



RESEARCH ARTICLE

Biogeographic analysis and key to the genera of ferns and lycophytes of Mburucuyá National Park, Corrientes, Argentina

Análisis biogeográfico y clave de géneros de los helechos y licofitos del Parque Nacional Mburucuyá, Corrientes, Argentina

ESTEBAN I. MEZA-TORRES^{1,*}, ELÍAS R. DE LA SOTA² & MARÍA S. FERRUCCI¹

¹Instituto de Botánica del Nordeste, Sargento Cabral 2131, C.C. 209, C.P. 3400, Corrientes, Argentina

²Cátedra de Morfología Vegetal, Facultad de Ciencias Naturales y Museo, UNLP, Paseo del Bosque s/n, B1900FWA, La Plata, Argentina

*Autor correspondiente: meзаторresii@yahoo.com.ar

ABSTRACT

The diversity of ferns and lycophytes of Corrientes province, Argentina is not well understood. Our field work in the Mburucuyá National Park in Corrientes province as well as a literature review finds 29 genera and 48 infrageneric taxa of ferns and lycophytes for this Park. A comparison of the Park's species diversity with other protected areas in northeastern Argentina using Jaccard's similarity coefficient and the infrageneric taxa biodiversity index proposed by Squeo et al. (1998) are analyzed. A key to the Park's ferns and lycophytes genera is provided.

Key words: Floristic diversity, monilophytes, protected area, pteridophytes.

RESUMEN

El Parque Nacional Mburucuyá, cuenta con una superficie de 176.80 km², se encuentra en la provincia de Corrientes, Argentina, dentro de una región ecotonal entre los dominios Chaqueños y Amazónicos. En esta área se registraron 29 géneros y 48 taxones infragenéricos de helechos y licófitos fueron registrados. Las especies registradas son comparadas con las áreas protegidas ya estudiadas del noreste de Argentina utilizando el coeficiente de similitud de Jaccard y el índice de biodiversidad de Squeo et al. (1998) a nivel infragenérico. En este trabajo se proporciona una clave para diferenciar los géneros presentes en el Parque.

Palabras clave: Área protegida, diversidad florística, monilófitos, pteridófitas.

INTRODUCTION

In tropical woodlands, ferns are often present at or above eye level. In arid areas or on newly exposed surfaces such as burns, clear-cuts or landslides, ferns can be present and sometimes are the dominant vegetation (Sharpe et al. 2010). Some species possess high reproductive and dispersal capacities; if appropriate conditions are present, they may become invasive (Caluff & Fiallo 2008).

There are few studies of the fern (monilophytes, sensu Pryer et al. 2004), and lycophyte flora of northeastern Argentina. The synopsis of these groups for the Cuña Pirú Reserve from the province of Misiones (Márquez et al. 2006) is the only study available for this part of Argentina. There are

few other fern and lycophyte inventories for Misiones (Biganzoli & Múlgura de Romero 2004, Tressens et al. 2008), and Corrientes (Arbo & Tressens 2002). To date, including the works cited above as well as new records, 103 infrageneric taxa of ferns and lycophytes are known in the province of Corrientes (Meza-Torres & Keller 2008¹).

The Mburucuyá National Park (N. P.) in Corrientes, Argentina, was established on June 27th, 2001, by an Argentinian National Law 25447. This Park, with an area of 176.80 km², was originally two ranches, Santa Teresa and Santa María; whose owner, Troels Myndel

¹MEZA-TORRES, EI & HA KELLER (2008) Novedades para la pteridoflora del Nordeste argentino. Boletín de la Sociedad Argentina de Botánica, Suplemento 44: 95.

Pedersen, donated them to the Argentinian government in 1991, with the explicit objective of establishing a national park. Pedersen (1992) compiled a floristic inventory of the park based on more than 40 years of botanical collections. This inventory included 28 genera and 43 infrageneric taxa of ferns and lycophytes, two were exotic and only one species was considered endemic. Novelties to this fern flora have been documented in Macluf et al. (2010), Meza-Torres et al. (2006, 2008), and Meza-Torres (2011).

According to Cabrera (1971), the area is an ecotone with elements from Paranaense, Chaco and Espinal phytogeographical provinces. Saibene & Montanelli (1997) mapped the park's woody plant communities, and recognized the following units: hygrophilous forest; subxerophytic forest; *Guadua chacoensis* bamboo forest, "Tacuaral"; *Copernicia alba* palm forest ("Caranday" palm forest); *Schinopsis balansae* forest; *Prosopis affinis* forest, "Espinillo" forest; and the Yatay palm grove. The presence of marshes and ponds contribute to the area's diverse wetland vegetation. This array of plant communities explains the region's floristic richness, with 1383 species; of which 933 are Dicotyledons

and 407 are Monocotyledons (Arbo 2004), this represents over half of the species recorded for the entire province (Zuloaga et al. 1999). In the *Copernicia alba* palm forest, *Schinopsis balansae* forest, *Prosopis affinis* forest, and Yatay palm grove, periodic controlled burning is conducted to reduce fuel build-up, which decreases the likelihood of serious wildfires, and curbs the proliferation of shrubs in grasslands.

In 2003, researchers from the Instituto de Botánica del Nordeste initiated a project to study the Flora of Mburucuyá N. P. because Corrientes province's ferns and lycophytes were not well studied, one of the aims of the project was to survey the area's ferns and lycophytes, as well as develop descriptions and keys for the genera.

The aims of this paper are: 1) to provide a key of the fern and lycophyte genera growing in Mburucuyá N. P.; 2) to estimate the diversity of these plant groups and, 3) to compare species diversity of the park with other nearby protected areas (Iberá macrosystem in Corrientes, the Valle del Arroyo Cuñá Pirú Reserve, Guaraní Multiple Uses Reserve, and Teyú Cuaré Provincial Park, from the province of Misiones). These protected areas were selected because they are the ones closest to

