THE FERNS AND LYCOPHYTES OF A MONTANE TROPICAL FOREST IN SOUTHERN BAHIA, BRAZIL

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ABSTRACT

The Serra Bonita Mountain Range is located in southern Bahia State, northeastern Brazil, and occupies an area of approximately 7,500 ha. The Serra Bonita Reserve encompasses the last remnants of old-growth forest from that region, protecting about 2,000 ha of land (at 300 to 1,080 m a.s.l.) in the center of this mountain range. A floristic survey of the ferns and lycophytes of this Reserve was carried out from 2005 to 2009 in areas above 600 m, resulting in the collection of 182 species, distributed among 67 genera and 23 families. Ferns comprised 173 species in 64 genera and 21 families, while the lycophytes comprised nine species in three genera and two families. Approximately 25 percent of these species were recorded for the first time in Bahia State or northeastern Brazil (44 new records). Special mention is given to *Asplenium truncorum* (Aspleniaceae), *Megalastrum indusiatum* (Dryopteridaceae), and *Thelypteris beckeriana* (Thelypteridaceae), which were described for the first time from recent collections in the study area. The Serra Bonita Reserve also harbors the only known population of *Terpsichore asplenifolia* (Polypodiaceae) in Brazil.

RESUMO

A cadeia de montanhas da Serra Bonita localiza-se no sul da Bahia, nordeste do Brasil, e ocupa uma área de aproximadamente 7.500 ha. Com o intuito de proteger os últimos remanescentes de floresta bem preservada da região, a Reserva Serra Bonita abrange cerca de 2.000 ha (entre 300 e 1080 m s.n.m.) na porção central desta serra. Durante os anos de 2005 a 2009 foi realizado o levantamento das samambaias e licófitas desta Reserva. Para tanto, foram feitas coletas periódicas de material botânico, exclusivamente acima dos 600 m de altitude, resultando em 182 espécies, distribuídas em 67 gêneros e 23 famílias. Dentre estas, as samambaias compreenderam 173 espécies, distribuídas em 64 gêneros e 21 famílias, enquanto as licófitas incluíram nove espécies em três gêneros e duas famílias. Aproximadamente 25 por cento destas espécies são citadas pela primeira vez para o Estado da Bahia ou para o Nordeste do Brasil (44 novos registros). Menção especial para *Asplenium truncorum* (Aspleniaceae), *Megalastrum indusiatum* (Dryopteridaceae) e *Thelypteris beckeriana* (Thelypteridaceae), descritas com base em materiais recentemente coletados na área estudada. A Reserva também abriga a única população conhecida de *Terpsichore asplenifolia* (Polypodiaceae) no Brasil.

INTRODUCTION

Bahia is one of the richest states in Brazil in terms of numbers of plant species and contains representative areas of almost all of the phytogeographic domains in the country (Brazão & Araújo 1981). According to Harley and Mayo (1980), two factors that contribute greatly to this species richness are the topography and the extension of the state, which covers an area of approximately 560,000 km^2 (larger than France, with ca. 544,000 km^2). This ample territory likewise contains considerable climatic diversity, principally as one moves from the coast to the continental interior. Humid Atlantic Forests are found in the eastern part of the state, while semi-arid regions (including the "caatinga" [dryland], "cerrado" [savanna], riparian forests, seasonal forests, and "campos rupestres" [open, rocky mountain vegetation]) occupy more than 50% of the state (Giulietti et al. 2006).

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Although this floristic richness has attracted the attention of many visiting botanists starting in the 19th century (for a more detailed account, see Urban, 1906), few collections have been made in the humid forests of southern Bahia.

Remnants of the Atlantic Coastal Forest in southern Bahia are known to be among the most important sites for conservation of biodiversity in the world. Indeed, these forests seem to hold higher levels of species richness and plant endemism than any other part of the Brazilian Atlantic Rain Forest (Mori et al. 1981; Thomas et al. 1998, 2008; Martini et al. 2007). Southern Bahia is also considered one of the most remarkable Pleistocene forest refuge areas, and a center of diversity for several major groups of organisms (Mori et al. 1983; Whitmore & Prance 1987; Gentry 1992).

Most botanists studying this region have directed their efforts towards angiosperms, with only rare studies of ferns and lycophytes, although the plant lists prepared by Mori et al. (1983) and Amorim et al. (2005, 2008) are notable exceptions. Additional recent taxonomic information has also become available concerning specific groups of ferns in Fernandes (2003), Labiak and Prado (2003, 2005a, 2005b, 2005c, 2007), Matos et al. (2009, 2010), Prado (2000), and Sundue and Prado (2005). In addition to species lists of the ferns and lycophytes of southern Bahia State, Paciencia and Prado (2004, 2005a, 2005b) have described some of the ecological aspects of the area.

Considering these survey limitations and the fact that essentially all of the floristic studies undertaken in southern Bahia have focused on the diversity of lowland vegetation, it is clear that the regional flora continues to be insufficiently studied. In an effort to further our floristic knowledge of the Brazilian Atlantic Forest, the present study examined the fern and lycophyte species in a fragment of montane humid forest in southern Bahia.

STUDY SITE

The Serra Bonita Mountain Range occupies an area of approximately 7,500 ha in the municipalities of Camacan and Pau-Brasil, 130 km from the city of Ilhéus and 526 km from the state capital, Salvador (Fig. 1).

The Serra Bonita Private Reserve is located in the central region of this range (15°23'S × 39°33'W) and was founded to help protect regional biodiversity. The reserve occupies an area of approximately 2,000 hectares at elevations that vary from 300 to 1,080 m (Amorim et al. 2009).

