An Acad Bras Cienc (2020) 92(1): e20180983 DOI 10.1590/0001-3765202020180983
Anais da Academia Brasileira de Ciências | *Annals of the Brazilian Academy of Sciences*
Printed ISSN 0001-3765 I Online ISSN 1678-2690
www.scielo.br/aabc | www.fb.com/aabcjournal

BIOLOGICAL SCIENCES

Weedy ferns (Polypodiopsida) in Argentina: diversity, distribution and impact on human activities and ecosystems

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Abstract: Currently, in Argentina 368 species of true ferns (i.e. Polypodiopsida class) are distributed throughout the country, however, only four of them have been mentioned until now as weeds and ruderal species. The goal of this work was to generate an update of weedy ferns from Argentina, including morphology, distribution, and type of weed according to their impact on natural habitats and/or human activities. All Argentinian fern species were analyzed based on references, herbarium specimens, and field trips. As a result of our study 25 species were recorded from Argentina and classified as segetal, ecological, or aquatic weeds, and ruderal and/or toxic species. Current taxonomic identity, diagnostic characters, origins, habitats, geographical distribution, common names, and impact and potential risks were indicated by species. In addition, we provide a dichotomous key to species, presence of these species in southern South American countries, as well as and photographs in natural habitat. This work represents the first review on native and exotic ferns from Argentina that cause an impact on human activities or disturbe native habitats. The results provide information for the development of weed management tools and priority areas to implement them.

Key words: anthropized areas, aquatic weed, ecological weed, ruderal weed, segetal weed, toxic plant.

INTRODUCTION

This work represents the first contribution on the weedy "fern" or "true ferns" species (Polypodiopsida *sensu* PPG I) that grow in Argentina and their relationships with natural habitats and human activities. Previously, until more than a decade ago, the ferns and lycophytes (Lycopodiopsida class *sensu* PPG I 2016) were grouped in the paraphyletic clade "Pteridophytes" but they later separated based on morphological and molecular data (Smith et al. 2006).

Phylogenetically, Polypodiopsida is the sister group of the seed plants and consists of about 10578 species in the world (PPG I 2016), of which 368 are present in Argentina (Ponce & Arana 2016). Although ferns are usually recognized by humans due to their ornamental and/or medicinal uses, more than 157 species in the world have been registered as alien weeds, of which 39% behave as invasive species (Jones et al. 2018) or toxic for animals and humans (Siman et al. 2000). The controversial term "weed" can be defined, in a broad sense, as those plant species that interfere with human activity because they grow at a time and place where they are unwanted (Holzner 1978, Fryer 1979). From a biogeographical perspective, "weeds" are considered exotic species that are distributed

outside their native distribution area due to an unnatural cause (Rejmánek 1995). However, if ecological changes occur under man-made management systems, species of the native flora can expand their range of distribution and invade new habitats (Mortimer 1990). From an ecological perspective, "colonizing weeds" are considered those pioneer species that rapidly invade those areas where the original vegetation was altered (Baker 1974, Pysek 1995, Wijesundara 2017).

Colonizing species can be considered as weeds because they invade cultivable areas and decrease the productivity of the crop (segetal weeds), and because they invade disturbed natural habitats and, if these are exotic, they could displace native species (environmental or ecological weeds) (Holzner 1978, 1982, Lorenzi 2008). Furthermore, some aquatic species can also be considered colonizing weeds, when their populations grow excessively under favorable environmental conditions. These populations reach to cover completely bodies of water hindering navigation, fishing, and electrical generation, and contributing to the ecosystem eutrophication due to the symbiosis of aquatic species with Cyanobacteria (Randall 1996).

On the other hand, other species are considered weeds but because of their toxicity. In addition to the risk to human health, the poisoning caused by the ingestion of toxic plants is one of the main causes of mortality of livestock animals and causes great economic losses (Gallo 1979, Acamovic et al. 2004, Campos et al. 2016).

Finally, sometimes the concept "weed" includes those species called "ruderals". These species grow spontaneously in urban microhabitats such as stone or brick walls, roofs, roadsides, and margins of railway lines, and ditches (Holzner 1978, Caluff & Fiallo 2008, Edgington 2008, Morajkar et al. 2015). Although in many cases the ruderal species do not cause a direct impact on the anthropic activities, and even provide an ecosystem service, their excessive growth for a long time can turn them into "annoying" or unwanted species (Del Tredici 2010).

It is important to note that the recognition of a species as a weed varies according to the region and over time, since it depends on the subjectivity of the human with respect to the problems that the species causes (Marzocca 1986, Binggeli 1994).

Ferns have reproductive strategies that in many cases coincide with those of a colonizing weed. Among these can be highlighted: production of thousands of anemophilous spores that are dispersed hundreds of kilometers and remain dormant for years forming a spores bank in the soil (Tryon 1986); rapid and massive germination and young fast-growing sporophytes; long creeping rhizomes sometimes fire-resistant (Roos et al. 2010); vegetative multiplication through fragmentation and/or through gemmiferous rhizomes, rachis, and leaves (Vasco et al. 2013), and production of allelopathic substances that inhibit the growth of other species. In this way, exotic species of ferns have displaced native representatives in different parts of the world, producing numerous adverse effects on the ecosystems that invade (Sharpe et al. 2010, Akomolafe & Rahmad 2018).

Despite the important diversity of ferns in the Argentine flora, only four species were considered weeds in general or local works as weeds (Marzocca 1986, Lallana 1989, Califano & Echazú 2013, Rosato et al. 2015, Fernández et al. 2016).

The goals of this work are (1) to suggest which among the fern species present in the Argentine flora behave as weeds (including ruderal) and to review their taxonomic and morphological diversity, (2) to update information about their

habitat and geographical distribution, and (3) to classify them according to their impacts on natural habitats and/or human activities. In addition, a dichotomous key and additional diagnostic character to species are provided, and a comparative analysis with the southern South American countries is discussed.

MATERIALS AND METHODS

We elaborated a list of weedy fern species, collecting information from herbarium specimens, field trips, and by revising the literature.

The species in the final list belong to one or more of the following weed categories: Segetal weed (SEW): colonizing species that invades crops or cultivable areas; Ecological weed (ECW): colonizing species that invade disturbed natural habitats; Aquatic weed (AQW): colonizing species from aquatic habitats which, because of their excessive growth, cause problems for human activities; Toxic (TOX): species poisonous for animals and humans; Ruderal (RUD): species growing spontaneously in urban microhabitats.

For the analysis of herbarium specimens, the following institutions were consulted: BA, BAB, LP, MCNS and SI (abbreviations follow Thiers 2018). In addition, field trips were made mainly to the Northwest, Northeast, and central Argentina, from 2010-2017. The species were photographed and georeferenced and vouchers were deposited at BA and SI. Photographs of species were taken by the authors or provided by the database Documenta Florae Australis (http://www.floraargentina.edu.ar). A dichotomous key was elaborated to distinguish the species listed in this studied. In addition, in the treatment of each species, additional diagnostic morphological characters not mentioned in the key were described.

An exhaustive bibliographic analysis about ferns species of the Argentina flora was carried out to establish the distribution, growth habits and environments of species that correspond to any of the aforementioned categories (i.e. Capurro 1968, de la Sota 1977, Moore 1983, Ponce 1994, de la Sota & Ponce 1998, de la Sota et al. 2001, Ponce et al. 2002, Pensiero et al. 2005, Arana & Bianco 2009, Morero et al. 2014, Ponce & Arana 2016). Additionally, surveys of weedy and ruderal species from worldwide (Randall 2017, Akomolafe & Rahmad 2018), southern South America (Gallo 1979), and Argentina (Burkart 1933, Marzocca, 1986, Fernández et al. 2016), Brazil (Cardenas & Coulston 1967, Lorenzi 2008), Chile (Matthei et al. 1995), Cuba (Caluff & Fiallo 2008, Caluff et al. 2017), North America (Dickinson & Royer 2014), Oceania (Wilcox & Rogan 1999), Paraguay (De Egea et al. 2016), Peru (Sagástegui & Leiva 1993), and Venezuela (Zambrano 1974), were examined with the aim of carrying out an exhaustive analysis of the ecological role that the studied species have in Argentina and in other areas of their distribution throughout the World. Finally, we revised the literature on ferns in Bolivia (Jørgensen et al. 2014, Kessler & Smith 2017, Smith & Kessler 2017, 2018, Schwartsburd et al. 2017), Brazil (BFG 2018), Chile (Rodriguez 1995), Paraguay (http://www.tropicos.org/Project/Paraguay), Uruguay (Brussa & Grella 2005) and southern South America (Zuloaga & Belgrano 2008) to make a preliminary survey about the weedy role of the studied species in southern countries of South America, and to make comparisons with the populations studied in Argentina.

Published studies that add relevant information on the distribution, morphological characteristics, reproduction strategies and ecological roles were added to the description of each species. We follow Schulz (1976) and De la Peña (1997) for the common species names used

in Argentina. When a common name does not exist in Argentina, names from other countries were included.

The code assigned in the Global Database of the European and Mediterranean Plant Protection Organization is provided for each species (https://gd.eppo.int/). This database contains basic information for species of interest to agriculture, forestry, and plant protection. Likewise, those species that are cited in the Global Invasive Species Database of the IUCN are indicated (GISD) (http://www.iucngisd.org/gisd/).

To analyze the species distributions in Argentina and detect if there is a variation in the diversity of weedy species and in the relationship between native / exotic species, the following geopolitical regions were considered: Northwest region (Catamarca, Jujuy, La Rioja, Salta, Santiago del Estero, and Tucumán provinces), Northeast region (Chaco, Corrientes, Formosa, and Misiones provinces), Cuyo region (Mendoza, San Juan, and San Luis provinces), Central region (Buenos Aires City and Buenos Aires, Córdoba, Entre Ríos, La Pampa, and Santa Fe provinces) and Patagonian region (Chubut, Neuquén, Río Negro, Santa Cruz, and Tierra del Fuego provinces). These regions have, in most cases, an uniformity in terms of socio-productive activities (e.g. land use, regional economies, population density), which is interesting to compare with the distribution of the different types of weeds studied.

