* Trappe. Mycotaxon 6: 263–264. 1977.
Habitat: agrosystems, natural and impacted caatinga (mining).
- Acaulospora spinosa* C. Walker & Trappe. Mycotaxon 12: 515. 1981.
Habitat: agrosystems and natural caatinga.
- Acaulospora tuberculata* Janos & Trappe. Mycotaxon 15: 519. 1982.
Habitat: agrosystems, natural and impacted caatinga (mining).
- Kuklospora colombiana* (Spain & N.C. Schenck) Oehl & Sieverd. Journal of Applied Botany and Food Quality 80: 74. 2006.
Basionym: *Entrophospora colombiana* Spain & N.C. Schenck. Mycologia 76: 693–694. 1984.
Habitat: agrosystems and natural caatinga.
- Kuklospora kentinensis* (C.G. Wu & Y.S. Liu) Oehl & Sieverd. Journal of Applied Botany and Food Quality 80: 74. 2006.
Basionym: *Entrophospora kentinensis* C.G. Wu & Y.S. Liu. Mycotaxon 53: 283. 1995.
Habitat: natural caatinga.

Ambisporaceae

Ambispora appendicula (Spain, Sieverd. & N.C. Schenck) Spain, Oehl & Sieverd. Mycological Research 112: 298. 2008.

Basionym: *Acaulospora appendicula* Spain, Sieverd. & N.C. Schenck. Mycologia 76: 686. 1984 = *Appendicispora appendicula* (Spain, Sieverd. & N.C. Schenck) Spain, Oehl & Sieverd., Mycotaxon 97: 170. 2006 = *Ambispora leptoticha* (N.C. Schenck & G.S. Sm.) C. Walker, Vestberg & Schuessler. Mycological Research 111: 148. 2007.

Habitat: agrosystems, natural and impacted caatinga (mining).

Ambispora jimgerdemannii (Spain, Oehl & Sieverd.) C. Walker. Mycological Research 112: 298. 2008.

Basionym: *Appendicispora jimgerdemannii* Spain, Oehl & Sieverd. Mycotaxon 97: 176. 2006.

Habitat: agrosystems.

Ambispora leptoticha (N.C. Schenck & T.H. Nicolson) C. Walker, Vestberg & Schuessler. Mycological Research 112: 298. 2008.

Basionym: *Glomus leptotichum* N.C. Schenck & T.H. Nicolson. Mycologia 74: 82–83. 1982.

Habitat: agrosystems and natural caatinga.

Archaeosporaceae

Archaeospora trappei (R.N. Ames & Linderman) J.B. Morton & D. Redecker emend. Spain. Mycotaxon 87: 111. 2003.

Basionym: *Acaulospora trappei* R.N. Ames & Linderman. Mycotaxon 3: 566. 1976.

Habitat: agrosystems.

Diversisporaceae

Diversispora spurca (C.M. Pfeifer, C. Walker & Bloss) C. Walker & Schuessler. Mycological Research 108: 982. 2004.

Basionym: *Glomus spurcum* C.M. Pfeifer, C. Walker & Bloss. Mycotaxon 14: 374. 1996.

Habitat: agrosystems and natural caatinga.

Entrophosporaceae

Entrophospora infrequens (I.R. Hall) R.N. Ames & Schneid. emend. Oehl & Sieverd. Journal of Applied Botany and Food Quality 80: 71. 2006.

Basionym: *Glomus infrequens* I.R. Hall. Transactions of the British Mycological Society 68: 345–347. 1977.

Habitat: agrosystems, natural and impacted caatinga (mining).

Gigasporaceae

Gigaspora albida N.C. Schenck & G.S. Sm. *Mycologia* 77: 85. 1982.

Habitat: agrosystems, natural and impacted caatinga (mining).

Gigaspora decipiens I.R. Hall & Abbott. *Transactions of the British Mycological Society* 83: 204. 1984.

Habitat: agrosystems, natural and impacted caatinga (mining).