Roeder (1975) described the climate of the region as warm and humid, with an average annual rainfall of 1,500–1,800 mm that is well distributed throughout the year. Average annual temperatures vary between 23 and 24°C, the total annual evapotranspiration potential is 1,200–1,300 mm, and the relative humidity reaches 80%. There is no specific information currently available for precipitation and temperature within the study area itself, although there are obvious climatic variations between the highland and lowland areas, where Roeder's earlier collections (1975) were made.

Both the degree of preservation and the physical structure of the vegetation within the reserve vary greatly, with some regions having intact forests while others have forests in different stages of regeneration (areas that were harvested for timber or cleared for agriculture). Additionally, a road leading to a mountaintop transmission tower cuts through part of the Reserve, resulting in the eradication of the original vegetation in that area (Amorim et al. 2009).

Recent research has shown that the few remaining moist forest fragments in the region shelter large numbers of rare species, including two endangered primates: *Cebus xanthosternos* (yellow-breasted capuchin) and *Leontopithecus chrysomelas* (golden-headed lion tamarin) (Vitor O. Becker, pers. comm.). Preliminary floristic studies have identified ca. 700 species of angiosperms (Amorim et al. 2009), with several species new to science, including a very notable bromeliad (Amorim & Leme 2009).

However, despite its remarkable regional biodiversity, the harvesting of native trees for timber continues to be a major contributor to forest destruction in this area.

FIG. 1. Serra Bonita Reserve and its location in southern Bahia, Brazil (South America).

METHODS

A floristic survey was carried out in Serra Bonita at elevations from 600 to 1,080 m, from January 2005 to July 2009, during ten collecting expeditions undertaken at intervals of approximately six months.

More than 400 specimens of ferns and lycophytes were collected by the authors during the present study, in addition to occasional collections made by other botanists. Among the herbarium material available for this area are some ferns and lycophytes that were collected by Talmon Soares dos Santos (in 1969, 1971, and 1979), Scott Alan Mori (in 1979), André Maurício Vieira de Carvalho (in 1983), and Wm. Wayt Thomas (in 1994 and 2002). Complete sets of all of these collections are deposited in the CEPEC herbarium, and duplicates have been sent to NY and UPCB.

While duplicates of some collections were sent to specialists of other institutions for identification, the great majority of the plants were identified by the first author using well-documented collections at CEPEC, NY and UPCB (among others) and specific bibliographies.

The ferns and lycophytes are arranged alphabetically in the checklist by family, genus, and then species. The fern families were circumscribed according to the system proposed by Smith et al. (2006). Authors of species names are abbreviated according to Pichi Sermolli (1996). Occasionally, a specimen could be reliably identified only to genus but was clearly distinct from any of the identified material; these specimens were included in the list as "sp." In the present work, the concept of Atlantic Forest was treated in a broader sense (Oliveira-Filho & Fontes 2000), with the result that the areas of distribution of some species extended into the continental interior, sometimes reaching neighboring countries (Argentina and Paraguay).

RESULTS

A total of 182 species in 67 genera and 23 families of ferns and lycophytes from the Serra Bonita Reserve are presented here (Appendix 1). The ferns comprised 173 species in 64 genera and 21 families, while the lycophytes included nine species in three genera and two families. Only three species remained unidentified (*Ctenitis* sp., *Elaphoglossum* sp., and *Thelypteris* sp.), but they are distinctly different from all of the other species in their respective genera.

The most diverse fern families were Polypodiaceae (35), Dryopteridaceae (28), Pteridaceae (19), and Hymenophyllaceae (16). Together, these four families comprise about 57 percent of the species found in Serra Bonita. The most species-rich genera were *Asplenium* (12), followed by *Elaphoglossum* (11), *Thelypteris* (10), and *Diplazium* (9).

Several specimens collected during this study have been identified as new species or are currently being described by specialists, including: *Asplenium truncorum*, *Megalastrum indusiatum*, and *Thelypteris beckeriana* (Fig. 2C–E).

Terpsichore asplenifolia (Fig. 2F) was recorded for the first time in Brazil, and this species shows a disjunct distribution between the Venezuelan-Guyana Shield and the Serra do Mar Mountains in northeastern Brazil (Labiak & Prado 2007). Forty-three additional species were recorded for the first time for Bahia or northeastern Brazil (comprising the states of Alagoas, Bahia, Ceará, Maranhão, Paraíba, Pernambuco, Piauí, Rio Grande do Norte, and Sergipe), representing 24.2% of the total number of species found in the reserve. These new records are indicated with asterisks in the checklist (Appendix 1). In general, these new records represent species characteristic of montane areas of the Atlantic Forest of southeastern Brazil, and are not expected to occur in the other states of northeastern Brazil. *Polypodium dulce*, *Pteris schwackeana*, *Selaginella decomposita*, *S. flexuosa*, and *Serpocaulon levigatum* have been previously reported from other states in northeastern Brazil, but are new records for the Atlantic Rain Forest of southern Bahia.

In terms of habitat preferences, many representatives of the local flora are typically associated with disturbed environments (e.g., roadsides, forest edges, forest regrowth, cabrucas [cocoa plantations under native forests], and other anthropogenic sites), and include: *Adiantum latifolium*, *Asplenium auritum*, *Blechnum brasiliense* (Fig. 3), *B. occidentale*, *Dennstaedtia globulifera*, *Dicranopteris flexuosa*, *Gleichenella pectinata* (Fig. 3), *Hemionitis tomentosa*, *Hypolepis* aff. *repens*, *Lycopodiella cernua*, *Lygodium volubile*, *Osmundastrum cinnamomeum*, *Pityrogramma calomelanos*, *Pleopeltis pleopeltifolia*, *Pteridium arachnoideum*, *Sticherus bifidus*, *S. lanuginosus*, *Thelypteris opposita*, and *T. serrata*.

