Diamonds and Daisies: Floristics and Conservation of Asteraceae in One of Brazil’s Major Centers of Endemism

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Abstract
Brazilian rupestrian grasslands (campos rupestres) are old, climatically buffered infertile landscapes, which support many endemic species. Asteraceae show the high levels of plant endemism and contain more endangered species than any other family in Brazil. Here, we evaluated the complementarity of two protected areas for the conservation of endangered Asteraceae along the Espinhaço Mountain range, Southeast Brazil. Specifically, we investigated if the known endangered Asteraceae flora of the Diamantina District Plateau (38 species) occurs in two protected areas, Rio Preto State Park and Sempre Vivas National Park, and if these areas are complimentary or overlapping in protecting endangered Asteraceae species. To survey Asteraceae, we used a standardized RAPELD protocol (211 ha plots) and traditional floristic collecting (117 ha polygon/32 days/average team = 2.1 collectors) across different habitats and altitudes within both areas. RAPELD protocol recorded 115 species in a sample of 12,775 individuals of Asteraceae. Traditional floristic collecting recorded 172 species in a sample of 613 collections. Seventy-nine percent of endangered species known to occur within the Plateau were recollected by either RAPELD or traditional floristic collecting. Only 13% of endangered Asteraceae flora was common to both protected areas; 47% occur in Rio Preto State Park and 34% in Sempre Vivas National Park; combined, they recorded 68% of the endangered Plateau Asteraceae flora; only one critically endangered species was recorded. The two parks are complimentary but insufficient to protect the endangered Asteraceae flora of the Plateau; the uneven distribution of endangered species in the Diamantina District Plateau is a threat to their conservation.

Keywords
endangered species, Rupestrian grasslands, Espinhaço Mountain range, OCBIL, conservation in situ

Introduction
Floristic studies are fundamental for conservation planning (Prance, 1994; Zuquim et al., 2014). In one of the few country-level strategic studies where plants were included (Dobson, Rodriguez, Roberts, & Wilcove, 1997), the conservation of endangered plant species was found to maximize protection of endangered species of amphibians, arachnids, birds, clams, crustaceans, fish, insects, mammals, reptiles, and snails.

The campos rupestres (rupestrian grasslands) are old, climatically buffered infertile landscapes or OCBILs (Silveira et al., 2016) and, like other OCBILs in South Africa and southwestern Australia, support many

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endemic species of plants, animals, and arbuscular mycorrhizal fungi (Carvalho et al., 2012; Conceição et al., 2016; Rapini, Ribeiro, Lambert, & Pirani, 2008). Despite covering less than 1% of Brazil, the flora of the campos rupestres comprises at least 5,000 plant species (Silveira et al., 2016), and nearly 40% of them are endemic (BFG 2015).

The Espinhaço Mountain range (Cadeia do Espinhaço, hereafter CdoE), where campo rupestre dominates, runs c. 1,200 km from northern Bahia to southern Minas Gerais, in Southeastern Brazil. There is a major floristic discontinuity in the CdoE at c. 14°S (Arruda et al., 2008; Rizzini, 1979) corroborated by lithostructural contrast (Saadi, 1995), between the states of Bahia and Minas Gerais, so the northern portion is often referred to as the “Bahia” CdoE (also called the Septentrional Plateau; Saadi, 1995) and the Southern portion as the “Minas Gerais” CdoE (also called the Meridional Plateau; Saadi, 1995). This discontinuity was tested and 32.7% of species in the vascular flora were endemic to either the northern or southern CdoE (Conceição et al., 2016). Some authors have claimed that because of the high frequency of narrow endemics, selection of priority areas for conservation would not be as effective as if the whole Espinhaço Range were protected (Echternacht, Trovó, Oliveira, & Pirani, 2011; Rapini, Mello-Silva, & Kawasaki, 2002). Monteiro et al. (2017) used distribution of 255 endangered species of the CdoE (as well as distribution of farming, mining, and fires) to suggest a conservation plan for these species and indicate priority areas for their conservation.

The Diamantina District Plateau (hereafter ‘Plateau’) is the largest continuous area in the “Minas Gerais” CdoE (Echternacht et al., 2011). Within this Plateau, there are two protected areas: Rio Preto State Park (PERP) and Sempre Vivas National Park (PNSV). Chaves et al. (2019) have shown that the main environmental predictors of Asteraceae distribution patterns in these two protected areas are either edaphic, that is, sum of bases and levels of aluminum (Al), clay, and sand, or associated with elevation and slope. Combined spatial and environmental components performed better at explaining Asteraceae floristic and relative abundance than either component by itself.

The Asteraceae was chosen for the study because (a) it is well represented in open and montane areas of the Neotropics and is the most species-rich family in campos rupestres vegetation (Silveira et al., 2016); (b) it represents almost 10% of the total angiosperm flora of Brazil (Flora do Brasil 2020 em construção, 2017a); (c) campos rupestres have the highest levels of Asteraceae endemism in Brazil (Flora do Brasil 2020 em construção, 2017b); (d) more species of Asteraceae face some level of threat than any other family in Brazil (Martinelli & Moraes, 2013; Ministério do Meio Ambiente, 2014).

We generated a list of the Asteraceae from PERP and PNSV to address two questions: (a) Is the known endangered Asteraceae flora of the Diamantina Plateau protected by these two protected areas? (b) Are these two protected areas complimentary or overlapping in protecting endangered species?

Methods

Study Area

Two protected areas and their surroundings within the Plateau were chosen for our study: PERP and PNSV (Figures 1 and 2). PERP has an area of 10,700 hectares and is in the municipality of São Gonçalo do Rio Preto (18°04'12" to 18°14'15" S, and 43°23'34" to 43°18'18" W). PNSV occupies an area of ca. 124,555 hectares in the municipalities of Olhos D’Água, Bocaiúva, Buenópolis, and Diamantina (17°44’11” to 17°59’28” S and 43°35’50” to 43°59’33” W).

