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A phytosociological analysis of *Butia yatay* (Arecaceae) palm groves and gallery forests in Entre Rios, Argentina

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Abstract. Multivariate floristic analyses of *Butia yatay* palm groves and gallery forest associated with the Uruguay River basin of Entre Rios Province (Argentina) were performed, including vegetation stands of Rio Grande do Sul State (Brazil). Several new phytosociological associations were identified. These include *Eugenio myrcianthis–Butietum yatay* association, which represents palm groves on sandy soils evolved from ancient river deposits, and *Bignonio callistegioidis–Terminalietum australis* association, which represents some gallery forests on regular floodplains of the Uruguay River. Both are placed in the new Pampean alliance *Guettardo uruguensis–Bution yatay*, which is part of the *Dyckio brevifoliae–Terminalietalia australis* order and *Sebastianio schottiae–Terminalietea australis* class, which has been described for Brazil.

Additional keywords: *Butia* associations, *Terminalia* gallery forest, phytosociology, Uruguay River.

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Introduction

Butia (Becc.) Becc. is a genus that belongs to the Arecaceae family and is composed of ~20 species distributed in South America. *Butia yatay* (Mart.) Becc. is an endemic palm distributed in the centre-east of Argentina, west of Uruguay and south-west of Brazil (Zuloaga *et al*. 2008; Soares *et al*. 2014).

This species is a significant element in the landscape and is associated with forests and savannas, growing generally in groups, conforming palm groves (‘palmares’) that have a disjunct distribution (Báez 1942). In Entre Ríos Province, *B. yatay* conforms palm groves, mainly in the Uruguay River basin (Lorentz 1876; Martínez Crovetto and Piccinini 1950; Chebataroff 1974). This ecosystem is widely recognised for its scenic value, having a valuable floral and faunal biodiversity (APN 1982; Aceñolaza and Rodriguez 2009; Aceñolaza and Rodriguez 2011).

Butia yatay is associated with savannas and other plant physiognomies distributed on elevated former fluvial terraces, sandy soils and interfluves in several zones of Uruguay (Henderson *et al*. 1995), Santa Fe (Argentina; Martínez-Crovetto and Piccinini 1950), Corrientes (Argentina; Eskuche 1992), Misiones (Argentina; Fontana 1996) and Rio Grande do Sul (Brazil; Fiaschi and Pirani 2009). Aside from the floristic characterisations documented by Burkart (1957) and Chebataroff (1974), phytosociological studies including this arecoid palm have been conducted by Martínez-Crovetto and Piccinini (1950), Eskuche (1992), Fontana (1996) and Batista *et al*. (2014). The paper by Martínez-Crovetto and Piccinini (1950) is a phytosociological synthesis of grazing palm groves of Argentina. Eskuche (1992) wrote a synthesis of the grasslands of eastern Argentina, where the associations *Crotono–Elyonuretum mutici* (Esteros de Iberá, Corrientes Province) and *Schlechtendalio luzulaefoliae–Brometum auletici* (El Palmar National Park, Entre Rios Province) were described as a successional feature of the *Butia* vegetation complex. The same occurs with the *Macrosiphonio undulatae–Aristidetum jubatae* described by Fontana in Misiones Province. Also, Batista *et al*. (2014) defined several vegetation types of El Palmar National Park, including some *B. yatay* units, but without any description of syntaxa following the International Code of Phytosociological Nomenclature (Martínez Carretero *et al*. 2016).

In lower topographic positions, where flooding effects can exclude *B. yatay*, gallery forests of the Uruguay River are found. These forests contain *Nectandra*, *Pouteria*, *Lythraea* and several species of *Myrtaceae*, which floristically connect them to the rain forests of southern Brazil, as we know from the phytosociological contributions by Bolòs *et al*. (1991) and Kegler *et al*. (2010), Venezuela (Galán de Mera *et al*. 2006), Bolivia (Galán de Mera and Linares Perea 2008) and Colombia (Rangel 2015).

Thus, the aim of the study was to describe plant associations related to *B. yatay* groves and Uruguay River gallery forest by using the syntaxonomical system. As a specific objective, we compared this vegetation with similar forests described from south-eastern Brazil. Variation in floristic composition was quantified, and related to climate and soil gradients.

Materials and methods

Study area

The present work was conducted in the middle–lower section of the Uruguay River basin, in several locations belonging to the El Palmar National Park and surrounding areas of Entre Ríos Province, Argentina (Fig. 1).

El Palmar National Park (31°52 S, 58°15 W) extends over 8500 ha on the western margin of the Uruguay River. The landscape in the Park is slightly undulating, between 6 and 77 m asl, and is structured with streams flowing towards the Uruguay River. In this watershed, the alluvial plain contains riparian forests, whereas the highlands are composed of a heterogeneous landscape of forest, savannas and grasslands with *B. yatay* palms that grow in a variable density from pure groves to mixed forest (APN 1982; Aceñolaza and Rodriguez 2011; Rolhauser and Batista 2014).

Most of this region corresponds to an undulating landscape that has been shaped by fluvial erosion over Pleistocenic subtrata, which presents an heterogeneous deposit of ancient Uruguay River composed of medium–dense soils, mainly silt, sand and gravel (Aceñolaza 2007; Iriondo and Krohling 2008). Topographic gradients include lower deposition areas, associated with Rio Uruguay floodplain, sandy flats, and medium and upper terraces with frank and sandy soils. Some eroded soils can expose gravel hills present in the former mining areas (Godagnone *et al*. 2002; Aceñolaza 2007). Top soils are mainly Entisols, (Udifluvents) 75%, Molisols (Fluventic Hapludols) 20% and Vertisols 5% (INTA 1998).

The climate of north-eastern Argentina varies between the tropical humid conditions of the Misiones Province and temperate conditions with a lower humidity in the Entre Rios Province. According to the Global Bioclimatic Classification System developed by Rivas-Martínez (Rivas-Martínez and Rivas-Sáenz 2015) and his biogeographical synthesis (Rivas-Martínez *et al*. 2011), the study area presents a temperate oceanic climate and, in this classification, the Mesophytic Pampean Province belongs to the temperate zone of South America (Austroamerican Sunkingdom). In this climate type, the thermotemperate bioclimatic belt with its subhumid version can be recognised (Table 1). In all, 73% of annual precipitation occurs in the warm season, from October to April, and the mean annual precipitation for this region is 1275 mm (Rojas and Saluso 1987; Brizuela 2006). Mean annual temperature is 18.5°C, with the mean temperature for the coldest month (July) being 12.3°C, and that for the warmest month (January) 25°C.

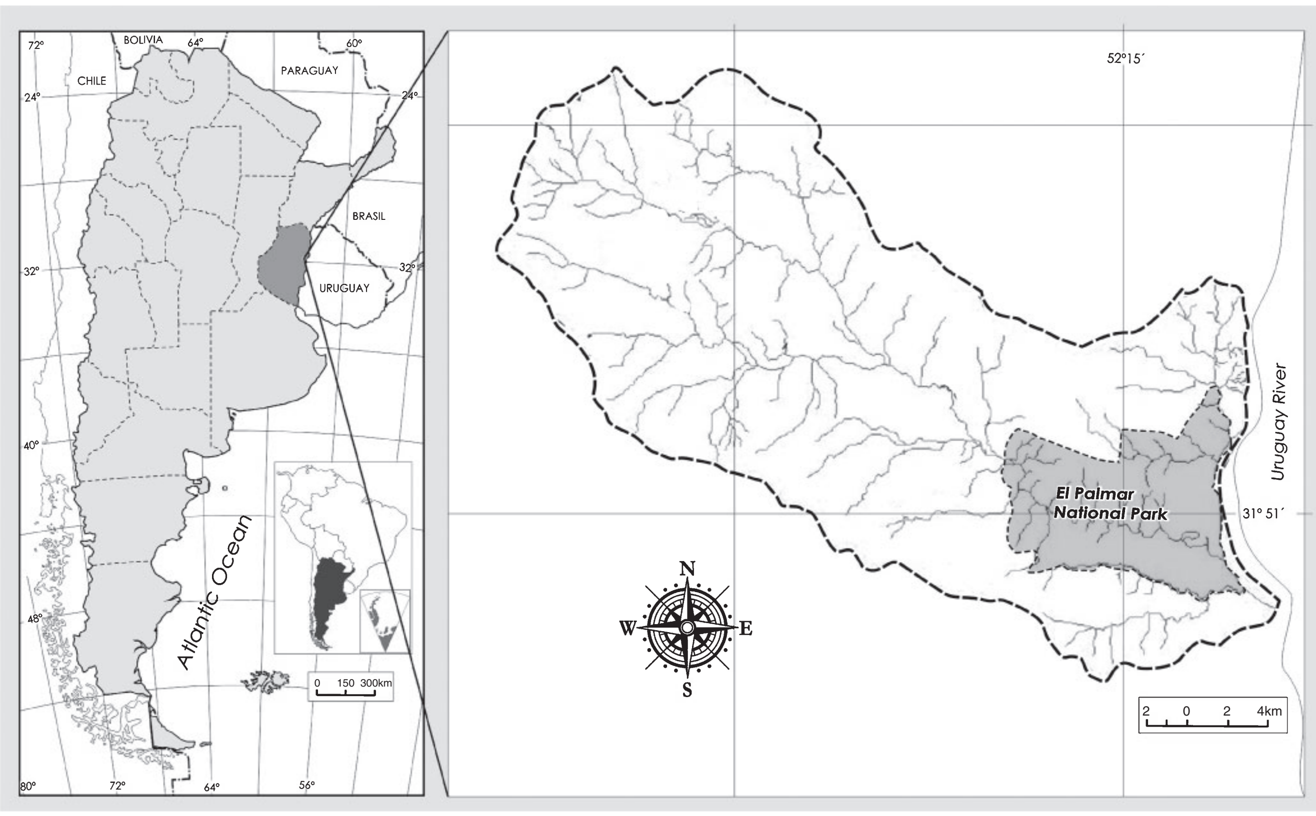

Fig. 1. Location of the studied area in Argentina.

Table 1. Meteorological, climatic data, bioclimatic diagnosis and correspondence with associations in the meteorological stations consulted in Argentina (ARG), Brazil (BRA) and Uruguay (URU)

H, altitude (m); Ic, continentality index; Io, annual ombrothermic index; Ios3, precipitation and temperature quotient of the warmest 3-monthly period; Ioti, precipitation and temperature quotient of the coldest 3-monthly period; It, thermicity index; P, annual precipitation; T, mean annual temperature; Tp, positive temperature. But, *Eugenio myrcianthis–Butietum yatay*; Butia, *Butia* reports not in phytosociological tables; Big-Te, *Bignonio callistegioidis–Terminalietum australis*; Geo-Fic, *Geonomo elegantis–Ficetum organensis*; Caly-Ara, *Calyptrantho concinnae–Araucarietum angustifoliae*; Myr-Siph, *Myrceugenio glaucescentis–Siphoneugenetum reitzii*; Cup-Lue, *Cupanio vernalis–Luehetum divaricatae*; and Dyc-Salic, *Dyckio brevifoliae–Salicetum humboldtianae*

Meteo station	H	T	P	Ic	It	Tp	Io	Ios3	Ioti	Bioclimatic diagnosis	Association
Concepción ARG	72	21.1	1247	11.7	519	2537	4.9	5.3	3.9	Oceanic, thermotropical, subhumid	But
Concordia ARG	22	18.6	1278	13.0	435	2230	5.7	4.7	5.6	Oceanic, thermotemperate, subhumid	But
Goya ARG	54	20.3	1108	12.0	493	2438	4.5	4.3	2.8	Oceanic, thermotropical, subhumid	But
Loreto ARG	147	20.7	1749	10.4	522	2487	7.0	5.6	7.5	Hyperoceanic, thermotropical, humid	Butia
Saladas ARG	59	20.9	1097	11.9	509	2508	4.3	3.1	3.0	Oceanic, thermotropical, subhumid	But
San Ignacio ARG	89	20.9	1732	10.3	526	2505	6.9	5.5	7.3	Hyperoceanic, thermotropical, humid	Butia
Ubajay ARG	44	18.3	1186	13.4	421	2192	5.4	4.4	5.5	Oceanic, thermotemperate, subhumid	But, Big-Te
Bom Jesus BRA	1047	15.2	1743	8.6	380	1823	9	6.7	11.5	Hyperoceanic, mesotropical, humid	Myr-Siph
Caxias do Sul BRA	788	16.6	1908	8.7	421	1991	9.5	8.3	11.0	Hyperoceanic, mesotropical, humid	Cup-Lue
Giruá BRA	350	19.6	1847	10.1	486	2346	7.8	6.1	10.3	Hyperoceanic, thermotropical, humid	Butia
Santa Maria do Herval BRA	470	17.9	1706	8.9	455	2147	7.9	6.8	9.6	Hyperoceanic, mesotropical, humid	Dyc-Salic
São Francisco de Paula BRA	878	15.3	2119	8.5	378	1834	11.5	9.3	20.5	Hyperoceanic, mesotropical, humid	Geo-Fic, Caly-Ara
Paysandú URU	41	18.3	1175	13.5	423	2199	5.3	5.7	5.8	Oceanic, thermotemperate, subhumid	Butia
Salto URU	45	18.5	1294	13.0	432	2218	5.8	4.7	5.8	Oceanic, thermotemperate, subhumid	Butia

Data, nomenclature and collections

This phytosociological study is based on 38 plots surveyed in El Palmar National Park (Entre Rios, Argentina), following the Braun-Blanquet method (Braun-Blanquet 1979). Structurally homogeneous sampling sites were selected in the study area (forests, palm forests, riverine forests and grasslands) on the basis of previous field research, satellite images Landsat 5 TM Path 224/Row 083 and Google Earth images.

Forest plots of 10 × 10 m were selected, following the minimum average phytosociological principal area (Dengler *et al*. 2008). Area of the sample plots was determined by the minimal-area method. Thirteen other plots, which had previously been surveyed by Martínez Crovetto and Piccinini (1950) in Entre Ríos, Corrientes and Santa Fe provinces, were added. Cover abundance of each species in the sample units (from herbaceous to woody) was estimated in the field within each homogeneous vegetation unit (Gehu and Rivas-Martínez 1981) and each physiotope (Schwabe and Kratochwil 1994). All plots were prepared in a phytosociological table using SORT 4.1 program (Ackermann and Durka 1997), taking the Braun-Blanquet scale into account (<5% = R, 6–10% = +, 11–20% = 1, 21–40% = 2, 41–60% = 3, 61–80% = 4 and >81% = 5).