Gigaspora gigantea (T.H. Nicholson & Gerd.) Gerd. & Trappe. *Mycologia Memoir* 5: 29. 1974.

Basionym: *Endogone gigantea* T.H. Nicholson & Gerd. *Mycologia* 60: 321. 1968.

Habitat: agrosystems, natural and impacted caatinga (mining).

Gigaspora margarita W.N. Becker & I.R. Hall. *Mycotaxon* 4: 155–156. 1976.

Habitat: agrosystems, natural and impacted caatinga (mining).

Gigaspora rosea T.H. Nicolson & N.C. Schenck. *Mycologia* 71: 190. 1976.

Habitat: not informed.

Gigaspora ramisporophora Spain, Sieverd. & N.C. Schenck. *Mycotaxon* 34: 668. 1989.

Habitat: agrosystems and natural caatinga.

Scutellosporaceae

Scutellospora aurigloba (I.R. Hall), C. Walker & F.E. Sanders. *Mycotaxon* 27:

180. 1986 emend. C. Walker & I.R. Hall. *Mycological Research* 95: 400. 1991.

Basionym: *Gigaspora aurigloba* I.R. Hall. *Transactions of the British Mycological Society* 68: 351. 1977.

Habitat: agrosystems and natural caatinga.

Scutellospora calospora (T.H. Nicolson & Gerd.) C. Walker & F.E. Sanders.

Mycotaxon 27: 180. 1986.

Basionym: *Endogone calospora* T.H. Nicolson & Gerd. *Mycologia* 60: 322. 1968.

=*Gigaspora calospora* (T.H. Nicolson & Gerd.) Gerd. & Trappe. *Mycologia Memoir* No. 5: 28. 1974.

Habitat: agrosystems and natural caatinga.

Scutellospora dipurpurescens J.B. Morton & Koske. *Mycologia* 80: 520. 1988.

Habitat: natural caatinga.

Scutellospora pernambucana Oehl, D.K. Silva, N. Freitas & L.C. Maia.

Mycotaxon 106: 371–370. 2008.

Habitat: natural caatinga.

Dentiscutataceae

Dentiscutata biornata (Spain, Sieverd. & S. Toro) Oehl, F.A. de Souza & Sieverd. Mycotaxon 106: 342. 2008.

Basionym: *Scutellospora biornata* Spain, Sieverd & S. Toro. Mycotaxon 35: 220. 1989.
Habitat: natural and impacted caatinga (mining).

Dentiscutata cerradensis (Spain & J. Miranda) Oehl, F.A. de Souza & Sieverd. Mycotaxon 106: 342. 2008.

Basionym: *Scutellospora cerradensis* Spain & J. Miranda. Mycotaxon 60: 130. 1996.
Habitat: agrosystems.

Dentiscutata colliculosa B.T. Goto & Oehl. Nova Hedwigia 90: 385. 2010.
Habitat: natural caatinga.

Dentiscutata scutata (C. Walker & Dieder.) Oehl, F.A. de Souza & Sieverd. Mycotaxon 106: 342. 2008.

Basionym: *Scutellospora scutata* C. Walker & Dieder. Mycotaxon 35: 357. 1989.
Habitat: natural caatinga.

Fuscutata heterogama Oehl, F.A. de Souza, L.C. Maia & Sieverd. Mycotaxon 106: 344. 2008.

Habitat: agrosystems, natural and impacted caatinga (mining).

Quatunica erytropa (Koske & C. Walker) Oehl, F.A. de Souza & Sieverd. Mycotaxon 106: 348. 2008.

Basionym: *Gigaspora erythropus* Koske & C. Walker. Mycologia 76: 250. 1984.
=*Scutellospora erythropus* (Koske & C. Walker) C. Walker & F.E. Sanders. Mycotaxon 27: 181. 1986.

Habitat: agrosystems and impacted caatinga (mining).

Racocetraceae

Cetraspora gilmorei (Trappe & Gerd.) Oehl, F.A. de Souza & Sieverd. Mycotaxon 106: 338. 2008.