Floristic Survey

Botanical collections were made (SISBIO Licence 40530–1 issued to the first author on August 6, 2013) using two different methods, the RAPELD protocol (Magnusson et al., 2005), with a reduction to 7 ha per module and some modifications to suit the campo rupestre environment (see Chaves et al., 2019), and traditional floristic collecting, between August 2013 and October 2014. For the RAPELD protocol, three sample modules were established, each of which with 21 sample units. Two sample modules were set up in PERP (PERP I and PERP II) and one in PNSV (PNSV I). Sample units were demarcated along two 5 km trails perpendicular to the isolines (topographic contours) of the terrain. Sample units measured 250 m × 40 m (=10,000 m² = 1 ha) and were demarcated at 10 m increases in altitude in PNSV and 25 m increases in altitude in PERP (1,000, 1,025 m, etc.; Figure 1). Each 10,000 m² unit was subdivided into 25 subunits of that measures 10 m along the isoline × 40 m across that were easy to visualize and uniform in altitude, topography, and soil type. RAPELD collections were made within sample units, and both fertile and sterile specimens were collected. Even if additional specimens were added to the collection from the immediate vicinity of the unit, this was still considered a RAPELD collection since the motivation for the collection was its occurrence in the sample unit. Traditional floristic collecting (Mori et al., 1985; Ter Steege, Harisbersaud, Bánki, & Schieving, 2011) was done in and out of the two protected areas, within a 117 ha polygon area of the Plateau whenever an Asteraceae was found either flowering or fruiting; sterile specimens were not collected. Total
collecting effort was 32 collecting days (1–5 collecting days per month) with teams of 1 to 4 collectors (average team = 2.1 collectors) between August 2013 and October 2014.

The PERP I module ran through savanna (cerrado) as well as campos rupestres, while the PERP II and PNSV I modules were in an area mainly of campos rupestres (Figure 2). All campos rupestres areas showed high heterogeneity of microhabitats with differences in soil, humidity levels, altitude, and floristic composition. In PERP I altitude varied between 760 and 940 m on poorly drained and well-drained soils, while in the savanna areas soils were deep with a high proportion of clay. In PERP II, altitude varied between 1,350 and 1,525 m, with prevalent rocky outcrops and some gallery forests, wet and well-drained fields (campos). In PNSV I, there was little variation in altitude (1,220–1,290 m), with campos rupestres dominating the vegetation but with pockets of savanna and gallery forest.

**Principle of Analysis**

Complementarity of areas (often considered the defining concept of spatial conservation prioritization; Kukkala & Moinen, 2013) was used to compare the two protected areas. Complementarity is a simple, iterative method of assessing the relative value of areas for conservation (Justus & Sarkar, 2002): one approach predicts that a set of areas that are species-rich for the surrogate taxon will be species-rich in general due to ecological complementarity and habitat limitation (Faith & Walker, 1996; Williams, Faith, Manne, Sechrest, & Preston, 2006). Since many species have not yet been sampled phylogenetically in the CdoE, phylogenetic approaches would be very incomplete. Asteraceae, the chosen surrogate taxon, is suitable for the following reasons: (a) it presents a wide variety of growth forms, including some that are specific to campo rupestre (Clarke et al., 2013; Lusa, Appezzato-da-Glória, Loeuille, Bartoli, & Ciccarelli, 2014) and (b) it is species-rich, taxonomically diverse and responsive to environmental drivers (Chaves et al., 2019) making it a good
surrogate of functional diversity, a highly informative biodiversity metric (Gallardo, Gascón, Quintana, & Comín, 2011). Asteraceae genera have been used to evaluate the efficiency of the conservation unit network in Mexico (Villaseñor, Ibarra, & Ocaña, 1998).

**Taxonomic Identification**

Authors J. B. A. B. Jr., J. N. N., and V. L. R. are Asteraceae specialists and identified most of the species but other specialists were consulted (see Acknowledgments). Herbarium vouchers were deposited in the Universidade de Brasília and in the Universidade Federal do Vale do Jequitinhonha e do Mucuri (see also Species Link 2017a, 2017b, 2017c, 2017d). Species with doubtful identifications (affinis or conferatum) and potential new species were listed in Table 1 but not counted and considered in the comparative analysis. Species’ geographic distributions were compiled from the literature (Suppl. Information) and on-line databases (Herbário Virtual Reflora, 2017; Species Link, 2017a). Scientific names were updated following Flora do Brasil 2020 em construção (2017a).

**Results**

R**ichness and Endemism**

A total of 613 collections of Asteraceae were made that resulted in 172 published, named species (Table 1); five morpho-species that are either undescribed species or
Table 1. List of Asteraceae Species Collected in Two Conservation Units and Their Surroundings in the Campos Rupestres of the Diamantina Plateau in the Espinhaço Mountain Range.

| Genus/species | Endemism          | Campo rupestre specialist | PNSV | PERP | Other DD localities | Voucher |
|---------------|-------------------|---------------------------|------|------|---------------------|---------|
| Acanthospemum | W                 |                           |      |      |                     |         |
| 1. Acanthospemum australis (Loefl.) Kuntze | W | x | x |         |         |
| Achyrocline  | W                 |                           |      |      |                     |         |
| 2. Achyrocline satureioides (Lam.) DC. | W | x | x |         |         |
| Acritopappus  | BR                |                           |      |      |                     |         |
| 3. Acritopappus inviniti R.M.King & H.Rob. (E) | BR, CdoE | x |         |         | 90      |
| 4. Acritopappus longifolius (Gardner) R.M.King & H.Rob. | BR | x | x |         | 188, 229, 451 |
| Ageratum      | W                 |                           |      |      |                     |         |
| 5. Ageratum fastigiatum (Gardner) R.M.King & H.Rob. | W | x | x |         | 22, 372 |
| Aldama        | W                 |                           |      |      |                     |         |
| 6. Aldama bracteata (Gardner) E.E.Schill. & Panero | BR | x | x | x |         | 285, 214, 340 |
| Apopyros      | W                 |                           |      |      |                     |         |
| 7. Apopyros aff. corymbosus (Hook. & Arn.) G.L. Nesom | BR | x | x |         |         | 565 |
| Aspilia       | BR                |                           |      |      |                     |         |
| 8. Aspilia andersonii H. Rob. | BR, CdoE, DD | x |         |         | 139 |
| 9. Aspilia diamantinae J.U. Santos (E) | BR, CdoE, DD | Yes | x | x |         | 241 |
| 10. Aspilia foliosa (Gardner) Baker | BR | x | x |         |         | 101 |
| 11. Aspilia fruticosa (Gardner) Baker | BR | x | x |         |         | 62 |
| 12. Aspilia riedeli Baker | BR | x | x |         |       | 169, 320 |
| 13. Aspilia subpetioluta Baker | BR | x |       |         |         | 388 |
| Ayapana       | W                 |                           |      |      |                     |         |
| 14. Ayapana amygdalina (Lam.) R.M.King & H. Rob. | W | x | x |         |         | 31, 531 |
| Baccharis     | W                 |                           |      |      |                     |         |
| 15. Baccharis aphylla (Vell.) DC. | W | x |     |         |         | 525 |
| 16. Baccharis brevifolia DC. | W | x |      |         |         | 555, 587 |
| 17. Baccharis clauseni Baker | BR | Yes | x |         |         | 576 |
| 18. Baccharis calvescens DC. | BR | x | x |         |         | 369 |
| 19. Baccharis crispoglobose Spreng. | W | x | x |         |         | 557 |
| 20. Baccharis elliptica Gardner (E) | BR | Yes | x |         |         | 148 |
| 21. Baccharis ligustrina DC. | BR | x |     |         |         | 558 |
| 22. Baccharis linearifolia (Lam.) Pers. | W | x |     |         |         | 414 |
| 23. Baccharis lychnophora Gardner (E) | BR | x | x |         |         | 599, 333 |
| 24. Baccharis minutiflora Mart. ex Baker | BR | Yes | x |         |         | 507, 568 |
| 25. Baccharis perlata Sch.Bip. ex Baker | BR | x | x |         |         | 99, 200, 319, 363 |
| 26. Baccharis platypoda DC. | W | x | x | x |         | 89, 386, 63 |
| 27. Baccharis pseudolaepestris Malag. (E) | BR | Yes | x |         |         | 574 |
| 28. Baccharis reticulata DC. | BR | x | x | x |         | 313, 488, 164 |
| 29. Baccharis retusa DC. | BR | x | x | x |         | 84, 264, 329 |