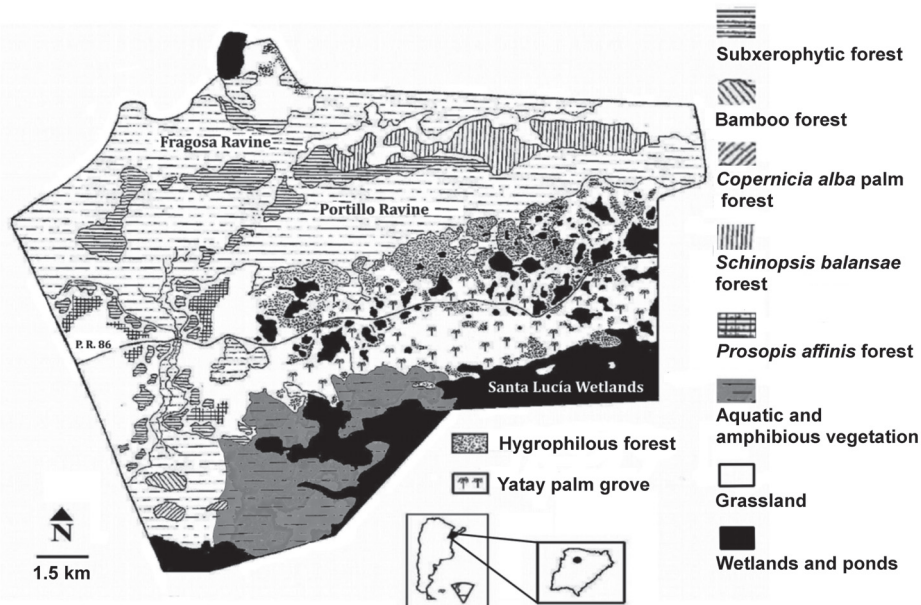


Fig. 1. Location of Mburucuyá National Park. Map based on Saibene & Montanelli (1997).

Localización del Parque Nacional Mburucuyá basada en Saibene & Montanelli (1997).

Mburucuyá N. P. for which there are studies available.

METHODS

Study area

Mburucuyá N. P. is 176.80 km² in area, located in the province of Corrientes (27°58'–26°05'S, 57°59'–58°08'W), about 150 km SE of Corrientes city (Fig. 1). The land is in the NE part of Mburucuyá Department, delineated by Santa Lucía wetlands to the south and Frágosa Ravine to the north. The park is crossed by the west-east running N° 86 road, which connects Mburucuyá and Palmar Grande. The climate in Mburucuyá N. P. is warm subtropical, with a low annual thermal amplitude. Average annual rainfall is 1300 mm, decreasing from northeast to southwest, and is almost evenly distributed throughout the year; although with a low decrease in summer and a more marked decrease in winter. Fall and winter are the wettest and driest seasons. Mean annual temperature in the period from 1961–1990 was between 21°–23°C (Pedersen, ined.). Between 1980 and 1981, mean annual humidity was 75.9 % (<http://www.patrimonionatural.com>).

Systematic assignment

We analyzed the historical specimens of the Pedersen herbarium, which are deposited in the CTES Herbarium, as well as the most recent collections of E.I. Meza-Torres from the study area. As there is no consensus among taxonomists in delimitation of ferns and lycophyte families, the present contribution provides results only at the genus level, and does not include family treatment (Keller et al. 2011). Genera nomenclature follows Smith et al. (2006).

Analysis of floristic diversity

Nomenclature of biogeographic areas follows Cabrera (1971) and Cabrera & Willink (1980). We constructed a presence (1) – absence (0) qualitative matrix of infrageneric taxa for the biogeographic areas (Appendix 2). According to Squeo et al. (1998), the number of taxa depends logarithmically on the sampling area and taxonomic biodiversity (B) is calculated as $B = n_i / \ln A_i$, where n_i is the number of taxa (species = Bsp) and \ln is the natural logarithm of the sampling unit area in km². The diversity of ferns and lycophytes Mburucuyá N. P. were compared with the protected areas in the Iberá macrosystem in Corrientes Province, Valle del Arroyo Cuñá Pirú Reserve, Guaraní Multiple Uses Reserve, Teyú Cuaré Provincial Park, and surrounding areas from the province of Misiones. These protected areas were selected because they are closest to Mburucuyá N. P. for which studies are available. Due to constant transfers genus of the species by advances in taxonomic studies, diversity indices were evaluated only at the species level. The number of taxa and the area of each sampling unit were taken from Arbo & Tressens (2002), Biganzoli & Múlgura de Romero (2004), Márquez et al. (2006), and Tressens et al. (2008). Floristic similarity of infrageneric taxa among the protected areas was estimated with the Jaccard's similarity index (I_j) with the software PAST version 1.75b (Hammer et al. 2001).

RESULTS

Twenty nine genera and 48 infrageneric taxa were recorded in the Park, from which 53 % of species were found in the hygrophilous forest (Fig. 2). Amphibious vegetation represents 25 % of the

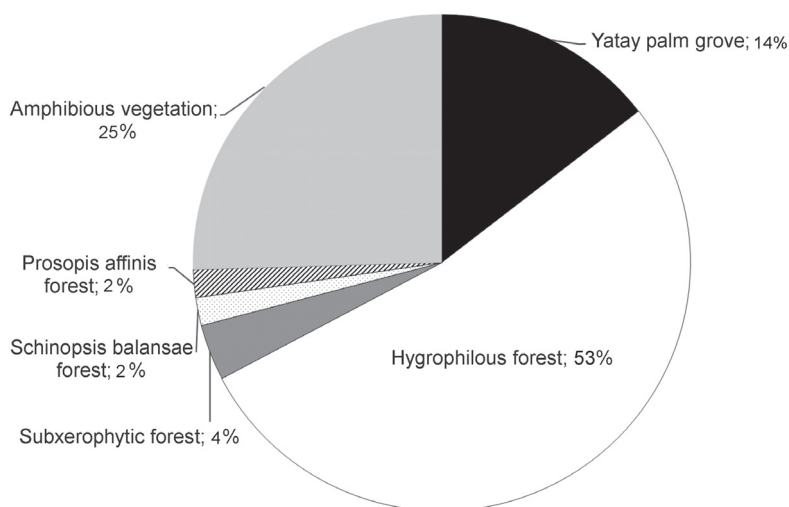


Fig. 2. Percentages of ferns and lycophytes occupying various plant communities in Mburucuyá National Park, Corrientes, Argentina.

Relaciones entre los porcentajes de helechos y licofitos en la composición de las comunidades de plantas en el Parque Nacional Mburucuyá, Argentina.