RESULTS

We found a total of 25 species that could be classified according to the types of weeds considered in this study (Fig. 1). Three of them were recognized as toxic for animals and humans, eight were ruderal associated with urban environments, and 12 spp. were associated with crops (segetal weed), natural habitats (ecological weed) and/or aquatic habitats (aquatic weeds). Also, *Christella dentata* (Forssk) Brownsey and Jermy and *Macrothelypteris torresiana* (Gaudich) Ching were recorded as both ruderal and ecological weed, and five species recognized as ruderal or ecological weeds have toxic chemical principles:*Dryopteris filix-mas* (L.) Schott (Schönfelder and Schönfelder 2001), *Equisetum giganteum* L. (Riet-Correa et al. 2017), *Marsilea ancylopoda* A. Braun (Skalski et al. 2016), *Pellaea ternifolia* (Cav.) Link (Califano and Echazú 2013), and *Pteridium esculentum* subsp. *arachnoideum* (Kaulf.) Thomson (Furlan et al. 2014, Tourchi-Roudsari 2014).

From a taxonomical point of view, the 25 species belong to 16 genera and ten families of Polypodiopsida. The families most represented were Pteridaceae, with 11 mostly ruderal and toxic species, followed by Salviniaceae, with six aquatic weeds.

Regarding the original distributions, 14 of the weedy species are native and widely distributed in the country. Of these, twelve occur in three out of five regions of Argentina (Fig. 3). The remaining 11 species are exotic and, in most cases, their introduction into the country may be due to their ornamental use followed by the establishment beyond human control. However, the causes of the introduction of *Macrothelypteris torresiana* (Gaudich.) Ching, *Pteris cretica* L., and *Salvinia adnata* Desv remain unknown.

Geographically, the highest number of species (21) is recorded in the Central region, and the lowest number (five) in the Patagonian region. The province of Salta in Northwest Argentina and the Buenos Aires province in the Central region, recorded the highest weed species richness (18). Furthermore, Salta has the largest number of native weedy species in the country, while Buenos Aires has the largest

number of alien weedy species in the country (Fig 2). In contrast, Tierra del Fuego (Patagonian region) is the province where the lowest number of weedy species was observed, just two: *Azolla filiculoides* Lam. and *Equisetum giganteum* L.

Despite the fact that most species identified in the present study are also cited in floras of South American countries, only in some cases these were recognized as weeds (Sagástegui & Leiva 1993, Mattheii et al. 1995, Kissmann 1997, Lorenzi 2008, De Egea et al. 2016) (Fig. 1).

In relation to this, seven Argentinian colonizing weeds (segetals, environmentals or aquatics) are also distributed in Uruguay, six in Brazil, three in Peru, two in Bolivia and only one in Chile and Paraguay. In the case of Argentinian ruderal species, *Macrothelypteris torresiana* is also distributed in Brazil, *Adiantum capillus-veneris* and *Cyrtomium falcatum* in Peru, and *Nephrolepis cordifolia*, *Pteris cretica*, *P. tremula* and *P. vittata* in Uruguay. *Pteridium esculentum* subsp. *arachnoideum* and *Equisetum giganteum* were explicitly recognized as toxic weeds in Brazil and Chile, respectively (Fig. 1).

Finally, three species were explicitly mentioned as weed in the most countries: *Azolla filiculoides, Equisetum giganteum* and *Pteridium esculentum* subsp. *arachnoideum.*

Key to weedy and ruderal ferns species from Argentina

1. Fronds reduced, squamiform, fused in a sheath around nodes; sporangia borne on peltate sporangiophores aggregated in strobiles at the end of the branches .....*Equisetum giganteum*

1'. Fronds evident, simple or compound, free; sporangia grouped in sori or coenosori on the abaxial surface or marginal lamina, or microsori and megasori surrounded by membranous indusia or sporocarps 2

2. Plants aquatic 3

2'. Plants terrestrial 9

3. Plants rooted in swampy or shallow waters; hard sporocarps present, drought-resistant, with several sori, each sorus with both megasporangia and microsporangia ..... *Marsilea ancylopoda*

3'. Plants not rooted, floating; thin sporocarps, not drought-resistant, each one with only one type of sorus (megasorus or microsorus) 4

4. Roots present; stem branched many times; frond simple with margin lobulate; venation free; microspores adhered in massulae with glochids 5

4'. Roots absent; stem few branched; frond compound, pinnate; venation anastomosed; microspores free, massulae and glochids absent 6

5. Adaxial margin of floating lobes with 1-celled papillae; massulae of microspores with glochids 1-septate or without septs ....*Azolla filiculoides*

5'. Adaxial margin of floating lobes with 2-celled papillae; massulae of microspores with glochids 3-4-septate..... *Azolla cristata*

6. Apices of the hairs of epidermal papillae free or sometimes fused with the apices of the neighboring hair; submerged part with fertile axes not branched; sori sessile .... *Salvinia minima*

6'. Apices of the hairs of epidermal papillae fused with each other, never with the apices of the neighboring hairs; submerged part with fertile axes branched; sori long pedunculate or subsessile 7

7. Submerged segments of the fronds with the main axis (pedicel) very brief or nonexistent, first pair of lateral axes curved; fertile axes with few sori long pedunculate and not apiculate..... *Salvina auriculata*

7'. Submerged segments of the fronds with main axis (pedicel) developed, first pair of lateral

Figure 1.

SPECIES	FAMILY	TYPE	ORIGIN	REFERENCES IN SOUTHERN SOUTH AMERICAN COUNTRIES						
				BO	BR	CH	PA	PE	UR	SELECTED EXAMINED SPECIMEN
Adiantopsis chlorophylla	Pteridaceae	SEW, ECW	Native	Kessler et al. 2017	Ponce et al. (2008a), Flora do Brasil 2020		Paraguay Checklist, Ponce et al. (2008a)	Tryon & Stolze (1989)	Brussa pers. comm.*; Brussa & Grella (2005), Ponce et al. (2008a)	**Bacigalupo & Kiesling 1753 (SI)**
Adiantum capillus-veneris	Pteridaceae	RUD	Exotic		Ponce et al. (2008a), Flora do Brasil 2020	Rodríguez Ríos (1995), Ponce et al. (2008a).		Tryon & Stolze (1989)▲		**Ramos Giacosa 8 (LP), Hicken s.n. (SI)**
Azolla cristata	Salviniaceae	AQW	Native		Flora do Brasil 2020		De la Sota & Ponce (2008a)		Brussa pers. comm.	**Martinez 172 (MCNS)**
Azolla filiculoides	Salviniaceae	AQW	Native	Jørgensen et al. (2014)	de la Sota & Ponce (2008a) Lorentzi (2008)*	Rodríguez Ríos (1995), Matthei et al. (1995)*	Paraguay Checklist, de la Sota & Ponce (2008a)	Sagástegui & Leiva (1993)*	Brussa pers. comm.*; Brussa & Grella (2005), de la Sota and Ponce (2008a)	**De la Sota 1097 (BA)**
Cheilanthes pruinata	Pteridaceae	TOX	Native	Jørgensen et al. (2014)		Rodríguez Ríos (1995), Baeza et al. (1998)		Tryon & Stolze (1989)		**D´Angelo s.n. (BA 92519)**
Christella dentana	Thelypteridaceae	SEW, ECW, RUD	Exotic (naturalized)	Smith & Kessler (2017)	Lorentzi (2008)*, Ponce & Salino (2008)	Rodriguez (1995), Baeza et al. (1998)	Abbiatti (1964), Ponce & Salino (2008)	Tryon & Stolze (1992)	Brussa & Grella (2005), Ponce & Salino (2008)	**Boelcke et al. 13321 (BAB); Hicken 50 (SI)**

Figure i. Continuation

Cyrtomium falcatum	Dryopteridaceae	RUD	Exotic					Tryon & Stolze (1991)▲		**Irazoqui 4 (BA)**
Dryopteris filix-mas	Dryopteridaceae	ECW, TOX	Exotic			Rodríguez (1995), Salino & Ponce (2008)				**Diem 3596 (BAB)**
Equisetum giganteum	Equisetaceae	SEW, TOX	Native	Kessler & Smith (2017)	Kissmann (1997)•, Lorentzi (2008)*, de la Sota & Ponce (2008b)	Rodriguez (1995), Baeza et al. (1998), de la Sota & Ponce (2008b), Riet-Correa et al (2017)•	Paraguay Checklist, de la Sota & Ponce (2008b)	Sagástegui & Leiva (1993)*, Zegarra (1996)*	Brussa & Grella (2005), de la Sota & Ponce (2008b)	**Crespo &. Calieses 2262 (BAB)**
Macrothelyperis torresiana	Thelypteridaceae	ECW, SEW, RUD	Exotic (naturalized)	Smith & Kessler (2017)*	Ponce & Salino (2008). Flora do Brasil 2020▲		Paraguay Checklist, Ponce et al. (2008)	Tryon & Stolze (1992)	Brussa pers. comm.*; Brusa & Grella (2005), Ponce & Salino (2008a)	**Guillén 368 (SI); Burkart 21520 (SI)**
Marsilea ancylopoda	Marsileaceae	AQW, TOX	Native		De la Sota & Ponce (2008c), Flora do Brasil 2020		Johnson (1986), de la Sota & Ponce (2008c)	Tryon & Stolze (1994)	Brussa pers. comm.*; Brusa & Grella (2005), de la Sota & Ponce (2008c)	**Castellanos s.n. (BA 19405)**
Nephrolepis cordifolia	Nephrolepidaceae	RUD	Exotic (naturalized)	Smith & Kessler (2018)	Ponce and de la Sota (2008); Flora do Brasil 2020		Ponce & de la Sota (2008)	Tryon & Stolze (1993)	Brussa pers. comm.▲	**Hurrel et al. 2233 (BAB)**
Pellaea ternifolia	Pteridaceae	TOX, RUD	Native	Kessler et al. (2017)		Baeza et al. (1998), Ponce et al. (2008)		Tryon & Stolze (1989)		**Gutiérrez et al. 423 (BA)**