(continued)
| Genus/species | Endemism | Campo rupestré specialist | PNSV | PERP | Other DD localities | Voucher |
|---------------|----------|--------------------------|------|------|---------------------|---------|
| 30. Baccharis serrulata (Lam.) Pers. | BR |  | x |  | 219, 412 | |
| 31. Baccharis subdendata DC. | BR |  | x |  | 474 | |
| Bidens | W |  |  |  |  | |
| 32. Bidens flagellaris Baker | BR |  | x |  | 206 | |
| 33. Bidens sp. 1a | ? |  | x | x | 223, 447 | |
| Calea | W |  |  |  |  | |
| 34. Calea ferruginea Sch. Bip. ex Baker | W |  |  | x | 231 | |
| 35. Calea graminifolia Sch.Bip. ex Krasch. | BR |  | x | x | 109, 577 | |
| 36. Calea nitida Less. | BR |  | x |  | 569 | |
| 37. Calea oxylepis Baker | BR, CdoE |  | x |  | 545 | |
| 38. Calea sp. 1a | ? |  | x |  | 266 | |
| Campuloclinium | W |  |  |  |  | |
| 39. Campuloclinium campuloclinioides (Baker) R.M. King & H. Rob. | BR |  | x |  | 195 | |
| Chaptalia | W |  |  |  |  | |
| 40. Chaptalia integerrima (Vell.) Burkart | W |  | x |  | 559 | |
| Chresta | W |  |  |  |  | |
| 41. Chresta pycnocephala DC. | BR |  | x |  | 30 | |
| 42. Chresta sphaerocephala DC. | BR |  | x | x | 20, 36 | |
| Chromolaena | W |  |  |  |  | |
| 43. Chromolaena barraoa R.M. King & H. Rob. | BR, CdoE |  | x | x | x | 184, 424, 322 |
| 44. Chromolaena chaseae (B.L. Rob.) R.M. King & H. Rob. | BR |  | x | x | x | 411, 147 |
| 45. Chromolaena horminoides DC. | BR |  | x | x | x | 207, 230, 358 |
| 46. Chromolaena multiflora (DC.) R.M. King & H. Rob. | BR |  | x | x | x | 86, 166, 48 |
| 47. Chromolaena pedalis (Sch.Bip. Ex Baker) R.M. King & H. Rob. | BR |  | x | x | x | 352 |
| 48. Chromolaena pungens (Gardner) R.M. King & H. Rob. | BR |  | x | x | x | 297, 359 |
| 49. Chromolaena maximiliani (Schrad, ex DC.) R.M.King & H. Rob. | W |  | x |  | 392 | |
| 50. Chromolaena squalida var. martiusii (DC.) Baker | W |  | x |  | 505 | |
| 51. Chromolaena squalida var. squalida DC. | W |  | x |  | 277 | |
| 52. Chromolaena squalida var. subvelutinum (DC.) Baker | W |  | x | x | 448 | |
| Chronopappus | W |  |  |  |  | |
| 53. Chronopappus bifrons (DC. ex Pers.) DC. (E) | BR, CdoE |  | x |  | 600 | |
| Chrysolaena | W |  |  |  |  | |
| 54. Chrysolaena obovata (Less.) Dematt. | W |  | x | x | 92, 431 | |
| 55. Chrysolaena simplex (Less.) Dematt | W |  | x |  | 549 | |
| Dasphyllum | W |  |  |  |  | |
| 56. Dasphyllum sprengelianum (Gardner) Cabrera | BR |  | x | x | 309, 265 | |
| Dimerostemma | W |  |  |  |  | |
| 57. Dimerostemma brasilianum Cass. | W |  | x | x | 192 | |
| 58. Dimerostemma oblongum (Gardner) G.M.Barroso | BR, CdoE |  | x |  | 395 | |

(continued)
Table 1. Continued.