The great majority of the ferns and lycophytes identified in the present study (more than 70%), however, were characteristic of intact forests or areas in advanced states of regeneration.

In relation to the plant habitats, 49% of the species inventoried were exclusively terrestrial (89 spp.

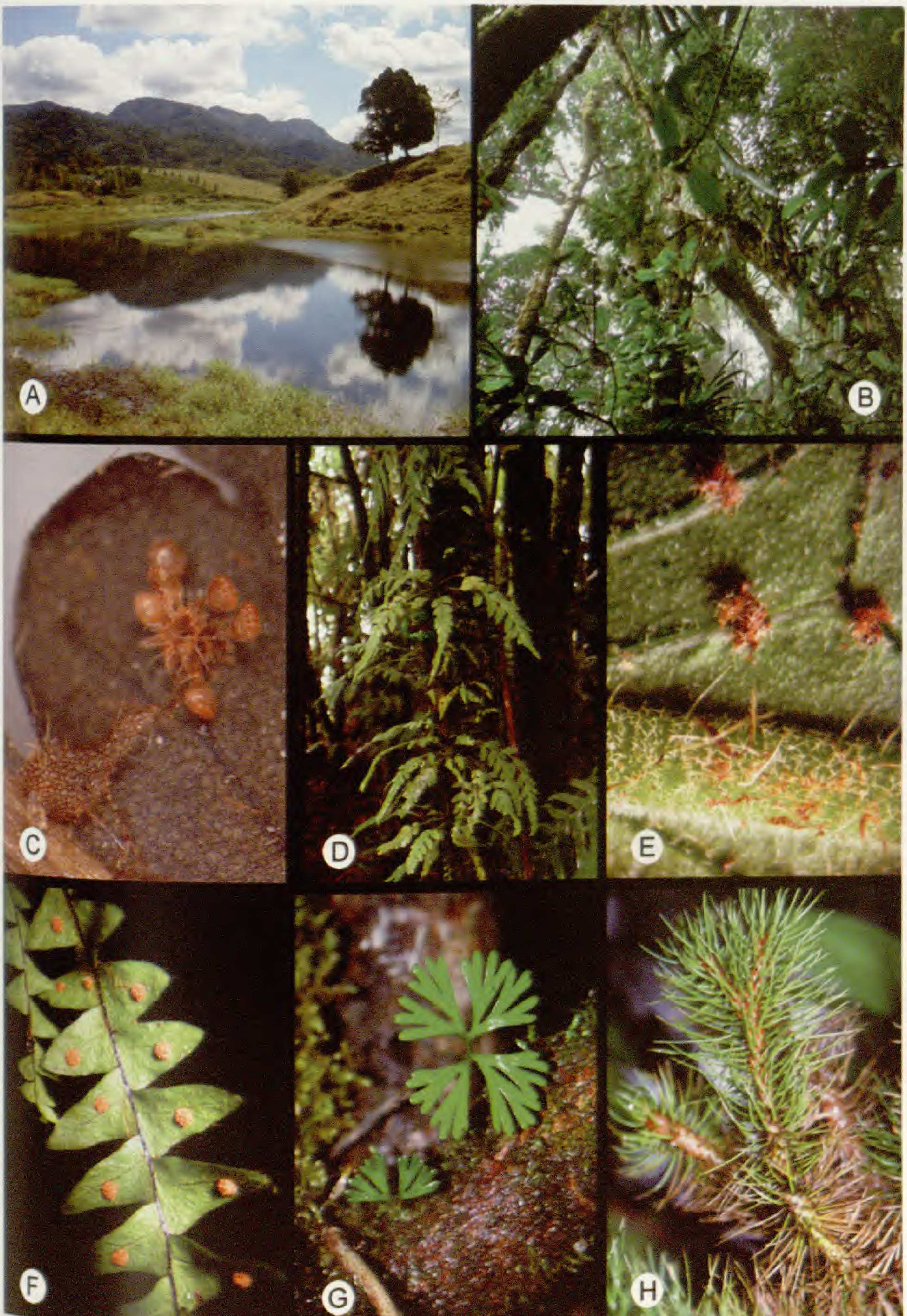

Fig. 2. Vegetation of the Serra Bonita Reserve. **A.** View of the eastern mountainside. **B.** Interior of the forest at the top of the mountain, showing many epiphytes. **C.** *Megalastrum indusiatum*. **D.** *Asplenium truncorum*. **E.** *Thelypteris beckeriana*, described in honor of Dr. Vitor O. Becker, owner of the Serra Bonita Reserve. **F.** *Terpsichore asplenifolia*. **G.** *Elaphoglossum peltatum*. **H.** *Huperzia mandiocana*, a lycophyte. All photos by F.B. Matos.

including herbaceous, arboreal and climbing plants), 32.5% were epiphytes (59 spp.), 5% were rupiculous (9 spp.), and 2% were hemi-epiphytes (4 spp.); another 21 taxa (11.5%) were encountered in more than one type of habitat.

DISCUSSION

Habitat

Ferns are the third most species-rich group of epiphytes in the New World, after orchids and bromeliads (Gentry & Dodson 1987). The last two groups are represented in the Serra Bonita Reserve by 62 and 25 species respectively (Amorim et al. 2009), thus making the ferns the second most diverse group of epiphytic plants in the area (59 spp.).

Several authors (e.g., Moran et al. 2003; Mehltreter 2008) have observed that some epiphytic fern species demonstrate notable specificity in relation to the type of substrate (i.e., phorophytes) on which they can grow. The arboreal ferns of the family Cyatheaceae stand out among the phorophyte supports available in tropical humid forests, as they generally have a dense mass of adventitious roots surrounding their trunks, which can store considerable quantities of water and nutrients due to their high porosity (Mehltreter 2008). In Serra Bonita, five epiphyte species were observed growing exclusively on this type of substrate (notably on *Alsophila setosa*), including *Asplenium truncorum*, *Pecluma truncorum*, *Polyphlebium angustatum*, *Terpsichore asplenifolia*, and *Trichomanes polypodioides*. However, most epiphytic species inventoried did not appear to depend exclusively on these ferns and were collected on a wide variety of angiosperms.