Figure i. Continuation

Pityrogramma trifoliata	Pteridaceae	ECW, SEW	Native	Kessler et al. (2017)	Ponce et al. (2008a); Flora do Brasil 2020	Rodríguez (1995), Baeza et al. (1998), Ponce et al. (2008)	Ponce et al. (2008a), Paraguay Checklist	Tryon & Stolze (1989)	Ponce et al.(2008)	**Meyer 15423 (BA)**
Pteridium esculentum subsp. arachnoideum	Dennstaedtiaceae	SEW, TOX	Native	Schwartsburd et al. (2017)*	Kissmann (1997)•, Lorentzi (2008)*, Ponce et al. (2008b)		De Egea et al. (2016)*, Ponce et al. (2008b)	Tryon & Stolze (1989)*	Brussa pers. comm.*; Brusa & Grella (2005), Ponce et al. (2008b)	**Yañez et al. 437 (BA)**
Pteris cretica	Pteridaceae	RUD	Exotic (naturalized)		Flora do Brasil 2020			Tryon & Stolze (1989)	Brussa pers. comm.▲	**Burkart 3338 (SI)**
Pteris deflexa	Pteridaceae	TOX	Native	Kessler et al. (2017)	Ponce et al. (2008a), Flora do Brasil 2020		Paraguay Checklist	Tryon & Stolze (1989)	Brusa & Grella (2008a)	**Schinini et al. 5999 (BA)**
Pteris multifida	Pteridaceae	RUD	Exotic (naturalized)	Jørgensen et al. (2014)	Flora do Brasil 2020				Ponce et al. (2008a)	**Ginastera s.n. (LP 42568)**
Pteris plumula	Pteridaceae	TOX	Native	Jørgensen et al. (2014)	Ponce et al. (2008a), Flora do Brasil 2020		Paraguay Checklist, Ponce et al. (2008)			**Zuloaga 7471 (SI)**
Pteris tremula	Pteridaceae	RUD	Exotic						Brussa pers. comm.▲	**Torres Robles & Voglino 831 (LP).**
Pteris vittata	Pteridaceae	RUD	Exotic (naturalized)		Lorentzi (2008)*, Ponce et al. (2008a)			Tryon & Stolze (1989)	Brussa pers. comm.▲; Brussa & Grella (2005), Ponce et al. (2008a)	**De la Sota 7154 (LP)**

Figure i. Continuation

Salvinia adnata	Salviniaceae	AQW	Exotic		Kissmann (1997)*, Flora do Brasil 2020					**Forno s.n. (Z) (not seen)**
Salvinia auriculata	Salviniaceae	AQW	Native	Jørgensen et al. (2014)	Kissmann (1997)*, Lorentzi (2008)*, de la Sota & Ponce (2008d)	Rodríguez (1995)	Paraguay Checklist, de la Sota & Ponce (2008d)	Tryon & Stolze (1994)	Brussa pers. comm.*; Brusa & Grella (2005), de la Sota & Ponce (2008d)	**Partridge 203 (BA)**
Salvinia biloba	Salviniaceae	AQW	Native		Kissmann (1997)*, de la Sota & Ponce (2008d), Flora do Brasil 2020		Paraguay Checklist, de la Sota & Ponce (2008d)		Brusa & Grella (2005), de la Sota & Ponce (2008d)	**Weber & Bachmann s.n. (BA 57976)**
Salvinia minima	Salviniaceae	AQW	Native	Jørgensen et al. (2014)	de la Sota & Ponce (2008d), Flora do Brasil 2020		Paraguay Checklist, de la Sota & Ponce (2008d)	Tryon & Stolze (1994)	Brussa pers. comm.*; Brusa & Grella (2005), de la Sota & Ponce (2008d)	**Partridge s.n. (BA 58081)**

Figure 1 - Type of weedy and ruderal ferns from Argentina and their distribution in the southern South American countries. Acronyms of species type: SEW = Segetal weed; ECW = Ecological weed; AQW = Aquatic weed; TOX = Toxic; RUD = Ruderal. Acronyms of southern South American countries: BO = Bolivia; BR = Brasil; CH = Chile;PA= Paraguay; PE = Peru; UR = Uruguay.Symbols: * = Species recorded as colonizing weeds (segetal, ecological or aquatic); ▲= Species recorded as ruderal or in anthropic areas; ● = Species recorded as toxic.

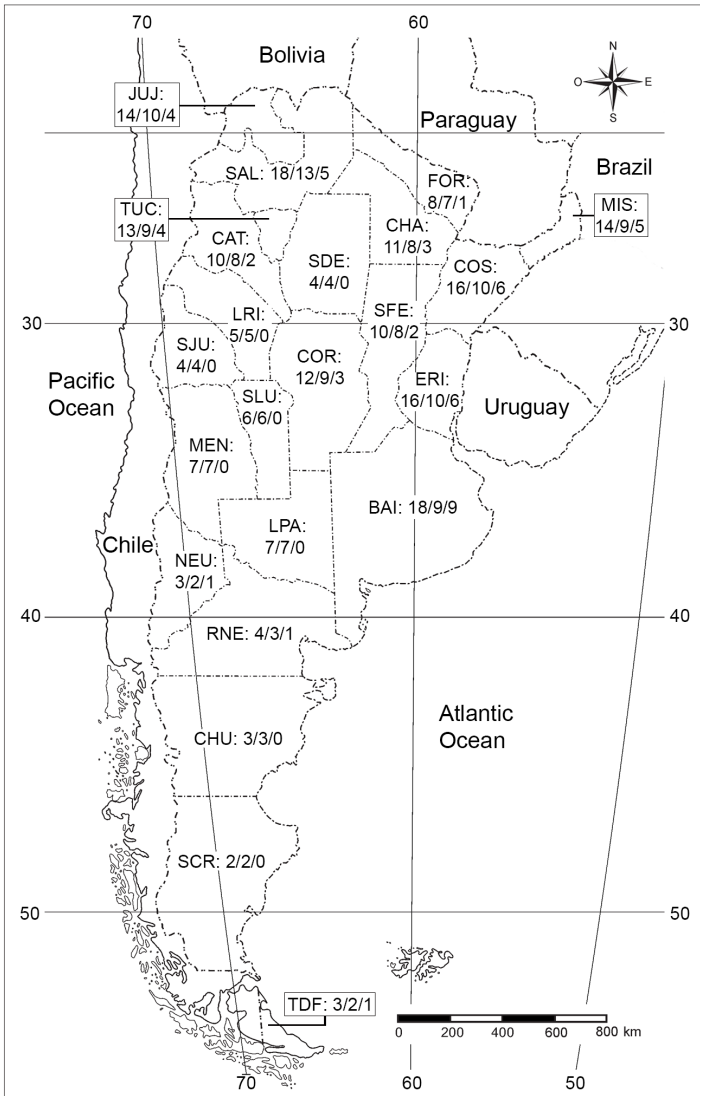

Figure 2 - **Map of Argentina. Acronyms of main political divisions of Argentina (provinces and a federal city): JUJ = Jujuy; SAL = Salta; TUC = Tucumán; LRI = La Rioja; CAT = Catamarca; SDE = Santiago Del Estero; FOR = Formosa; CHA = Chaco; MIS = Misiones; COS = Corrientes; ERI = Entre Ríos; SJU = San Juan; SLU = San Luis; MEN = Mendoza; CBA = Buenos Aires city; COR = Córdoba; SFE = Santa Fe; BAI = Buenos Aires; LPA = La Pampa; NEU = Neuquén; RNE = Río Negro; CHU = Chubut; SCR = Santa Cruz; TDF = Tierra del Fuego. First numer: weedy species / Second number: native species / Third number: exotic species.**

ARG REGIONS	DIV POL	NATIVE SPECIES														EXOTIC SPECIES										
		chl	cri	fil	pru	gig	anc	ter	tri	esc	def	plu	aur	bil	min	cap	den	fal	max	tor	cor	cre	mul	tre	vit	adn
NOW	JUJ	×		×	×	×	×	×	×	×	×	×								×	×	×			×	
	SAL	×	×	×	×	×	×	×	×	×	×	×		×	×					×	×	×	×		×	
	TUC	×	×	×	×	×		×	×	×	×						×				×	×			×	
	LRI			×	×	×		×	×																	
	CAT	×		×	×	×		×	×	×	×										×				×	
	SDE			×		×		×	×																	
NOE	FOR	×		×		×	×		×				×	×			×									
	CHA	×	×	×		×	×	×	×	×							×						×		×	
	MIS	×		×		×	×		×	×	×	×		×			×			×	×	×			×	
	COS	×	×	×		×	×		×	×			×	×	×		×			×	×	×			×	×
CUY	SJU			×	×	×		×																		
	SLU			×	×	×	×	×	×																	
	MEN		×	×	×	×	×	×	×																	
CEN	CBA	×		×		×			×					×		×					×		×	×	×	
	ERI	×	×	×		×	×		×	×			×	×	×		×	×		×	×	×			×	
	COR	×	×	×	×	×	×	×	×	×							×				×				×	
	SFE	×		×		×	×		×	×				×	×						×				×	
	BAI	×		×		×	×	×	×	×				×	×	×	×	×		×	×	×	×	×	×	
	LPA		×	×		×	×	×	×	×																
PAT	NEU			×		×													×							
	RNE			×		×	×												×							
	CHU			×		×	×																			
	SCR			×		×																				
	TDF			×		×																×				

Figure 3. Distribution of weedy and ruderal ferns by both regions and main political divisions of Argentina. Acronyms of Argentinian regions: NOW = Northwest region; NOE = Northeast region; CUY = Cuyo region; CEN = Central region; PAT = Patagonian region. Acronyms of main political divisions of Argentina (provinces and a federal city): JUJ = Jujuy; SAL= Salta; TUC = Tucumán; LRI = La Rioja; CAT = Catamarca; SDE = Santiago Del Estero; FOR = Formosa; CHA = Chaco; MIS = Misiones; COS = Corrientes; ERI = Entre Ríos; SJU = San Juan; SLU = San Luis; MEN = Mendoza; CBA = Buenos Aires city; COR = Córdoba; SFE = Santa Fe; BAI = Buenos Aires; LPA = La Pampa; NEU = Neuquén; RNE = Río Negro; CHU = Chubut; SCR = Santa Cruz; TDF = Tierra del Fuego e Islas del Atlántico Sur. Acronyms of ferns species: chl = *Adiantopsis chlorophylla*; cri = *Azolla cristata;* fil = *Azolla filiculoides*; pru = *Cheilanthes pruinata*; gig = *Equisetum giganteum;* anc = *Marsilea ancylopoda*; ter = *Pellaea ternifolia;* tri = *Pityrogramma trifoliata*; esc = *Pteridium esculentum subsp. arachnoideum;* def = *Pteris deflexa;* plu = *Pteris plumula*; aur = *Salvinia auriculata*; bil = *Salvinia biloba;* min = *Salvinia minima;* cap = *Adiantum capillus-veneris*; den = *Christella dentata;* fal = *Cyrtomium falcatum;* max = *Dryopteris filix-mas;* tor = *Macrothelypteris torresiana;* cor = *Nephrolepis cordifolia;* cre = *Pteris cretica;* mul = *Pteris multifida;* tre = *Pteris tremula;* vit = *Pteris vittata;* adn = *Salvinia adnata.*

axes not curved; fertile axes with many sori sessile or subsessile, apiculate 8

8. Primary areoles, usually 10 or more; microsori pedunculate .....*Salvinia biloba*

8'. Primary areoles, usually less than 10; microsori sessile or subsessile ... *Salvinia adnata*