| Genus/species | Endemism | Campo rupestre specialist | PNSV | PERP | Other DD localities | Voucher |
|---------------|----------|----------------------------|------|------|---------------------|---------|
| **Disynaphia** | W        |                            |      |      |                     |         |
| 59. *Disynaphia praeficta* (B.L.Rob) R.M.King & H.Rob. (E) | BR, CdoE | Yes                   | x    | x    |                     | 283, 382, 71 |
| **Echinocoryne** | BR       |                           |      |      |                     |         |
| 60. *Echinocoryne schwenkifolia* Mart. ex DC. | BR | x                       | x    | x    |                     | 301, 409, 365 |
| **Erechtites** | W        |                           |      |      |                     |         |
| 61. *Erechtites hieraciifolius* (L.) Raf. ex DC. | W | x                       | x    | x    |                     | 79, 250, 51 |
| 62. *Erechtites valerianifolius* (Link ex Spreng.) DC. | W | x                       |      |      |                     | 327     |
| **Eremanthus** | W        |                           |      |      |                     |         |
| 63. *Eremanthus crotonoides* (DC.) Sch.Bip. | BR | x                       |      |      |                     | 198     |
| 64. *Eremanthus elaegnus* (Mart. ex DC.) Sch.Bip | BR | x                       | x    | x    |                     | 95, 175, 162 |
| 65. *Eremanthus erythropappus* (DC.) MacLeish | BR | x                       |      |      |                     | 267     |
| 66. *Eremanthus glomerulatus* Less. | BR | x                       | x    | x    |                     | 275, 177, 343 |
| 67. *Eremanthus inanus* (Less.) Less. | BR | x                       |      |      |                     | 464, 163 |
| 68. *Eremanthus polycephalus* (DC.) MacLeish (E) | BR | x                       |      |      |                     | 468, 41  |
| **Eupatorium** | W        |                           |      |      |                     |         |
| 69. *Eupatorium lineatum* Sch. Bip. ex Baker | BR | x                       |      |      |                     | 427     |
| **Grazielia** | W        |                           |      |      |                     |         |
| 70. *Graziella bishopii* R.M.King & H.Rob. | BR | x                       |      |      |                     | 125, 194 |
| **Heterocoma** | BR       |                           |      |      |                     |         |
| 71. *Heterocoma erecta* (H. Rob.) B. Loeuille, J.N. Nakaj. & Semir | BR | Yes                   |      |      |                     | 427     |
| 72. *Heterocoma sp. 1* (sp. nov.) | BR, CdoE, DD | x                   |      |      |                     | 615     |
| **Heterocondylus** | W        |                           |      |      |                     |         |
| 73. *Heterocondylus alatus* (Vell.) R.M. King & H. Rob. | BR | x                       | x    |      |                     | 58      |
| 74. *Heterocondylus pumilus* (Gardner) R.M. King & H. Rob. | BR | x                       |      |      |                     | 589     |
| **Hoehnephytum** | W        |                           |      |      |                     |         |
| 75. *Hoehnephytum trixoides* (Gardner) Cabrera | BR | x                       |      |      |                     | 592     |
| 76. *Ichthyothere terminalis* (Spreng.) S.F.Blake | BR | x                       |      |      |                     | 482     |
| **Inulopsis** | W        |                           |      |      |                     |         |
| 77. *Inulopsis camorum* (Gardner) G.L. Nesom | W | x                       |      |      |                     | 603     |
| 78. *Inulopsis scaposa* (DC.) O.Hoffm. | W | x                       |      |      |                     | 605     |
| **Koanophyllon** | W        |                           |      |      |                     |         |
| 79. *Koanophyllon adamantium* (Gardner) R.M. King & H. Rob. | BR | x                       |      |      |                     | 499     |
| **Lepidaploa** | W        |                           |      |      |                     |         |
| 80. *Lepidaploa argyrotricha* (Sch. Bip. ex Baker) H. Rob. | BR | x                       |      |      |                     | 380     |
| 81. *Lepidaploa lilacina* (Mart. ex DC.) H. Rob. | BR | x                       | x    |      |                     | 292, 467 |
| 82. *Lepidaploa rufogrisea* (A. St.-Hil.) H. Rob. | BR | x                       | x    |      |                     | 57, 100, 253 |
| 83. *Lepidaploa sororia* (DC.) H.Rob. | BR | x                       |      |      |                     | 544     |
| 84. *Lepidaploa spixiana* (Mart. ex DC.) H. Rob. (E) | BR | Yes                   | x    |      |                     | 616, 38 |
| Genus/species | Endemism | Campo rupestre specialist | PNSV | PERP | Other DD localities | Voucher |
|---------------|----------|--------------------------|------|------|----------------------|---------|
| **Lessingianthus** |          |                          |      |      |                      |         |
| 85. Lessingianthus adenophyllus (Mart. ex DC.) H. Rob. (E) | BR, CdoE | Yes | x | x | 98, 385 | |
| 86. Lessingianthus ammophilus (Gardner) H. Rob. | BR | x | | | | |
| 87. Lessingianthus bardanoides (Less.) H. Rob. | W | | | | | |
| 88. Lessingianthus brevipediolatus (Sch. Bip. ex Baker) H. Rob. | BR | | | | | |
| 89. Lessingianthus cardiger (Mart. ex DC.) H. Rob. | BR, CdoE | Yes | | x | | |
| 90. Lessingianthus coriaceus (Less.) H. Rob. | BR | x | x | | 186, 226 | |
| 91. Lessingianthus laevigatus (Mart. ex DC.) H. Rob. | W | | | | | |
| 92. Lessingianthus psilophyllus (DC.) H. Rob. | BR, CdoE, DD | x | x | | 547, 604 | |
| 93. Lessingianthus stoechas (Mart. ex Baker) H. Rob. (E) | BR | x | | | | |
| 94. Lessingianthus tomentellus (Mart. ex DC.) H. Rob. | BR | x | x | | 612 | |
| 95. Lessingianthus vepretorum (Mart. ex DC.) H. Rob. | BR | Yes | x | x | 124, 70, 404 | |
| 96. Lessingianthus warmingianus (Baker) H. Rob. | BR | x | x | | 228, 144 | |
| **Lucilia** |          |                          |      |      |                      |         |
| 99. Lucilia lycopodioides (Less.) S.E. Freire | W | | | | | 537–9, 590 |
| **Lychnophora** |          |                          |      |      |                      |         |
| 100. Lychnophora diamantinana Coile & Jones (E) | BR, CdoE, DD | Yes | | x | 133 | |
| 101. Lychnophora ericoides Mart. | BR | Yes | x | | 34 | |
| 102. Lychnophora gardneri Sch. Bip. (E) | BR, CdoE, DD | Yes | x | | 3 | |
| 103. Lychnophora cf. humillima Sch. Bip. | BR | Yes | | | | 597 |
| 104. Lychnophora martiana Gardner (E) | BR, CdoE | Yes | | x | 442 | |
| 105. Lychnophora passerine (Mart. ex DC.) Gardner | BR | Yes | x | | 455 | |
| 106. Lychnophora pinaster Mart. | BR | Yes | x | | 26 | |
| 107. Lychnophora pohlii Sch. Bip. | BR, CdoE | Yes | | x | 6 | |
| 108. Lychnophora reticulata Gardner | BR | Yes | x | | 153 | |
| 109. Lychnophora rosmaninifolia Mart. | BR | Yes | x | | 16 | |
| 110. Lychnophora rupestris Semir & Leitão | BR | Yes | x | | 7 | |
| 111. Lychnophora salicifolia Mart. | BR | Yes | x | | 152 | |
| 112. Lychnophora sellowii Sch. Bip. | BR, CdoE | Yes | x | | 44 | |
| 113. Lychnophora staiooides Mart. | BR, CdoE, DD | Yes | x | x | 479, 17 | |
| 114. Lychnophora syncephala (Sch. Bip.) Sch. Bip. | BR | x | x | | 199, 134 | |
| 115. Lychnophora tomentosa (Mart. ex DC.) Sch. Bip. | BR, CdoE | Yes | x | x | 97, 437, 2 | |
| 116. Lychnophora triflora (Mattf.) H. Rob. | BR, CdoE | Yes | x | | 25, 103, 118 | |
| 117. Lychnophora uniflora Sch. Bip. | BR | Yes | x | | 149 | |
| 118. Lychnophora villosissima Mart. (E) | BR, CdoE | Yes | x | x | 315, 149 | |
| 119. Lychnophora sp. 1 (sp. nov. ined. "cryptomerioides") | BR, CdoE, DD | Yes | | x | 428 | |
| 120. Lychnophora sp. 2 (sp. nov.) | BR, CdoE, DD | Yes | x | | 197 | |