So as to relate *Butia*-dominated vegetation from Argentina to the neighbouring vegetation from Brazil, 59 plots from a phytosociological survey conducted in Brazil (Kegler *et al*. 2010) were included in the analysis. These authors followed the Braun-Blanquet method and proposed two phytosociological classes for the vegetation of Rio Grande do Sul (Brazil), according to the following syntaxonomical scheme (the plot numbers of each association and description are given in parentheses):

Class *Cedrelo fissilis–Ocoteetea puberulae* (Bolòs *et al*. 1991)
Order *Araucario angustifoliae–Ocoeteetalia puberulae* (Bolòs *et al*. 1991)
Alliance *Araucario angustifoliae–Ocoteion puberulae* (Bolòs *et al*. 1991)
Association *Calyptrantho concinnae–Araucarietum angustifoliae* (Kegler *et al*. 2010)
(29. Paranean mesotropical and humid forests developed on basaltic soils that are dry or with a persistent humidity).
Association *Myrceugenio glaucescentis–Siphoneugenetum reitzii* (Kegler *et al*. 2010)
(3. Paranean mesotropical and hyperhumid forests developed on basaltic soils).
Order *Piptadenio rigidae–Nectandretalia megapotamicae* (Bolòs *et al*. 1991)
Alliance *Erythrino falcatae–Phytolaccion dioicae* (Kegler *et al*. 2010)
Association *Cupanio vernalis–Luehetum divaricatae* (Kegler *et al*. 2010)
(19. Paranean mesotropical and humid forests developed on deep and drained soils that had sporadically flooded).
Order *Fico organensis–Nectandretalia rigidae* (Kegler *et al*. 2010)
Alliance *Fico organensis–Nectandrion rigidae* (Kegler *et al*. 2010)
Association *Geonomo elegantis–Ficetum organensis* (Kegler *et al*. 2010)
(3. Atlantic Brazilian mesotropical and humid forests developed on basaltic soils).
Class *Sebastianio schottianae–Terminalietea australis* (Kegler *et al*. 2010)
Order *Dyckio brevifoliae–Terminalietalia australis* (Kegler *et al*. 2010)
Alliance *Dyckio brevifoliae–Salicion humboldtianae* (Kegler *et al*. 2010)
Association *Dyckio brevifoliae–Salicetum humboldtianae* (Kegler *et al*. 2010)
(5. Paranean mesotropical humid edapho-hygrophilous forests developed on fluvial deposists).

Nomenclatural and author data of plants follow The Plant List (2015) database; the collected specimens were lodged at the DTE herbaria (Thiers 2016). For plant identification, the main territorial floras were consulted (Cabrera 1963, 1965*a*, 1965*b*, 1967, 1968, 1970; Burkart 1969, 1974, 1979, 1987; Cabrera and Zardini 1993; Burkart and Bacigalupo 2005; Anton and Zuloaga 2012*a*, 2012*b*, 2012*c*, 2012*d*, 2013, 2014*a*, 2014*b*, 2014*c*, 2015). Syntaxonomy is based on the International Code of Phytosociological Nomenclature (Weber *et al*. 2000) and plant distributions in Tropicos (2016).

Vegetation classification, bioclimatic analysis and ecological variability

We used the phytosociology method (Braun-Blanquet system) for vegetation classification, the aim of which is to define vegetation units by grouping plots with similar species compositions together and arrange these units into a hierarchical system for comparing the qualitative and quantitative floristic compositions of different geographic spaces (Dengler *et al*. 2008; Chytrý *et al*. 2011). Thus, phytosociology can be used to define biogeographical units with a cartographic delimitation of the vegetation, in addition to suitably compiled and mapped bioclimatic and soil factors (Rivas-Martínez *et al*. 2011). Braun-Blanquet system has been applied on the vegetation around the world (i.e. tropical Andes by Rangel *et al*. 1997; Galán de Mera *et al*. 2014; South Africa, Lesotho and Swaziland by Mucina and Rutherford 2006; American Arctic Zone by Walker *et al*. 2011; Western North America by Peinado *et al*. 2011; Taiwan by Li *et al*. 2015; Europe by Mucina *et al*. 2016; and Argentina by Martínez Carretero *et al*. 2016). Recently, to compare plot datasets, and to group species into phytosociological units (syntaxonomic scheme), the analytical software JUICE (Tichý 2002, 2005; Peinado *et al*. 2013) has been implemented. Associations and higher units represent a synthetic way to display the vegetation of a territory on SIG-cartography as the US National Vegetation Classification approach (Matthews *et al*. 2011).

Association is the basic vegetation unit in the Braun-Blanquet system; alliance, order and class are higher-order vegetation units in the classification hierarchy. Here, we defined an association as a community unit with a homogeneous floristic composition and similar habitat conditions among plots (Biondi 2011).

So as to group diagnostic species into phytosociological units, and to identify fidelity among plant species on plots from Entre Rios Province (Argentina) and Rio Grande do Sul (Brazil), we used JUICE software (Tichý 2002), with phi coefficient as the fidelity measure (Chytrý *et al*. 2002); this coefficient is a standard method in phytosociological studies because phi coefficient is independent of the number of plots in the dataset. JUICE standardises to equal size of all plot groups (Tichý and Chytrý 2006). These groups were separated according to types of vegetation (forests, palm forests, riverine forests and grasslands) and sorted by percentage frequency. Species with a phi of $\geq$0.25 were considered diagnostic for classes, and species with a phi of $\geq$0.50 were termed highly diagnostic of orders, alliances and associations. The species concentration was significant when Fishers' exact test presented α of $\geq$0.05. For grassland species, only those with more than three census presences were listed, because the presence of grassland species has a low significance for the phytosociological units of a forest.

To examine relationships between climate and associations, the bioclimatic system of Rivas-Martínez (Rivas-Martínez and Rivas-Sáenz 2015) was used, with data from several meteorological stations of north-eastern Argentina, western Uruguay and Rio Grande do Sul (Brazil), and with data also taken from Schwarz (2015). Annual precipitation (P) and mean annual temperature (T) were used, as well as several bioclimatic indices, including continentality index (Ic = Tmax – Tmin, where Tmax = mean temperature of the warmest month, Tmin = mean temperature of the coldest month), thermicity index (It = (T + M + m) 10, where M = average maximum temperature, and m = average minimum temperature of the coldest month of the year), positive temperature (Tp, summed in degree tenths when T > 0°C) and ombrothermic indices (precipitation and temperature quotient, I = P/Tp $\times$ 100) of the year (Io), and of the warmest and coldest 3-monthly periods (Ios3 and Ioti).

As soon as characteristic species of phytosociological units were identified for *Butia yatay* and gallery forests of Entre Ríos Province, we performed a classification using the Sorensen index and group average as the group-linkage method (Dengler *et al*. 2008). The phytosociological table was ordered with the SORT program, according to the groups generated by the resulting dendrogram. We used detrended correspondence analysis (DCA), including plots and their species, so as to show floristic dissimilarities in palm groves of *B. yatay* and river forests, and their relation to soil conditions and vegetation strata. Statistical analysis was performed using PC-ORD 5 software (McCune and Mefford 2011).

Results

Relation between floristic composition and bioclimatic indices

The relationships between the vegetation studied and the meteorological data, altitude and the blioclimatic indices are shown in the Table 1. Brazilian associations belonging to the *Cedrelo fissilis–Ocoteetea puberulae* (*Calyptrantho concinnae–Araucarietum angustifoliae*, *Myrceugenio glaucescentis–Siphoneugenetum reitzii*, *Cupanio vernalis–Luehetum divaricatae* and *Geonomo elegantis–Ficetum organensis* associations) and to *Sebastianio schottianae–Terminalietea australis* (*Dyckio brevifoliae–Salicetum humboldtianae* association) classes are more closely linked to annual precipitation (P) and ombrothermic indices (Io, Ios3 and Ioti); however, *Dyckio brevifoliae–Salicetum humboldtianae* association is close to that of Entre Ríos (Argentina) and Uruguay. In contrast, *Butia* sites present a thermotemperate or thermotropical bioclimate, whereas *Cedrelo–Ocoteetea* associations are placed in a mesotropical region. The *Dyckio brevifoliae–Salicetum humboldtianae* association is also situated in a mesotropical area, but with a higher thermicity index (It = 455). Thus, from a bioclimatic point of view, both classes can be separated.

Appendix 1 shows the plant composition in the palm groves and river forest of Entre Rios (Columns 1–4) and Rio Grande do Sul (Brazil) vegetation (Columns 5–9) and the frequency of occurrence of each species. Underlined numbers indicate phi of ≥25%. Species in Column 5 belong to *Dyckio brevifoliae–Salicetum humboldtianae*, those in Column 6 to *Calyptrantho concinae–Araucarietum angustifoliae*, in Column 7 to *Myrceugenio glaucescentis–Siphoneugenetum reitzii* (*Araucario angustifoliae–Ocoteion puberulae* alliance, and *Araucario angustifoliae–Ocoteetalia puberulae* order), in Column 8 to *Cupanio vernalis–Luehetum divaricatae* and in Column 9 to *Geonomo elegantis–Ficetum organensis* (*Fico organensis–Nectandrion rigidae* alliance, and *Fico organensis–Nectandretalia rigidae* order). All belong to the hyperoceanic mesotropical humid class *Cedrelo fissilis–Ocoteetea puberulae*, and present a common plant set with *Butia yatay* communities (Columns 1–3) and river forests (Column 4) of Entre Ríos, including *Allophylus edulis*, *Blepharocalyx salicifolius*, *Celtis iguanaea*, *Daphnopsis racemosa*, *Eugenia uniflora*, *Maytenus ilicifolia*, *Myrcia selloi*, *Sapium glandulosum* and *Sebastiania commersoniana*; many of them have a wide distribution in South America. *Dyckio brevifoliae–Salicetum humboldtianae* (Column 5) are Brazilian mesotropical humid (saxicoluos) edapho-hygrophilous forests that include plants in common with the Uruguay River basin in Argentina (including *Acacia bonariensis*, *Guettarda uruguensis*, *Luehea divaricata*, *Nectandra megapotamica*, *Pouteria salicifolia*, *Salix humboltiana* and *Terminalia australis*). However, some species such as *Bignonia callistegioides*, *Eugenia myrcianthes* and *Myrsine laetevirens* are absent from Brasilian stands, whereas *Bauhinia forficata*, *Calliandra brevipes*, *C. tweedii*, *Chrysophyllum gonocarpum*, *Dyckia brevifolia*, *Hedychium coronarium* and *Sebastiania schottiana* are not present in Argentinean plots. According to this different floristic combination, the *Bignonio callistegioidis–Terminalietum australis* association can be accepted for the riverine forests of the Uruguay River basin in Argentina.

Palm groves of *Butia yatay* contain species in common with the *Bignonio callistegioidis–Terminalietum australis* association, including *Acacia bonariensis*, *Cephalanthus glabratus*, *Eugenia myrcianthes*, *Guettarda uruguensis*, *Myrceugenia glaucescens*, *Myrsine laetevirens*, *Nectandra megapotamica* and *Pouteria salicifolia*. This situation leads us to set forth a new association, *Eugenio myrcianthis–Butietum yatay*, and a new alliance, *Guettardo uruguensis–Bution yatay*, inside *Sebastiano schottianae–Terminalietalia australis*.

Syntaxonomical synopsis

The following two associations and one alliance are described within the same phytosociological class (Table 2):

Class: *Sebastianio schottianae–Terminalietea australis* Butzke & Penas in Kegler *et al*. (2010).
Order: *Dyckio brevifoliae–Terminalietalia australis* Butzke & Penas in Kegler *et al*. (2010).
Alliance: *Guettardo uruguensis–Bution yatay* Rodriguez, Aceñolaza, Linares & Galán *ass. nov. hoc loco*
Associations:
Eugenio myrcianthis–Butietum yatay Rodriguez, Aceñolaza, Linares & Galán *ass. nov. hoc loco*
Bignonio callistegioidis–Terminalietum australis Rodriguez, Aceñolaza, Linares & Galán *ass. nov. hoc loco*

Description of the associations and the alliance

Eugenio myrcianthis–Butietum yatay Rodriguez, Aceñolaza, Linares & Galán *ass. nov. hoc loco*

Nomenclature type plot: Table 2, Plot P14 (*holotypus hoc loco designatus*).

Diagnostic species: *Baccharis coridifolia*, *Butia yatay*, *Dolichandra cynanchoides*, *Eugenia myrcianthes*, *Lantana megapotamica* and *Myrsine laetevirens*.

Dominant trees and shrubs: *Blepharocalyx salicifolius*, *Cephalanthus glabratus*, *Daphnopsis racemosa*, *Eugenia myrcianthes*, *Myrcia selloi*, *Myrsine laetevirens*, *Guettarda uruguensis*, *Maytenus ilicifolia*, *Pouteria salicifolia* and *Sebastiania commersoniana* are dominant in the canopy and *Butia yatay* is an emergent palm ~12–18 m (Fig. 2).

Herbs: *Andropogon lateralis*, *Desmanthus virgatus*, *Dorstenia brasiliensis*, *Elephantopus mollis*, *Hyptis mutabilis* and *Setaria parviflora*.

Oceanic thermotemperate subhumid palm groves situated on Entisols associated with former deposition areas of the lower Uruguay River basin; may present sandy and gravel soils (INTA 1998). This association occurs mainly in eastern Entre Rios Province and western Uruguay Republic.

Bignonio callistegioidis–Terminalietum australis Rodriguez, Aceñolaza, Linares & Galán *ass. nov. hoc loco*

Nomenclature type plot: Table 2, Plot P48 (*holotypus hoc loco designatus*).

Diagnostic species: *Bignonia callistegioides*, *Cardiospermum grandiflorum*, *Eugenia uruguayensis*, *Ruprechtia salicifolia*, *Salix humboldtiana* and *Terminalia australis*.

Dominant trees and shrubs: *Acacia bonariensis*, *Eugenia uruguayensis*, *Guettarda uruguensis*, *Ruprechtia salicifolia* and *Terminalia australis*. Homogeneous canopy ~6 m.

Herbs: *Adiantopsis chlorophylla*, *Dichondra* aff. *macrocalyx*, *Galium richardianum*, *Juncus* sp., *Oxalis conorrhiza*, *Plantago australis*, *Spigelia scabra* and *Tradescantia fluminensis*.

Oceanic thermotemperate gallery forests situated on regular floodplains of the Uruguay River basin with sandy and slimy soils (Fluvent Entisols, INTA 1998). This association also occurs in eastern Entre Rios Province and in western Uruguay.

Guettardo uruguensis–Bution yatay Rodriguez, Aceñolaza, Linares & Galán *all. nov. hoc loco*

Nomenclature type association: *Eugenio myrcianthis–Butietum yatay* Rodriguez, Aceñolaza, Linares & Galán *ass. nov.* (*holotypus hoc loco designatus*).