Among the terrestrial species, it is clearly noticeable the preference of many narrowly distributed species to the forest understory, occurring exclusively in well-preserved forest remnants. The high diversity of epiphytic ferns, and the large number of terrestrial species in the forest understory, show the importance of well-preserved environments not only for the richness of species in numerical terms, but also for the maintenance of the narrowly distributed species populations.

Geographical distribution and endemism

According to Tryon (1972), Brazil is one of the principal centers of fern and lycophyte diversity and endemism in the Neotropical region, with about 40% endemism.

The number of species endemic to the Atlantic Rain Forest that were encountered in the Serra Bonita Reserve is quite high (59 species, or 32.5% of the total), especially when compared with other studies undertaken in the Atlantic Rain Forest domain (e.g., Labiak & Prado 1998; Salino et al. 2005; Schwartsburd & Labiak 2007; Amorim et al. 2008).

Similar to the situation of many angiosperms (Amorim et al. 2009), the mountains of southern Bahia appear to constitute the northern limit of occurrence for many endemic ferns and lycophytes in the Atlantic Forest. Some of these species can be considered characteristic of the montane regions of southeastern and southern Brazil (e.g., *Adiantum mynssenae*, *Asplenium scandicinum*, *Cyathea rufa*, *Huperzia flexibilis*, *H. martii*, *Micropolypodium achilleifolium*, *Pleopeltis pleopeltidis*, *Pteris angustata*, *Terpsichore reclinata*, *Thelypteris raddii*, and *Vittaria scabrida*, among others).

Paradoxically, the southern region of Bahia represents the southern limit of distribution of some species endemic to the Atlantic Forest, as they also occur in the "Brejos de altitude" (high elevation dryland forests) of northeastern Brazil. Two examples of this unusual situation among the taxa recorded for the Serra Bonita Reserve are *Cyathea praecincta* and *Megalastrum eugenii*.

Although ferns and lycophytes are usually capable of dispersing over large areas, mountain chains have been found to represent frequent barriers to their migration (Tryon 1986; Moran 1995, 2008). In addition to favoring high levels of endemism, mountains can also influence the taxonomic richness of a given region. Entire families can sometimes be considered typical (but not exclusive to) high elevation regions and have a fundamental role in the floristic characterization of those areas (Moran 1995; Paciencia 2008). According to these authors, the main examples of these families are Cyatheaceae, Dryopteridaceae, Hymenophyllaceae, Lycopodiaceae, and Polypodiaceae. In the same sense, many tropical genera such as *Diplazium* and *Elapho-*