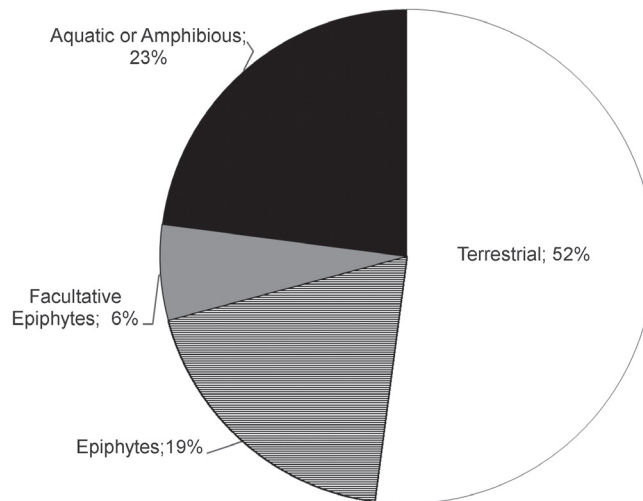


Fig. 3. Percentages of ferns and lycophytes with their habitat preferences in Mburucuyá National Park, Corrientes, Argentina.

Relaciones entre los porcentajes de especies de helechos y licofitos con sus preferencias de sustrato en el Parque Nacional Mburucuyá, Argentina.

species. The Yatay palm grove has 14 % of the species. The lower numbers of species occupy Subxerophytic forest (4 %), *Schinopsis balansae* forest (2 %), and *Prosopis affinis* forest (2 %).

A key to the genera of ferns and lycophytes is shown in Appendix 1.

Regarding to habitat substrate preferences, 52 % of the species have a terrestrial habit (Fig. 3), whereas only 23 % of the species are aquatic. Epiphytic ferns are an important group within the park, as they represent the 19 % of the species, to this value 6 % must be added for the facultative epiphytic species, *Phlebodium*

aureum (L.) J. Sm. and *Psilotum nudum* (L.) P.Beauv.

Biodiversity and similarity indices

Except for Iberá (Bsp = 4.7), the Biodiversity Index of N. Mburucuyá (Bsp = 9.1) was lower than other surrounding protected areas (Table 1).

The results of the Jaccard's similarity index (Table 2) for the different areas showed that the Mburucuyá N. P. shares the most similarity with Iberá R. ($I_j = 0.44$), while the lowest similarity occurs with Teyú Cuaré P. P. ($I_j = 0.20$).

TABLE 1

Comparison of the number of genera, number of infrageneric taxa, indexes of diversity (biodiversity of infrageneric taxa = Bsp) and area of the protected areas studied in the northeast Argentina.

Análisis comparativo de helechos y licofitos, número de géneros y taxa infragenéricos, con los índices de diversidad de las áreas protegidas estudiadas en el noreste de Argentina. Biodiversidad de taxa infragenéricos = Bsp

Protected areas	Number of genera	Number of infrageneric taxa	Bsp	Area (km ²)
Mburucuyá N.P.	29	48	9.2	176.80
Iberá R. N.	26	44	4.7	12000
Teyú Cuaré P.P.	25	37	19.9	6.4
Guaraní M. U. R.	38	80	20.1	53.44
Valle del Arroyo Cuñá Pirú R.	28	52	12.6	61.44

TABLE 2

Matrix representing the similarity (I_j) of the composition of infrageneric taxa of ferns and lycophytes between the different protected areas.

Matriz representando la similitud (I_j) en la composición de los taxa infragénicos de helechos y licofitos entre las diferentes áreas protegidas estudiadas.

	Mburucuyá	Cuñá Pirú	Teyú Cuaré	Guaraní	Iberá
Mburucuyá	1	0.22	0.20	0.23	0.44
Cuñá Pirú	0.22	1	0.22	0.44	0.23
Teyú Cuaré	0.20	0.22	1	0.15	0.27
Guaraní	0.23	0.44	0.15	1	0.22
Iberá	0.44	0.23	0.27	0.22	1

DISCUSSION

The genus *Thelypteris* Schmidel with five species (10.41 % of the park's fern and lycophyte flora) is most species rich genus in the Park, followed by *Pecluma* M.G. Price, with four species (8.33 %), and *Doryopteris* J. Sm. and *Ophioglossum* L. with three species each (6.25 %), whereas two infrageneric taxa were recorded for *Adiantopsis* Fée, *Anemia* Sw., *Asplenium* L., *Azolla* Lam., *Pityrogramma* L., *Pleopeltis* Willd., and *Salvinia* Ség. (4.16 %) (Fig. 4). The other genera are represented by only one species each (2.08 %).

Among the 48 species, only two are exotic, *Macrothelypteris torresiana* (Gaudich.) Ching and *Thelypteris dentata* (Forssk.) E.P. St. John (Ponce 1987); these ferns are considered weeds by Caluff & Fuentes Fiallo (2008). Pedersen (1992) reported the presence of *M. torresiana* at only two sites within the park, and one site for *T. dentata*, these three sites are about 4 km northwest of the Santa Teresa Ranch. recent collections, (2007), *T. dentata* expanded its distribution southward, up to 2 km south of Santa Teresa Ranch. *Macrothelypteris torresiana* grows within the Santa Maria Ranch, to 9 km west of the sites previously reported by Pedersen (1992). Was observed that *T. dentata* invaded old abandoned houses that were absorbed by the forest. *Macrothelypteris torresiana* has invaded artificial streams and moved into the forest. Fortunately, both species are not as highly invasive, as was observed (Keller pers. com. 2008) in Misiones province, where *M. torresiana* colonizes and invades the planted *Araucaria angustifolia* forest. Controlled burning is periodically conducted

in the *Copernicia alba* palm forest, *Schinopsis balansae* forest, *Prosopis affinis* forest, and Yatay palm grove. Native species inhabiting these environments survive the burns because many of these species have rhizomes that help make them fire resistant (e.g. *Adiantopsis chlorophylla* (Sw.) Fée, *A. tweedieana* (Hook.) Link-Pérez & Hickey, *Blechnum serrulatum* Rich., *Pityrogramma trifoliata* (L.) R.M. Tryon, *Pteridium arachnoideum* (Kaulf.) Maxon).

An important point to note is that the Mburucuyá N. P. is the type locality for *Isoetes pedersenii* E.I. Meza & Macluf; there are only two known localities for this species, one into the Park (Macluf et al. 2010), and the other in the Brazilian Pantanal (Pott & Pott 1997).