Diagnostic species: *Aloysia gratissima*, *Baccharis coridifolia*, *Bignonia callistegioides*, *Butia yatay*, *Dolichandra cynanchoides*, *Eugenia myrcianthes*, *Lantana megapotamica*, *Myrsine laetevirens* and *Xylosma tweediana*.

Dominant trees and shrubs: *Acacia bonariensis*, *A. caven*, *Allophylus edulis*, *Bignonia callistegioides*, *Blepharocalyx salicifolius*, *Butia yatay*, *Cardiospermum grandiflorum*, *Cephalanthus glabratus*, *Daphnopsis racemosa*, *Eugenia myrcianthes*, *E. uniflora*, *E. uruguayensis*, *Guettarda uruguensis*, *Maytenus ilicifolia*, *Myrcia selloi*, *Myrsine laetevirens*, *Pouteria salicifolia*, *Ruprechtia salicifolia*, *Salix*

Table 2. Phytosociological associations with their variants, and higher units in El Palmar National Park (Entre Rios, Argentina)
Plot numbers and groups are ordered according to dendrogram. Plots P1–P13 come from Entre Rios, Corrientes and Santa Fe provinces by Martínez-Crovetto and Piccinini (1950). See Fig. 3 for explanation of association codes. DCA, detrended correspondence analysis

Parameter	Dendrogram and DCA group A	B	C	D	E	F	G	H	I
Plots	PPPP	P	PPPP	PPPPPPPP	PPPPPPPP	PPPP	PPPPP	PPPPP	PPP
	PPPPPPPPP1111	1	1111	12222222	22233333	3333	34444	44444	455
	1234567890123	4	5678	90123456	78901234	5678	90123	45678	901
Area (m^2)	2222222222222	1	1111	11111111	11111111	1111	11111	11111	111
	5555555555555	0	0000	00000000	00000000	0000	00000	00000	000
	0000000000000	0	0000	00000000	00000000	0000	00000	00000	000
Altitude (m)	3444–65216267	3	2332	22222222	33343443	2232	22222	21211	11
	6465–23662157	4	9009	88877877	69919019	9748	79888	94234	348
Eugenio myrcianthis–Butietum yatay									
Butia yatay	5422243344233	1	2121	21111112	21111112	1R00	000RR	00000	000
Baccharis coridifolia	0RR0R1++R01+0	0	11RR	1111111R	21RRR1RR	0000	00000	00000	000
Lantana megapotamica	0000000000000	0	RRRR	RR1RRRRR	00000000	0000	00000	00000	000
Dolichandra cynanchoides	0000000000000	1	0000	00000000	00000000	0000	111R1	00000	000
Bignonio callistegioidis–Terminalietum australis									
Bignonia callistegioides	0000000000000	0	0000	R111RR1R	00000000	0000	001R0	0R1R1	110
Guettardo uruguensis–Bution yatay									
Eugenia myrcianthes	0000000000000	3	R1R1	000011RR	00000000	0221	0001R	00001	000
Myrsine laetevirens	0000000000000	0	R1R1	1R111RR1	00000000	0000	00000	R0002	000
Xylosma tweediana	0000000000000	0	R1R1	0000R111	00000000	0000	00000	00000	000
Aloysia gratissima	0000000000000	0	0000	11R1RR11	00000000	0000	00000	00000	000
Dyckio brevifoliae–Terminalietalia australis									
Guettarda uruguensis	0000000000000	1	111R	RRRR11RR	00000000	0000	00000	11001	211
Scutia buxifolia	0000000000000	0	0000	121R0000	00000000	00RR	11011	00000	000
Pouteria salicifolia	0000000000000	0	RR11	00000000	00000000	0000	00000	20123	033
Cephalanthus glabratus	0000000000000	0	R1RR	00000000	00000000	0000	00000	11R00	010
Acacia bonariensis	0000000200000	0	0000	00000000	00000000	0000	00000	11R0R	R02
Acacia caven	0000000000000	0	0000	00000000	00000000	2101	22000	00000	000
Eugenia aff. *uruguayensis*	0000000000000	0	0000	00000000	00000000	0000	00000	22000	011
Cardiospermum grandiflorum	0000000000000	0	0000	00000000	00000000	0000	00000	2200R	001
Ruprechtia salicifolia	0000000000000	0	0000	00000000	00000000	0000	00000	11000	304
Salix humboldtiana	0000000000000	0	0000	00000000	00000000	0000	00000	00110	001
Sebastianio schottianae–Terminalietea australis									
Smilax campestris	000000+000000	2	11R1	11111R1R	00000000	RR0R	121R0	32112	101
Terminalia australis	0000000000000	0	0000	00000000	00000000	0000	00000	34332	141
Myrceugenia glaucescens	0000000000000	0	12R1	00000000	00000000	0000	000R0	00242	111
Plants with wide distribution in South America									
Allophylus edulis	0000000000000	1	1RR2	11RR11R2	00000000	1113	23210	0010R	010
Maytenus ilicifolia	0000000000000	1	1R1R	1RR1RRRR	00000000	0000	11111	R1011	R10
Blepharocalyx salicifolius	0000000000000	2	1R11	222111R1	00000000	0000	11R0R	10000	110
Sebastiania commersoniana	0000000000000	0	1211	211R2122	00000000	0000	00000	000R0	111
Myrcia selloi	0000000000000	4	0000	01121321	00000000	0000	20000	10010	000
Daphnopsis racemosa	0000000000000	1	1R12	00000000	00000000	0000	00000	00R14	0R0
Eugenia uniflora	000000+000000	0	0000	00000000	00000000	0000	22000	10000	100
Urvillea uniloba	0000000000000	0	0000	00000000	00000000	0000	0010R	00000	000
Schinus longifolia	0000000000000	0	0000	00000000	00000000	1001	00000	00000	000
Nectandra sp.	0000000000000	0	0000	00000000	00000000	0000	00000	00000	220
Celtis iguanaea	0000000000000	0	0000	00000000	00000000	0001	00000	00000	000
Variants of the associations									
Ephedra triandra	0000000000000	0	0000	RRR1RR11	00000000	0000	00000	00000	000
Trixis pallida	0000000000000	0	0000	R11RRR1R	00000000	0000	00000	00000	000
Myrcianthes cisplatensis	0000000000000	0	0000	00002213	00000000	0000	00000	00000	000
Baccharis aff. *salicina*	0000000000000	0	0000	00000000	1RRR1R1R	RR00	00000	00000	000
Ligustrum lucidum	0000000000000	0	R1RR	00000000	00000000	0000	44455	00000	000
Gleditsia triacanthos	0000000000000	R	0000	00000000	00000000	R000	RR01R	00000	0RR
Ligustrum sinense	0000000000000	0	0000	00000000	00000000	5555	02401	00000	000
Melia azedarach	0000000000000	0	0000	00000000	00000000	2232	01013	00000	000

(*continued next page*)

Table 2. (*continued*)

Parameter	Dendrogram and DCA group								
	A	B	C	D	E	F	G	H	I
Pyracantha sp.	0000000000000	0	0000	00000000	00000000	2001	01201	00000	000
Morus alba	0000000000000	0	0000	00000000	00000000	0000	00010	00100	2RR
Citrus sp.	0000000000000	0	0000	RR0000R0	00000000	0000	00000	00000	000
Desmodium affine	0000000000000	0	1RR2	00000000	00000000	0000	00000	00000	000
Euphorbia selloi	0000000000000	0	R1RR	00000000	00000000	0000	00000	00000	000
Tagetes minuta	0000000000000	0	R1RR	00000000	00000000	0000	00000	00000	000
Galactia marginalis	0000000000000	0	R111	00000000	00000000	0000	00000	00000	000
Lippia arechavaletae	0000000000000	0	RR1R	00000000	00000000	0000	00000	00000	000
Metastelma diffusum	0000000000000	0	R1RR	00000000	00000000	0000	00000	00000	000
Oxalis eriocarpa	0000000000000	0	R121	00000000	00000000	0000	00000	00000	000
Stenachaenium riedelii	0000000000000	0	RR11	00000000	00000000	0000	00000	00000	000
Senecio selloi	0000000000000	0	1RRR	00000000	00000000	0000	00000	00000	000
Porophyllum ruderale	0000000000000	0	1R11	00000000	00000000	0000	00000	00000	000
Portulaca cryptopetala	0000000000000	0	RR11	00000000	00000000	0000	00000	00000	000
Schizachyrium condensatum	0000000000000	0	2121	00000000	00000000	0000	00000	00000	000
Spergula grandis	0000000000000	0	R1RR	00000000	00000000	0000	00000	00000	000
Zornia ovata	0000000000000	0	R1RR	00000000	00000000	0000	00000	00000	000
Apodanthera sagittifolia var. *villosa*	0000000000000	0	RRRR	00000000	00000000	0000	00000	00000	000
Gomphrena sp.	0000000000000	0	0000	RRRR11RR	00000000	0000	00000	00000	000
Elionurus muticus	0000000000000	0	0000	1112RR12	00000000	0000	00000	00000	000
Aspilia montevidensis	0000000000000	0	0000	00000000	21121221	0000	00000	00000	000
Tripogandra glandulosa	0000000000000	0	0000	00000000	R1R1R11R	0000	00000	00000	000
Angelonia integerrima	0000000000000	0	0000	00000000	R1111R11	0000	00000	00000	000
Schizachyrium spicatum	0000000000000	0	0000	00000000	1R211121	0000	00000	00000	000
Eryngium coronatum	0000000000000	0	0000	00000000	1R1R1RR1	0000	00000	00000	000
Chloris canterae	0000000000000	0	0000	00000000	R22R1121	0000	00000	00000	000
Bidens pilosa	0000000000000	0	0000	00000000	R1RRR1R1	0000	00000	00000	000
Companions									
Croton sp.	0000000000000	R	112R	11R22211	21312112	0000	00000	00000	000
Eupatorium inulifolium	0000000000000	0	0000	00000000	111RRR1R	0000	00000	00000	000
Vernonanthura montevidensis	0000000000000	0	RR11	00001RRR	00000000	0000	00000	00000	000
Cestrum parqui	00000000R0000	0	0000	0000R11R	00000000	R000	0000R	0R000	000
Sapium haematospermum	0000000000010	0	R1R1	00000000	00000000	000R	00000	00000	000
Lantana camara	0000000000000	2	1111	00000000	00000000	0R00	00000	00000	000
Baccharis trimera	0R00000000000	0	1R21	00000000	00000000	R000	00000	00000	000
Sebastiania brasiliensis	0000000000000	0	0000	00000000	00000000	0000	00000	44411	000
Nectandra megapotamica	0000000000000	0	0000	00000000	00000000	0000	0000R	R001R	002
Trixis praestans	0000000000000	1	0000	00000000	00000000	R0R0	00R0R	00000	000
Ephedra tweedieana	0000000000000	0	1R1R	00000000	00000000	0000	00000	00000	000
Pouteria gardneriana	0000000000000	0	0000	00000000	00000000	0000	000R0	00200	210
Dolichandra unguis-cati	0000000000000	0	0000	00000000	00000000	0000	000R0	21000	001
Croton echinulatus	1R0000000001+	0	0000	00000000	00000000	0000	00000	00000	000
Baccharis dracunculifolia	0000000000000	0	2122	00000000	00000000	0000	00000	00000	000
Schinus polygama	000000+0R+000	0	0000	00000000	00000000	0000	00000	00000	000
Mikania micrantha	0000000000000	0	0000	00000000	00000000	0000	00000	00000	RR1
Lantana montevidensis	0R0000000000+	R	0000	00000000	00000000	0000	00000	00000	000
Psidium salutare var. *mucronatum*	000RR+0000000	0	0000	00000000	00000000	0000	00000	00000	000
Myrtaceae sp.	0000000000000	0	0000	00000000	00000000	0000	11100	00000	000
Cissampelos pareira	0000000000000	0	0000	00000000	00000000	R000	00000	0R001	000
Cestrum guaraniticum	0000000000000	1	0000	00000000	00000000	0000	00000	00R0R	000
Plants of grasslands and of shady communities									
Setaria parviflora	RRRRR0++R+R++	0	1R1R	0R1RR1R0	12RR1RR0	0000	00000	00000	000
Elephantopus mollis	000000++0000+	1	1112	R2121111	R11R1211	RR00	00R00	00000	000
Hyptis mutabilis	210R0+++1+00+	2	RRR1	00000000	1R1RR1R1	0000	00000	00000	000
Desmanthus virgatus	RRRRR00+00R00	0	0RR0	121R11R2	10110R0R	0000	00000	00000	000
Dorstenia brasiliensis	00R0000000000	0	RRR1	1RR11RRR	RR1R0RRR	0000	R000R	00000	000
Sida rhombifolia	0R0R0+++0+R0+	R	1RR1	00000000	0RRR1RRR	0R00	00000	00000	000
Andropogon lateralis	RR0R0++000R00	0	2111	R2010R22	01R11000	0000	00000	00000	000
Paspalum notatum	1R341554R+0++	0	0000	00000000	21R1R1R1	0000	00000	00000	000

(*continued next page*)

Table 2. (*continued*)