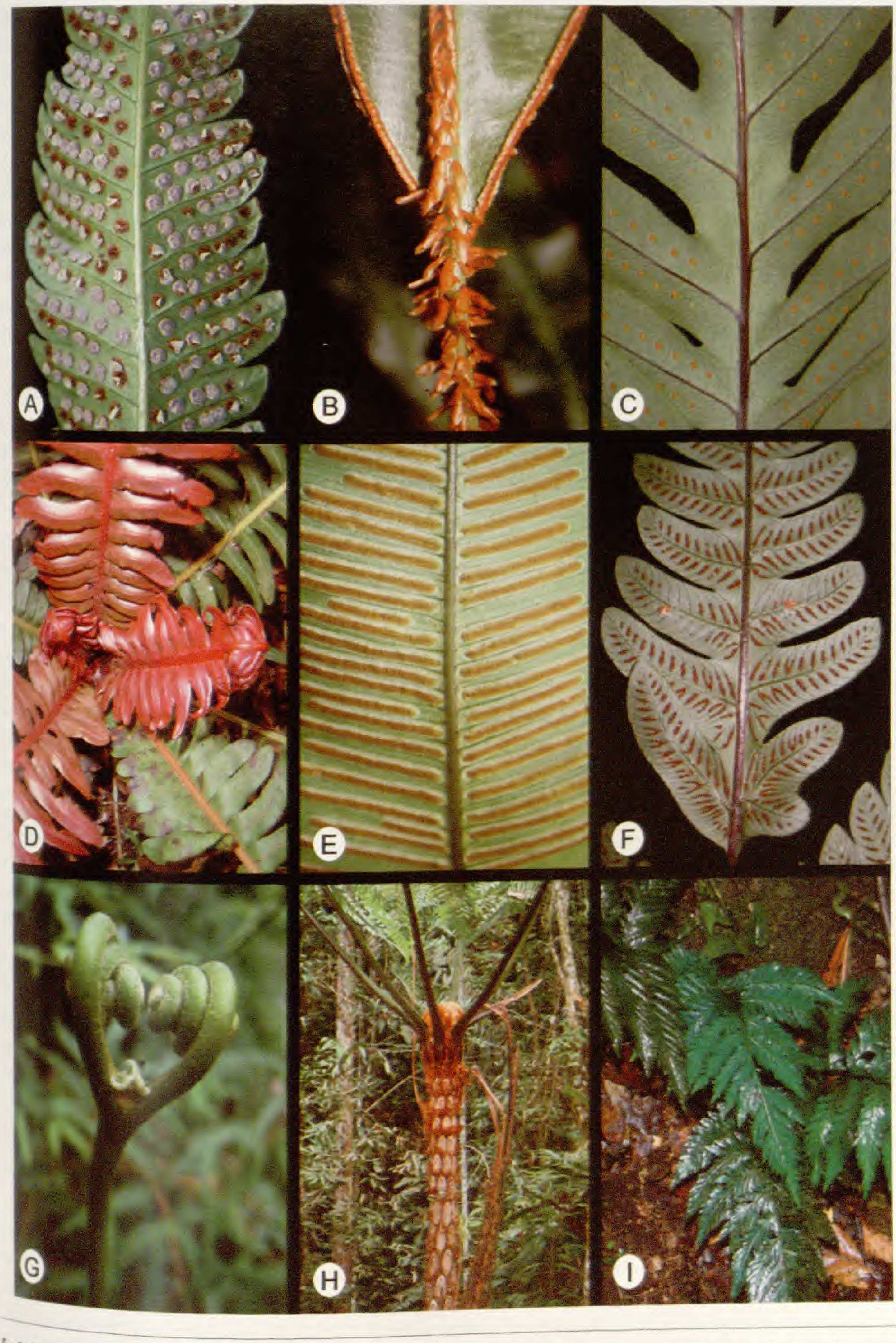

Fig. 3. Some characteristic ferns of the Serra Bonita Reserve. **A.** *Cyclodium heterodon*. **B.** *Elaphoglossum decoratum*. **C.** *Phlebodium pseudoaureum*. **D.** *Blechnum brasiliense*. **E.** *Diplazium lechleri*. **F.** *Thelypteris polypodioides*. **G.** *Gleichenella pectinata*. **H.** *Cyathea delgadii*. **I.** *Trichomanes elegans*. All photos by F.B. Matos.

glossum are predominantly found at high elevations, and it is therefore not a coincidence that they show the greatest species richness in the Serra Bonita Reserve.

It is also important to note the existence of species with disjunct distributions between the Atlantic and Amazon (and/or Andean) forests. According to Tryon (1986), a given fern species can be considered disjunct when the distance between its populations reach about 1,000 km or more, even though there are adequate environments for their occurrence in the intervening regions. *Doryopteris sagittifolia* (Pteridaceae), for example, occurs in the mountains of eastern Brazil but has also been reported in isolated populations in various countries in northern South America (Guyana, French Guyana, Suriname and Venezuela). *Terpsichore asplenifolia* (a species widely distributed from southern Mexico to Bolivia and the Antilles) occurs disjunctly in Brazil, and the Serra Bonita Reserve is the site of the only known population in the country (Labiak & Prado 2007). Also noteworthy are *Elaphoglossum gardnerianum*, *Hymenophyllum caudiculatum* and *Pleopeltis monoides*, Brazilian endemics showing disjunct distributions between the Atlantic and Amazon forests; 58 additional species encountered in our study occur in both southern Bahia and in Amazon forests.

Some Brazilian species have wide geographical distributions throughout many parts of the world (e.g., *Adiantum latifolium*, *Asplenium auritum*, *Hymenophyllum polyanthos*, *Lycopodiella cernua*, and *Pityrogramma calomelanos*), so it is not surprising to encounter them in most Brazilian phytogeographical domains. The number of species shared by both the Atlantic and Amazon forests (a total of 61 species) is still quite notable, however, especially in view of the fact that these two extensive forest formations are separated by a "diagonal of drought"—a corridor of highly seasonal and dry formations (e.g., the "Caatinga" of northeastern Brazil, the "Cerrado" savanna of Central Brazil, and the "Chaco" of Paraguay, Argentina and Bolivia) (Prado & Gibbs 1993) that "isolates" the Atlantic Rain Forest from other rain forests in South America (Andean and Amazon forests).

Although reported by many authors (e.g., Andrade-Lima 1953, 1966, 1969; Bigarella et al. 1975; Mori et al. 1981; Rizzini 1997), the disjunction observed between species of the floras of northern and eastern Brazil must be evaluated with some caution, as the differentiation between long distance dispersal and vicariance in the historical biogeographical patterns of fern distribution requires still more intensive examination (Wolf et al. 2001).

Invasive species

In spite of the relatively recent introduction of *Macrothelypteris torresiana*, *Nephrolepis brownii*, *N. cordifolia*, and *Thelypteris dentata* into the tropical Americas, these species are already found in many areas of South America (Mickel & Smith 2004; Hovenkamp & Miyamoto 2005). These species are primarily associated with ruderal environments in the Serra Bonita Reserve (e.g., along forest edges, disturbed areas, and areas under cultivation) and apparently are not yet seriously competing with the local flora for habitats.

Taxonomic difficulties

The low number of unidentified species encountered in the present study (three) is due, in large part, to the collaboration of many specialists in identifying this material (see Acknowledgments). Identification was especially difficult in very diverse or little-studied genera such as *Ctenitis*, *Elaphoglossum*, and *Thelypteris*, each of which had one species of unknown identity.

Floristic relationships

Preliminary analyses of similarities between the flora of southern Bahia and other diverse localities in tropical America (Matos 2009) indicate that the montane forests of southern Bahia are especially characterized by "southern" elements of the Atlantic Forest. The large number of new records reported here supports this view, as the majority of these species are characteristic of the montane regions of southern Brazil. The same close floristic relationships between the montane forests of southern Bahia and the mountains of southeastern Brazil has likewise been observed for the angiosperms (Amorim et al. 2009). On the other hand, the low elevation forests of southern Bahia appear to be more closely related to the Amazon forests or to northern areas of the Atlantic Forest. More detailed studies are still necessary, however, to better evaluate these relationships.

Conservation

One of the greatest modern challenges to mankind is reconciling economic growth (which usually implies increased utilization of natural resources) with global biodiversity conservation, and preservation efforts must be optimized by establishing criteria that guarantee the most favorable possible balance between costs, social needs and the efficient functioning of established conservation areas (Crozier 1997; Crandall et al. 2000).