Basionym: *Gigaspora gilmorei* Trappe & Gerd. Mycologia Memoir 5: 27. 1974.
=*Scutellospora gilmorei* (Trappe & Gerd.) C. Walker & F.E. Sanders. Mycotaxon 27: 181. 1986.
Habitat: natural caatinga.

Cetraspora pellucida (T.H. Nicolson & N.C. Schenck) Oehl, F.A. de Souza & Sieverd. Mycotaxon 106: 338. 2008.

Basionym: *Gigaspora pellucida* T.H. Nicolson & N.C. Schenck. Mycologia 71: 189. 1979.
=*Scutellospora pellucida* (T.H. Nicolson & N.C. Schenck) C. Walker & F.E. Sanders. Mycotaxon 27: 181. 1986.

Habitat: agrosystems, natural and impacted caatinga (mining).

Racocetra castanea (C. Walker) Oehl, F.A. de Souza & Sieverd. Mycotaxon 106: 336. 2008.

Basionym: *Scutellospora castanea* C. Walker. Cryptogamie Mycologie 14: 280. 1993.

Habitat: agrosystems.

Racocetra coralloidea (Trappe, Gerd. & I. Ho) Oehl, F.A. de Souza & Sieverd.

Mycotaxon 106: 336. 2008.

Basionym: *Gigaspora coralloidea* Trappe, Gerd. & I. Ho. Mycologia Memoir 5: 30. 1974.

=*Scutellospora coralloidea* (Trappe, Gerd. & I. Ho) C. Walker & F.E. Sanders. Mycotaxon 27: 181. 1986.

Habitat: agrosystems.

Racocetra fulgida (Koske & C. Walker) Oehl, F.A. de Souza & Sieverd.

Mycotaxon 106: 336. 2008.

Basionym: *Scutellospora fulgida* Koske & C. Walker. Mycotaxon 27: 221. 1986.

Habitat: agrosystems.

Racocetra gregaria (N.C. Schenck & T.H. Nicolson) Oehl, F.A. de Souza &

Sieverd. Mycotaxon 106: 337. 2008.

Basionym: *Gigaspora gregaria* N.C. Schenck & T.H. Nicolson. Mycologia 71: 185. 1979.

=*Scutellospora gregaria* (N.C. Schenck & T.H. Nicolson) C. Walker & F.E. Sanders. Mycotaxon 27: 181. 1986.

Habitat: agrosystems, natural and impacted caatinga (mining).

Racocetra intraornata B.T. Goto, L.C. Maia & Oehl. Mycotaxon 109: 485. 2009.

Habitat: natural caatinga.

Racocetra persica (Koske & C. Walker) Oehl, F.A. de Souza & Sieverd.

Mycotaxon 106: 337. 2008.

Basionym: *Gigaspora persica* Koske & C. Walker. Mycologia 77: 708. 1985.

=*Scutellospora persica* (Koske & C. Walker) C. Walker & F.E. Sanders. Mycotaxon 27: 181. 1986.

Habitat: agrosystems.

Racocetra verrucosa (Koske & C. Walker) Oehl, F.A. de Souza & Sieverd.

Mycotaxon 106: 337. 2008.

Basionym: *Gigaspora verrucosa* Koske & C. Walker. Mycologia 77: 705. 1985.

=*Scutellospora verrucosa* (Koske & C. Walker) C. Walker & F.E. Sanders. Mycotaxon 27: 181. 1986.

Habitat: agrosystems, natural and impacted caatinga (mining).

Racocetra weresubiae (Koske & C. Walker) Oehl, F.A. de Souza & Sieverd.

Mycotaxon 106: 337. 2008.

Basionym: *Scutellospora weresubiae* Koske & C. Walker. Mycotaxon 27: 224. 1986.

Habitat: natural caatinga.

Glomeraceae

Glomus aggregatum N.C. Schenck & G.S. Sm. *Mycologia* 77: 80. 1982.
Habitat: agrosystems.