Parameter	Dendrogram and DCA group								
	A	B	C	D	E	F	G	H	I
Adiantopsis chlorophylla	0000000000000	1	0000	111R2112	R2RRRR11	R000	00000	000RR	000
Oxalis conorrhiza	0RR00000000++	0	0000	R1.1R.RR	1RR00000	R000	00000	00RRR	000
Iresine diffusa	00000+00R0000	1	RRRR	R1R11R1R	00000000	0000	00R00	00000	000
Axonopus compressus	1R12R000R00++	0	0000	00000000	21211111	0000	00000	00000	000
Acalypha communis	R00RR00+R+000	R	0000	00000R1R	RRRR0000	0000	00000	00000	010
Desmodium incanum	RRRR0+++00000	1	0000	00000000	1R1R1RRR	0000	00000	00000	000
Oxalis sellowiana	0000000000000	0	1122	111311R2	11110000	0000	00000	00000	000
Pavonia sepium	0000000000000	0	0000	R11RR11R	00000000	0000	1R111	00000	1R0
Pfaffia tuberosa	RRRRR+++000++	1	RRRR	00000000	00000000	0000	00000	00000	000
Richardia brasiliensis	00R000++00000	0	1RR2	00000000	11R121R1	0000	00000	00000	000
Tragia geraniifolia	RR00R000R0R00	R	0000	RRRRRRR1	00000000	0R00	00000	00000	000
Wissadula glechomatifolia	000R0000000+0	R	1R1R	111RRRRR	00000000	0000	00000	00000	000
Achyrocline satureioides	0010000000000	R	RR1R	1RRRRRRR	00000000	0000	00000	00000	000
Eleusine tristachya	00RRR0++0+000	0	0000	00000000	1R121RR1	0000	00000	00000	000
Melica sarmentosa	0000000000000	R	0000	111RR1R1	00000000	R000	00R0R	RR000	000
Wahlenbergia linarioides	RRRRR+++0000+	0	1R1R	00000000	00000000	0000	00000	00000	000
Commelina diffusa	0000000000000	0	RR11	00000000	R1RRR11R	0000	00000	00000	000
Piptochaetium montevidense	2RRR0+0000R00	2	1R21	00000000	00000000	R000	00000	00000	000
Bidens laevis	0000000000000	0	RR1R	R1RR11RR	00000000	0000	00000	00000	000
Acanthostyles buniifolius	0000000000000	0	2311	21111232	00000000	0000	00000	00000	000
Sporobolus junceus	RRRRR+++0+R0+	0	0000	00000000	00000000	0000	00000	00000	000
Chaptalia integerrima	R00RR00000000	0	0000	00000000	RRRR1RRR	0000	00000	00000	000
Podocoma hirsuta	R0000000R0R00	0	0000	00000000	1RRR1RRR	0000	00000	00000	000
Eragrostis lugens	RRRRR+++0+R+0	0	0000	00000000	00000000	0000	00000	00000	000
Krapovickasia flavescens	000RR00+00000	0	0000	RRR11R11	00000000	0000	00000	00000	000
Eragrostis cataclasta	0000000000000	0	0000	01R11021	000RRR1R	0000	00000	00000	000
Eryngium paniculatum	R0RRR+++R+200	0	0000	00000000	00000000	0000	00000	00000	000
Pterocaulon lorentzii	RRRR0+++0+0++	0	0000	00000000	00000000	0000	00000	00000	000
Digitaria sacchariflora	RR0RR+++R+00+	0	0000	00000000	00000000	0000	00000	00000	000
Hyptis floribunda	0000000+00000	0	0000	1R11R1R1	00000000	R000	00000	00000	000
Juncus capillaceus	RRRRR+++R0000	0	0000	00000000	00000000	0000	00000	00000	000
Bothriochloa laguroides	RRRRR+00R+R00	0	0000	00000000	00000000	0000	00000	00000	000
Coelorachis selloana	RR0RR00000000	0	0000	R1R00101	00000000	0000	00000	00000	000
Erigeron bonariensis	00RRR+++R+00+	0	0000	00000000	00000000	0000	00000	00000	000
Galianthe centranthoides	00000000000+0	0	0000	R11RR1R1	00000000	0000	00000	00000	000
Chrysopogon gryllus	RRRRR+0000R+0	0	0000	00000000	00000000	0000	00000	00000	000
Aristida venustula	R000000000R+0	0	1R12	000000R0	00000000	0000	00000	00000	000
Steinchisma hians	RR000+0+00R00	0	0000	00000000	00000000	0R00	00000	00001	010
Macroptilium prostratum	0RRR00000000+	0	R1RR	00000000	00000000	0000	00000	00000	000
Cyperus haspan	02RRR0++R000+	0	0000	00000000	00000000	0000	00000	00000	000
Cyperus entrerianus	0R00R+0+00R00	0	0000	R100R000	00000000	0000	00000	00000	000
Commelina sp.	0000000000000	R	0000	00000000	00000000	R000	00000	R0RRR	R0R
Bernardia sellowii	0000000000000	0	11RR	000R0000	R00R1000	0000	00000	00000	000
Oplismenus hirtellus	0000000000000	0	0000	00000000	00000000	21R0	R01R0	00000	R00
Eustachys bahiensis	R00R0+++0+00+	0	0000	00000000	00000000	0000	00000	00000	000
Kyllinga vaginata	R00RR+++0000+	0	0000	00000000	00000000	0000	00000	00000	000
Paspalum nicorae	RRRRR000000++	0	0000	00000000	00000000	0000	00000	00000	000
Eustachys retusa	RRRR0+++00000	0	0000	00000000	00000000	0000	00000	00000	000
Ambrosia tenuifolia	0R0100++R200+	0	0000	00000000	00000000	0000	00000	00000	000
Verbena intermedia	00RRR+00R+R00	0	0000	00000000	00000000	0000	00000	00000	000
Solanum sisymbriifolium	000000++0000+	0	0000	00000000	1RR10000	0000	00000	00000	000
Spigelia scabra	0000000000000	0	0000	00000000	00000000	0000	00000	111RR	011
Cyperus sp.	0000000000000	0	0000	00000000	00000000	0RR0	R0R10	1000R	000
Schlechtendalia luzulaefolia	0000000000000	0	00R2	0010RR01	00000R00	0000	00000	00000	000
Evolvulus sericeus	0RR0000000000	0	RR1R	00000000	00000000	0R00	00000	00000	000
Pavonia hastata	RR00000000000	0	RRR1	00000000	00000000	0000	00000	00000	000
Carex sororia	RRR0R000R0000	0	0000	00000000	00000000	0000	00000	0000R	000
Briza subaristata	RR0RR0000+000	0	0000	00000000	00000000	R000	00000	00000	000
Commelina virginica	RRRR000+000+0	0	0000	00000000	00000000	0000	00000	00000	000

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Table 2. (*continued*)

Parameter	Dendrogram and DCA group								
	A	B	C	D	E	F	G	H	I
Dichondra repens	0R11R0++00000	0	0000	00000000	00000000	0000	00000	00000	000
Stevia aristata	00R000000+000	0	1RRR	00000000	00000000	0000	00000	00000	000
Orthopappus angustifolius	000R0+++0+000	R	0000	00000000	00000000	0000	00000	00000	000
Hemarthria altissima	000000+000000	0	1RRR	00000000	00000000	0000	00000	01000	000
Solidago chilensis	0000000+0000+	0	RR11	00000000	00000000	0000	00000	00000	000
Dichondra aff. *macrocalyx*	0000000000000	0	0000	00000000	00000000	0100	00000	0R122	001
Nassella neesiana	1R0RR00000R00	0	0000	00000000	00000000	0000	00000	00000	000
Schizachyrium salzmannii	R000000000000	0	1221	00000000	00000000	0000	00000	00000	000
Aspilia buphthalmiflora	R0RR000+R0000	0	0000	00000000	00000000	0000	00000	00000	000
Hypericum connatum	R000000000000	0	RRR1	00000000	00000000	0000	00000	00000	000
Axonopus argentinus	RR0R000+000+0	0	0000	00000000	00000000	0000	00000	00000	000
Cyperus reflexus	RRRRR00000000	0	0000	00000000	00000000	0000	00000	00000	000
Oxalis sp.	RR0R000000000	R	0000	00000000	00000000	00R0	00000	00000	000
Ageratina liebmannii	0RRR000+00R00	0	0000	00000000	00000000	0000	00000	00000	000
Croton argenteus	0000000000R00	0	1R1R	00000000	00000000	0000	00000	00000	000
Cyperus aggregatus	00000+0000000	0	R111	00000000	00000000	0000	00000	00000	000
Bothriochloa saccharoides	000000000+000	0	1R11	00000000	00000000	0000	00000	00000	000
Stachytarpheta aff. *cayenensis*	000000000000+	0	0RR0	00000R00	00R00000	0000	00000	00000	000
Heimia salicifolia	0000000+00000	0	0000	R1RR0000	00000000	0000	00000	00000	000
Campuloclinium macrocephalum	0000000+00000	0	1R11	00000000	00000000	0000	00000	00000	000
Galium latoramosum	0000000000000	R	R111	00000000	00000000	0000	00000	00000	000
Sinningia allagophylla	0000000000000	R	RR11	00000000	00000000	0000	00000	00000	000
Forsteronia glabrescens	0000000000000	0	0000	RR1R0000	00000000	0000	00000	R0000	000
Doryopteris concolor	0000000000000	0	0000	00000000	00000000	R000	10R11	00000	000
Microgramma sp.	0000000000000	0	1132	10000000	00000000	0000	00000	00000	000
Chaptalia nutans	0000000000000	0	RRRR	00000000	00000000	0000	00000	00000	000
Tradescantia fluminensis	0000000000000	1	0000	00000000	00000000	0000	00001	00000	0R1
Eragrostis neesii	RRRR00000000	0	0000	00000000	00000000	0000	00000	00000	000
Paspalum quadrifarium	R003400000R00	0	0000	00000000	00000000	0000	00000	00000	000
Galianthe thalictroides	RRRR000000000	0	0000	00000000	00000000	0000	00000	00000	000
Petunia violacea	RRRR000000000	0	0000	00000000	00000000	0000	00000	00000	000
Plantago berroi	R00RR00+00000	0	0000	00000000	00000000	0000	00000	00000	000
Tripogandra aff. *serrulata*	RR0000++00000	0	0000	00000000	00000000	0000	00000	00000	000
Portulaca grandiflora	R0R0000+0000+	0	0000	00000000	00000000	0000	00000	00000	000
Acanthospermum australe	R0R00000000+3	0	0000	00000000	00000000	0000	00000	00000	000
Oenothera longiflora	0RRRR00000000	0	0000	00000000	00000000	0000	00000	00000	000
Chromolaena squarrulosa	0R0000+0R0100	0	0000	00000000	00000000	0000	00000	00000	000
Galium richardianum	00000++000000	0	0000	00000000	00000000	0000	00000	00R0R	000
Plantago aff. *australis*	0000000000000	0	0000	00000000	00000000	R000	00000	00R11	000
Panicum sabulorum	RR0R000000000	R	0000	00000000	00000000	0000	00000	00000	000
Parietalia debilis	0000000000000	R	0000	00000000	00000000	1000	000R1	00000	000
Kyllinga odorata	0000000000000	0	0000	00000000	R1RR0000	0000	00000	00000	000
Bromus auleticus	R0000000R+000	0	0000	00000000	00000000	0000	00000	00000	000
Agrostis montevidensis	RR0R000000000	0	0000	00000000	00000000	0000	00000	00000	000
Setaria aff. *fiebrigii*	R000R000R0000	0	0000	00000000	00000000	0000	00000	00000	000
Panicum bergii	R000R00000R00	0	0000	00000000	00000000	0000	00000	00000	000
Leptocoryphium lanatum	RR000000R0000	0	0000	00000000	00000000	0000	00000	00000	000
Pluchea sagittalis	R000000+00R00	0	0000	00000000	00000000	0000	00000	00000	000
Gnaphalium purpureum	RR0000000+000	0	0000	00000000	00000000	0000	00000	00000	000
Spermacoce dasycephala	RR0R000000000	0	0000	00000000	00000000	0000	00000	00000	000
Lessingianthus sellowii	RR00000000R00	0	0000	00000000	00000000	0000	00000	00000	000
Euphorbia hypericifolia	R000000+0+000	0	0000	00000000	00000000	0000	00000	00000	000
Pavonia sp.	0RRR000000000	0	0000	00000000	00000000	0000	00000	00000	000
Cypella herbertii	0R0R0000R0000	0	0000	00000000	00000000	0000	00000	00000	000
Cardionema ramosissimum	0RR000+000000	0	0000	00000000	00000000	0000	00000	00000	000
Spermacoce verticillata	00RR00000000+	0	0000	00000000	00000000	0000	00000	00000	000
Cynodon dactylon	00R001+000000	0	0000	00000000	00000000	0000	00000	00000	000
Euphorbia papillosa	00RR00000000+	0	0000	00000000	00000000	0000	00000	00000	000
Stipa hyalina	0000R000R0R00	0	0000	00000000	00000000	0000	00000	00000	000

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Table 2. (*continued*)

Parameter	Dendrogram and DCA group								
	A	B	C	D	E	F	G	H	I
Piptochaetium stipoides	0000R000R0000	0	0000	00000000	00000000	0R00	00000	00000	000
Cuphea glutinosa	R000R00000000	R	0000	00000000	00000000	0000	00000	00000	000
Baccharis pingraea	0000000+R0R00	0	0000	00000000	00000000	0000	00000	00000	000
Glandularia peruviana	0000000+R+000	0	0000	00000000	00000000	0000	00000	00000	000
Crotalaria incana	000+++0000000	0	0000	00000000	00000000	0000	00000	00000	000
Jatropha isabellei	000000000+0++	0	0000	00000000	00000000	0000	00000	00000	000
Borreria sp.	0000000000000	R	0000	00000000	00000000	0R00	00000	0000R	000
Solanum sp.	0000000000000	0	0000	00000000	00000000	0001	00R00	00R00	000
Juncus sp.	0000000000000	0	0000	00000000	00000000	0000	00R00	00021	000
Solanum laxum	0000000000000	0	0000	00000000	00000000	1110	00000	00000	000