9. Rhizome hairy; linear sori marginal with a double indusium (an internal indusium and an external pseudoindusium) ..... *Pteridium esculentum* subsp. *arachnoideum*

9'. Rhizome scaly or naked; sori marginal or superficial, or linear sori without a double indusium 10

10. Sori marginal or submarginal, with different shapes, never circular or elliptical, spore trilete, tetrahedral to globose 11

10'. Sori abaxial , never in the margin, sori circular or elliptical, spore monolete, ellipsoidal 21

11. Pinnule flabellate; sporangia on the internal surface of lobes formed by the reflexed margin ..... *Adiantum capillus-veneris*

11'. Pinnules with different shapes, never flabellate; sporangia on abaxial surface or margins, never on the internal surface of lobes formed by the reflexed margin 12

12. Axes stramineous or yellowish (brown in *Pteris tremula*); sporangia forming a continuous, long, linear sori along the margin, usually with paraphyses 13

12'. Axes brownish, atropurpureous or black, sometimes lustrous; sori isolated or confluent, never in continuos linear sori, without paraphyses 18

13. Lamina 3-4-pinnate ..... *Pteris tremula*

13'. Lamina pinnatisect to 2-pinnate 14

14. Lamina ternate at base ..... *Pteris deflexa*

14'. Lamina not ternate at base..... 15

15. Petiole and rachis with scales; pinnas auriculate at base ..... *Pteris vittata*

15'. Petiole and rachis glabrous, rarely with hairs; pinnas not auriculate at base.....16

16. Pinnas pinnatisect ..... *Pteris plumula*

16'. Pinnas entire or sometimes the first pair divided 17

17. Pinnas decurrent at base, with wings on rachis..... *Pteris multifida*

17´. Pinnas attenuate to subdecurrent at base, without wings on rachis ..... *Pteris cretica*

18. Sporangia along subterminal veinlets, covering partial or totally the lamina; lamina with white or yellow wax abaxially..... *Pityrogramma trifoliata*

18'. Sporangia at the veinlets apex; lamina glabrous or glandular, without wax 19

19. Petiole subterete, with 2 ribs, brownish; sori isolated, pseudoindusium reflexed, discrete, lobulate ..... *Adiantopsis chlorophylla*

19'. Petiole terete, without ribs; sori subconfluent, pseudoindusium recurved, subcontinuous or continuous 20

20. Lamina glabrous, pinnae 3-foliolate, entire.....*Pellaea ternifolia*

20'. Lamina glutinous with glandular hairs, pinnae alternate, pinnatifid..... *Cheilanthes pruinata*

21. Plants epiphytic; lamina pinnate; pinna articulate with the rachis; sori elliptic, and indusium lunulate ..... *Nephrolepis cordifolia*

21' Plants terrestrial; lamina divided in several levels; pinnae not articulate with the rachis; sori circular, and indusium circular, orbicular or reniform 22

22. Rachis with scales; indusium glabrous 23

22'. Rachis and indusium with hairs 24

23. Lamina pinnate, venation anastomosed ..... *Cyrtomium falcatum*

23'. Lamina 2-pinnate-pinnatifid, venation free ..... *Dryopteris filix-mas*

24. Lamina 2-3-pinnate-pinnatifid; costa plain adaxially; veins not reaching the margin ..... *Macrothelypteris torresiana*

24'. Lamina pinnate-pinnatifid; costa grooved adaxially; veins finishing at the margin ..... *Christella dentata*

Figure 4. Weedy and ruderal ferns in natural and urban habitats from Argentina. a, *Adiantopsis cholorophylla* (photo by A. Yañez); b, *Adiantum capillus-veneris* (photo by A. Yañez); c, *Azolla filiculoides* (photo by D. H. Bazzano); d, *Cheilanthes pruinata* (photo by F. O. Zuloaga); e, *Christella dentata* (photo by A. Yañez); f, *Cyrtomium falcatum* (photo by A. Yañez); g, *Equisetum giganteum* (photo by C. Aguirre); h, *Macrothelypteris torresiana* (photo by A. Yañez); i, *Marsilea ancylopoda* (photo by L. Aagesen).

List of species

Adiantopsis chlorophylla (Sw.) Fée, Mém. Foug. 5: 145. 1852. = *Cheilanthes chlorophylla* Sw., Kongl. Vetensk. Acad. Handl. 1817: 76. 1817. EPPO: Not reported. Fig. 4a.

Weed type: Segetal weed and ecological weed.

Common name in Argentina: "Doradilla" (Barrett and Tressens 1996).

Additional diagnostic characters: Laminae 2-pinnate-pinnatifid to 3-pinnate, triangular.

Origin area and distribution in Argentina: Native species from Mexico up to central Argentina and southern Brazil (Ponce 2016). In Argentina, it is distributed on the northwest and northeast, reaching Central region (Fig. 3).

Growth habits / Impact / Relationship to human activities: It is frequent as a large-coverage weed, usually in road margins, understory of degraded native forests, and grazed areas. It has been recorded as a weed in overgrazed field in Entre Ríos province (Cottani & Sabattini 2006), associated with forest crops of *Eucalyptus grandis* W. Hill in Corrientes province (Barrett & Tressens 1996), and growing in implanted forests of *Pinus elliotti* Engelm. and *Pinus taeda* L. in Córdoba province (Morero 2006). Likewise, the presence of *A. chlorophylla* in pastures abandoned after agricultural exploitation and its predominance with respect toother pioneer species has been recorded in an experimental field located from Santa Fe province (Etchepare & Boccanelli 2007, Boccanelli & Pire 2011).

Observations: *A. chlorophylla* has xeromorphic characteristics such as lamina with glandular trichomes, and petioles, rachis and lamina with abundant sclerenchyma tissue. These characters give it ecological plasticity and advantage over competing species to grow in a great diversity of environments (Hernández & Rodríguez 2010). Also, it has robust rhizomes that are fire resistant (Meza Torres et al. 2013a).

2. Adiantum capillus-veneris L., Sp. Pl. 2: 1096. 1753. EPPO: ADICV. Fig. 4b.

Weed type: Ruderal.

Common names in Argentina: "Arañuela", "Adiantum cabello de Venus", "capilera", "culantrillo de pozo", "helecho cabello de doncella", "sanguinaria".

Additional diagnostic characters: Rhizome thin creeping; laminae light green; fronds 3-pinnate, membranous, flabellate or rhombic; fertile pinnulae with rectangular to orbicular pseudoindusium.

Origin area and distribution in Argentina: It is a cosmopolitan species. In the Americas it is distributed from southern United States and Mexico, throughout Central America, the Caribbean and northern South America up to Chile and Argentina (Davidse et al. 1995). It was cited in floras of Venezuela (Vareschi 1969), Peru (Tryon & Stolze 1989) and Chile (Rodriguez 1995). There are no older references of this species in Argentine flora, but there are records of cultivated specimens at the end of the 19th Century (Hicken s.n., SI). In Argentina, recently it was cited growing on walls at the Natural Reserve of Punta Lara, on the southern coast of Rio de la Plata, Buenos Aires province (Giudice et al. 2011) (Fig. 3).

Growth habits / Impact / Relationship to human activities: It is a ruderal species in urban habitats where it colonizes gardens and pots and grows on brick walls, favored by calcareous substrate.

Observations: Frequently used as ornamental.

***Additional references*:** Li et al. (2013).

3. Azolla cristata Kaulf., Enum. Filic.: 274. 1824. EPPO: AZOME.

Weed type: Aquatic weed.

Common name in Argentina: **"**Helechito de agua".

Additional diagnostic characters: Fronds 1-5 cm long or more, loosely imbricate; segments suborbicular, reddish.

Origin area and distribution in Argentina: It is widely distributed in the Americas, on the Southeast and Southwest of Canada and the United States, throughout Central America and South America up to Uruguay and Argentina (Arana 2016). In Argentina, it is distributed mainly from northern and Central regions (Fig. 3).

Growth habits / Impact / Relationship to human activities: This species inhabits lentic water bodies (e.g. ditches, ponds and temporary puddles) and its populations present an annual cycle with periods of growth in the warm season. Its rapid vegetative reproduction by mean of rhizome fragmentation obstructs the passage of light and oxygen in a short time. This alters the balance of the ecosystem and inhibit the growth of submerged vegetation.

Additional references: Evrard & Van Hove (2004).

4. Azolla filiculoides Lam., Encycl. 1(1): 343. 1783. EPPO: AZOFI. Fig. 4c.

Taxonomic notes: Currently, *Azolla caroliniana* Willd. is a synonym of *A. filiculoides* (Ponce & Arana 2016) but in previous provincial floras of Argentina were treated as distinct species (Capurro 1968, de la Sota 1977, Ponce 1994).

Weed type: Aquatic weed.

Common name in Argentina: **"**Helechito del agua".

Additional diagnostic characters: Fronds up to 5 cm length, densely imbricated, green to reddish; segments elliptic to ovate. Morphologically it is very similar to *A. cristata* and it only differs from this one by microscopic characters (see key to species).

Origin area and distribution in Argentina: It is widely distributed in the Americas, from Alaska on the North to Tierra del Fuego and Malvinas Islands on the South (Arana 2016). It is present in all the provinces of Argentina (Fig. 3).