(continued)
### Table 1. Continued.

| Genus/species                      | Endemism | Campo rupestre specialist | PNSV | PERP | Other DD localities | Voucher |
|------------------------------------|----------|---------------------------|------|------|---------------------|---------|
| Lychnophoriopsis                  | BR       |                           |      |      |                     |         |
| 121. Lychnophoriopsis candelabrum  | BR, CdoE, DD | Yes                      |      |      |                     | 39      |
| H. Rob. (E)                       |          |                           |      |      |                     |         |
| Mikania                           |          |                           |      |      |                     |         |
| 122. Mikania glauca Mart. (E)      | BR       | Yes                       |      |      |                     | 530     |
| 123. Mikania luetzelburgii Mattf.  | BR       |                           |      |      |                     | 272, 64 |
| 124. Mikania microphila Sch.Bip. Ex Baker | BR |                          |      |      |                     | 367     |
| 125. Mikania neurocula DC. (E)     | BR       |                           |      |      |                     | 82, 685 |
| 126. Mikania nummularia DC.        | BR       |                           |      |      |                     | 593     |
| 127. Mikania officinalis Mart.     | BR       |                           |      |      |                     | 123, 154 |
| 128. Mikania ramosissima Gardner   | BR       |                           |      |      |                     | 76, 529 |
| 129. Mikania reticulata Gardner   | BR       |                           |      |      |                     | 65, 561, 566 |
| 130. Mikania sessilibloa DC.       | BR       |                           |      |      |                     | 383, 355 |
| 131. Mikania parvifolia Baker     | BR, CdoE |                           |      |      |                     | 506     |
| 132. Mikania aff. phaeoclados Mart.| ?        |                           |      |      |                     | 476     |
| 133. Mikania sp. I                | ?        |                           |      |      |                     | 239, 410, 457 |
| Minasia                           |          |                           |      |      |                     |         |
| 134. Minasia alpestris (Gardner) H. Rob. (E) | BR, CdoE, DD | Yes                      |      |      |                     | 110, 438 |
| 135. Minasia pereirae H. Rob. (E)  | BR, CdoE | Yes                       |      |      |                     | 23      |
| 136. Minasia scapigera H.Rob. (E)  | BR, CdoE | Yes                       |      |      |                     | 444     |
| Moquinia                          |          |                           |      |      |                     |         |
| 137. Moquini racemosa DC.         | BR       |                           |      |      |                     | 113, 512 |
| Moquiniastrum                     |          |                           |      |      |                     |         |
| 138. Moquiniastrum blanchetianum  | BR       |                           |      |      |                     | 312, 224 |
| (DC.) G. Sancho                   |          |                           |      |      |                     |         |
| 139. Moquiniastrum floribundum    | W        |                           |      |      |                     | 453     |
| (Cabrera) G. Sancho               |          |                           |      |      |                     |         |
| 140. Moquiniastrum hatschbachii   | BR, CdoE |                           |      |      |                     | 415     |
| (Cabrera) G. Sancho (E)           |          |                           |      |      |                     |         |
| 141. Moquiniastrum paniculatum    | BR       |                           |      |      |                     | 19, 540 |
| (Less.) G. Sancho                 |          |                           |      |      |                     |         |
| Paralychnophora                   |          |                           |      |      |                     |         |
| 142. Paralychnophora glaziouana    | BR, CdoE | Yes                       |      |      |                     | 104, 284 |
| Loeuille                          |          |                           |      |      |                     |         |
| Piptolepis                        |          |                           |      |      |                     |         |
| 143. Piptolepis buxoides (Less.) Sch. Bip. (E) | BR, CdoE | Yes                       |      |      |                     | 379     |
| 144. Piptolepis canepistis Semir & B. Loeuille | BR, CdoE, DD | Yes                      |      |      |                     | 591, 344 |
| 145. Piptolepis ericoides (Less.) Sch. Bip. | BR, CdoE | Yes                       |      |      |                     | 189     |
| 146. Piptolepis leptospermoideas (Mart. ex DC.) Sch. Bip. (E) | BR, CdoE, DD | Yes                      |      |      |                     | 117, 75 |
| Paraphyllym                       |          |                           |      |      |                     |         |
| 147. Paraphyllym angustissimum     | W        |                           |      |      |                     | 128, 471, 72 |
| Gardner                           |          |                           |      |      |                     |         |
| Praxelis                           |          |                           |      |      |                     |         |
| 148. Praxelis decumbens (Gardner) A. Teles & R. Esteves | BR |                          |      |      |                     | 419, 326 |
| Proteopsis                        |          |                           |      |      |                     |         |
| 149. Proteopus argentea Mart. & Zucc. ex Sch. Bip. (E) | BR |                          |      |      |                     | 190     |