Further do occur

Cyclospermum leptophyllum P4:R, P10:+; *Vernonanthura discolor* P4:R, P8:+; *Piptochaetium lasianthum* P1:1, P2:R; *Calamagrostis viridiflabescens* P1:R, P10:+; *Eryngium nudicaule* P1:R, P3:R; *Indigofera asperifolia* P1:R, P3:R; *Carthamus lanatus* P1:R, P4:R; *Spermacoce eryngioides* P2:R, P10:+; *Stylosanthes montevidensis* P2:R, P8:+; *Rhynchosia senna* P2:R, P11:R; *Commelina* aff. *platyphylla* P2:R, P3:R; *Bouteloua megapotamica* P2:R, P9:R; *Nothocactus* sp. P3:R, P45:R; *Elionurus tripsacoides* P3:R, P4:R; *Sisyrinchium pachyrhizum* P3:R, P4:R; *Halimium brasiliense* P3:R, P4:R; *Mitracarpus* sp. P3:R, P12:+; *Gnaphalium cheiranthifolium* P3:R, P4:R; *Croton hirtus* P3:R, P13:+; *Gnaphalium filagineum* P3:R, P4:R; *Lepidium auriculatum* P3:R, P10:+; *Eryngium elegans* P4:R, P10:+; *Ammi majus* P4:R, P9:R; *Croton parvifolius* P5:R, P9:R; *Abutilon pauciflorum* P5:R, P11:R; *Hordeum stenostachys* P5:R, P10:+; *Eragrostis acutiglumis* P5:R, P6:+; *Chloris ciliata* P5:R, P10:+; *Verbena gracilescens* P5:R, P11:R; *Polygala duarteana* P5:R, P11:R; *Paspalum denticulatum* P5:R, P10:+; *Xanthium spinosum* P5:R, P11:R; *Sphaeralcea bonariensis* P9:R, P11:R; *Stipa papposa* P9:R, P11:R; *Melica macra* P9:1, P11:R; *Vernonanthura chamaedrys* P9:R, P10:+; *Dysphania ambrosioides* P9:R, P13:+; *Baccharis incisa* P6:+, P12:+; *Paspalum plicatulum* P6:+, P7:+; *Agalinis communis* P6:+, P10:+; *Paspalum simplex* P8:+, P10:+; *Adiantum raddianum* P42:1, P48:1; *Bulbostylis capillaris* P8:+, P13:+; *Senecio grisebachii* P8:+, P13:+; *Sorghastrum setosum* P8:+, P13:+; *Cenchrus echinatus* P8:+, P13:+; *Digitaria sanguinalis* P8:+, P13:+; *Teucrium vesicarium* P14:1, P35:1; *Carex* bm P14:R, P45:R; *Hydrocotyle bonariensis* P44:1, P47:2; *Hydrocotyle pusilla* P45:1, P48:R; *Pycreus megapotamicus* P35:1, P46:1; *Hymenachne grumosa* P47:1, P48:1; *Cuphea fruticosa* P47:2, P48:R; *Carex* g P47:1, P48:R; *Phyllanthus sellowianus* P47:R, P48:R; *Juncus* zm P35:R, P36:R; *Urtica* sp. P37:R, P38:R; *Ephedra* sp. P39:R, P41:1; *Chaptalia* sp. P39:1, P42:R; *Orthosia virgata* P41:R, P43:R; *Peperomia* sp. P42:R, P43:1; *Cyperus odoratus* P27:1, P28:1; *Vernonia rubricaulis* P15:R, P16:R; *Steinchisma decipiens* P5:R; *Aristida murina* P1:R; *Melica brasiliana* P1:R; *Monnina resedoides* P1:R; *Eryngium ebracteatum* P1:R; *Erigeron primulifolium* P2:R; *Polygala linoides* P2:R; *Bouchetia anomala* P2:R; *Anagallis arvensis* P2:R; *Polygala pulchella* P2:R; *Mecardonia procumbens* P2:R; *Aristida pallens* P3:R; *Astyposanthes subviscosa* P3:R; *Eryngium divaricatum* P3:R; *Sida variegata* P4:R; *Briza hackelii* P4:R; *Noticastrum diffusum* P4:R; *Asclepias mellodora* P4:R; *Stenandrium dulce* P4:R; *Gyptis commersonii* P4:R; *Zornia harmsiana* P4:R; *Adesmia punctata* P4:R; *Ipomoea nitida* P4:R; *Rhodophiala bifida* P4:R; *Polygala tenella* P4:R; *Abutilon terminale* P5:R; *Melochia pyramidata* P5:R; *Nassella philippii* P5:R; *Tridens brasiliensis* P5:R; *Convolvulus ottonis* P5:R; *Modiola caroliniana* P5:R; *Scutellaria racemosa* P5:R; *Phalaris angusta* P5:R; *Nassella churruana* P11:R; *Nothoscordum* aff. *bivalve* P11:R; *Bromus catharticus* P11:R; *Abobra tenuifolia* P9:R; *Baccharis artemisioides* P9:1; *Croton* sp. P9:1; *Solanum chenopodioides* P9:R; *Mandevilla petraea* P9:R; *Dicliptera niederleiniana* P9:R; *Leptochloa virgata* P9:R *Modiolastrum gilliesii* P9:R; *Cyperus incomtus* P9:R; *Salpichroa origanifolia* P9:R; *Lactuca serriola* P9:R; *Centaurea melitensis* P9:R; *Andropogon selloanus* P6:+; *Eupatorium purpureum* P10:+; *Paspalum dilatatum* P10:+; *Aster squamatus* P10:+; *Glandularia aristigera* P10:+; *Phyla canescens* P10:1; *Acmella decumbens* P10:+; *Cyperus eragrostis* P10:+; *Hygrophila costata* P48:1; *Scoparia montevidensis* P7:+; *Acicarpha tribuloides* P7:+; *Chromolaena hirsuta* P12:+; *Chamaecrista* aff. *fasciculata* P12:+; *Microstachys hispida* P12:+; *Ipomoea* sp. P12:+; *Haplopappus macrocephalus* P12:+; *Clitoria epetiolata* P12:+; *Eriosema* sp. P12:+; *Lessingianthus eitenii* P12:+; *Pterocaulon angustifolium* P12:+; *Rhynchosia lineata* P12:+; *Galactia* sp. P12:1; *Ludwigia sericea* P13:+; *Sida viarum* P13:+; *Cienfuegosia sulfurea* P13:+; *Polygala molluginifolia* P13:+; *Cnidoscolus loasoides* P13:+; *Desmodium barbatum* P13:+; *Cyperus surinamensis* P13:+; *Portulaca oleracea* P13:+; *Bidens subalternans* P13:+; *Angelphytum arnottii* P8:+; *Calibrachoa thymifolia* P8:+; *Malvastrum coromandelianum* P8:+; *Gomphrena pulchella* P8:+; *Gomphrena perennis* P8:+; *Adesmia bicolor* P8:+; *Silene gallica* P14:R; *Galium hirtum* P14:1; *Janusia guaranitica* P14:R; *Spergula* sp. P14:R; *Cerastium* sp. P14:R; *Galium* hg P14:R; *Petunia* sp. P14:R; *Panicum* aff. *capillare* P14:R; *Opuntia* sp. P14:R; *Dichondra sericea* var. *tomentosa* P44:R; *Eclipta prostrata* P44:R; *Marsilea ancylopoda* P44:1; *Panicum prionitis* P45:R; *Alternanthera philoxeroides* P47:R; *Centella asiatica* P47:R; *Tripogandra* sp. P48:R; *Gonolobus parviflorus* P48:R; *Lippia alba* P49:R; *Carex* ex P35:1; *Borreria* sp. 2 P35:R; *Eryngium* aff. *horridum* P35:R; *Muehlenbeckia sagittifolia* P37:R; *Stellaria* sp. P38:R; *Pleopeltis squalida* P42:1; *Musci* P38:R; *Cyrtocymura scorpioides* P42:R; *Habranthus tubispathus* P2:R, P4:R; *Senna occidentalis* P4:R, P8:+; *Clematis campestris* P7:+, P9:R; *Passiflora caerulea* P9:R, P44:R; *Eugenia pitanga* P12:+, P13:+; *Erythrina crista-galli* P8:+, P48:R; *Croton uruguayensis* P44:1, P45:1; *Manettia cordifolia* P35:R, P44:R; *Eugenia* sp. P46:R, P50:R; *Passiflora elegans* P42:R, P43:1; *Rivina humilis* P43:1; *Ficus luchnatiana* P7:+; *Lithraea molleoides* P43:R; *Luehea divaricata* P48:1; *Stigmaphyllon jatrophifolium* P42:2; *Psidium salutare* var. *sericeum* P4:R; *Prunus* sp. P38:1; *Celtis spinosa* P5:R; *Paullinia elegans* P51:R; *Trithrinax campestris* P9:R; *Inga uruguensis* P49:1; *Castela tweediei* P9:R; *Mikania periplocifolia* P49:1; *Thabernaemontana catharinensis* P7:+; *Dioscorea campestris* P47:R; *Xylosma venosa* P7:+; *Cestrum euanthes* P45:R; *Mycianthes pungens* P45:1; *Mutisia coccinea* P14:1; *Schinus weinmannifolius* P12:+; *Opuntia elata* P8:+; *Mimosa obtusifolia* P13:+.

humboldtiana, *Scutia buxifolia*, *Sebastiania commersoniana* and *Terminalia australis*.

Herbs: *Achyrocline satureioides*, *Commelina diffusa*, *Desmodium incanum*, *Dorstenia brasiliensis*, *Elephantopus mollis*, *Iresine diffusa*, *Melica sarmentosa*, *Oplismenus hirtellus*, *Pfaffia tuberosa*, *Richardia brasiliensis*, *Sida rhombifolia* and *Wissadula glechomatifolia*.

This alliance groups edapho-hygrophilous thermotemperate associations of the eastern Mesophytic Pampean biogeographical province. These groups developed on sandy soils that do not show

Fig. 2. Landscape showing the *Eugenio myrcianthis–Butietum yatay* association in El Palmar National Park (Argentina).

profile development other than an A horizon and are basically a deposition of unconsolidated sediments.

Multivariate analysis of species and associations

Results from cluster analysis (Fig. 3) and the DCA ordination (Fig. 4) show the composition and distribution of the plots, which is also reflected in Table 2. Groups A–G belong to the palm groves, and Groups H and I to the gallery forests. Group A (Plots P1–P13) are palm groves, where there is a high presence of *Baccharis coridifolia* and grassland plants (such as *Paspalum notatum*), this group corresponds mainly to grazing-land spots. Group B (Plot P14) corresponds to a palm grove with cattle exclusion, presenting species such as *Eugenia myrcianthes*, *Guettarda uruguensis*, *Blepharocalyx salicifolius* and *Myrcia selloi*. That is the reason why this plot was selected as a holotype. Group C (Plots P15–P18) is composed of ruderal plants on sandy and gravelly well drained soils (*Apodanthera sagittifolia* var. *villosa*, *Desmodium affine*, *Euphorbia selloi*, *Galactia marginalis*, *Lippia arechavaletae*, *Metastelma diffusum*, *Oxalis eriocarpa*, *Porophyllum ruderale*, *Portulaca cryptopetala*, *Senecio selloi*, *Spergula grandis*, *Stenachaenium riedelii*, *Tagetes minuta* and *Zornia ovata*), but with *Schizachyrium condensatum* as the main species. Group D (Plots P19–P26) is represented by *Gomphrena* sp., *Trixis pallida* and *Elionorus muticus* as a representative of grasslands, and some other elements such as *Ephedra triandra* and *Myrcianthes cisplatensis* can be found on sandy soils. Group E (Plots P27–P34) shows soils with a greater water retention because of finer sediments and includes *Angelonia integerrima*, *Aspilia montevidensis*, *Baccharis salicina*, *Bidens pilosa*, *Chloris canterae*, *Eryngium coronatum*, *Tripogandra glandulosa* and *Schizachyrium spicatum* as a grass element. Groups F (Plots P35–P38) and G (Plots P39–P43) are integrated by introduced shrubs and trees (*Gleditsia triacanthos*, *Ligustrum lucidum*, *L. sinense*, *Melia azedarach*, *Morus alba* and *Pyracantha* sp.). However, G includes more forest plants with a wider distribution in South America, such as *Blepharocalyx salicifolius*, *Eugenia uniflora*, *Maytenus ilicifolia*, *Myrcia selloi* and *Urvillea uniloba*, and has a very low frequency of *Butia yatay*. Finally, Groups H and I of DCA are gallery forest plots of the Uruguay River with *Acacia bonariensis*, *Cardiospermum grandiflorum*, *Eugenia uruguayensis*, *Ruprechtia salicifolia*, *Salix humboldtiana* and *Terminalia australis*. In contrast to the DCA, dendrogram and Table 2 show Groups H (Plots P44–P48) and I (Plots P49–P51), which can be distinguished by the presence of *Gleditsia triacanthos* and *Morus alba*.

Discussion

Butia yatay is a palm associated with the Uruguay and Parana River basins (Henderson *et al*. 1995; Orme 2007), under a thermotropical subhumid bioclimate in Misiones and Corrientes provinces, and a thermotemperate subhumid bioclimate (Table 1) in Entre Rios Province (Martínez-Crovetto and Piccinini 1950), similar to that of the territory opposite of Uruguay (Chebataroff 1974). As well as for the *Eugenio myrcianthis–Butietum yatay*, which has been described, it is necessary to conduct a phytosociological study of the thermotropical humid zone of north-western Argentina, where new associations belonging to the *Guettardo uruguensis–Bution yatay* alliance can be hypothesised, owing to the floristic composition of the forests and grasslands (Fontana 1996).

In the context of the syntaxonomical studies in America (USA by Rivas-Martínez *et al*. 1999; and Peinado *et al*. 2011; Cuba by Borhidi 1996; Venezuela by Cuello and Cleef 2009; and Galán de Mera 2015; Brasil by Bolòs *et al*. 1991; and Kegler *et al*. 2010; Colombia by Rangel *et al*. 1997; Ecuador by Bussmann 2003; Peru by Galán de Mera *et al*. 2002, 2014; Bolivia by Navarro and

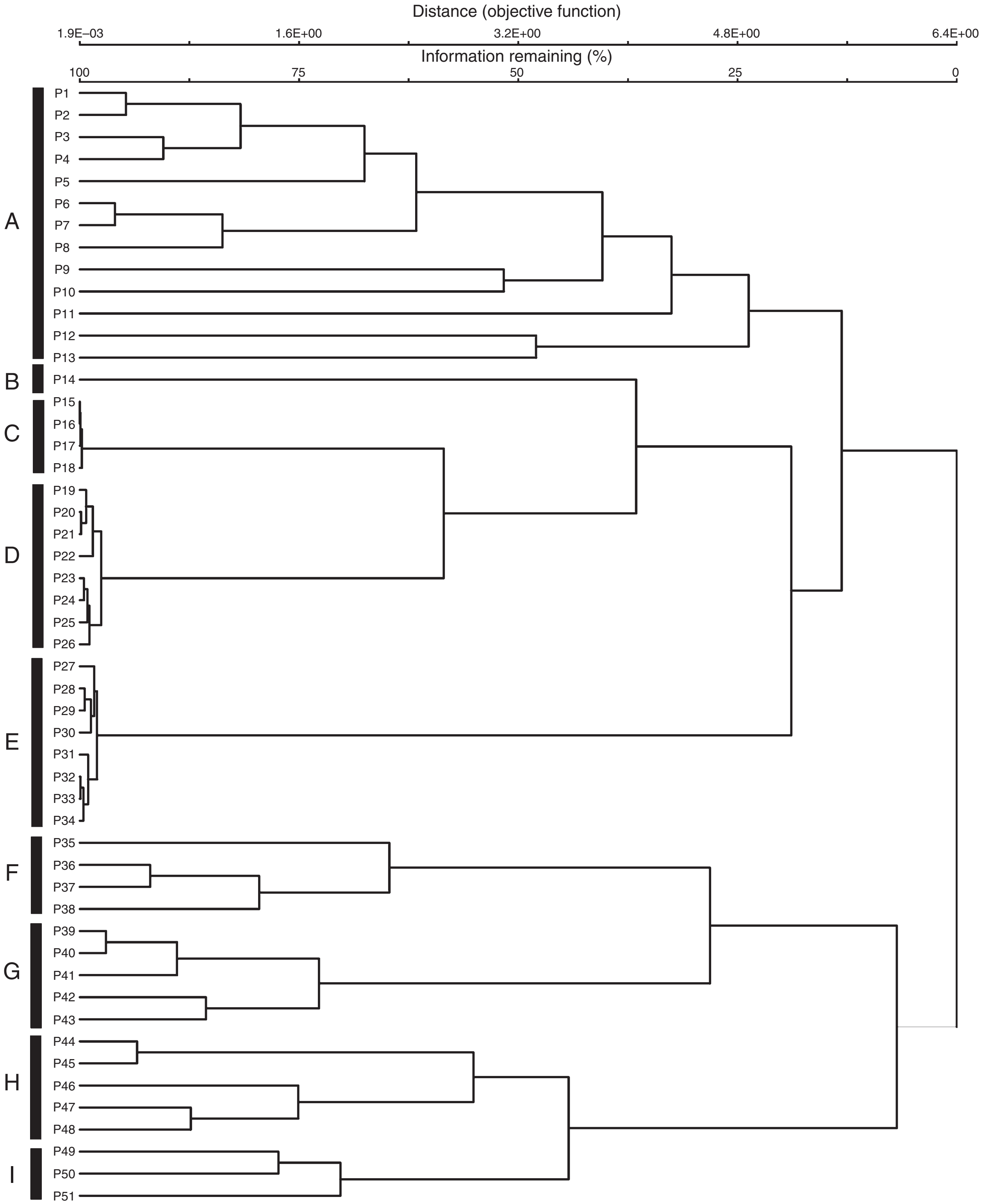

Fig. 3. Dendrogram showing the variability of *Eugenio myrcianthis–Butietum yatay* (EB) and *Bignonio callistegioidis–Terminalietum australis* (BT) associations. A, EB with *Baccharis corilifolia* and *Paspalum notatum*. B, EB with native trees (*Eugenia myrcianthes*, *Guettarda uruguensis*). C, EB with ruderal plants on dry soils (*Apodanthera sagittifolia* var. *villosa*, *Desmodium affine*). D, EB with native trees and subtropical grasslands on sandy soils (*Elionorus muticus*, *Myrcianthes cisplatensis*). E, EB with humid soil elements (*Angelonia integerrima*, *Baccharis salicina*). F, EB with introduced trees (*Ligustrum lucidum*, *Melia azedarach*). G, EB with a low frequency of palms and native shrubs mixed with introduced trees (*Gleditsia triacanthos*, *Ligustrum lucidum*). H, BT gallery forest (*Salix humboldtiana*, *Terminalia australis*). I, BT gallery forest with introduced trees (*Gleditsia triacanthos*, *Morus alba*).