Compared with nearby protected areas (Table 1), Mburucuyá N. P. (with 29 genera) has a higher genera richness than Cuñá Pirú Reserve (28 genera) and Teyú Cuaré Provincial Park (25 genera). However, Guaraní Multiple Use Reserve exhibits the highest species richness, with 80 infrageneric taxa of ferns and lycophytes grouped into 38 genera. As it was expected, the three protected areas of Misiones presented the highest biodiversity indices at genus and species levels; these results agree with findings of Cabrera (1971), since the entire Misiones province is influenced by the Amazon phytogeographic domain, characterized by a high species richness of ferns. Indeed, Teyú Cuaré Provincial Park is a particular biogeographic area, with Amazonian elements of the Paranaense and Cerrado phytogeographic provinces, represented by species such as *Trichomanes pilosum* Raddi and *Elaphoglossum pachydermum* (Fée) T. Moore (Biganzoli & Múlgura de Romero 2004). Another

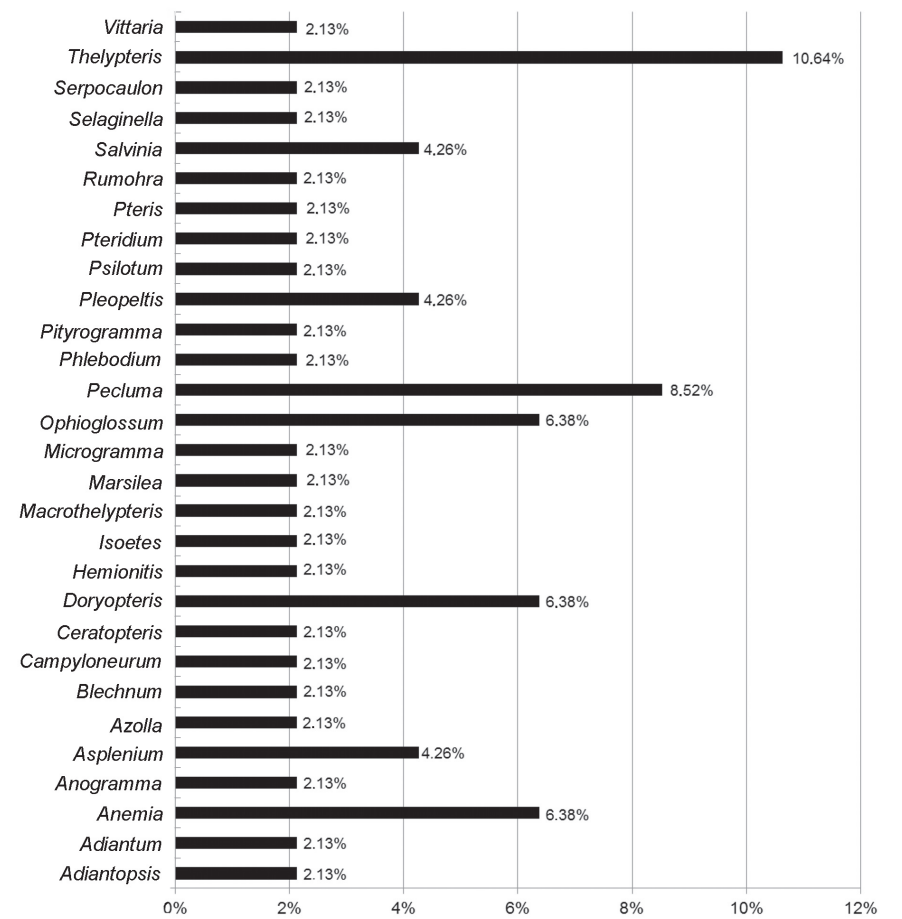


Fig.4. Percentage of fern and lycophyte genera composition in Mburucuyá National Park, Corrientes, Argentina.

Composición en porcentajes de géneros de helechos y licofitos en el Parque Nacional Mburucuyá, Argentina.

phytogeographic phenomenon observed in Mburucuyá N. P. are its ecotones (Cabrera 1971), the park harbours different elements from Amazonian domains (*sensu* Cabrera & Willink 1980), such as *Asplenium gastonis* Fée, *Campyloneurum nitidum* (Kaulf.) C. Presl, and other species of the genus *Pecluma* (*P. filicula* (Kaulf.) M.G. Price, *P. pectinatiformis* (Lindm.) M.G. Price, *P. sicca* (Lindm.) M.G. Price, and *P. robusta* (Fée) M. Kessler & A.R. Sm.). In addition, species of the Chaco domain are represented, such as *Anogramma chaerophylla* (Desv.) Link, and *Adiantopsis tweedieana*, the latter from Eastern Chaco and Highland Chaco, which is also present in the “Espinal” phytogeographical province (Ponce & Morbelli 1989).

Iberá Natural Reserve is also situated in an ecotone, but has relatively low diversity (Bsp = 4.7), probably because most of the reserve area is covered by water and harbours hydrophytic vegetation. For this reason, endemic species are not present in the Mburucuyá N. P. and the Iberá region.

Mburucuyá N. P. has seven species that are not known from the other study areas (*Asplenium sellowianum* Hieron., *Doryopteris lorentzii* (Hieron.) Diels, *Isoetes pedersenii*, *Phlebodium aureum*, *Rumohra adiantiformis* (G. Forst.) Ching, *Salvinia auriculata* Aubl., and *Vittaria graminifolia* Kaulf.) (Appendix 2). The matrix calculated using Jaccard’s similarity indices (Table 2) reveals that Mburucuyá N. P. and Iberá Macrosystem show great

affinity ($I_j = 0.44$), sharing 28 infrageneric taxa, such as *Anemia phyllitidis* (L.) Sw. var. *tweedieana* (Hook.) Hassl., *Doryopteris pentagona* Pic. Serm., *Marsilea ancylopoda* A. Braun, *Microgramma vacciniifolia* (Langsd. & Fisch.) Copel., *Ophioglossum reticulatum* L., *Pityrogramma calomelanos*, *Pleopeltis minima* (Bory) J.Prado & R.Y.Hirai, *Pteridium arachnoideum*, *Selaginella sellowii* Hieron., *Thelypteris dentata*, and *T. hispidula* (Decne.) C.F. Reed. Another seven species shared only between these two areas have a wider distribution; these are *Azolla filiculoides* Lam., *Blechnum serrulatum*, *Ceratopteris pteridoides* (Hook.) Hieron., *Ophioglossum nudicaule* L. f., *Pecluma robusta*, *Salvinia minima* Baker, and *Thelypteris interrupta* (Willd.) K. Iwats. Floristic similarity to the other three areas is relatively low, with values below $I_j : 0.23$. The areas of greatest similarity with Mburucuyá N. P. are Guarani M. U. R. ($I_j : 0.23$) and R. Valle del Arroyo Cuñá Pirú R ($I_j : 0.22$). The taxa shared by these three areas are *Adiantopsis chlorophylla*, *Adiantum pseudotinctum* Hieron., *Anemia phyllitidis* var. *phyllitidis*, *A. phyllitidis* var. *tweedieana*, *Asplenium gastonis*, *Doryopteris pentagona*, *Macrothelypteris torresiana*, *Pecluma filicula*, *Pleopeltis minima*, *Pteridium arachnoideum*, *Pteris denticulate* Sw., *Thelypteris dentata*. Whereas taxa common to all the study areas are *Adiantopsis chlorophylla*, *Anemia phyllitidis* var. *phyllitidis*, *Anogramma chaerophylla*, *Campyloneurum nitidum*, *Doryopteris concolor* (Langsd. & Fisch.) Kuhn, *Hemionitis tomentosa* (Lam.) Raddi, *Pleopeltis pleopeltifolia* (Raddi) Alston.