Among the notable examples of diversity observed in the region, some species are noteworthy by their rarity, ecological importance, or elevated level of endemism:

- *Asplenium truncorum*, *Megalastrum indusiatum*, and *Thelypteris beckeriana* (Fig. 2): these species have only recently been described based on collections made during the present study (Matos et al. 2009, 2010; Moran et al. 2009);
- *Terpsichore asplenifolia* (Fig. 2): despite the fact that this species has wide geographical distribution in many countries in tropical America, the Serra Bonita Reserve holds the only population currently known from Brazil (Labiak & Prado 2007);
- The Cyatheaceae: besides their ecological importance, it is also well known that members of the Cyatheaceae suffer harvesting pressure from human communities in many tropical regions as they are used in craft articles, plant vases, and as a substrate for cultivating epiphytes. For these reasons, all of the species of this family are now included in the CITES listing (2009). This group is represented by eight species in the Serra Bonita Reserve, including the northernmost populations of *Cyathea rufa*.

It should also be noted that the new records for Bahia and northeastern Brazil (marked with asterisks in Appendix 1) represent approximately 25% of the total number of ferns and lycophytes encountered in the Serra Bonita Reserve.

The montane forests of the Serra Bonita Reserve offer ideal environmental conditions for the establishment and growth of ferns and lycophytes, harboring almost all of the taxonomic orders proposed by Smith et al. (2006) (the only exceptions being the Psilotales, Equisetales and the heterosporous ferns [Salviniales], although the last can be found at lower elevations in the region). The conservation importance of the Serra Bonita Reserve therefore lies not just in the number of species, but also in the phylogenetic diversity it preserves.

APPENDIX 1

Checklist of the ferns and lycophytes from the Serra Bonita Reserve, southern Bahia, Brazil. The asterisk before species names denotes the first records for northeastern Brazil or Bahia, whereas a circle refers to species newly described, based on material collected during the present study. Full name of collectors are as follows: **AA** = André M. Amorim, **FF** = Fabrício M. Ferreira, **FM** = Fernando B. Matos, **ML** = Márdel M. Lopes, **PL** = Paulo H. Labiak, and **WT** = Wm. Wayt Thomas. Abbreviation for the habitat of the species: **EP** = Epiphytic, **HE** = Hemi-epiphytic, **RU** = Rupestrial, and **TE** = Terrestrial.

FERNS AND LYCOPHYTES

Anemiaceae

Anemia hirta (L.) Sw.—FM 625, RU/TE
Anemia mandiocana Raddi—FM 638, RU/TE
Anemia phyllitidis (L.) Sw.—FM 1789, TE

Aspleniaceae

**Asplenium angustum* Sw.—FM 1552, EP
Asplenium auriculatum Sw.—FM 306, EP/RU/TE
Asplenium auritum Sw.—FM 1543, RU
**Asplenium cirrhatum* Rich. ex Willd.—FM 1538, TE
Asplenium feei Kunze ex Fée—FM 448, EP
Asplenium kunzeanum Klotzsch ex Rosenst.—PL 3730, TE/RU
Asplenium martianum C. Chr.—FM 1562, EP/TE
Asplenium pteropus Kaulf.—FM 1567, EP
**Asplenium scandicinum* Kaulf.—FM 299, EP
Asplenium serra Langsd. & Fisch.—AA 5435, EP
**Asplenium triquetrum* N. Murak. & R.C.Moran—FM 313, RU
°*Asplenium truncorum* F.B. Matos, Labiak & L. Sylvestre—FM 1537, EP (Fig. 2)

Blechnaceae

Blechnum acutum (Desv.) Mett.—FM 292, HE/TE
Blechnum brasiliense Desv.—FM 614, TE (Fig. 3)
Blechnum occidentale L.—FM 316, TE
**Blechnum organense* Brade—FM 1064, TE
Salpichlaena volubilis (Kaulf.) J. Sm.—FM 1366, TE

Cyatheaceae

Alsophila setosa Kaulf.—FM 447, TE
Alsophila sternbergii (Sternb.) D.S. Conant—FM 1384, TE
Cyathea corcovadensis (Raddi) Domin—FM 1550, TE
Cyathea delgadii Sternb.—FM 1382, TE (Fig. 3)
Cyathea glaziovii (Fée) Domin—FM 636, TE
Cyathea phalerata Mart.—FM 619, TE
Cyathea praecincta (Kunze) Domin—FM 1088, TE
**Cyathea rufa* (Fée) Lellinger—FM 1103, TE

Dennstaedtiaceae

Dennstaedtia cornuta (Kaulf.) Mett.—FM 1563, TE
Dennstaedtia dissecta (Sw.) T. Moore—FM 295, TE
Dennstaedtia globulifera (Poir.) Hieron.—FM 1529, TE
Dennstaedtia obtusifolia (Willd.) T. Moore—FM 1063, TE
Histiopteris incisa (Thunb.) J. Sm.—PL 3715, TE

Hypolepis aff. *repens* (L.) C. Presl—FM 1522, TE
Pteridium arachnoideum (Kaulf.) Maxon—FM 1368, TE