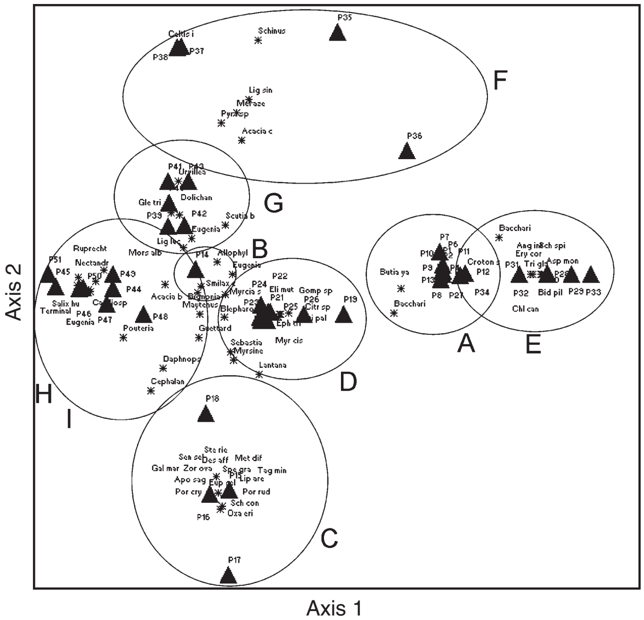

Fig. 4. A–G, detrended correspondence analysis (DCA) with the variability groups of *Eugenio myrcianthis–Butietum yatay*; H, I, *Bignonio callistegioidis–Terminalietum australis* associations. See Fig. 3 for definition of group codes. Triangles are the plots from El Palmar National Park, including those of Martínez Crovetto and Piccinini (1950) from Entre Rios, Corrientes and Santa Fe provinces; stars are main plants for each group. Circles represent the generated groups of plots.

Maldonado 2005; and Chile by Luebert and Pliscoff 2006), Martínez-Carretero *et al*. (2016) published a new approach to the Argentinian vegetation, with 57 phytosociological classes of the 95 registered by Galán de Mera and Vicente Orellana (2006). Martínez-Carretero *et al*. (2016) cited only three phytosociologycal classes for the grasslands of Entre Rios Province (*Piptochaetio–Stipetea neesianae*, *Panicetea racemosi* and *Panico urvilleani–Sporoboletea rigentis*), but no forest for this region, except *Butia yatay* communities with grasslands by Martínez-Crovetto and Piccinini (1950) and those of *B. yatay* with some trees (*Sapium haematospermum*, *Schinus longifolius* and *Sebastiania commersioniana*) by Batista *et al*. (2014). Batista *et al*. (2014) indicated the use of the phytosociology for studying the vegetation of the El Palmar National Park; however, they did not follow the cover-abundance values of the phytosociology method, mixed some physiotopes and did not consider the stratification of the vegetation; therefore, we could not compare their plots with those in our study nor with those of other regions of South America with palm communities, and humid or gallery forests.

Martínez-Carretero *et al*. (2016) also presented a distribution of the *Cedrelo fissilis–Ocoteetea puberulae* class from Brazil to north-eastern Argentina and south-eastern Paraguay but did not indicate the *Sebastianio schottianae–Terminalietea australis* class in Argentina.

In the present work, we have described two new associations and one alliance. The identification and determination of the diagnostic species presented some considerations; for example, *Nectandra megapotamica*, with high frequency of presence in Entre Rios and southern Brazil, is characteristic only of the *Piptadenio rigidae–Nectandretalia megapotamicae* order from Brazil, because of its low fidelity in Entre Rios. *Sebastiania brasiliensis* (Table 2), with a very low fidelity (missing in Appendix 1) could be a characteristic species of the association *Bignonio callistegioidis–Terminalietum australis*. In contrast, *Acacia caven*, *Cardiospermum grandiflorum*, *Eugenia uruguayensis*, *Ruprechtia salicifolia* and *Salix humboldtiana* (Table 2, Groups H and I, Plots 44–51), which seem characteristic of the association, can be included only in the *Dyckio brevifoliae–Terminalietalia australis* order (Appendix 1), because of their low phi and distribution in both Argentina and Brazil. In general, all the forests studied represent tree and scrub vegetation types that are widely distributed in South America (Appendix 1). This leads us to consider a phytosociological class which is broader than the *Cedrelo fissilis–Ocoteetea puberulae* concept, taking into account the fact that Bolòs *et al*. (1991) described this class using only two plots, because a high number of its plants present a wider distribution than the geographic border of the class.

The variability of *Eugenio myrcianthis–Butietum yatay*, as seen in the dendrogram (Fig. 3) and DCA (Fig. 4), confirms the results of other regional studies, namely that with respect to floristic composition, soil conditions and vegetation dynamics can be crucial. Martínez-Crovetto and Piccinini (1950) not only characterised palm groves with a high herb cover as a result of cattle grazing (see also Table 2), but also palm communities with gallery-forest elements of the north Parana River basin (*Erythrina crista-galli*, *Ficus luschnathiana* and *Nectandra angustifolia*), and with plants of the xerophytic forest of north-western Entre Rios Province and central and southern Corrientes (*Acacia caven*, *Celtis spinosa*, *Geoffroea decorticans*, *Prosopis affinis*, *P. nigra* and *Trithrinax campestris*). These plant communities, which include *Butia yatay*, were outside our study area. However, some plants indicated by Martínez-Crovetto and Piccinini (1950) are similar to those of Group C of the DCA (*Euphorbia*, *Portulaca*), which also includes *Galactia marginalis*, *Lippia arechavaletae*, *Schizachyrium condensatum* and *Stenachaenium riedelii* as elements of the subtropical grasslands of *Elyonuretea mutici* class (Eskuche 1992). The same interpretation can explain Group D, with the presence of *Elionurus muticus*, but also forest elements such as *Allophylus edulis*, *Blepharocalyx salicifolius*, *Maytenus ilicifolia*, *Sebastiana commersoniana* and *Myrcia selloi*, which show a low burn frequency that favours forest development, as concluded by Eskuche (1992) and Fontana (1996). Group E is a more humid version of palm grove, because of the presence of *Baccharis salicina*, and grassland where *Angelonia integerrima*, *Schizachyrium spicatum* and *Chloris canterae* are representative, together with *Eryngium coronatum* as a burn indicator (Fontana 1996). *Schizachyrium spicatum* also grows in the grasslands of northern South America (Galán de Mera 2015). Groups F and G are the most humid and they thrive in flat areas closer to the Uruguay River or lower topographic gradient of palm groves at the Uruguay River basin. There are some floristic combinations that coincide with the palm groves of western Uruguay (Chebataroff 1974). However, in El Palmar National Park, an important set of introduced trees is part of the forest canopy, including *Ligustrum lucidum*, *L. sinense*, *Gleditsia triacanthos*, *Melia azedarach*, *Pyracantha* sp. and other species, as indicated by Batista *et al*. (2014). Some of these introduced woody species are able to withstand periodic floods.

Box (1986) and Fontana (2015) indicated *Albizia inundata* and *Inga uruguensis* as the main species of the gallery forest both in the Uruguay River and the Parana River; both species were absent from the study area, even though *Bignonia callistegioides*, *Guettarda uruguensis*, *Ruprechtia salicifolia* or *Terminalia australis* were the main plants in the thermotemperate zone of the Uruguay River. Rodriguez (2013) suggested that this is a differentiation in floristic composition between the forests of the Uruguay River and those of the Parana River. Even though these communities share some elements, they differ from each other in the presence (or absence) of species associated with the Chaco region (Parana River forest) or with the Paranense region (Uruguay River forest) and also with different edafic and hidrosedimentological characteristics of both rivers.

The results obtained in the present study provide a syntaxonomic classification of the palm groves of Entre Rios and Uruguay River gallery forest; two new associations and one alliance were described as a starting point for future studies.

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References

Aceñolaza FG (2007) Geología y recursos geológicos de la Mesopotamia Argentina. *Revista del Instituto Superior de Correlación Geológica* **22**, 149–155.

Aceñolaza PG, Rodriguez EE (2009) 'Sitio Ramsar 'Arroyo El Palmar' (Informe florístico).' (Secretaria de Ambiente de Entre Ríos: Paraná, Argentina)

Aceñolaza PG, Rodriguez EE (2011) Flora del 'Arroyo El Palmar', Provincia de Entre Ríos. *Boletín de la Sociedad Argentina de Botánica* **46**, 179.

Ackermann W, Durka W (1997) 'SORT 4.1. Processing of vegetation releves and species lists.' (Edition of the authors: Leipzig, Germany)

Anton AM, Zuloaga FO (Dirs) (2012*a*) 'Flora Argentina: Flora vascular de la República Argentina, Volumen 3, Tomo I.' (Instituto de Botánica Darwinion: Buenos Aires)

Anton AM, Zuloaga FO (Dirs) (2012*b*) 'Flora Argentina: Flora vascular de la República Argentina, Volumen 3, Tomo II.' (Instituto de Botánica Darwinion: Buenos Aires)

Anton AM, Zuloaga FO (Dirs) (2012*c*) 'Flora Argentina: Flora vascular de la República Argentina, Volumen 8.' (Instituto de Botánica Darwinion: Buenos Aires)

Anton AM, Zuloaga FO (Dirs) (2012*d*) 'Flora Argentina: Flora vascular de la República Argentina, Volumen 14.' (Instituto de Botánica Darwinion: Buenos Aires)

Anton AM, Zuloaga FO (Dirs) (2013) 'Flora Argentina: Flora vascular de la República Argentina, Volumen 13.' (Instituto de Botánica Darwinion: Buenos Aires)

Anton AM, Zuloaga FO (Dirs) (2014*a*) 'Flora Argentina: Flora vascular de la República Argentina, Volumen 7, Tomo I.' (Instituto de Botánica Darwinion: Buenos Aires)

Anton AM, Zuloaga FO (Dirs) (2014*b*) 'Flora Argentina: Flora vascular de la República Argentina, Volumen 7, Tomo II.' (Instituto de Botánica Darwinion: Buenos Aires)

Anton AM, Zuloaga FO (Dirs) (2014*c*) 'Flora Argentina: Flora vascular de la República Argentina, Volumen 7, Tomo III.' (Instituto de Botánica Darwinion: Buenos Aires)

Anton AM, Zuloaga FO (Dirs) (2015) 'Flora Argentina: Flora vascular de la República Argentina, Volumen 15.' (Instituto de Botánica Darwinion: Buenos Aires)

APN (1982) 'Anales de parques nacionales.' (Administración de Parques Nacionales: Buenos Aires)

Báez JR (1942) 'Las palmeras en la flora de Entre Ríos.' (Comisión Coordinadora de Servicios, Paraná, Argentina and Exposición Forestal, M.A.N., Buenos Aires)

Batista WB, Rolhauser AG, Biganzoli F, Burkart SE, Goveto L, Maranta A, Pignataro AG, Morandeira NS, Rabadán M (2014) Las comunidades vegetales de la sabana del Parque Nacional El Palmar (Argentina). *Darwiniana* **2**, 5–38.

Biondi E (2011) Phytosociology today: methodological and conceptual evolution. *Plant Biosystems* **145**, 19–29.

Bolòs O, Cervi AC, Hatschbach G (1991) Estudios sobre la vegetación del estado de Paraná (Brasil meridional). *Collectanea Botanica (Barcelona)* **20**, 79–182.

Borhidi A (1996) 'Phytogeography and vegetation ecology of Cuba.' (Akadémiai Kiadó: Budapest)

Box EO (1986) Some climatic relationships of the vegetation of Argentina, in global perspective. Veröffentlichungen des Geobotanischen Institutes der Eidgenössische Technische Hochschule, Stiftung Rübel, in Zürich **91**, 181–216.

Braun-Blanquet J (1979) 'Fitosociología: bases para el estudio de las comunidades vegetales.' (H Blume: Madrid)

Brizuela A (2006) Síntesis climática de Entre Ríos, descripción y efectos. In 'El Arroz: su cultivo y sustentabilidad en Entre Ríos'. (Ed. R Benavidez) pp. 185–204. (Universidad Nacional del Litoral, Universidad Nacional de Entre Ríos: Paraná, Argentina)

Burkart A (1957) La vegetación del delta del rio Paraná. *Darwiniana* **11**, 457–561.