According to the information from the Catalogue of Vascular Plants of the Southern Cone and recent published works (Meza-Torres et al. 2008, Meza-Torres & Keller 2008¹) the number of infrageneric taxa of ferns and lycophytes in the province of Corrientes amounts to 103. Notably, Mburucuyá N. P., with an area of 176.80 km² (about 0.2 % of the area of Corrientes province), harbours about 43.7 % of the fern and lycophyte species known for this political province. Thus, this National Park is critical for the conservation of the provinces fern and lycophyte flora.

Further floristic studies in Copo National Park, located in the Chaco phytogeographic province, are necessary in order to exclusively

Chacoan species can be compared with the areas analyzed in this study.

ACKNOWLEDGMENTS: We thank M. M. Arbo for reviewing an earlier version of the manuscript as well as National Park Administrator, G. Rubio for helpful suggestions on the manuscript, J. R. Gutierrez-Camus and M. Stensvold for improving the English version. We also thank the park foresters for their hospitality during the development of this project. Financial support was provided by Myndel Botanica Foundation, the Consejo Nacional de Investigaciones Científicas y Técnicas (PIP N° 112-200801-02248), the Universidad Nacional del Nordeste (PIA005-2009).

LITERATURE CITED

ARBO MM (2004) Flórlula del Parque Nacional Mburucuyá. In: Aceñolaza FG (ed.) Temas de la Biodiversidad del Litoral Fluvial Argentino, INSUGEO, Miscelánea 12: 117-124. San Miguel de Tucumán, Argentina.

ARBO MM & SG TRESSSENS (eds) (2002) Flora del Iberá. EUDENE-UNNE Corrientes, Argentina.

BIGANZOLI F & ME MÚLGURA DE ROMERO (2004) Inventario Florístico del Parque Provincial Teyú Cuaré y alrededores (Misiones, Argentina). Darwiniana (Argentina) 42: 1-24.

CABRERA AL (1971) Fitogeografía de la República Argentina. Boletín de la Sociedad Argentina de Botánica 14: 1-42 + 8 plates.

CABRERA AL & A WILLINK (1980) Biogeografía de América Latina, Serie Biología 13, Secretaría de la OEA, pp. 117. 2nd Ed. Washington D.C. USA.

CALUFF MG & V FUENTES FIALLO (2008) Malezas pteridofíticas de Cuba. Revista del Jardín Botánico Nacional (Cuba) 29: 51-56.

HAMMER Ø, DA HARPER & PD RYAN (2001) Past: Paleontological Statistics Software Package for Education and Data Analysis. Palaeontologia Electronica (USA) 4 art. 4: 9pp. (on line) URL: http://palaeo-electronica.org/2001_1/past/past.pdf (accessed 22 June 2001)

KELLER HA, EI MEZA-TORRES & G PRANCE (2011) Ethnopteridology of the Guaranís of Misiones Province, Argentina. American Fern Journal 101: 193-204.

MACLUF CC, EI MEZA-TORRES & SM SOLÍS (2010) *Isoetes Pedersenii*, a new species from South America. Anais da Academia Brasileira de Ciências 82: 353-359.

MÁRQUEZ GJ, GE GIUDICE & MM PONCE (2006) Pteridofitas de la Reserva "Valle del Arroyo Cuñá Pirú" (Misiones, Argentina). Darwiniana (Argentina) 44: 108-126.

MEZA-TORRES EI (2011) Lectotypification of *Asplenium sellowianum* C. Presl ex Hieron. and Related Names. American Fern Journal, 101:125-126.

MEZA-TORRES EI, ER DE LA SOTA & MS FERRUCCI (2006) *Phlebodium aureum* (Polypodiaceae-Pteridophyta), nueva cita para Argentina. Boletín de la Sociedad Argentina de Botánica 41: 71-76.

MEZA-TORRES EI, GJ MÁRQUEZ, ER DE LA SOTA & MS. FERRUCCI (2008) Nuevas citas en *Argyrochosma* y *Vittaria* (Pteridophyta) del NE Argentino. Darwiniana (Argentina) 46: 360-366.

- PEDERSEN TM (1992) Anexo B. Inventario Florístico. In: Gómez DA & A Bosso (eds.) La naturaleza de los Campos Santa Teresa y Santa María. Departamento Mburucuyá, Prov. de Corrientes. Informe Preliminar: 1-34. Administración de Parques Nacionales. Dirección de Conservación y Manejo. Buenos Aires, Argentina.
- PONCE MM (1987) Revisión de las Thelypteridaceae (Pteridophyta) argentinas. *Darwiniana* (Argentina) 28: 317-390.
- PONCE MM. & M MORBELLI (1989) The *Cheilanthes dichotoma* group of South America. *American Fern Journal*. 79: 127-135.
- POTT VJ & A POTT (1997) Checklist das macrófitas aquáticas do Pantanal, Brasil. *Acta Botanica Brasílica* 11: 215-227.
- PRYER KM, E SCHUETTPELZ, PG WOLF, H SCHNEIDER, AR SMITH & R CRANFILL. (2004) Phylogeny and evolution of ferns (Monilophytes) with a focus on the early Leptosporangiate divergences. *American Journal of Botany* 91: 1582-1598.
- SHARPE JM, K MEHLTRETER & LR WALKER (2010) Ecological importance of ferns. In: Mehlreter K, LR Walker & JM Sharpe (eds.) *Fern Ecology*: 1-21. Cambridge University Press. Cambridge. USA.
- SMITH AR, K M PRYER, E SCHUETTPELZ, P KORALL, H SCHNEIDER & PG WOLF (2006) A classification for extant ferns. *Taxon* 55: 705-731.
- SAIBENE CS & SB MONTANELLI (1997) Mapeo de las comunidades vegetales leñosas del Parque Nacional Mburucuyá, Corrientes, Argentina. *FACENA* (Argentina) 13: 49-57.
- SQUEO FA, LA CAVIERES, G ARANCIO, JE NOVOA, O MATTHEI, et al. (1998) Biodiversidad de la Flora Vasculare en la Región de Antofagasta, Chile. *Revista Chilena de Historia Natural* 71: 571-591.
- TRESSENS, SG, HA KELLER & V REVILLA (2008) Las plantas vasculares de la reserva de uso múltiple Guaraní, Misiones, Argentina. *Boletín de la Sociedad Argentina de Botánica*. 43: 273-293.
- ZULOAGA F, O MORRONE & D RODRÍGUEZ (1999) Análisis de la biodiversidad en plantas vasculares de la Argentina. *Kurtziana* (Argentina) 27: 17-167.