Growth habits / Impact / Relationship to human activities: It grows between sea level to 3800 m, on banks of stagnant waters, lakes, ditches, gutters of roads and, less frequently in channels and slow streams. It can cover the entire surface of water body by blocking the light entrance and disturbing the ecological balance of aquatic ecosystem. The massive propagation is facilitated through rhizomes fragmentation and the differentiation in new individuals. This vegetative mechanism constitutes a more common type of reproduction than sexual reproduction. On the other hand, *A. filiculoides* establishes a symbiosis with the Cyanobacteria *Anabena azollae* that fixes atmospheric nitrogen. Thus, the excessive growth of the species can generate eutrophication of the environment. In addition, this species can absorb heavy metals from the environment and become potentially toxic to animals (Kissmann 1997).

Mechanical control and control through herbicides have been tested in *Azolla filiculoides* with few and expensive results. Also, two insect species were identified as possible candidates for the biological control of this weed: *Pseudolampsis guttata* (Leconte) (Chrysomelidae) and *Stenopelmus rufinasus* Gyllenhal (Curculionidae) (Hill & Cilliers 1999, McConnachie et al. 2003).

Observations: It is one of the most cited weeds for irrigated rice crops (Lallana 2005), paradoxically it can be used as an economic biofertilizer in these crops.

***Additional references*:** Lallana (1989), Sabattini et al. (2001), Castro et al. (2002).

5. Cheilanthes pruinata Kaulf., Enum. Filic.: 210. 1824. EPPO: No consigned. Fig. 4d.

Weed type: Toxic.

Common names in Argentina: "Helecho petiso", "raki raki".

Additional diagnostic characters: Fronds 10-40 cm long; laminae linear, narrow; pinnae with triangular or pentagonal contour, pinnatisect.

Origin area and distribution in Argentina: It is distributed from Peru, Bolivia and northern Chile, in Andean and sub-Andean environments to central Argentina (Ponce 2016). In Argentina, it grows from the Northwest to the Pampean mountains range between sea level to 2000 and 4800 m (Fig. 3). Among fern species, it inhabits the highest number of different ecosystems in the country.

Growth habits / Impact / Relationship to human activities: It is a xeromorphic epipetric species that grows in ravines and rocky slopes, crevices and edges of water springs. *C. pruinata* affects livestock activity due to its toxicity (Califano and Echazú 2011, 2013). When ingested, it affects the nervous system of animals causing depression, anorexia, muscle fibrillation and locomotor ataxia, decubitus position and, finally, death. It affects especially the offspring of sheep and goats, between 48 to 72 hours after consumption. Cases of poisoning have been detected in Jujuy province localities and towns of the Iruya River Basin, northwestern Argentina, in Salta province where livestock consume it during the spring due to a shortage of other forage species.

Observations: It is used by traditional Andean cultures for the medical treatment of urinary disorders, Chagas disease and postpartum, stomach, menstrual and head pains (Navarrete et al. 2006).

Additional references: Morbelli and Michelena (1989) and Flores et al. (2016).

6. Christella dentata (Forssk.) Brownsey and Jeremy, Brit. Fern Gaz. 10: 338. 1973. - *Polypodium dentatum* Forssk., Fl. Aegypt.-Arab.: 185. 1775. EPPO: CXLDE. Fig. 4e.

Taxonomic notes: This species was cited under *Thelypteris dentata* (Forssk.) E. P. St. John in the Flora Argentina (Ponce & Arana 2016). However, a phylogenetic study based on molecular data placed this species within *Christella* (Almeida et al. 2016).

Weed type: Segetal weed, ecological weed and ruderal.

Common names in Argentina: unknown; "Soft fern", "downy wood fern" in United States (CABI).

Additional diagnostic characters: Segments with basal pair of adjacent veins joined forming a single vein; circular sori protected by indusia with acicular short and dense hairs; sporangium with one glandular hair on the stalk.

Origin area and distribution in Argentina: It is a paleotropical species, originally distributed in Africa, Asia, Australia and South Pacific islands. In the Americas, it is introduced and naturalized at present from the southeastern United States to Argentina (e.g. Smith 1971, Holttum 1976). Although the origin of its introduction is not determined, specimens in North America and the Antilles are frequently recorded from 1930 where it could have been dispersed (Strother & Smith 1970). Because in Argentina cultivated specimens are kept at herbaria since 1908 (Hicken 50, SI), probably naturalization of this species could involve independent events in the continent. *Christella dentata* grows on the northwest and northeast of this country, reaching the Central region (Fig. 3). According to Smith (1971), this species has the most quantity of recorded specimens within Thelypteridaceae.

Growth habits / Impact / Relationship to human activities: It forms dense populations in exposed habitats and colonizes margins of roads, edges of fields, perennial crops and understory of tree plantations such as *Pinus*

sp. and *Araucaria* sp. It is also found as ruderal, growing in wasteland or on walls in urban and suburban areas. Occasionally, it is cultivated for ornamental purposes. It is a potential invasive species and displacement of native species due to this type of growth has been indicated for Mexico (Tejero–Díez & Torres–Díaz 2012). According to Murakami et al. (2007), urban matrix growth facilitates the expansion of this species since, in an urban environment, it prefers artificial structures such as side walls or bottoms of drainage channels, crevices in stone walls and roadsides instead of forest-floor environments. Furthemore, the roots of *C. dentata* possess an allelopathic substance, Thelypterin A and B that inhibits gametophytes growth of other ferns (Davidonis 1976).

7. Cyrtomium falcatum (L. f.) C. Presl, Tent. Pterid.: 86. 1836. - *Polypodium falcatum* L. f., Suppl. Pl.: 446. 1782. EPPO: CWUFA. Fig. 4f.

Weed type: Ruderal.

Common names in Argentina: **"**Helecho acebo", "helecho cirtomio".

Additional diagnostic characters: Fronds of 25-90 cm long; pinnae petiolulate, rhombiform to falcate, with subulate apex and acroscopical auriculate base, irregular crenate margin, subcoriaceous, dark green, shiny, adaxially glabrous and sparsely scaly and hairy on the abaxial side; sori with circular and peltate indusium.

Origin area and distribution in Argentina: it is native of eastern Asia, mainly in China, Japan, South Korea, and Taiwan. It was introduced worldwide for ornamental use and currently is naturalized in Europe, North America, Oceania, and South Africa with few records in the Caribbean and South America (Ponce & Arana 2016). In Argentina, it was introduced as ornamental due to its successful growth in temperate climates and easy propagation through rhizomes multiplication. It is currently recorded on the east of Argentina (Fig. 3).

Growth habits / Impact / Relationship to human activities: It is a ruderal species frequently associated with urban areas, growing on rocky surfaces of walls, stairs or water wells. This species requires humid or shaded conditions for its establishment and it is sensitive to low temperatures. However, it has a rapid growth once it was established. Colonization of new habitats is facilitated by its apogamic reproduction (Robinson 2009). In Argentina, it is associated mainly with anthropized landscapes; however, in the Caribbean it was recorded in natural areas displacing native species (Santos-guerra et al. 2013, Copeland & Malcolm 2014, Barrios et al. 2015). Particularly in the United States, it is recognized by the National Park Service as an aggressive invader in most of its range.

Observations: Three cytotypes of *C. falcatum* have been identified: sexual diploid, sexual tetraploid and apomictic triploid forms (Lu et al. 2006). Matsumoto (2003) distinguished three subspecies: subsp. *falcatum*, subsp. *littorale* and subsp. *australe* based on cytological evidence and geographic distribution.

8. Dryopteris filix-mas (L.) Schott, Gen. Filic.: tab. 67. 1834. - *Polypodium filix-mas* L., Sp. Pl. 2: 1090. 1753. EPPO: DYOFM.

Taxonomic notes: It was cited as *Dryopteris patagonica* Diem in a floristic work (Diem 1960).

Weed type: Ecological weed, toxic.

Common names in Argentina: "Dentabrón", "filix mas", "helecho macho".

Additional diagnostic characters: Fronds of 30-60 cm long; laminae elliptical-lanceolate, herbaceous, glabrous; segments oblique, serrate; sori rounded with indusia orbicular-reniform, persistent.

Origin area and distribution in Argentina: It is distributed in North America, Europe, northern and central Asia and Madagascar; introduced

species in New Zealand and South America (Ponce & Arana 2016). In Argentina, it inhabits northern Patagonia (Fig. 3).

Growth habits / Impact / Relationship to human activities: Populations in Argentina were originated from ornamental culture of northwestern Patagonia that escaped in the region of Nahuel Huapi Lake, Neuquén and Río Negro provinces. Also, it has been registered as an invader of degraded and anthropically altered sites in New Zealand like urban and suburban areas (e.g. Christchurch and Dunedin), rural vegetation from unimproved hill country pasture, exotic forest and indigenous forest remnants (Ure 2014). Its role as a colonizing species is due to the tolerance to a wide range of environmental conditions, including soils compacted by livestock, and the long-distance dispersal of its spores. *D. filix-mas* is used as antiparasitic, and anthelmintic in traditional medicine (Blakemore et al. 1964), and in Argentina, it is an official drug cited by the Argentine Pharmacopoeia (Bandoni et al. 1978) or in phytotherapy (Disposition 2673/99, National Administration of Drugs, Food and Medical Technology). However, its intake must be controlled because it can be very toxic to humans if it is ingested in large quantities. There are records of vomiting, dizziness with visual disturbances to blindness or even death due to the ingestion of this species (Schönfelder & Schönfelder 2001).

Observations: It is a tetraploid originated by alopoliploidy with *D. oreades* Fomin and *D. caucasica* (A. Braun) Fraser-Jenk. and M.F.V. Corley as parental species (Sessa et al. 2012).

***Additional references*:** Britton & Jermy (1974), Korpelainen (1994).

9. Equisetum giganteum L., Syst. Nat. (ed. 10) 2: 1318. 1759. - *Hippochaete gigantea* (L.) Holub., Preslia 44: 128. 1972. EPPO: EQUGI. Fig. 4g.

Weed type: Segetal weed, toxic.

Common names in Argentina: "Chigote de fraile", "cola de caballo", "yerba de la plata".

Additional diagnostic characters: Rhizomes erect or decumbent; aerial stem cylindrical, green-grayish, rough (siliceous), with longitudinal sulcus and ribs; spherical spores with elaters.

Origin area and distribution in Argentina: It is widely distributed in tropical areas of the Americas (Arana 2016). In Argentina it is widely distributed (Fig 3).