Glomus albidum C. Walker & L.H. Rhodes. *Mycotaxon* 12: 509–510. 1981.
Habitat: natural caatinga.

Glomus ambisporum G.S. Sm. & N.C. Schenck. *Mycologia* 77: 566. 1982.
Habitat: natural caatinga.

Glomus arborens McGee. *Transactions of the British Mycological Society* 87: 123. 1986.
Habitat: agrosystems.

Glomus claroideum N.C. Schenck & G.S. Sm. *Mycologia* 77: 84. 1982.
Habitat: agrosystems.

Glomus clarum T.H. Nicolson & N.C. Schenck. *Mycologia* 71: 182. 1979.
Habitat: agrosystems and impacted caatinga (mining).

Glomus clavisorum (Trappe) R.T. Almeida & N.C. Schenck. *Mycotaxon* 6: 359. 1977.
Habitat: natural caatinga.

Glomus constrictum Trappe. *Mycotaxon* 6: 361. 1977.
Habitat: agrosystems.

Glomus coremioides (Berk. & Broome) D. Redecker & J.B. Morton. *Mycologia* 92: 282–285. 2000.
Basionym: *Sclerocystis coremioides* Berk. & Broome, *Journal of the Linnean Society of London* 14: 137. 1873.
=*Xenomycetes ochraeus* Cesati, *Atti della Reale Accademia delle Scienze Fisiche e Matematiche di Napoli* 8(4): 26. 1878.
=*Ackermannia coccogena* Pat., *Bulletin de la Société Mycologique de France* 18: 183. 1902.
=*Sphaerocreas coccogena* (Pat.) von Höhn., *Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften in Wien Mathematisch-Naturwissenschaftlich Klasse Abteilung I.* 118: 401. 1909.
=*Sclerocystis coccogena* (Pat.) von Höhn., *Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften in Wien Mathematisch-Naturwissenschaftlich Klasse Abteilung I.* 119: 399. 1910.
=*Ackermannia dussii* Pat., *Bulletin de la Société Mycologique de France* 18: 180–181. 1902.
=*Sphaerocreas dussii* (Pat.) von Höhn., *Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften in Wien Mathematisch-Naturwissenschaftlich Klasse Abteilung I.* 118: 401. 1909.

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=*Sphaeroceas javanicum* von Höhn, Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften in Wien Mathematisch-Naturwissenschaftlich Klasse. Abteilung I. 117: 1014–1015. 1908.

=*Endogone minutissima* Beeli, Bulletin de la Société Royale de Botanique de Belgique 56: 57. 1923.

=*Sclerocystis alba* Petch, Annals of the Royal Botanic Gardens, Peradenya 9: 322–383. 1925.

=*Endogone alba* (Petch) Gerd. & Trappe. Mycologia Memoir 5: 25. 1974.

Habitat: agrosystems and natural caatinga.

Glomus deserticola Trappe, Bloss & J.A. Menge. Mycotaxon 20: 123. 1984.

Habitat: agrosystems.

Glomus diaphanum J.B. Morton & C. Walker. Mycotaxon 21: 433. 1982.

Habitat: agrosystems, natural and impacted caatinga (mining).

Glomus etunicatum W.N. Becker & Gerd. Mycotaxon 6: 29. 1977.

Habitat: agrosystems, natural and impacted caatinga (mining).

Glomus fasciculatum (Thaxter) Gerd. & Trappe emend. C. Walker & Koske. Mycotaxon 30: 255. 1987.

Habitat: natural caatinga.

Glomus geosporum (T.H. Nicolson & Gerd.) C. Walker. Mycotaxon 15: 56. 1982.

Basionym: *Endogone macrocarpa* (Tul. & C. Tul.) Tul & C. Tul. var. *geospora* T.H. Nicolson & Gerd. Mycologia 60: 318–319. 1968.

=*Glomus macrocarpum* var. *geosporum* (T.H. Nicolson & Gerd.) Gerd. & Trappe. Mycologia Memoir 5: 55–56. 1974.

Habitat: agrosystems and natural caatinga.