(continued)
| Genus/species                      | Endemism | Campo rupestre specialist | PNSV | PERP | Other DD localities | Voucher |
|-----------------------------------|----------|---------------------------|------|------|----------------------|---------|
| **Pseudobrickellia**              |          |                           |      |      |                      |         |
| 150. *Pseudobrickellia angustissima* (Spreng. ex Baker) R.M. King & H. Rob. | BR       | x                         | x    | x    | 274, 258, 156        |         |
| 151. *Pseudobrickellia brasiliensis* (Spreng.) R.M. King & H. Rob.       | BR       | x                         | x    | x    | 108, 456, 29         |         |
| **Pteroaulon**                   |          |                           |      |      |                      |         |
| 152. *Pteroaulon rugosum* (Vahl) Malme                                 | W        | x                         | x    | x    | 585, 33              |         |
| **Richterago**                   |          |                           |      |      |                      |         |
| 153. *Richterago angustifolia* (Gardner) Roque (E)                      | BR, CdoE | Yes                       | x    |      | 111                  |         |
| 154. *Richterago arenaria* (Baker) Roque (E)                            | BR, CdoE | Yes                       | x    | x    | 282, 510, 47         |         |
| 155. *Richterago discoidea* (Less.) Kuntze                              | BR       | x                         | x    | x    | 263, 347             |         |
| 156. *Richterago elegans* Roque (E)                                     | BR, CdoE, DD | Yes                   | x    | x    | 281, 519, 325        |         |
| 157. *Richterago polyphylla* (Baker) Ferreyra (E)                       | BR, CdoE, DD | Yes                   | x    | x    | 571, 141             |         |
| **Riencourtia**                 |          |                           |      |      |                      |         |
| 158. *Riencourtia oblongifolia* Gardner                               | W        | x                         |      |      | 496                  |         |
| **Senecio**                     |          |                           |      |      |                      |         |
| 159. *Senecio brasiliensis* (Spreng.) Less.                            | W        | x                         | x    | x    | 514, 12              |         |
| 160. *Senecio macrostis* Baker                                          | BR       | Yes                       | x    |      | 436                  |         |
| **Stenocephalum**               |          |                           |      |      |                      |         |
| 161. *Stenocephalum megapotamicum* (Spreng.) Sch. Bip.                  | BR       | x                         | x    | x    | 211, 260, 321        |         |
| **Stenophalium**                |          |                           |      |      |                      |         |
| 162. *Stenophalium gardneri* (Baker) D.J.N.Hind                        | BR, CdoE | Yes                       | x    |      | 74                   |         |
| **Stomatanthes**                |          |                           |      |      |                      |         |
| 163. *Stomatanthes polyceramus* (Sch. Bip. ex B.L. Rob.) H. Rob.        | BR       | x                         | x    | x    | 32                   |         |
| **Symphyophyllum**              |          |                           |      |      |                      |         |
| 164. *Symphyophyllum brasiliensis* (Gardner) R.M. King & H. Rob         | BR       | x                         | x    | x    | 187, 66              |         |
| 165. *Symphyophyllum cuneatus* (DC.) Sch.Bip. ex Baker                  | BR       | x                         | x    | x    | 116, 180             |         |
| 166. *Symphyophyllum decussatus* Turcz.                                 | BR       | x                         | x    | x    | 107, 465, 53         |         |
| 167. *Symphyophyllum reitzii* (Cabrera) R.M.King & H.Rob.               | BR       | x                         | x    |      | 119, 611             |         |
| **Trichogonia**                 |          |                           |      |      |                      |         |
| 168. *Trichogonia hirtiflora* (DC.) Sch. Bip. ex Baker                  | BR       | x                         | x    | x    | 88, 583, 336         |         |
| 169. *Trichogonia salviifolia* Gardner                                 | BR       | x                         | x    |      | 138                  |         |
| 170. *Trichogonia villosa* Sch. Bip. ex Baker                          | BR       | x                         | x    | x    | 276, 433, 5          |         |
| **Trixis**                     |          |                           |      |      |                      |         |
| 171. *Trixis glutinosus* D. Don                                        | BR       | x                         |      |      | 478                  |         |
| 172. *Trixis nobilis* (Vell.) Katinas                                  | BR       | x                         |      |      | 130, 191             |         |
| 173. *Trixis vouthieri* DC.                                             | BR       | x                         | x    | x    | 21, 449, 14          |         |
| **Verbesina**                  |          |                           |      |      |                      |         |
| 174. *Verbesina macrophylla* (Cass.) S.F. Blake                        | W        | x                         |      |      | 389                  |         |
| **Vernonanthura**              |          |                           |      |      |                      |         |
| 175. *Vernonanthura laxa* (Gardner) H. Rob.                            | BR       | x                         | x    |      | 303, 493             |         |

(continued)
doubtful identifications are not included in this tally. The RAPELD survey recorded 115 species in a sample of 12,775 individuals of Asteraceae. Forty-seven species (27%) are endemic to campo rupestre vegetation, and 38 species (22%) are found only in the southern “Minas Gerais” region of the CdoE mountain range (Figure 1; Table 1). Furthermore, 13 of these species (7.5%) are endemic to the Plateau. The true number of endemic species of the Plateau may be even higher as collections of three possible new species were made. *Lychnophora* sp. 1 (Table 1) is an unpublished species recognized by Semir (1991).

PERP had two RAPELD modules located at different altitudes, one through campos rupestres and one through campos rupestres grading into savanna (cerrado); PNSV had only one module mainly through campos rupestres. This resulted in 226 RAPELD collections in PERP versus 83 RAPELD collections in PNSV. In PERP, with two sample modules, there was more diversity (127 vs. 76 species in PNSV) and 57 species collected were exclusive to PERP and were not found in PNSV or the park’s surrounding areas. On the other hand, in PNSV, only 16 exclusive species were found. Interestingly, 21 species were collected in the surroundings of both parks but recorded in neither of them (Table 1).

### Endangered Species and Conservation Status

A total of 38 endangered species of Asteraceae, representing 16% of the Asteraceae on Brazil’s official list (Ministério do Meio Ambiente, 2014), are known to occur in the Plateau (Table 2). We recollected 30 of these (Figure 3; Tables 1 and 2), of which 26 species were recorded in one or both parks and 4 species were only recorded by traditional floristic collecting out of the park areas. The status of the recollected species was one critically endangered, 19 endangered, and 10 vulnerable (Martineilli & Moraes, 2013; Ministério do Meio Ambiente, 2014; Table 2). The number of endangered species recorded in PERP (18 spp.) and in PNSV (13 spp.) was similar but only five species were common to both parks (Table 1). Eight endangered species with known distribution within the Plateau were not recollected. Only one of the six critically endangered species from the Plateau was found (*Piptolepis leptospermoide* recollected from PNSV by traditional floristic collecting).