Growth habits / Impact / Relationship to human activities: It is an invasive species of grasslands and waterlogged crops, channels and ditches, drainage channels, wasteland and roadsides. Additionally, it represents a serious problem for irrigation systems of crops in flood zones in Brazil and Peru (Sagástegui & Leiva 1993, Zegarra 1996, Lorenzi 2008). Colonization is facilitated by its rhizomes fragmentation. Also, *E. giganteum* is toxic for horses and other domestic animals because it produces anti-thiaminic substances that causes weight loss, weakness, signs of paralysis and temporary excitement by its ingestion (Alvin-Carneiro 1948, Kissmann 1997, Riet-Correa et al. 2017). On the other hand, the aqueous extract of vegetative organs shows allelopathic principles that inhibit seed development (Franco et al. 2014).

Observations: *Equisetum hyemale* L. is a close species that was recently identified as a problematic invasive in Uruguay (C. Brussa comm. pers.). Because this species is cultivated in Argentina studies are necessary for avoiding its probable invasion in this country.

***Additional references*:** de la Sota (1985), Troiani & Steibel (2008).

10. Macrothelypteris torresiana (Gaudich) Ching, Acta Phytotax. Sin. 8: 310. 1963. - *Polystichum torresianum* Glaudich., Voy. Uranie 8: 333. 1828. EPPO: MKTTO. Fig. 5h.

Weed type: Segetal weed, ecological weed, ruderal.

Common name in Argentina: "Penquita".

Additional diagnostic characters: Rhizomes with hairy scales; laminae deltate; rachis 2-surcate; sori rounded protected by an indusia with glandular hairs.

Origin area and distribution in Argentina: It is a Paleotropical species, distributed from tropical and subtropical Africa, Asia, and the Pacific islands (Ponce 2016). In the Americas, it is a widely naturalized species from the United States to southern Brazil and central Argentina (Fig 2).

Growth habits / Impact / Relationship to human activities: It grows in modified and open habitats such as margins of ditches and roads, embankments, margins of railways, associated with sandy or rocky soils, or lands covered with litter. In Argentina, it invades forests of *Araucaria angustifolia* (Gaudich.) Ching on the east of the country (Meza Torres et al. 2013b). In addition, it is registered as ruderal since 1960 (Burkart 21520, SI). Potential colonizing of *M. torresiana* is mainly due to the enormous production of spores several times by year.

***Observations*:** This species is considered a source of anti-cancer drugs because recent studies detected flavonoids in the roots with antitumor action in vitro (Huang et al. 2010).

Additional reference: Ponce (1987).

11. Marsilea ancylopoda A. Braun, Monatsber. Königl. Preuss. Akad. Wiss. Berlin 1863: 434. 1864. - *Zaluzianskia ancylopoda* (A. Braun) Kuntze,

Figure 5. Weedy and ruderal ferns in natural and urban habitats from Argentina. a, *Pellaea ternifolia* (photo by C. A. Zanotti); b, *Nephrolepis cordifolia* (photo by A. Yañez); c, *Pityrogramma trifoliata* (photo by F. O. Zuloaga); d, *Pteridium esculentum* subsp. *arachnoideum* (photo by D. G. Gutierrez); e, *Pteris deflexa* (photo by A. Yañez); f, *Pteris multifida* (photo by A. Yañez); g, *Pteris tremula* (photo by A. Yañez); h, *Pteris vittata* (photo by A. Yañez); i, *Salvinia auriculata* (photo by C. Aguirre).

Revis. Gen. Pl. 2: 823. 1891. EPPO: No consigned. Fig. 4i.

Weed type: Aquatic weed, toxic.

Common names in Argentina: "Trébol de cuatro hojas", "trébol de la suerte", "trébol del agua".

Additional diagnostic characters: two pairs of opposing pinnae on a very short rachis (resembling a clover with four leaflets), floating; petioles up to 20 cm long, submerged; sporocarps growing under the substrate.

Origin area and distribution in Argentina: It is distributed in the Americas from Mexico up to southern Argentina. In Argentina inhabits from the north of the country up to northern Patagonia (Fig. 3).

Growth habits / Impact / Relationship to human activities: It inhabits lentic environments such as banks of ponds, dams and temporary water puddles. It is a frequent weed of rice crops. Its main colonization strategies are the vegetative fragmentation of rhizomes and the presence of closed reproductive bodies (sporocarps) within which spores can resist dormant in soils flooded for many years.

Observations: The enzyme Tiaminase I, which promotes the breakdown of thiamine (Vitamin B1), has been found in the leaves of *Marsilea* species. This process represents a risk of intoxication for livestock (Skalski et al. 2016).

12. Nephrolepis cordifolia (L.) C. Presl, Tent. Pterid.: 79. 1836. - *Polypodium cordifolium* L., Sp. Pl. 2: 1089. 1753. EPPO: NEHCO. Fig. 5b.

Weed type: Ruderal.

Common name in Argentina: "Helecho serrucho".

Additional diagnostic characters: Rhizomes with branched stolons with gemmiferous tubers; laminae pinnate with strongly reduced base; pinnae patent or slightly falcate, with unequal base, rounded apex and dentate margin.

Origin area and distribution in Argentina: It is distributed as native from Africa, southeastern Asia, Indochina, Australia, New Zealand and the Pacific Islands, and probably northern South America and the Caribbean (Hovenkamp & Miyamoto 2005). In the remaining Neotropical countries, it is probably a crop escape. This species is naturalized in Argentina, Bolivia, Brazil, Paraguay, and Peru. In Argentina, it is distributed from the north to the center of the country (Fig. 3).

Growth habits / Impact / Relationship to human activities: This species forms dense populations in a very short time due to a rapid rhizomes growth and production of many stolons with tubers. In Argentina, it is a spontaneous species in urban and suburban areas, on walls and roofs of abandoned buildings, and has been frequently recorded on trunks of *Melia azedarach* L. and *Phoenix* or *Butia* species. It is also part of the Global Invasive Species Database. *Nephrolepis cordifolia* has been introduced in different countries around the world because its use as ornamental. In the United States (Florida estate), it alters and displaces native species, changing structure or ecological functions of the community and hybridizing with native taxa (Langeland 2014).

Observations: In Argentina only *N. cordifolia* var. *cordifolia* occurs. It is characterized by its short rhizomes, cordiform pinnae with basiscopic rounded bases, and straight margins. ***Additional references:*** Piñeiro & Morbelli (2012).

13. Pellaea ternifolia (Cav.) Link, Fil. Spec.: 59. 1841. - *Pteris ternifolia* Cav., Descr. Pl. : 266. 1802. EPPO: No consigned. Fig. 5a.

Weed type: Toxic, ruderal.

Common names in Argentina: "Chucho", "chujchu macho".

Additional diagnostic characters: Laminae pinnate, linear-lanceolate; pinnae ternate, sessile or subsessile, coriaceous, glabrous, with

recurvate and whitish margin and mucronate apex.

Origin area and distribution in Argentina: It is widely distributed in the Americas, from southern United States up to central Argentina (Arana 2016). In Argentina, it inhabits from the Andean Mountains on the Northwest of the country (reaching 4300 m u.s.l.) up to Sierra de la Ventana mountain range (reaching ca. 1200 m u.s.l.) in southern Buenos Aires province in the pampas region (Fig. 3).

Growth habits / Impact / Relationship to human activities: It is usually recorded on walls in urban areas because it is a xeromorphic species that grows in nature on mountains, hills and ravines. It is a toxic for livestock, goats and sheeps, especially in northwestern Argentina (Califano & Echazú 2013). This species and *Cheilanthes pruinata*, both named "chujchu" by Andean people, are mentioned as having similar effects on livestock (Villagrán et al. 2003).

Observations: In Argentina two subspecies occurs: subsp. *weddeliana* (Feé) Arana, restricted to Salta province, and subsp. *ternifolia*.

14. Pityrogramma trifoliata (L.) R. M. Tryon, Contr. Gray Herb. 189: 68.1962. - *Acrostichum trifoliatum* L., Sp. Pl. 2: 1070. 1753. EPPO: PIYTR. Fig. 5c.

Weed type: Segetal weed, ecological weed.

Common name in Argentina: "Amambay guazú".

Additional diagnostic characters: Fronds erect; laminae narrow; pinnae with 2-3 segments, margins serrate, abaxial surface glandular with white or yellow farinose secretions.

Origin area and distribution in Argentina: It is widely distributed in the Americas from southern United States to central Argentina (Giudice & Luna 2016). In Argentina, it inhabits from the northwest of the country up to the Río de la Plata region (Fig. 3).

Growth habits / Impact / Relationship to human activities: It usually grows in anthropized environments such as margins of crops, roadsides, channels and ditches. In the outskirts of San Miguel de Tucumán, it was observed forming dense populations in the margins of maize plantations (Yañez et al. 315 BA).

***Additional references*:** Burkart (1933) and Tryon (1962).

15. Pteridium esculentum (G.Forst.) Cockayne subsp. **arachnoideum** (Kaulf.) J. A. Thomson, Telopea 14(1): 45. 2012. = *Pteris arachnoidea* Kaulf., Enum. Filic.: 190. 1824, nom. cons. EPPO: PTEAA as *P. aquilinum* (L.) Kuhn var. *arachnoideum* (Kaulf) Brade. Fig. 5d.

Taxonomic notes: circumscriptions of *Pteridium* species (and their infraspecific taxa) are very controversial due to the high morphological variability and population's phenotypic plasticity throughout their geographic range. Previous studies have cited this southern South American taxon as *Pteridium arachnoideum* (Kaulf.) Maxon (Der et al. 2009), *Pteridium aquilinum* var. *arachnoideum* (Kaulf.) Brade (Thomson 2000), *Pteridium caudatum* subsp. *arachnoideum* (Kaulf.) Lellinger (Lellinger 2003) y *Pteridium psittacinum* Maxon (Ramos Giacosa et al. 2004). In the present work, we follow Thomson (2012) and Schwartsburd et al. (2018).

Weed type: Segetal weed, toxic.

Common names in Argentina: "Amambay", "helecho macho", "samambaia".

Additional diagnostic characters: Fronds erect or scandent, up to 4 m long; laminae 3-4-pinnate-pinnatifid, triangular; pinnae and pinnules distally with free lobes between the segments; compound distal segments with caudate apex.

Origin area and distribution in Argentina: It is distributed in the tropical and subtropical regions of the Americas (Schwartsburd et al.