Burkart A (1969) 'Flora ilustrada de Entre Ríos (Argentina), Parte 2.' (Colección Científica INTA, Tomo VI: Buenos Aires)

Burkart A (1974) 'Flora ilustrada de Entre Ríos (Argentina), Parte 5.' (Colección Científica INTA, Tomo VI: Buenos Aires)

Burkart A (1979) 'Flora ilustrada de Entre Ríos (Argentina), Parte 6.' (Colección Científica INTA, Tomo VI: Buenos Aires)

Burkart A (1987) 'Flora ilustrada de Entre Ríos (Argentina), Parte 3.' (Colección Científica INTA, Tomo VI: Buenos Aires)

Burkart A, Bacigalupo N (2005) 'Flora ilustrada de Entre Ríos (Argentina), Tomo VI, Parte 4.' (Colección Científica INTA: Buenos Aires)

Bussmann RW (2003) The vegetation of Reserva Biológica San Francisco, Zamora–Chinchipe, southern Ecuador: a phytosociological synthesis. *Lyonia* **3**, 145–254.

Cabrera A (1963) 'Flora de la Provincia de Buenos Aires, Parte 6.' (Colección Científica INTA, Tomo IV: Buenos Aires)

Cabrera A (1965*a*) 'Flora de la Provincia de Buenos Aires, Parte 4.' (Colección Científica INTA, Tomo IV: Buenos Aires)

Cabrera A (1965*b*) 'Flora de la Provincia de Buenos Aires, Parte 5.' (Colección Científica INTA, Tomo IV: Buenos Aires)

Cabrera A (1967) 'Flora de la Provincia de Buenos Aires, Parte 3.' (Colección Científica INTA, Tomo IV: Buenos Aires)

Cabrera A (1968) 'Flora de la Provincia de Buenos Aires, Parte 1.' (Colección Científica INTA, Tomo IV: Buenos Aires)

Cabrera A (1970) 'Flora de la Provincia de Buenos Aires, Parte 2.' (Colección Científica INTA, Tomo IV: Buenos Aires)

Cabrera A, Zardini E (1993) 'Manual de la flora de los alrededores de Buenos Aires.' (ACME: Buenos Aires)

Chebataroff J (1974) 'Palmeras del Uruguay.' (Bouzout: Montevideo, Uruguay)

Chytrý M, Tichý L, Holt J, Botta-Dukat Z (2002) Determination of diagnostic species with statistical fidelity measures. *Journal of Vegetation Science* **13**, 79–90.

Chytrý M, Schaminée JH, Schwabe A (2011) Vegetation survey: a new focus for applied vegetation science. *Applied Vegetation Science* **14**, 435–439.

Cuello NL, Cleef AM (2009) The páramo vegetation of Ramal de Guaramacal, Trujillo State, Venezuela. 1. Zonal communities. *Phytocoenologia* **39**, 295–329.

Dengler J, Chytry M, Ewald J (2008) Phytosociology. In 'Encyclopedia of ecology'. (Eds SE Jørgensen, BD Fath) pp. 2767–2779. (Elsevier: Oxford, UK)

Eskuche U (1992) Sinopsis cenosistemática preliminar de los pajonales mesófilos semi-naturales del nordeste de la Argentina, incluyendo pajonales pampeanos y puntanos. *Phytocoenologia* **21**, 237–312.

Fiaschi P, Pirani JR (2009) Review of plant biogeography studies in Brazil. *Journal of Systematics and Evolution* **47**, 477–496.

Fontana JL (1996) Los pajonales mesófilos semi-naturales de Misiones (Argentina). *Phytocoenologia* **26**, 179–271.

Fontana JL (2015) Flora y vegetación del Nordeste de Corrientes y sur de Misiones. In 'El Patrimonio Natural y Cultural en el área de influencia del Embalse de Yacyretá, Argentina'. (Eds V Bauni, M Homberg, V Capmourteres) pp. 9–27. (Fundación Félix de Azara: Buenos Aires)

Galán de Mera A (2015) La vegetación de las sabanas de los Llanos de Venezuela. In 'Colombia diversidad biótica: la región de la Orinoquia de Colombia, Vol. XVI'. (Ed. O Rangel) pp. 447–482. (Universidad Nacional de Colombia: Bogotá)

Galán de Mera A, Linares Perea E (2008) Datos sobre la vegetación de los humedales de América del Sur. De las sabanas bolivianas a los Llanos del Orinoco. *Acta Botanica Malacitana* **33**, 271–288.

Galán de Mera A, Vicente Orellana JA (2006) Aproximación al esquema sintaxonómico de la vegetación de la región del Caribe y América del Sur. *Annals of Biology* **28**, 3–27.

Galán de Mera A, Rosa MV, Cáceres C (2002) Una aproximación sintaxonómica sobre la vegetación del Perú. Clases, órdenes y alianzas. *Acta Botanica Malacitana* **27**, 75–103.

Galán de Mera A, González A, Morales R, Oltra B, Vicente Orellana JA (2006) Datos sobre la vegetación de los Llanos Occidentales del Orinoco (Venezuela). *Acta Botanica Malacitana* **31**, 97–129.

Galán de Mera A, Méndez E, Linares Perea E, Campos de la Cruz J, Vicente Orellana JA (2014) Plant communities linked with cryogenic processes in the Peruvian Andes. *Phytocoenologia* **44**, 121–161.

Gehu JM, Rivas-Martínez S (1981) Notions fondamentales de phytosociologie. In 'Syntaxonomie'. (Ed. H Dierschke) pp. 5–33. (J Cramer: Vaduz)

Godagnone RE, Bertola H, Ancarola M (2002) 'Mapa de suelos de Argentina. Escala 1 : 2.500.000.' (Instituto Nacional de Tecnología Agropecuaria: Buenos Aires)

Henderson A, Galeano G, Bernal R (1995) 'Field guide to the palms of the Americas.' (Princeton University Press: Princeton, NJ)

INTA [Instituto Nacional de Tecnología Agropecuaria] (1998) 'Carta de suelos de la República Argentina. Departamento Colón, Provincia de Entre Ríos. Memoria técnica plan mapa de suelo.' Serie relevamiento de recursos naturales 21. (Instituto Nacional de Tecnología Agropecuaria: Buenos Aires)

Iriondo MH, Krohling D (2008) 'Cambios ambientales en la Cuenca del Uruguay (desde el presente hasta dos millones de años atrás).' (Ediciones Universidad Nacional del Litoral: Santa Fé, Argentina)

Kegler A, Diesel A, Wasum RA, Herrero L, Del Rio S, Penas A (2010) Contribution to the phytosociological survey of the primary forests in the NE of Rio Grande do Sul (Brazil). *Plant Biosystems* **144**, 53–84.

Li CF, Zelený D, Chytrý M, Chen MY, Chen TY, Chiou CR, Hsia YJ, Liu HY, Yang SZ, Yeh CL, Wang JC, Yu CF, Lai YJ, Guo K, Hsieh CF (2015) Chamaecyparis montane cloud forest in Taiwan: ecology and vegetation classification. *Ecological Research* **30**, 771–791.

Lorentz P (1876) Cuadro de la vegetación de la República Argentina. In 'La República Argentina'. (Ed. R Napp) pp. 77–136. (Sociedad Anónima de Tipografía, Litografía y Fundición de Tipos: Buenos Aires)

Luebert F, Pliscoff P (2006) 'Sinopsis bioclimática y vegetacional de Chile.' (Editorial Universitaria: Santiago de Chile)

Martínez Carretero E, Faggi AM, Fontana JL, Aceñolaza PG, Gandullo R, Cabido M, Iriart D, Prado D, Roig FA, Eskuche U (2016) Prodromus sinsistemático de la República Argentina y una breve introducción a los estudios fitosociológicos. *Boletín de la Sociedad Argentina de Botánica* **51**, 469–549.

Martínez-Crovetto R, Piccinini BG (1950) La vegetación de la República Argentina, 1. Los palmares de *Butia yatay*. *Revista de Investigaciones Agrícolas* **4**, 153–242.

Matthews ER, Peet RK, Weakley AS (2011) Classification and description of alluvial plant communities of the Piedmont region, North Carolina, USA. *Applied Vegetation Science* **14**, 485–505.

McCune B, Mefford MJ (2011) 'PC-ORD. Multivariate analysis of ecological data. Version 6.' (MjM Software: Gleneden Beach, OR)

Mucina L, Rutherford MC (2006) 'The vegetation of South Africa, Lesotho and Swaziland.' (South African National Biodiversity Institute: Pretoria, South Africa)

Mucina L, Bültmann H, Dierßen K, Theurillat JP, Raus T, Carni A, Šumberová K, Willner W, Dengler J, Gavilán R, Chytrý M, Hájek M, Di Pietro R, Iakushenko D, Pallas J, Daniëls FJA, Bergmeier E, Santos A, Ermakov N, Valachovič M, Schaminée JHJ, Lysenko T, Didukh YP, Pignatti S, Rodwell JS, Capelo J, Weber HE, Solomeshch A, Dimopoulos P, Aguiar C, Hennskens SM, Tichý L (2016) Vegetation of Europe: hierarchical floristic classification system of vascular plant, bryophyte, lichen, and algal communities. *Applied Vegetation Science* **19**, 3–264.

Navarro G, Maldonado M (2005) 'Geografía ecológica de Bolivia. Vegetación y ambientes acuáticos.' (Fundación Simón I. Patiño: Santa Cruz, Bolivia)

Orme AR (2007) Tectonism, climate, and landscape change. In 'The physical geography of South America'. (Eds TT Veblen, KR Young, AR Orme) pp. 23–44. (Oxford University Press: New York)

Peinado M, Ocaña-Peinado FM, Aguirre JL, Delgadillo J, Macías MÁ, Díaz-Santiago G (2011) A phytosociological and phytogeographical survey of the coastal vegetation of western North America: beach and dune vegetation from Baja California to Alaska. *Applied Vegetation Science* **14**, 464–484.

Peinado M, Díaz G, Ocaña-Peinado FM, Aguirre JL, Macías MA, Delgadillo J, Aparicio A (2013) Statistical measures of fidelity applied to diagnostic species in plant sociology. *Modern Applied Science* **7**, 106–120.

Rangel O (2015) La biodiversidad de Colombia: significado y distribución regional. *Revista de la Academia Colombiana de Ciencias Exactas, Físicas y Naturales* **39**, 176–200.

Rangel O, Lowy PD, Aguilar M (1997) 'Tipos de vegetación en Colombia. Colombia diversidad biótica II.' (Universidad Nacional de Colombia: Bogotá)

Rivas-Martínez S, Navarro G, Penas A, Costa M (2011) Biogeographic map of South America. A preliminary survey. *International Journal of Geobotanical Research* **1**, 21–40.

Rivas-Martínez S, Rivas-Sáenz S (2015) 'Worldwide bioclimatic classification system.' (Phytosociological Research Center: Madrid). Available at http://www.globalbioclimatics.org [Verified 10 January 2016]

Rivas-Martínez S, Sánchez-Mata D, Costa M (1999) North American boreal and western temperate forest vegetation (syntaxonomical synopsis of the potential natural plant communities of North America, II). *Itinera Geobotanica* **12**, 5–316.

Rodriguez EE (2013) Heterogeneidad de la vegetación en una porción del Espinal Mesopotámico. Tesis de Doctorado en Ciencias Biológicas, Facultad de Ciencias Naturales, Universidad Nacional de Salta, Salta, Argentina.

Rojas AE, Saluso JH (1987) 'Informe climático de la Provincia de Entre Ríos.' (Estación Experimental Agropecuaria: Paraná, Argentina)

Rolhauser A, Batista W (2014) From pattern to process: estimating expansion rates of a forest tree species in a protected palm savanna. *Landscape Ecology* **29**, 919–931.

Schwabe A, Kratochwil A (1994) Are biocoenotic principles also applicable for the landscape ecological level? Examples of habitat complexes of central alpine dry areas. *Phytocoenologia* **24**, 1–22.

Schwarz T (2015) 'Climate-data.org.' (AmbiWeb GmbH: Gernsbach, Germany) Available at http://es.climate-data.org/ [Verified 15 December 2015]

Soares K, Longi S, Neto L, Cohelo L (2014) Palmeiras (Arecaeceae) no Rio Grande do Sul, Brasil. *Rodriguezia* **65**, 113–139.

The Plant List (2015) 'The plant list. A working list of all plant species.' (Kew Royal Botanic Gardens, Missouri Botanical Garden, The New York Botanical Garden) Available at http://www.theplantlist.org. [Verified 15 December 2015]

Thiers B (2016) 'Index herbariorum: a global directory of public herbaria and associated staff.' (New York Botanical Garden's Virtual Herbarium: New York) Available at http://sweetgum.nybg.org/science/ih/ [Verified 8 December 2015]

Tichý L (2002) JUICE, software for vegetation classification. *Journal of Vegetation Science* **13**, 451–453.

Tichý L (2005) New similarity indices for the assignment of relevés to the vegetation units of an existing phytosociological classification. *Plant Ecology* **179**, 67–72.

Tichý L, Chytrý M (2006) Statistical determination of diagnostic species for site groups of unequal size. *Journal of Vegetation Science* **17**, 809–818.

Tropicos (2016) 'Tropicos.org.' (Missouri Botanical Garden: St Louis, MO) Available at http://www.tropicos.org [Verified 15 June 2016]

Walker DA, Kuss P, Epstein HE, Kade AN, Vonlanthen CM, Raynolds MK, Daniëls FJA (2011) Vegetation of zonal patterned-ground ecosystems along the North America Arctic bioclimate gradient. *Applied Vegetation Science* **14**, 440–463.

Weber HE, Moravec J, Theurillat JP (2000) International code of phytosociological nomenclature. 3rd edn. *Journal of Vegetation Science* **11**, 739–768.