Glomus glomerulatum Sieverd. Mycotaxon 29: 74. 1987.

Habitat: agrosystems, natural and impacted caatinga (mining).

Glomus halonatum S.L. Rose & Trappe. Mycotaxon 10: 413. 1980.

Habitat: natural caatinga.

Glomus heterosporum G.S. Sm. & N.C. Schenck. Mycologia 77: 567–569. 1985.

Habitat: agrosystems.

Glomus intraradices N.C. Schenck & G.S. Sm. Mycologia 77: 78. 1982.

Habitat: agrosystems, natural and impacted caatinga (mining).

Glomus invermaium I.R. Hall. Transactions of the British Mycological Society 68: 345. 1977.

Habitat: agrosystems, natural and impacted caatinga (mining).

Glomus macrocarpum Tul. & C. Tul. *Giornale Botanico Italiano* 2 (1): 63. 1844.
Habitat: agrosystems, natural and impacted caatinga (mining).

Glomus microaggregatum Koske, Gemma & P.D. Olexia. *Mycotaxon* 26: 125–126. 1986.
Habitat: agrosystems, natural and impacted caatinga (mining).

Glomus microcarpum Tul. & C. Tul. *Giornale Botanico Italiano* 2 (1): 63. 1844.
Habitat: agrosystems, natural and impacted caatinga (mining).

Glomus monosporum Gerd. & Trappe. *Mycologia Memoir* 5: 41–42. 1974.
Habitat: agrosystems.

Glomus mosseae (T.H. Nicolson & Gerd.) Gerd. & Trappe. *Mycologia Memoir* 5: 40–41. 1974.
Basionym: *Endogone mosseae* T.H. Nicolson & Gerd. *Mycologia* 60: 314–315. 1968.
Habitat: agrosystems, natural and impacted caatinga (mining).

Glomus pallidum I.R. Hall. *Transactions of the British Mycological Society* 68: 343. 1977.
Habitat: impacted caatinga (mining).

Glomus sinuosum (Gerd. & B.K. Bakshi) R.T. Almeida & N.C. Schenck. *Mycologia* 66: 343. 1990.
Basionym: *Sclerocystis sinuosa* Gerd. & B.K. Bakshi. *Transactions of the British Mycological Society* 66: 343. 1976.
Habitat: agrosystems, natural and impacted caatinga (mining).

Glomus tortuosum N.C. Schenck & G.S. Sm. *Mycologia* 77: 83–84. 1982.
Habitat: agrosystems, natural and impacted caatinga (mining).

Paraglomeraceae

Paraglomus occultum (C. Walker) J.B. Morton & D. Redecker. *Mycologia* 98: 190. 2001.
Basionym: *Glomus occultum* C. Walker. *Mycotaxon* 15: 50. 1982.
Habitat: agrosystems, natural and impacted caatinga (mining).

Paraglomus brasilianum (Spain & J. Miranda) J.B. Morton & D. Redecker. *Mycologia* 98: 190–192. 2001.
Basionym: *Glomus brasilianum* Spain & J. Miranda. *Mycotaxon* 60: 139. 1996.
Habitat: impacted caatinga (mining).

Discussion

Compared with this last review (Stürmer & Siqueira 2008), the data presented here increase the number of species known in Brazil, which now has at least 48.2% of the valid species worldwide. Most families of *Glomeromycota* (except *Geosiphonaceae* and *Pacisporaceae*) are represented in the Caatinga, with the number of species representing 74.5% of those recorded from Brazil and 35.9% of those known worldwide.

The majority of AMF studies in the Caatinga have so far focused on agrosystems (Stürmer & Siqueira 2008). However, despite the low number of inventories in the Caatinga, 57 species were listed from vegetation preserved in the biome, almost equaling the number of species (60) recorded from agrosystems throughout Brazil. This preliminary estimate of the AMF diversity in the Caatinga suggests that a high diversity will probably be found in the biome in the future, particularly considering the high number of plants and animals also present (Leal et al. 2003).

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