2018). In Argentina, it inhabits rocky soils from the northwestern Andean Mountains and northeastern subtropical forests up to Balcarce mountains in Buenos Aires province in the pampas region (Fig. 3). It was recorded in sandy islands of the Paraná Delta by Burkart (1933) and Capurro (1968).

Growth habits / Impact / Relationship to human activities: This species is one of the best known weeds in the world for its aggressiveness to colonize and modify habitats disturbed by anthropic activity, such as pastures, abandoned fields and deforested lands. This species presents a double system of branched, underground rhizomes, very difficult to remove (Watt 1940) and that is fire-resistant. This last characteristic allows the species to grow even in those regions where the burning of vegetation is the most frequent method to clean fields destined for planting (Roos et al. 2010). In addition, the reproductive success of this species is due to the enormous production of spores that are easily dispersed by the wind and germinate in short periods. Once the populations are established, the growth of other plant species is hindered because fronds up to 4 m length are scandent and form a thick covering that limits the germination of remaining seeds in the soil. Likewise, decomposing fronds release phenolic compounds that interfere in an allelopathic way, inhibiting the germination of seeds and the establishment and growth of possible competitors (Silva Matos & Belinato 2010, Xavier et al. 2016). As a defense mechanism against consumers, the species produces cyanogenic glycosides that, through their hydrolysis, release hydrogen cyanide (Oliveros-Bastidas & Alonso-Amelot 2010). Finally, in addition to invading altered habitats, intoxication events of livestock animals have been recorded by ingestion of this species for a long time (Marrero Faz & Calderón Tobar 2012, Furlan et al. 2014) due to the concentration of toxic Ptaquiloside in the aerial parts of the plant. This problem has been registered in Argentina, mainly in the northwest region (Marin et al. 2004, Marín 2011). In humans, carcinogenesis caused by ingestion or continuous contact with the species was also recorded (Simán et al. 2000, Recouso et al. 2003, Tourchi-Roudsari 2014).

Various mechanisms such as herbicides, mechanical extraction and the use of competing native species were used to control this species (Roos et al. 2011, Aguilar-Dorantes et al. 2014).

Observations: Colonization of new habitats by *Pteridium* species has been matched with human activity throughout history. In spite of genus origin was dated to the Miocene, its role as an invasive species has been recorded during the Mesolithic associated with modifications of natural environments by the human being (Rymer 1976).

Additional references: Silva Matos et al. (2014), Marrs et al. (2000).

16. Pteris cretica W. C. Shieh, Bot. Mag. (Tokyo) 79: 285. 1966. EPPO: PTJCR.

Taxonomic notes: Variegate specimens from Argentina belonging to this species were traditionally determined as *Pteris cretica* var. *albo-lineata* (Capurro 1968, Ponce et al. 2008a, Martinez & Prado 2016). Recently, following the works of Shieh (1966) and Jaruwattanaphan et al. (2013), Guerrero et al. (2017) redefined them as *P. nipponica*. In the present work, Martínez & Prado (2016) were followed because it is considered that more studies are needed about the infraspecific variability of this complex species to take taxonomic decisions.

Weed type: Ruderal.

Common names in Argentina: "Helecho de cinta", "*Pteris* de Creta".

Additional diagnostic characters: Laminae ovate-lanceolate to pyramidal; the proximal

pinna 1-furcate, 1-pinnatisect; the distal pinna entire with base attenuated to subdecurrent.

***Origin area and distribution in Argentina*:** It is distributed in the Paleotropical region and naturalized in the Americas from southeastern United States to southern Argentina, in the Malvinas archipelago (Martinez & Prado 2016).

Growth habits / Impact / Relationship to human activities: It is a very common species in disturbed and ruderal environments, such as roadsides or humid walls. It is registered as an apogamic species (Walker 1962, Martínez 2010) and, probably, this characteristic is related to the cosmopolitan distribution of the species and the facility to colonize new environments. According to Global Invasive Species Database, this species has caused the displacement of other native species in the USA.

***Additional references*:** Morton (1957), Martínez & Morbelli (2009), Martínez (2011).

17. Pteris deflexa Link, Hort. Berol. 2: 30. 1833. EPPO: No consigned. Fig. 5e.

Weed type: Toxic.

Common name in Argentina: "Helecho garrapata".

Additional diagnostic characters: Rhizomes short, creeping to erect, robust, 2-8 cm wide; costae and costulae sulcate abaxially, aristate with spines.

Origin area and distribution in Argentina: It is widely distributed in tropical and subtropical regions of the Americas, from the Caribbean to Uruguay (Martinez & Prado 2016). In Argentina, it inhabits the Yungas of the northwest region and the Paranaense forest in the northeast, at 500-2700 m u.s.l.

Growth habits / Impact / Relationship to human activities: Recent studies in northwestern Argentina have identified in this species the presence of Ptaquiloside (Pterosina B). This toxic compound causes Enzootic Bovine Hematuria in livestock (Gil da Costa et al. 2012). Recently, the direct association between *P. deflexa* (and *P. plumula* Desv., see below) with this disease was verified (Micheloud et al. 2017).

Additional references: Lellinger (1997), Martínez et al. (2013).

18. Pteris multifida Poir., Encycl. 5: 714. 1804. EPPO: PTJMU. Fig 4f.

Weed type: Ruderal.

Common name in Argentina: "Helecho araña".

Additional diagnostic characters: Morphologically, it is similar to juvenile forms of *P. cretica*. However, they can be easily distinguished by the winged or wingless rachis (see key).

Origin area and distribution in Argentina: It is distributed in tropical Asia and is widely naturalized in the Americas, from southeastern United States to the center of Argentina (Martinez and Prado 2016). In Argentina, it has been recorded in two disjunct areas: both Buenos Aires city and province in the pampas, and in the north of the country up to 1200 m u.s.l (i.e. Chaco and Salta provinces).

Growth habits / Impact / Relationship to human activities: It grows in ruderal habitats, on humid walls. In addition, this species has been defined as an ecological weed in other areas of its distribution (Murakami et al. 1997). Apogamous reproduction has been detected in this species (Kawakami et al. 1995) and self-fertilization events of gametophytes has been studied, which could be related to an adaptive advantage for the colonization of open and distant habitats (Watano 1988).

Observations: As in the case of *P. cretica*, there are ornamental cultivars for this species. According to Burkart (1933), this could be the origin of the spontaneous populations that are observed in Buenos Aires city.

Additional references: Burkart (1933), Morton (1957), Martínez (2011).

19. Pteris plumula Desv., Mém. Soc. Linn. Paris 6: 297. 1827. EPPO: No consigned.

Taxonomic notes: According to Moran and Riba (1995) and Arantes et al. (2010), this species is a synonym of *P. quadriaurita* Retz., a widely distributed species of southeastern Asia. On the contrary, other botanists consider *P. plumula* as a current species based on origin and ploidy (Lellinger 1989, Proctor 1989, Prado & Windisch 2000, Martinez & Prado 2016).

Weed type: Toxic.

Common name in Argentina: unknown.

Additional diagnostic characters: laminae deltate-lanceolate, pinnae of 3-15 pairs, with base truncate; costule sulcate adaxially with whitish trichomes and spines.

Origin area and distribution in Argentina: It is distributed in the tropical region of the Americas, from Mexico to northern Argentina (Martinez & Prado 2016). In Argentina, it inhabits both the Northwest and the Northeast regions up to 1500 m u.s.l.

Growth habits / Impact / Relationship to human activities: It causes Enzootic Bovine Hematuria of livestock in northwestern Argentina (Micheloud et al. 2017).

Observations: This species has been registered as triploid with an apogamic origin (Love et al. 1977).

20. Pteris tremula R. Br., Prodr. 154. 1810. EPPO: PTJTE. Fig 4g.

Weed type: Ruderal.

Common name in Argentina: unknown; "Shaking brake" in United States (Wilcox & Rogan 1999).

Additional diagnostic characters: Fronds up to 2 m long, dimorphic, pale green; petiole pale brown to chestnut-brown; rachis red-brown; last sterile segments up to 3 mm wide, narrow-oblong to linear, slightly toothed margins; last fertile segments up to 1.5 mm wide.

Origin area and distribution in Argentina: It is originally distributed in Australia (Orchard 1998). In Argentina, it is a common cultivated species that is a spontaneous in urban areas of both Buenos Aires city and province. However, according to Martínez & Prado (2016) it is not a naturalized species in the country.

Growth habits / Impact / Relationship to human activities: In Argentina, it is usually found as a ruderal species on walls, growing sub-spontaneous in gardens or on the banks of the Paraná river. Also, it is observed growing in protected areas of the province as Parque Natural Municipal Ribera Norte (San Isidro), Reserva Natural Avellaneda (Avellaneda) y Reserva Natural Punta Lara (Punta Lara) (Berrueta com pers.). Burkart (1933) noted that spontaneous specimens were smaller than those cultivated and often it were sterile. However, the specimens observed in the aforementioned protected areas are fertile. It is important to follow the naturalization process of this species with the objective of evaluating a possible displacement of native flora species.

21. Pteris vittata L., Sp. Pl. 2: 1074. 1753. - *Pycnodoria vittata* (L.) Small, Ferns Florida: 89. 1932. EPPO: PTJVI. Fig. 5h.

Taxonomic notes: According to early works, Argentine specimens were identified as *P. longifolia* L. (Burkart 1933, Capurro 1938, Capurro 1968, Cabrera & Zardini 1978). However, later on, de la Sota & Morbelli (1985) based on an exhaustive morphological analysis, determined that these specimens actually correspond to *P. vittata* and excluded *P. longifolia* of this country.

Weed type: Ruderal.

Common names in Argentina: "Helecho de habichuela", "helecho oxidado", "polipodio cordobés".

Additional diagnostic characters: Fronds pinnate with pinnae entire, sessile and linear. This species varies enormously in other frond

traits and in size, density and color of rachis scales.

Origin area and distribution in Argentina: It is distributed in the east of Asia, and naturalized in the Americas (Martinez & Prado 2016). In Argentina, it inhabits from the north to the center of the country, and in Buenos Aires city have been recorded spontaneous near its harbor from the early 20th Century (Burkart 1933)

Growth habits / Impact / Relationship to human activities: It has been introduced in the Americas with ornamental proposes. It is a ruderal species that grows sub-spontaneously in wall crevices with calcareous substrate. It is usually found on old houses roofs or abandoned buildings. It is a drought-resistant species, and can grow without soil, in shaded or sunny environments. It causes gradual substrate deterioration.