APPENDIX 1

Key to the genera of ferns and lycophytes from Mburucuyá National Park, Argentina.

Clave para los géneros de helechos y licofitos del Parque Nacional Mburucuyá, Argentina.

1. Plants aquatic or amphibious, the latter without blackish rhizomes (2)
 1'. Plants terrestrial, epiphytic or saxicolous, if amphibious with blackish rhizomes (6)
 2 (1). Blades with gemmae, bipinnate; homosporous plants9. *Ceratopteris* Brongn.
 2'. Blades without gemmae, lobate, linear or 4-foliolate (cloverlike); heterosporous plants..... (3)
 3 (2'). Free-floating plants; floating leaves orbicular or oval, submerged leaves modified into laciniae (4)
 3'. Amphibious plants, rooted; leaves linear or peltate 4-foliolate (cloverlike), laciniae absent..... (5)
 4 (3). Pinnae less than 1 mm long, the floating ones adaxially convex, with short dorsal papillae6. *Azolla* Lam.
 4'. Pinnae more than 10 mm long, the floating ones curled up, with dorsal papillae,
 each papilla with four apical hairs25. *Salvinia* Ség.
 5 (3'). Blades simple linear; sporangia axillary..... 12. *Isoetes* L.
 5'. Blades compound, 4-foliolate; sporangia in subterranean sporocarps 14. *Marsilea* L.
 6 (1'). Plants creeping forming grasses; linear-subulate microphylls up to 4 mm long..... 26. *Selaginella* P. Beauv.
 6'. Plants erect or epiphytic; macrophylls erect, developed, or with enations..... (7)
 7 (6'). Multilayered sporangial walls (eusporangiate)..... (8)
 7'. Single-layered sporangial wall (leptosporangiate)..... (9)
 8. Plants with macrophylls; sporangia clustered on a stalked spike inserted on the leaf base..... 16. *Ophioglossum* L.
 8'. Plants leafless or with sterile appendages, dichotomous axes; synangia axillary, 3-sporangiate,
 on a very short axis..... 21. *Psilotum* Sw.
 9 (7'). Sporangia clustered only in the proximal pair of pinnae.....3. *Anemia* Sw.
 9'. Sporangia clustered in the hypophyll (10)
 10 (9'). Sporangia clustered in elongated linear sori or costal coenosori..... (11)
 10'. Sporangia scattered along veins, or clustered in marginal coenosori,
 or sori round isolated or confluent at maturity..... (14)
 11 (10). Sporangia clustered in costal coenosori on pinnate blades 7. *Blechnum* L.
 11'. Sporangia clustered in elongated sori in secondary veins on divided blades or sori linear on linear blades (12)
 12 (11'). Rhizomes dorsiventral; sori with paraphysis29. *Vittaria* Sm.
 12'. Rhizomes radial; sori without paraphysis..... (13)
 13 (12'). Sori protected by a lateral indusium..... 5. *Asplenium* C. Presl
 13. Sori exindusiate..... 11. *Hemionitis* L.
 14 (10'). Sporangia naked or protected by indusia reniform or round, never protected

- by farinaceous secretions or recurved blade margins..... (15)
- 14'. Sporangia protected by recurved blade margins, pseudoindusium or by farinaceous secretions (23)
- 15 (14). Sori exindusiate; phyllopodium always present..... (16)
- 15'. Sori indusiate; indusium persistent or caducous; in the latter case bi-tripinnate blades;
 phyllopodium always absent..... (21)
- 16 (15). Blades entire (17)
- 16'. Blades pinnatisect or pinnatipartite (18)
- 17 (16). Fronds monomorphic more than 10 cm long, approximate; rhizome short and robust,
 with brown scales laxly arranged; sori multiseriate8. *Campyloneuron* C. Presl
- 17'. Fronds dimorphic, less than 10 cm long, spaced; rhizome long-creeping, with hyaline scales
 densely arranged; sori uniseriate..... 15. *Microgramma* C. Presl
- 18 (16'). Veins free; rhizome scales basally attached 17. *Pecluma* M. G. Price
- 18'. Veins netted; rhizome with peltate scales..... (19)
- 19 (18'). Fronds glabrous or glabrescent, generally more than 35 cm long; petiole straw-colored or brown shiny (20)
- 19'. Fronds scaly, smaller than 35 cm long; petiole scaly, never stramineous20. *Pleopeltis* Willd.
- 20 (19). Sori borned on two excurrent fused veinlets, included in an soriferous areole ...18. *Phlebodium* (R. Br.) J. Sm.
- 20'. Sori borned on a single, free, excurrent veinlet, included in an soriferous areole27. *Serpocaulon* A. R. Sm.
- 21 (15'). Blades pinnate, indusium generally persistent28. *Thelypteris* Schmidel
- 21'. Blades bi-tripinnate, indusium caduceus..... (22)
- 22 (21'). Fronds pilose..... 13. *Macrothelypteris* (H. Itô) Ching
- 22'. Fronds glabrous 24. *Rumohra* Raddi
- 23 (14'). Rhizome pilose; nectaries at base of proximal pinnae22. *Pteridium* Scop.
- 23'. Rhizome glabrous or scaly, nectaries absent (24)
- 24. (23') Sporangia immersed in farinaceous secretions 19. *Pityrogramma* Link
- 24'. Sporangia without farinaceous secretions..... (25)
- 25 (24'). Blades pinnate or pinnate-pinnatifid24. *Pteris* L.
- 25'. Blades bi-tripinnatipartite or pinnatisect, pentagonal or subtriangular, or 2 to more times pinnate,
 triangular-elongate (26)
- 26 (25'). Fronds bi-tripinnatipartite or -pinnatisect, pentagonal; sporangia in coenosori..... 10. *Doryopteris* J. Sm.
- 26'. Fronds tri-bipinnate or tripinnatisect, triangular o linear-lanceolate; sporangia in isolated
 sori or somewhat confluent at maturity or scattered along veins (27)
- 27. (26') Sporangia scattered along veins..... 4. *Anogramma* Link
- 27'. Sporangia in circular sori, sometimes connivent at maturity..... (28)
- 28. Pseudoindusium without veins1. *Adiantopsis* Fée
- 28' Pseudoindusium with veins..... 2. *Adiantum* L.