### Discussion

#### Endangered Species and Conservation Status

For 20 Diamantina Plateau endangered species (53% of the known total of 38 species), our study has brought qualitative gain: they are now known to occur in one or
| Species | IUCN\(^a\) status | IUCN\(^a\) criteria | Collecting method | Previous situation | Present situation |
|---------|---------------------|----------------------|-------------------|--------------------|-------------------|
| 1. Acritopappus irwinii R.M.King & H.Rob. | VU | B1ab(iii) | TRAD | NCUC (2) | (3)\(^b\) |
| 2. Aspilia diamantinae J.U. Santos | EN | B1ab(iii) | TRAD, RAPELD | NCUC (2) | (4)\(^b\) |
| 3. Aspilia egleri J.U. Santos | CR | B2ab(i,ii,iii,iv) | NC | ODUC\(^c\) (Montes Claros) | ODUC\(^c\) (Montes Claros) |
| 4. Aspilia jagata H. Rob. | CR | B2ab(i,ii,iii,iv) | NC | NCUC | NCUC |
| 5. Aspilia ovalifolia (DC.) Baker\(^d\) | CR | B2ab(i,ii,iii,iv) | NC | NCUC | NCUC |
| 6. Baccharis elliptica Gardner | EN | B1ab(i,ii,iii,iv) | TRAD | (2) | (2) |
| 7. Baccharis lychnophora Gardner | VU | B2 | TRAD, RAPELD | (1, 4) | (1, 4) |
| 8. Baccharis pseudoalpestris Malag. | VU | B1ab(i,iii) | RAPELD | NCUC | (4)\(^b\) |
| 9. Chronopappus bifrons (DC. ex Pers.) DC. | VU | B1ab(i,ii,iv); B2 | RAPELD | (1, 2, 4) | (1, 2, 4) |
| 10. Disynthia praeficta (B.L.Rob.) R.M.King & H.Rob. | EN | B2ab(i,ii,iii) | TRAD, RAPELD | (2) | (2, 3, 4) |
| 11. Eremanthus polycephalus (DC.) MacLeish Heterocoma erecta (H. Rob.) B. Loeuille, J.N. Nakaj., & Semir | VU | B2 | TRAD, RAPELD | (1, 2, 4) | (1, 2, 4) |
| 12. Lepidaploa spixiana (Mart. ex DC.) H. Rob. | EN | B1ab(i,ii,iii) | TRAD, RAPELD | (2) | (2) |
| 13. Lessingianthus adenophyllus (Mart. ex DC.) H. Rob. | EN | B2ab(iii) | TRAD, RAPELD | (2) | (2) |
| 14. Lessingianthus stoechas (Mart. ex Baker) H. Rob. | EN | B2ab(iii) | TRAD, RAPELD | ODUC \(^{1}\) (Veadeiros) | (3) |
| 15. Lychnophora albertinoides Gardner | CR | B2ab(ii) | NC | (2) | (2) |
| 16. Lychnophora diamantinana Coile & Jones | EN | B1ab(ii) + 2ab(ii) | TRAD | (2) | (2) |
| 17. Lychnophora gardnei Sch. Bip. | EN | B1ab(ii) + 2ab(ii) | TRAD | (2) | (2) |
| 18. Lychnophora martiana Gardner | EN | B1ab(iii) + 2ab(ii) | TRAD | NCUC | (4)\(^b\) |
| 19. Lychnophora souzae H.Rob. Lychnophora triflora (Mattf.) H.Rob. | CR | B2ab(ii) | NC | (2) | (2) |
| 20. Lychnophora villosissima Mart. | EN | B2ab(iii) | TRAD, RAPELD | (2) | (2, 3) |
| 21. Lychnophoriopsis candelabrum (Sch. Bip.) H. Rob. | EN | B1ab(ii) + 2ab(ii) | TRAD | ODUC (Cabral) | ODUC (Itacolomi) |
| 22. Lychnophoriopsis hatschbachii H. Rob. | EN | B2ab(ii) | NC | NCUC | NCUC |
| 23. Lychnophoriopsis heterotheca Sch. Bip. | EN | B2ab(ii) | NC | NCUC | NCUC |
| 24. Mikania glabra D.J.N. Hind | EN | B2ab(ii) | NC | NCUC | NCUC |
| 25. Mikania glauca Mart. | EN | B2ab(ii) | TRAD, RAPELD | ODUC (Itacolomi) | (4) |
| 26. Mikania neurocaula DC. | EN | B2ab(ii) | TRAD, RAPELD | (2) | (2, 3) |
| 27. Minasia alpestris (Gardner) H. Rob. | EN | B1ab(iii) + 2ab(ii) | TRAD | (2, 4) | (2, 3, 4) |
| 28. Minasia perereae H. Rob. | EN | B1ab(iii) + 2ab(ii) | TRAD | (2) | (2, 3) |
| 29. Minasia scapigera H.Rob. | EN | B1ab(ii) + 2ab(ii) | TRAD | (2, 4) | (2, 4) |
| 30. Moquiniastrum hatschbachii (Cabrera) G. Sancho | VU | B1ab(i,ii,iii) | TRAD | (2) | (2, 4) |

(continued)
Table 2. Continued.

| Species | IUCN\textsuperscript{a} status | IUCN\textsuperscript{a} criteria | Collecting method | Previous situation | Present situation |
|---------|-------------------------------|-------------------------------|-------------------|-------------------|------------------|
| 31. Piptolepis buxoides (Less.) Sch. Bip. | EN | B1ab(i,ii,iii,v) + 2ab(i,ii,iii,v) | TRAD | NCUC | (4)\textsuperscript{o} |
| 32. Piptolepis leptospermoides (Mart. ex DC.) Sch. Bip. | CR | B2ab(i,ii,iii) | TRAD | (3) | (3) |
| 33. Proteopsis argentea Mart. & Zucc. ex Sch. Bip. | VU | B2ab(i,iii) | RAPELD | (2) | (2, 3) |
| 34. Richterago angustifolia (Gardner) Roque | EN | B1ab(i,ii,iii) + 2ab(i,ii,iii) | TRAD | (2) | (2, 3) |
| 35. Richterago arenaria (Baker) Roque | VU | B1ab(i,ii,iii) + 2ab(i,ii,iii) | TRAD, RAPELD | (2) | (2, 3, 4) |
| 36. Richterago elegans Roque | VU | B1ab(i,ii,iii) + 2ab(i,ii,iii) | TRAD, RAPELD | (2) | (2, 3, 4) |
| 37. Richterago polyphylla (Baker) Ferreyra | EN | B1ab(i,ii,iii,v) + 2ab(i,ii,iii,v) | TRAD, RAPELD | (2) | (2, 4) |
| Verbesina macrophylla (Cass.) S.F.Blake | EN | B1ab(i,ii,iii,v) + 2ab(i,ii,iii,v) | TRAD | DE\textsuperscript{e} | (2, 4) |

Note. New records from one or both parks (this study) are indicated in bold. CR = critically endangered; DE = distribution expansion; EN = endangered; NC = not collected in our study; NCUC = not collected in any conservation unit; IUCN = International Union for Conservation of Nature; ODUC = collected in a conservation unit outside of the DD plateau, identified by name; RAPELD = collected with frequency and environmental data; TRAD = traditional collecting; VU = vulnerable. Voucher numbers refer to Chaves et al.'s collection numbers. (1) Recorded in Itambe State Park in the DD plateau. (2) Recorded in Biribiri State Park in the DD plateau. (3) Recorded in Sempre Vivas National Park in the DD plateau. (4) Recorded in Rio Preto State Park in the DD plateau.