Zuloaga FO, Morrone O, Belgrano MJ (Eds.) (2008) 'Catálogo de las plantas vasculares del Cono Sur. 3 vol.' (Missouri Botanical Garden: St Louis, MO)

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Appendix 1. Synoptic table of humid forest from Entre Rios (Argentina) and Rio Grande do Sul (Brazil)

Values in cells are percentage frequencies. Underlined numbers indicate species with a high (phi ≥0.50) and moderate (phi ≥0.25) fidelity. Only the most frequent and diagnostic species are shown. 1–4, Entre Rios, Argentina: 1, *Eugenio myrcianthes–Butietum yatay* (Martínez Crovetto and Piccinini 1950, p. 172); 2, 3, *Eugenio myrcianthis–Butietum yatay* (authors); 4, *Bignonio callistegioidis–Terminalietum australis* (authors); 5–9, Rio Grande do Sul, Brazil: 5, *Dyckio brevifoliae–Salicetum humboldtianae* (Kegler *et al*. 2010; table 5); 6, *Calyptrantho concinnae–Araucarietum angustifoliae* (Kegler *et al*. 2010, table 1); 7, *Myrceugenio glaucescentis–Siphoneugenetum reitzii* (Kegler *et al*. 2010, table 2); 8, *Cupanio vernalis–Luehetum divaricatae* (Kegler *et al*. 2010, table 4); 9, *Geonomo elegantis–Ficetum organensis* (Kegler *et al*. 2010, table 3)

Parameter	*Sebastianio–Terminalietea*							*Cedrelo–Ocoteetea*	
	Guettardo-Bution				*Dyckio-Salicion*	*Araucario-Ocoteion*		*Erythrino-Phytolaccion*	*Fico-Nectandrion*
Column number	1	2	3	4	5	6	7	8	9
Number of plots	13	10	20	8	5	29	3	19	3
Plants with a wide distribution in South America									
Allophylus edulis	.	90	60	38	40	28	.	89	.
Eugenia uniflora	8	20	.	25	20	7	.	42	.
Maytenus ilicifolia	.	60	60	75	.	34	.	.	33
Daphnopsis racemosa	.	10	20	50	.	38	.	11	.
Sapium glandulosum	.	.	.	.	20	28	33	26	67
Blepharocalyx salicifolius	.	50	60	38	.	45	.	.	.
Myrcia selloi	.	20	35	25	.	10	.	.	.
Sebastiania commersoniana	.	.	60	50	40	55	.	53	.
Celtis iguanaea	.	10	.	.	.	17	.	58	.
Rubus sellowii	.	.	.	.	.	21	33	.	33
Trema micrantha	.	.	.	.	.	3	.	5	33
Class 1. *Cedrelo fissilis–Ocoteetea puberulae*									
Cedrela fissilis	.	.	.	.	20	14	.	53	100
Sebastiania brasiliensis	.	.	.	63	.	24	.	53	33
Syagrus romanzoffiana	.	.	.	.	40	10	.	63	67
Carex sellowiana	.	.	.	.	20	38	.	21	.
Ilex microdonta	.	.	.	.	.	31	33	5	.
Rudgea parquioides	.	.	.	.	.	45	.	16	33
Symplocos uniflora	.	.	.	.	.	45	33	.	33
Myrciaria tenella	.	.	.	.	.	34	33	.	33
Prunus subcoriacea	.	.	.	.	.	34	33	.	33
Rollinia emarginata	.	.	.	.	.	28	.	32	.
Lamanonia ternata	.	.	.	.	.	17	.	11	.
Frangula sphaerosperma	.	.	.	.	.	17	33	.	.
Dasyphyllum tomentosum	.	.	.	.	.	10	.	.	.
Dalbergia frutescens	.	.	.	.	40	.	.	37	.
Cordia trichotoma	.	.	.	.	20	.	.	32	.
Order 1.1. *Araucario angustifoliae–Ocoteetalia puberulae*									
Ctenitis submarginalis	.	.	.	.	.	21	100	47	67
Miconia cinerascens	.	.	.	.	.	48	33	.	.
Ocotea puberula	.	.	.	.	.	28	.	68	.
Myrcianthes gigantea	.	.	.	.	.	31	.	11	.
Diplazium turgidum	.	.	.	.	.	.	67	.	33
Myrcia oblongata	.	.	.	.	.	34	.	.	.
Zanthoxylum fagara	.	.	.	.	.	31	.	.	.
Myrsine coriacea	.	.	.	.	.	21	.	.	.
Myrceugenia euosma	.	.	.	.	.	38	.	.	.
Alliance 1.1.1. *Araucario angustifoliae–Ocoteion puberulae*									
Myrceugenia glaucescens	.	10	20	75	.	.	100	.	.
Leandra regnellii	.	.	.	.	20	52	.	11	.
Eugenia involucrata	.	.	.	.	.	31	100	37	.
Araucaria angustifolia	.	.	.	.	.	100	100	.	.
Drimys brasiliensis	.	.	.	.	.	55	100	.	.
Lithraea brasiliensis	.	.	.	.	.	55	.	32	.
Acca sellowiana	.	.	.	.	.	52	.	.	.
Ilex dumosa	.	.	.	.	.	28	.	.	.
Myrciaria delicatula	.	.	.	.	.	59	.	.	.
Ocotea pulchella	.	.	.	.	.	41	.	.	.

(*continued next page*)

Appendix 1. (*continued*)

Parameter	*Sebastianio–Terminalietea*					*Cedrelo–Ocoteetea*			
	Guettardo-Bution				*Dyckio-Salicion*	*Araucario-Ocoteion*		*Erythrino-Phytolaccion*	*Fico-Nectandrion*
Association 1.1.1.1. *Calyptrantho concinnae–Araucarietum angustifoliae*									
Calyptranthes concinna	.	.	.	.	.	100	.	.	33
Miconia hyemalis	.	.	.	.	.	72	.	5	.
Podocarpus lambertii	.	.	.	.	.	66	.	.	.
Association 1.1.1.2. *Myrceugenio glaucescentis–Siphoneugenetum reitzii*									
Siphoneugena reitzii	.	.	.	.	.	38	100	.	.
Schinus polygama	23	.	.	.	.	24	100	.	.
Dicksonia sellowiana	.	.	.	.	.	41	100	.	.
Berberis laurina	.	.	.	.	.	31	100	.	.
Eleocharis nudipes	.	.	.	.	.	10	100	.	.
Acaena eupatoria	.	.	.	.	.	3	100	.	.
Blechnum penna-marina	.	.	.	.	.	.	67	.	.
Blechnum spannagelii	.	.	.	.	.	.	67	.	.
Erythroxylum cuneifolium	.	.	.	.	.	.	100	5	.
Myrsine venosa	.	.	.	.	.	.	67	.	.
Leandra carassana	.	.	.	.	.	.	67	.	.
Solanum vaillantii	.	.	.	.	.	7	67	.	.
Order 1.2. *Piptadenio rigidae–Nectandretalia megapotamicae*									
Nectandra megapotamica	.	10	.	50	40	38	.	100	67
Campomanesia xanthocarpa	.	.	.	.	20	24	.	68	33
Piper gaudichaudianum	.	.	.	.	40	7	.	100	100
Jacaranda micrantha	.	.	.	.	20	.	.	58	33
Casearia sylvestris	.	.	.	.	60	10	.	68	.
Trichilia claussenii	.	.	.	.	20	.	.	84	67
Anaemia phyllitidis	.	.	.	.	40	21	.	79	.
Asplenium claussenii	.	.	.	.	.	52	33	79	.
Christella dentata	.	.	.	.	40	7	.	58	.
Psychotria leiocarpa	.	.	.	.	.	24	.	58	33
Parapiptadenia rigida	.	.	.	.	40	.	.	58	.
Patagonula americana	.	.	.	.	20	.	.	47	.
Erythrina falcata	.	.	.	.	20	.	.	53	.
Ficus luschnathiana	8	.	.	.	.	.	.	37	.
Casearia decandra	.	.	.	.	.	38	.	47	.
Stillingia oppositifolia	.	.	.	.	.	21	.	37	.
Diplazium cristatum	.	.	.	.	.	7	.	37	.
Rollinia rugulosa	.	.	.	.	.	7	.	37	.
Eugenia rostrifolia	.	.	.	.	.	.	.	37	.
Stenochlaena palustris	.	.	.	.	.	.	.	32	.
Piper amalago	.	.	.	.	.	7	.	32	.
Maclura tinctoria	.	.	.	.	.	.	.	37	.
Alliance 1.2.1. *Erythrino falcatae–Phytolaccion dioicae*									
Luehea divaricata	.	.	.	13	60	3	.	100	.
Cupania vernalis	.	.	.	.	60	38	.	100	33
Trichilia elegans	.	.	.	.	40	14	.	100	33
Matayba eleagnoides	.	.	.	.	20	34	.	74	.
Piper mikanianum	.	.	.	.	40	14	.	95	.
Inga semialata	.	.	.	.	20	.	.	68	.
Acalypha gracilis	.	.	.	.	.	10	.	63	.
Pilocarpus pennatifolius	.	.	.	.	.	3	.	47	.
Myrocarpus frondosus	.	.	.	.	.	.	.	42	.
Phytolacca dioica	.	.	.	.	.	.	.	47	.
Citronella paniculata	.	.	.	.	.	.	.	42	.
Cabralea canjerana	.	.	.	.	.	.	.	63	.
Byttneria australis	.	.	.	.	.	.	.	58	.
Association 1.2.1.1. *Cupanio vernalis–Luehetum divaricatae*									
Urera baccifera	.	.	.	.	.	3	.	68	.
Chrysophyllum marginatum	.	.	.	.	.	.	.	68	.
Order 1.3. *Fico organensis–Nectandretalia rigidae*									

(*continued next page*)

Appendix 1. (*continued*)

Parameter	*Sebastianio–Terminalietea* *Guettardo-Bution*				*Dyckio-Salicion*	*Araucario-Ocoteion*		*Cedrelo–Ocoteetea* *Erythrino-Phytolaccion*	*Fico-Nectandrion*
Zanthoxylum rhoifolium	.	.	.	.	20	62	67	42	100
Myrsine umbellata	.	.	.	.	20	14	.	42	67
Crocosmia crocosmiiflora	.	.	.	.	.	.	.	.	33
Inga virescens	.	.	.	.	.	.	.	.	33
Nectandra oppositifolia	.	.	.	.	.	.	.	.	33
Piptocarpha axillaris	.	.	.	.	.	.	.	.	33
Alliance 1.3.1. *Fico organensis–Nectandrion rigidae*									
Alchornea triplinervia	.	.	.	.	.	7	.	26	67
Sorocea bonplandii	.	.	.	.	.	3	.	68	100
Association 1.3.1.1. *Geonomo elegantis–Ficetum organensis*									
Pachystroma longifolium	.	.	.	.	.	7	.	21	100
Actinostemon concolor	.	.	.	.	.	.	.	53	100
Mollinedia elegans	.	.	.	.	.	3	.	37	100
Nectandra reticulata	.	.	.	.	.	.	.	.	100
Cecropia glaziovii	.	.	.	.	.	.	.	.	67
Geonoma elegans	.	.	.	.	.	.	.	.	100
Ficus cestrifolia	.	.	.	.	.	.	.	.	100
Acacia magnibracteosa	.	.	.	.	.	.	.	.	100
Class 2. *Sebastianio schottianae–Terminalietea australis*									
Smilax campestris	8	80	60	88	.	14	33	.	33
Terminalia australis	.	.	.	100	100	.	.	.	.
Order 2.1. *Dyckio brevifoliae–Terminalietalia australis*									
Guettarda uruguensis	.	10	60	75	100	.	.	.	.
Acacia bonariensis	8	.	.	75	80	.	.	32	.
Scutia buxifolia	.	60	20	.	.	21	.	.	.
Pouteria salicifolia	.	.	20	75	100	.	.	.	.
Eugenia aff. uruguayensis	.	.	.	50	.	3	.	.	33
Cephalanthus glabratus	.	.	20	50	.	.	.	.	.
Cardiospermum grandiflorum	.	.	.	50	.	.	.	.	.
Ruprechtia salicifolia	.	.	.	50	.	.	.	.	.
Acacia caven	.	50	.	.	.	.	.	.	.
Alliance 2.1.1. *Dyckio brevifoliae–Salicion humboldtianae*									
Calliandra brevipes	.	.	.	.	100	.	.	16	.
Chrysophyllum gonocarpum	.	.	.	.	100	.	.	16	.
Dyckia brevifolia	.	.	.	.	100	.	.	.	.
Calliandra foliolosa	.	.	.	.	100	.	.	.	.
Hedychium coronarium	.	.	.	.	60	.	.	.	.
Association 2.1.1.1. *Dyckio brevifoliae–Salicetum humboldtianae*									
Salix humboldtiana	.	.	.	38	100	.	.	.	.
Bauhinia forficata	.	.	.	.	100	.	.	37	.
Calliandra tweedii	.	.	.	.	100	.	.	11	.
Morus nigra	.	.	.	.	100	.	.	.	.
Sebastiania schottiana	.	.	.	.	100	.	.	.	.
Alliance 2.1.2. *Guettardo uruguensis–Bution yatay all. nova*									
Eugenia myrcianthes	.	60	40	13	.	.	.	.	.
Myrsine laetevirens	.	.	60	25	.	.	.	.	.
Association 2.1.2.1. *Eugenio myrcianthis–Butietum yatay ass. nova*									
Butia yatay	100	50	100	.	.	.	.	.	.
Baccharis coridifolia	69	.	100	.	.	.	.	.	.
Dolichandra cynanchoides	.	60	.	.	.	.	.	.	.
Lantana megapotamica	.	.	60	.	.	.	.	.	.
Association 2.1.2.2 *Bignonio callistegioidis–Terminalietum australis ass. nova*									
Bignonia callistegioides	.	20	40	75	.	.	.	.	.
Companion species									
Pavonia sepium	.	50	40	25	80	.	.	37	.
Gleditsia triacanthos	.	60	.	25	.	.	.	.	.
Morus alba	.	10	.	50	.	.	.	.	.
Ligustrum lucidum	.	50	20	.	.	.	.	.	.

(*continued next page*)

Appendix 1. (*continued*)

Parameter	*Sebastianio–Terminalietea*							*Cedrelo–Ocoteetea*	
	Guettardo-Bution			*Dyckio-Salicion*		*Araucario-Ocoteion*		*Erythrino-Phytolaccion*	*Fico-Nectandrion*
Croton sp.	.	10	100	.	.	.	.	.	.
Ricinus communis	.	.	.	.	60	.	.	11	.
Pyracantha sp.	.	50	.	.	.	.	.	.	.
Melia azedarach	.	70	.	.	.	.	.	.	.
Ligustrum sinense	.	70	.	.	.	7	.	.	.
Plants of grasslands and other communities									
Adiantum raddianum	.	10	.	13	20	14	.	58	.
Oplismenus hirtellus	.	60	.	13	60	38	.	37	.
Sida rhombifolia	62	20	55	.	20	.	.	.	.
Pfaffia tuberosa	77	10	20	.	.	.	33	.	.
Elephantopus mollis	23	40	100	.	.	48	.	.	.
Tradescantia fluminensis	.	20	.	25	.	3	.	37	.
Chaptalia nutans	.	.	20	.	.	59	100	11	.
Dorstenia brasiliensis	8	20	95	.	.	.	.	.	.
Melica sarmentosa	.	40	40	25	.	.	.	.	.
Iresine diffusa	15	20	60	.	.	.	.	.	.
Desmodium incanum	54	10	40	.	.	.	.	.	.
Richardia brasiliensis	23	.	60	.	20	.	.	.	.
Wissadula glechomatifolia	15	10	60	.	.	.	.	.	.
Achyrocline satureioides	8	10	60	.	.	.	.	.	.
Cyclospermum leptophyllum	15	.	.	.	.	21	67	.	.
Commelina diffusa	.	.	60	.	.	14	.	16	.
Justicia brasiliana	.	.	.	.	60	10	.	74	.
Hydrocotyle leucocephala	.	.	.	.	.	34	100	21	.