APPENDIX 2

Matrix of taxa used to obtain the similarity index of the floristic composition of ferns and lycophytes among the different protected areas from northeast Argentina. Presence (1) - absence (0).

Matriz de taxa usada para obtener el índice de similitud de la composición florística de helechos y licofitos entre las diferentes áreas protegidas del nordeste de Argentina. Presencia (1) – ausencia (0).

TAXA	Mburucuyá	Iberá	Cuñá Pirú	Guarani	Teyú Cuaré
<i>Adiantopsis chlorophylla</i> (Sw.) Fée	1	1	1	1	1
<i>A. dichotoma</i> (Cav.) T. Moore.	0	0	1	0	1
<i>A. radiata</i> (L.) Fée	0	0	1	0	1
<i>A. tweedieana</i> (Hook.) Link-Pérez & Hickey	1	1	0	0	1
<i>A. x australopedata</i> Hickey et al.	0	0	1	0	0
<i>Adiantum latifolium</i> Lam.	0	0	0	0	1
<i>A. lorentzii</i> Hieron.	0	1	1	1	0
<i>A. pseudotinctum</i> Hieron.	1	0	1	1	0
<i>A. raddianum</i> C. Presl	0	1	1	1	1

TAXA	Mburucuyá	Iberá	Cuñá Pirú	Guaraní	Teyú Cuaré
<i>Alsophila setosa</i> Kaulf.	0	0	0	1	0
<i>Anemia phyllitidis</i> (L.) Sw. var <i>phyllitidis</i>	1	1	1	1	1
<i>A. phyllitidis</i> var. <i>tweedieana</i> (Hook.) Hassl.	1	1	1	1	0
<i>A. simplicior</i> (H. Christ) Mickel	1	0	0	0	0
<i>Anemia tomentosa</i> (Savigny) Sw.	0	1	0	1	0
<i>A. tomentosa</i> (Savigny) Sw. var. <i>anthriscifolia</i> (Schrad.) Mickel	0	0	1	1	1
<i>Anogramma chaerophylla</i> (Desv.) Link	1	1	1	1	1
<i>Asplenium abscissum</i> Willd.	0	0	1	1	0
<i>A. argentinum</i> Hieron.	0	0	1	0	0
<i>A. balansae</i> (Baker) Sylvestre	0	0	1	0	0
<i>A. brasiliense</i> Sw.	0	0	1	1	0
<i>A. gastonis</i> Fée	0	0	1	1	0
<i>A. inaequilaterale</i> Willd.	0	0	1	0	0
<i>A. kunzeanum</i> Rosenst.	0	0	0	1	0
<i>A. laetum</i> Sw.	0	0	0	1	0
<i>A. pulchellum</i> Raddi	0	0	1	0	0
<i>A. scandicinum</i> Kaulf.	0	0	0	1	0
<i>A. sellowianum</i> Hieron.	1	0	0	0	0
<i>A. serra</i> Langsd. & Fisch.	0	0	0	0	1
<i>A. serratum</i> L.	0	0	0	0	1
<i>A. ulbrichtii</i> Rosenst.	0	0	1	1	0
<i>A. triquetrum</i> N. Murak. & R.C. Moran	0	0	1	1	0
<i>Azolla cristata</i> Kaulf.	1	1	1	0	0
<i>A. filiculoides</i> Lam.	1	1	0	0	0
<i>Blechnum asplenioides</i> Sw.	0	0	0	0	1
<i>B. australe</i> L. subsp. <i>auriculatum</i> (Cav.) de la Sota	0	0	0	1	0
<i>B. austrobrasilianum</i> de la Sota	0	0	0	1	0
<i>B. binervatum</i> (Poir.) C.V. Morton & Lellinger subsp. <i>acutum</i> (Desv.) R.M. Tryon & Stolze	0	0	0	1	0
<i>B. brasiliense</i> Desv.	0	1	1	1	1
<i>B. laevigatum</i> Cav.	0	0	0	0	1
<i>B. lanceola</i> Sw.	0	0	0	1	0
<i>B. occidentale</i> L.	0	0	0	1	0
<i>B. serrulatum</i> Rich.	1	1	0	0	0
<i>Campyloneurum austrobrasilianum</i> (Alston) de la Sota	0	0	0	1	0
<i>C. minus</i> Fée	0	0	1	0	0
<i>C. nitidum</i> (Kaulf.) C. Presl	1	1	1	1	1
<i>Cassebeera tripilla</i> (Lam.) Kaulf.	0	1	1	1	0
<i>Ceratopteris pteridoides</i> (Hook.) Hieron.	1	1	0	0	0
<i>Cyathea atrovirens</i> (Langsd. & Fisch.) Domin	0	0	0	0	1