\textsuperscript{a}Fide Martinelli and Moraes (2013).
\textsuperscript{b}First collection in a Conservation Unit.
\textsuperscript{c}More commonly collected in the Northern “Bahia” CdoE.
\textsuperscript{d}Sensu Santos (2001).
\textsuperscript{e}First record of distribution expansion southwards from the Northern “Bahia” CdoE crossing the major barrier and into the “Minas Gerais” CdoE.
\textsuperscript{f}Also collected in highland areas of Goiás.
both parks, and in many cases, frequency data have been obtained from RAPELD modules (see Chaves et al., 2019). Five such endangered species have been recorded from protected areas for the first time (species marked with $b$ in Table 2). For the other 18 species (47%), there has been no qualitative change in conservation unit occurrence. However, only for five species does this ‘no change’ represent continued failure to record the species in a conservation unit. Most qualitative ‘no change’ means the species had already been recorded from the parks by previous collectors.

Our negative results from the three RAPELD modules, which sampled 12,775 individuals of Asteraceae and found only 27% of endangered species known to occur in the Plateau, are possibly as significant as the positive results (recollections of endangered species known to occur there). If endangered species were uniformly distributed in different habitats, a high

Figure 3. Asteraceae from the Diamantina Plateau. (a) Wunderlichia senaeii Glaz. ex Maguire & G.M. Barroso ‘E'; (b) Heterocoma erecta (H. Rob.) B. Loeuille, J.N. Nakaj. & Semir ‘E'; (c) Lychnophora cf. humillima Sch. Bip.; (d) Aspilia andersonii H. Rob.; (e) Aspilia diamantinae J.U. Santos ‘E'; (f) Verbesina macrophilla (Cass.) S.F. Blake; (g) Lychnophora triflora (Mattf.) H. Rob.; (h) Minasia scapigera H. Rob. ‘E'; (i) Lychnophora martiana Gardner ‘E'; (j) Piptolepis leptospermoide (Mart. ex DC.) Sch. Bip. ‘E'; (k) Minasia alpestris (Gardner) H. Rob. ‘E'; (l) Lychnophora uniflora Sch. Bip. ‘E'. ‘E' = endangered species, for category see Table 2.
percentage of endangered species recovery might have been expected from the RAPELD modules. Closer investigation of the endangered species that were not collected showed that two of them are common either in the northern “Bahia” CdoE or in the more westerly Serra Geral de Goiás. For species where wide-scale distributional data could not explain absence, microdistributional differences or microhabitat specialization, as proposed by Chaves et al. (2019), stochastic distribution, or a combination of these are the most likely explanations. Percentages of gravel, sand, and silt in the soil explained 67% of the difference between mycorrhizal communities (Carvalho et al., 2012). Substrate (quartzitic, arenitic, or ironstone) was the most important campo rupestre driver of floristic diversity (Zappi, Moro, Meagher, & Nic Lughadha, 2017). These findings suggest that these endangered species were absent because they are restricted to unsampled, microhabitat communities. Dimmerostema oblonga, collected by us and only three times in 175 years in widely separate campo rupestre areas, could be such a specialist—or simply a very rare species. Another possibility is extreme geographic narrow endemism, such as has been recorded for the charismatic, unmistakable Vellozia gigantea Mello-Silva whose nine known populations are within 27 km of each other (Lousada, Borba, Ribeiro, Ribeiro, & Lovato, 2011).

Conservation strategies and the choice of priority areas are usually based on the presence of red-listed endangered species, but abundance, persistence, geographic distribution, and level of threats should also be quantified (Kakkala & Moinen, 2013; Nakajima, Junqueira, Freitas, & Teles, 2012). Campo rupestre lineages show high phylogenetic conservatism and low dispersal and colonization capabilities and are thus highly deserving of conservation priority (Conceição et al., 2016). Knowledge of species abundance allows for safer decision-making during management of protected areas (Brandon, Fonseca, Rylands, & Silva, 2005). CdoE alpha-taxonomic knowledge remains incomplete and more collecting is needed (Madeira, Ribeiro, Oliveira, Nascimento, & Paiva, 2008; U. Oliveira et al., 2016).

Although many endangered species found in this study may appear protected, the protected areas often lack effective management and physical infrastructure. National and state parks are threatened by mining, criminal fires, invasive species, and habitat destruction as population and tourism grows (Eckernach et al., 2011; Silveira et al., 2016). It has been estimated under various climate change scenarios that between 40% and 82% of the CdoE’s area of campo rupestre will be lost or fragmented and practically disappear in the northern region by 2070 (Bitencourt, Rapini, Damascena, & De Marco, 2016; Fernandes, Barbosa, Negreiros, & Paglia, 2014; Fernandes, et al., 2018). Such area reduction could mean mass extinction of endemic species, even in current protected areas, that could shrink by up to 40% in area by 2050 (Bitencourt et al., 2016; Fernandes et al., 2018). Species distribution models that predict current as well as future species-range distribution patterns under climate change are essential so conservation planning can adapt to novel scenarios.

**Conservation Implications**

The answer to our first question is that the two protected areas are not sufficient to protect the endangered Plateau Asteraceae flora, since 29% of endangered species of Asteraceae have not yet been recorded in either park. For the CR species, 66% have not yet been recorded in either park. The answer to our second question is that the two parks are complimentary in preserving the endangered flora of the Plateau. Only five endangered species (13% of the 38 known endangered Asteraceae flora) were common to both parks; PERP is known to protect 47% of the endangered Asteraceae flora and PNSV to protect 34% of that flora; combined, the parks protect 68% of the endangered Asteraceae flora. Complementarity methods have been criticized for being data-hungry (Redford et al., 1997), but the large dataset generated by RAPELD undermines this criticism. Asteraceae endangered species at least are neither common nor uniformly distributed in the Plateau, a pattern that might be applicable to other families and OCBILs. Results support Monteiro et al.’s (2018) guidelines for campo rupestre conservation, which includes a recommendation that detailed in situ and ex situ studies of endangered species be done.

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Supplemental Material

Supplemental material for this article is available online.

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