Dryopteridaceae

**Ctenitis aspidioides* (C. Presl) Copel.—FM 1332, TE
Ctenitis distans (Brack.) Ching—FM 1372, TE
Ctenitis submarginalis (Langsd. & Fisch.) Ching—FM 264, TE
Ctenitis sp.—FM 1787, TE
Cyclodium heterodon (Schrad.) T. Moore—FM 1095, TE (Fig. 3)
Cyclodium meniscioides (Willd.) C. Presl—FM 321, TE
Didymochlaena truncatula (Sw.) J.Sm.—FM 1383, TE
Elaphoglossum sp.—FM 1329, EP
**Elaphoglossum decoratum* (Kunze) T. Moore—FM 445, RU (Fig. 3)
**Elaphoglossum gardnerianum* (Kunze ex Fée) T. Moore—JP 446, EP
Elaphoglossum glabellum J. Sm.—FM 607, RU
Elaphoglossum insigne (Fée) Brade—FM 620, EP
Elaphoglossum lingua Brack.—FM 1060, RU
**Elaphoglossum peltatum* (Sw.) Urb.—FM 1584, EP (Fig. 2)
**Elaphoglossum rigidum* (Aubl.) Urb.—FM 1331, EP
**Elaphoglossum strictum* (Raddi) T. Moore—JP 449, EP
**Elaphoglossum vagans* (Mett.) Hieron.—FM 1583, EP
**Elaphoglossum villosum* (Sw.) J. Sm.—FM 1572, EP
Lastreopsis amplissima (C. Presl) Tindale—FM 284, TE
Lomagramma guianensis (Aubl.) Ching—FM 1047, HE
Megalastrum canescens (Kunze ex Mett.) A.R. Sm & R.C. Moran—FM 1079, TE
Megalastrum connexum (Kaulf.) A.R. Sm. & R.C. Moran—FM 439, TE
Megalastrum eugenii (Brade) A.R. Sm. & R.C. Moran—FM 261, TE
°*Megalastrum indusiatum* R.C. Moran, J. Prado & Labiak—FM 1365, TE (Fig. 2)
**Megalastrum umbrinum* (C. Chr.) A.R. Sm. & R.C. Moran—FM 1076, TE
Olfersia cervina (L.) Kunze—FM 1096, RU/TE
**Polybotrya speciosa* Schott—ML 788, HE
Stigmatopteris prionites (Kunze) C. Chr.—FM 1548, TE

Gleicheniaceae

Dicranopteris flexuosa (Schrad.) Underw.—FM 1804, TE
Gleichenella pectinata (Willd.) Ching—FM 652, TE (Fig. 3)
Sticherus bifidus (Willd.) Ching—FM 657, TE
Sticherus lanuginosus (Fée) Nakai—FM 654, TE

Hymenophyllaceae

Abrodictyum rigidum (Sw.) Ebihara & Dubuisson—FM 301, TE
**Didymoglossum angustifrons* Fée—FM 1097, EP
Didymoglossum reptans (Sw.) C. Presl—FM 1784, EP
Hymenophyllum asplenioides (Sw.) Sw.—FM 648, EP
Hymenophyllum caudiculatum Mart.—FM 303, EP
**Hymenophyllum elegans* Spreng.—PL 3711, EP
Hymenophyllum hirsutum (L.) Sw.—FM 646, EP
Hymenophyllum polyanthos (Sw.) Sw.—FM 645, EP
Polyphlebium angustatum (Carmich.) Ebihara & Dubuisson—FM 1068, EP
Polyphlebium diaphanum (Kunth) Ebihara & Dubuisson—FM 650, EP
Polyphlebium hymenophylloides (Bosch) Ebihara & Dubuisson—FM 649, EP
Trichomanes elegans Rich.—FM 1371, TE (Fig. 3)
Trichomanes pilosum Raddi—FM 1337, EP
Trichomanes polypodioides L.—FM 302, EP
Vandenboschia collariata (Bosch) Ebihara & K. Iwats.—FM 304, RU
**Vandenboschia rupestris* (Raddi) Ebihara & K. Iwats.—FM 1555, RU

Lindsaeaceae

Lindsaea lancea (L.) Bedd.—FM 1376, TE
**Lindsaea quadrangularis* Raddi—FM 1551, TE

Lomariopsidaceae

Lomariopsis marginata (Schrad.) Kuhn—FM 1074, HE
Nephrolepis brownii (Desv.) Hovenkamp & Miyam.—FM 610, TE
Nephrolepis cordifolia (L.) C. Presl—FM 1523, TE
Nephrolepis pendula (Raddi) J. Sm.—FM 1588, EP/TE
Nephrolepis rivularis (Vahl) Mett. ex Krug—FM 1589, EP/TE

Lycopodiaceae

Huperzia acerosa (Sw.) Holub—FM 319, EP/RU
**Huperzia flexibilis* (Fée) B. Øllg.—FM 1571, EP
**Huperzia heterocarpon* (Fée) Holub—FM 1581, EP/RU
Huperzia mandiocana (Raddi) Trevis.—FM 1553, EP (Fig. 2)
Huperzia martii (Wawra) Holub—FM 1777, EP
Lycopodiella cernua (L.) Pic. Serm.—FM 653, TE

Lygodiaceae

Lygodium volubile Sw.—FM 265, TE

Marattiaceae

Danaea geniculata Raddi—FM 1335, TE
Eupodium kaulfussii (J. Sm.) J. Sm.—FM 1067, TE

Oleandraceae

Oleandra articulata (Sw.) C. Presl—FM 440, EP

Ophioglossaceae

Ophioglossum palmatum L.—FM 1375, EP

Osmundaceae

Osmundastrum cinnamomeum (L.) C. Presl—PL 3731, TE

Polypodiaceae

**Campyloneurum acrocarpon* Fée—WT 14230, EP
Campyloneurum aff. *angustifolium* (Sw.) Fée—FM 416, EP
**Campyloneurum decurrens* (Raddi) C. Presl—FM 290, RU
**Campyloneurum nitidum* (Kaulf.) C. Presl—FM 273, EP
Cochlidium serrulatum (Sw.) L.E. Bishop—FM 326, EP
Lellingeria suspensa (L.) A.R. Sm. & R.C. Moran—FM 1368, EP
**Melpomene melanosticta* (Kunze) A.R. Sm. & R.C. Moran—AA 6497, EP
Microgramma acatallela Alston—FM 1577, EP
Microgramma geminata (Schrad.) R.M. Tryon & A.F. Tryon—FM 315, EP
Microgramma lycopodioides (L.) Copel.—FM 1374, EP
Microgramma percussa (Cav.) de la Sota—FM 1544, EP
Microgramma tecta (Kaulf.) Alston—FM 327, EP
Microgramma vacciniifolia (Langsd. & Fisch.) Copel.—FM 279, EP