TAXA	Mburucuyá	Iberá	Cuñá Pirú	Guaraní	Teyú Cuaré
<i>Ctenitis submarginalis</i> (Langsd. & Fisch.) Ching	0	0	1	1	1
<i>Dennstaedtia globulifera</i> (Poir.) Hieron.	0	0	1	1	0
<i>Dicksonia sellowiana</i> Hook.	0	0	0	1	0
<i>Dicranopteris flexuosa</i> (Schrad.) Underw.	0	0	0	0	1
<i>Didymochlaena truncatula</i> (Sw.) Sm.	0	0	1	1	0
<i>Didymoglossum hymenoides</i> (Hedw.) Desv.	0	0	0	1	0
<i>D. reptans</i> (Sw.) C.Presl.	0	0	0	1	0
<i>Diplazium cristatum</i> (Desr.) Alston	0	0	1	1	0
<i>D. herbaceum</i> Fée	0	0	0	1	0
<i>D. striatum</i> (L.) C. Presl.	0	0	0	1	0
<i>Doryopteris concolor</i> (Langsd. & Fisch.) Kuhn	1	1	1	1	1
<i>D. pentagona</i> Pic. Serm.	1	1	1	1	0
<i>D. lorentzii</i> (Hieron.) Diels	1	0	0	0	0
<i>D. nobilis</i> (T. Moore) C. Chr.	0	0	1	1	1
<i>Equisetum giganteum</i> L.	0	1	0	0	0
<i>Elaphoglossum pachydermum</i> (Fée) T. Moore	0	0	0	0	1
<i>Hemionitis tomentosa</i> (Lam.) Raddi	1	1	1	1	1
<i>Huperzia mandiocana</i> (Raddi) Trevis.	0	0	0	1	0
<i>Hypolepis</i> sp.	0	0	0	1	0
<i>Isoëtes ekmanii</i> U. Weber	0	1	0	1	0
<i>I. pedersenii</i> E.I. Meza & Macluf	1	0	0	0	0
<i>Lastreopsis effusa</i> (Sw.) Tindale subsp. <i>divergens</i> (Schkuhr) Tindale	0	0	1	0	0
<i>L. effusa</i> (Sw.) Tindale subsp. <i>effusa</i>	0	0	0	1	0
<i>Lycopodiella alopecuroides</i> (L.) Cranfill	0	1	0	0	0
<i>L. cernua</i> (L.) Pic. Serm.	0	1	0	0	1
<i>Lygodium volubile</i> Sw.	0	0	0	0	1
<i>Macrothelypteris torresiana</i> (Gaudich.) Ching	1	0	1	1	0
<i>Marsilea ancylopoda</i> A. Braun	1	1	0	0	1
<i>Megalastrum connexum</i> (Kaulf.) A.R. Sm. & R. C. Moran	0	0	1	1	0
<i>Microgramma lindbergii</i> (Kuhn) de la Sota	0	0	0	0	1
<i>M. squamulosa</i> (Kaulf.) de la Sota	0	1	1	1	0
<i>M. vacciniifolia</i> (Langsd. & Fisch.) Copel.	1	1	0	0	1
<i>Niphidium crassifolium</i> (L.) Lellinger	0	0	1	1	0
<i>Ophioglossum crotalophoroides</i> Walter	1	0	0	1	0
<i>O. nudicaule</i> L. f.	1	1	0	0	0
<i>O. reticulatum</i> L.	1	1	0	1	0
<i>Osmunda regalis</i> L. var. <i>spectabilis</i> (Willd.) A. Gray	0	1	0	1	1
<i>Osmundastrum cinnamomeum</i> (L.) C.Presl	0	1	0	0	0
<i>Pecluma filicula</i> (Kaulf.) M.G. Price	1	0	1	1	0
<i>P. pectinatiformis</i> (Lindm.) M.G. Price	1	0	0	1	0

TAXA	Mburucuyá	Iberá	Cuñá Pirú	Guaraní	Teyú Cuaré
<i>P. robusta</i> (Fée) M. Kessler & A.R. Sm.	1	1	0	0	0
<i>P. sicca</i> (Lindm.) M.G. Price	1	0	0	1	0
<i>P. singeri</i> (de la Sota) M.G.Price	0	0	1	1	0
<i>Phlebodium areolatum</i> (Willd.) J. Sm.	0	0	0	0	1
<i>P. aureum</i> (L.) J. Sm.	1	0	0	0	0
<i>Pityrogramma calomelanos</i> (L.) Link	1	1	0	0	1
<i>P. trifoliata</i> (L.) R.M.Tryon	1	0	1	0	0
<i>Pleopeltis hirsutissima</i> (Raddi) de la Sota	0	0	1	1	0
<i>P. minima</i> (Bory) J.Prado & R.Y.Hirai	1	1	1	1	0
<i>P. pleopeltifolia</i> (Raddi) Alston	1	1	1	1	1
<i>Polyphlebium angustatum</i> (Carmich.) Ebihara & Dubuisson.	0	0	0	1	0
<i>Polystichum platyphyllum</i> (Willd.) C. Presl	0	0	0	1	0
<i>Psilotum nudum</i> (L.) P.Beauv.	1	0	0	1	0
<i>Pteridium arachnoideum</i> (Kaulf.) Maxon	1	1	1	1	0
<i>Pteris deflexa</i> Link	0	0	1	1	0
<i>P. denticulata</i> Sw.	1	0	1	1	0
<i>P. lechleri</i> Mett.	0	0	0	1	0
<i>Regenlidium diphyllum</i> Lindm.	0	1	0	0	0
<i>Rumohra adiantiformis</i> (G. Forst.) Ching	1	0	0	0	0
<i>Salvinia auriculata</i> Aubl.	1	0	0	0	0
<i>S. biloba</i> Raddi	0	1	0	0	0
<i>S. minima</i> Baker	1	1	0	0	0
<i>Selaginella microphylla</i> (Kunth) Spring	0	0	1	1	0
<i>S. muscosa</i> Spring	0	0	0	1	0
<i>S. sulcata</i> (Poir.) Mart.	0	0	0	1	0
<i>S. sellowii</i> Hieron.	1	1	0	0	1
<i>Serpocaulon vacillans</i> (Link.) A.R. Sm.	1	0	0	0	1
<i>Tectaria incisa</i> Cav.	0	0	1	0	1
<i>Thelypteris amambayensis</i> (H. Christ) Ponce	0	0	0	1	0
<i>T. conspersa</i> (Schrad.) A. R. Sm.	0	1	0	0	0
<i>T. dentata</i> (Forssk.) E.P. St. John	1	1	1	1	0
<i>T. hispidula</i> (Decne.) C.F. Reed	1	1	0	1	1
<i>T. interrupta</i> (Willd.) K. Iwats.	1	1	0	0	0
<i>T. metteniana</i> Ching	0	0	0	1	0
<i>T. patens</i> (Sw.) Small var. <i>smithiana</i> Ponce	0	0	0	1	0
<i>T. recumbens</i> (Rosenst.) C.F. Reed	0	0	0	1	0
<i>T. riograndensis</i> (Lindm.) C.F. Reed	0	0	1	1	0
<i>T. rivularioides</i> (Fée) Abbiatti	1	1	0	1	0
<i>T. sanctae-catharinae</i> (Rosenst.) Ponce	0	0	0	1	0
<i>T. scabra</i> (C. Presl) Lellinger	0	0	1	1	0
<i>T. serrata</i> (Cav.) Alston	1	1	0	0	0

TAXA	Mburucuyá	Iberá	Cuñá Pirú	Guaraní	Teyú Cuaré
<i>Trichomanes emarginatum</i> C.Presl	0	0	0	1	0
<i>T. pilosum</i> Raddi	0	0	0	0	1
<i>Vittaria graminifolia</i> Kaulf.	1	0	0	0	0
<i>V. lineata</i> (L.) Sm.	0	0	0	1	0

Editorial responsibility: Julio R. Gutiérrez

Received May 22, 2012; accepted December 28, 2012