Micropolypodium achilleifolium (Kaulf.) Labiak & F.B. Matos—FM 286, EP
Pecluma pilosa (A.M. Evans) M. Kessler & A.R. Sm.—FM 311, EP/RU
Pecluma plumula (Humb. & Bonpl. ex Willd.) M.G. Price—FM 283, EP/RU
Pecluma recurvata (Kaulf.) M. G. Price—FM 1545, EP/RU
Pecluma robusta (Fée) M. Kessler & A.R. Sm.—FM 1381, EP
Pecluma truncorum (Lindm.) M. G. Price—FM 1536, EP
Phlebodium pseudoaureum (Cav.) Lellinger—FM 280, EP/RU (Fig. 3)
Pleopeltis astrolepis (Liebm.) E. Fourn.—FM 1525, EP
Pleopeltis macrocarpa (Bory ex Willd.) Kaulf.—FM 1527, EP
Pleopeltis monoides (Weath.) Salino—FM 281, EP/RU
Pleopeltis pleopeltidis (Fée) de la Sota—FM 1528, EP
Pleopeltis pleopeltifolia (Raddi) Alston—FM 656, EP
Polypodium chnoophorum Kunze—FM 1526, EP
Polypodium dulce Poir.—FM 1093, RU/TE
Serpocaulon catharinae (Langsd. & Fisch.) A.R. Sm.—FM 291, EP
Serpocaulon fraxinifolium (Jacq.) A.R. Sm.—FM 323, EP
Serpocaulon levigatum (Cav.) A.R. Sm.—FM 629, EP
Serpocaulon meniscifolium (Langsd. & Fisch.) A.R. Sm.—FM 1059, EP/RU
Serpocaulon triseriale (Sw.) A.R. Sm.—FM 278, EP/RU/TE
Terpsichore asplenifolia (L.) A.R. Sm.—FM 1566, EP (Fig. 2)
Terpsichore reclinata (Brack.) Labiak—FM 1338, EP
Terpsichore taxifolia (L.) A.R. Sm.—FM 307, EP

Pteridaceae
Adiantopsis radiata (L.) Fée—FM 1369, TE
Adiantum abscissum Schrad.—FM 1373, TE
Adiantum dolosum Kunze—FM 1560, TE
Adiantum latifolium Lam.—FM 1388, TE
Adiantum mynssenae J. Prado—FM 1786, TE
Adiantum terminatum Kunze ex Miq.—FM 1389, TE
Doryopteris collina (Raddi) J. Sm.—FM 269, RU
Doryopteris rediviva Fée—FF 1294, TE
Doryopteris sagittifolia (Raddi) J. Sm.—WT 13030, RU
Hemionitis tomentosa (Lam.) Raddi—FM 270, RU/TE
Pityrogramma calomelanos (L.) Link—FM 275, TE
Polytaenium lineatum (Sw.) J. Sm.—FM 263, EP
Pteris angustata (Fée) C.V. Morton—FM 637, TE
Pteris decurrens C. Presl—FM 1541, TE
Pteris deflexa Link.—FM 660, TE
Pteris denticulata Sw.—FM 1387, TE
Pteris schwackeana H. Christ—FM 1091, TE
Pteris splendens Kaulf.—FM 1539, TE
Vittaria scabrida Klotzsch ex Fée—FM 632, EP

Saccolomataceae
Saccoloma inaequale (Kunze) Mett.—FM 1070, TE

Selaginellaceae
Selaginella decomposita Spring—FM 1069, TE
Selaginella flexuosa Spring—FM 310, EP/RU/TE
Selaginella muscosa Spring—FM 1586, TE

Tectariaceae
Tectaria incisa Cav.—FM 267, TE
Triplophyllum hirsutum (Holttum) J. Prado & R.C. Moran—FM 1549, TE

Thelypteridaceae
Macrothelypteris torresiana (Gaudich.) Ching—FM 274, TE
Thelypteris sp.—FM 1559, TE
°*Thelypteris beckeriana* F.B. Matos, A.R. Sm. & Labiak—FM 1558, TE (Fig. 2)
Thelypteris dentata (Forssk.) E.P. St. John—FM 1531, TE
Thelypteris leprieurii (Hook.) R.M. Tryon—FM 1532, TE
Thelypteris macrophylla (Kunze) C.V. Morton—FM 1561, TE
Thelypteris opposita (Vahl) Ching—FM 1524, TE
Thelypteris polypodioides (Raddi) C.F. Reed—FM 1380, TE (Fig. 3)
Thelypteris raddii (Rosenst.) Ponce—FM 288, TE
Thelypteris serrata (Cav.) Alston—FM 612, TE
Thelypteris vivipara (Raddi) C.F. Reed—FM 1781, TE

Woodsiaceae
Diplazium ambiguum Raddi—FM 658, TE
Diplazium asplenioides (Kunze) C. Presl—FM 296, TE
Diplazium celtidifolium Kunze—FM 1077, TE
Diplazium cristatum (Desr.) Alston—FM 1554, TE
Diplazium lechleri (Mett.) T. Moore—FM 622, TE (Fig. 3)
Diplazium leptocarpon Fée—FM 1081, TE
Diplazium lindbergii (Mett.) Christ—FM 1083, TE
Diplazium mutilum Kunze—FM 436, TE
Diplazium plantaginifolium (L.) Urb.—FM 1385, TE

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