Observations: This species has the ability to accumulate arsenic in fronds, petioles and roots, and it has been proposed for the phytoremediation of soils and water (Chen et al. 2002, Oliveira et al. 2017).

Additional references: Morton (1957)

22. Salvinia adnata Desv., Mém. Soc. Linn. Paris 6: 177. 1827. EPPO: SAVMO.

Taxonomic notes: We follow taxonomical point of view proposed by de la Sota (1995, 2001) and (Ponce & Arana 2016). However, according to Moran & Smith (1999), Salas-Pascual et al. (2016) it is *S. molesta* D.S. Mitch.

Weed type: Aquatic weed.

Common names in Argentina: "Helechito del agua", "salvinia gigante".

Additional diagnostic characters: Floating laminae bilobate, imbricate; microsori up to 55 by fertile axis.

Origin area and distribution in Argentina: It is distributed originally in southeastern Brazil. However, currently it has invaded tropical and subtropical regions around the world reaching 31 countries of four continents where it has become a worrisome weed (Luque et al. 2014). In many cases, introductions were due to its ornamental use in fish tanks and fountains. In Argentina, according to Arana (2016), it has been only recorded in the Iberá wetlands, Corrientes province. However, it is a doubtful species in Argentina since we could not find the unique cited specimen of the species for the country (Forno s.n., Z).

Growth habits / Impact / Relationship to human activities: According to the Global Invasive Species Database, it is one of the most aggressive weed belonging to the genus *Salvinia* in Africa, North America, and Oceania. It is a highly competitive species with a great capacity for vegetative proliferation by rhizome fragmentation. It disperses easily and has high tolerance to environmental stress factors such as low temperatures (Arana 2016). Under favorable conditions, this species forms dense populations over 50 cm thick that cover the entire body of water and limit the gas exchange and the photosynthesis process of other plant species, also deteriorating the physical-chemical quality of the water. It affects human activity because it interferes with fishing exploitation, the cultivation of species in flooded soil such as rice, the generation of hydroelectric energy (for obstruction of reservoirs) and maritime transport (Kissmann 1997). One of the methods of biological control frequently used is by *Cyrtobagous salviniae* which creates tunnels in rhizomes and feeds on buds (Jacono et al. 2001). Even though the species present nowadays a restricted distribution in Argentina, continuous monitoring is required to avoid a potential impacts..

Observations: *S. adnata* is a hybrid species originated between *S. biloba* and *S. auriculata* based on reproductive and morphological data (Loyal & Grewal 1966, Mitchell 1972).

Additional references: Forno & Harley (1979), Forno (1983), Moran (1992), Oliver (1993), DiTomaso & Healy (2003).

23. Salvinia auriculata Aubl., Hist. Pl. Guiane 2: 969, tab. 367. 1775. EPPO: SAVAU. Fig. 5i.

Weed type: Aquatic weed.

Common names in Argentina: "Acordeón de agua", "helechito del agua", "mota de negro".

Additional diagnostic characters: Floating pinnae oblong with base cordate to bilobate; microsori 4-10 by fertile axis.

Origin area and distribution in Argentina: It is widely distributed in the tropical region of the Americas, from Mexico and the Caribbean to Bolivia, Paraguay, southern Brazil, northeastern Argentina, and Uruguay reaching the Rio de la Plata (Arana 2016). In Argentina, inhabits the Northeast region in Corrientes and Entre Ríos provinces.

Growth habits / Impact / Relationship to human activities: Although it is usually used as an ornamental species in artificial ponds, its excessive growth causes problems in irrigation systems, dikes, canals and lakes, where it makes difficult navigation and fishing. This excessive growth is mainly due to its high vegetative reproduction by fragmentation that disperses new plants by natural movement of water.

Observations: Usually the name "*Salvinia auriculata*" refers to a complex of species distributed in the Neotropics: *S. adnata*, *S. auriculata*, and *S. biloba*. These species are morphologically very similar, with fused apices of hairs on the adaxial surface of pinnae (de la Sota 1962, Mitchell & Thomas 1972, Forno 1983). Its introduction in the United States is prohibited because of its rapid colonization of aquatic habitats (Jacono et al. 2001). *Salvinia auriculata* is a potential species to accumulate heavy metals and it can contribute to the bioremediation of contaminated environments (Kumari et al. 2016).

24. Salvinia biloba Raddi, Pl. Bras. Nov. Gen. 1: 4, tab. 1, Fig. 5. 1825. EPPO: SAVBI.

Taxonomic notes: According to de la Sota (1962), specimens of Santa Fe province belonged to *Salvinia herzogii*, however, nowadays, this species is a synonym of *S. biloba*.

Weed type: Aquatic weed.

Common name in Argentina: "Helechito de agua".

Additional diagnostic characters: Floating pinnae 2-lobate, up to 30 x 45 mm; 10 microsori or more by fertile axis.

Origin area and distribution in Argentina: It is distributed along the Plata basin in northeastern Argentina, southern Brazil, Paraguay, and Uruguay (Arana 2016).

Growth habits / Impact / Relationship to human activities: It is an aquatic weed that invades reservoirs, artificial lakes and channels. It forms large populations that cover the entire surface, blocking the passage of sunlight and interfering with the growth of other species because it limits gas exchange. Its main type of reproduction is a vegetative fragmentation because the populations are usually sterile.

Observations: According to de la Sota (1962), many specimens cited in Argentina as *Salvinia auriculata* are probably *S. biloba*. These species are distinguished by submerged rachis axes (short in *S. auriculata* against long in *S. biloba*) and the amount of sori by fertile axes (few with long pedicels against numerous sessile, respectively).

Additional references: Forno (1983).

25. Salvinia minima Baker, J. Bot. 24: 98. 1886. EPPO: SAVRO.

Taxonomic notes: This species was cited in early floristic works of Argentina as *S. rotundifolia* Willd. (Capurro 1968).

Weed type: Aquatic weed.

Common name in Argentina: "Helechito de agua".

Additional Diagnostic characters: First pair of floating pinnae up to 20-25 mm long. It differs from *S. auriculata* complex by the fusion of the apices of the papillae hairs (see dichotomous key).

Origin area and distribution in Argentina: It is widely distributed in the Americas, from the United States and central Mexico to central Argentina, where it was cited from Salta to Buenos Aires provinces (Arana 2016).

Growth habits / Impact / Relationship to human activities: As it happens with other species of the genus, the excessive growth of the populations of this species through vegetative fragmentation obstructs fluvial channels and affects the water quality. Alterations in water and soil quality and reduction of native biodiversity have been recorded because of the species growth by the Global Invasive Species Database. As with *Salvinia adnata*, it can be controlled by the action of the insect *Cyrtobagous salviniae* (Parys & Johnson 2013). *Salvinia minima* is frequently cultivated as ornamental in pools and aquariums due to its small size and thermal tolerance. Although it is registered as a weed in other countries of the Americas, up to now there is no exhaustive survey of its impact in Argentina.

Observations: *Salvinia minima* has the ability to absorb heavy metals such as arsenic and plumb (Hoffmann et al. 2004).

Additional references: de la Sota (1962, 1976), Forno (1983), Jacono et al. (2001).

DISCUSSION

The present study represents an important progress to the knowledge of the colonizing fern species of disturbed habitats (aquatic, ecological, segetal, or ruderal) and / or toxic for livestock animals from Argentina. In this sense, 20 more weedy ferns species are recognized than those mentioned in the last study of Argentinian weeds carried out by Fernandez et al. (2016). This represents an increase from 0.6% to 3% in the percentage of ferns in the Argentina weed list. Likewise, weeds represent 7% of 368 species of ferns recognized in the Argentinian flora (Ponce & Arana 2016).

Among the species studied, Pteridaceae is the best represented family and half of its representatives are exotic. This is consistent with the observations of Jones et al. (2018) who pointed out that, globally, Pteridaceae is the family with most number of species that have become alien.

The present study, also, constitutes the starting point for more exhaustive studies about the ecological role and the distribution of the studied species, which allow to identify suitable environmental conditions for their growth and to detect potential risks for human activities. In this sense, although some species such as *Pityrogramma trifoliata*, *Salvinia adnata* and *S. minima* have restricted distributions ranges and/or their impact is still little known in the country, the problems detected in other countries will contribute to future studies about the inconveniences that these species could cause.

Regarding the geographical distribution of the species, according to the results obtained in this study, the priority region for future analyzes is the central Argentina because the largest number of records of weed ferns was found here. Likewise, the province of Buenos Aires, from the Central region, was one of the two provinces with the largest number of weed species and the province with more exotic weed species. Due to the latter, it would be important to carry out studies in the province concerning the impact caused by exotic species on native flora populations, mainly in protected areas.

Authors studying weedy species in Asteraceae family made similar observations, as the greatest richness of adventitious Asteraceae species are distributed in the province of Buenos Aires (Katinas et al. 2007). The other province with high number of weedy fern species was Salta. High diversity of weedy ferns in Salta may simply reflect that Salta belongs to the Northwest region, one of the main centers of fern diversity in Argentina (Ponce et al. 2002).

Additionally, this survey provides further data to the scarce and fragmented information that up to now exists about the presence of fern species that can affect urban buildings (Bertolami 1990, Franceschi 1996, Franceschi & Boccanelli 2013, Rosato et al. 2015). Most of these species are exotic and only in some cases the origin of their invasion is clearly know. Therefore future studies are need to clarify their introduction to the country and categorize the state of the invasion (Blackburn et al. 2011) and the magnitude of the impact on native species, on the ecosystem structural characteristics or on human activities (Blackburn et al. 2014).

The results of this study provide information for the development of weed management tools and point to priority areas to implement them, distribution modeling and ecological niche modeling of invasive species or sanitary control to livestock where those species are found.

Acknowledgments

The authors thank the curators of the herbaria SI and LP; to the Instituto de Botánica Darwinion for providing photographs of the species in their natural habitat; to Marcelo Monge (Brazil), Daniel Montesinos (Peru) and Julia Tomaz Kilipper (Brazil) for providing valuable bibliography for the discussion of this work; to agronomist Carlos A. Brussa for providing valuable information about the ferns of Uruguay and to Lone Aagesen for helping us improve the language of the manuscript. We especially thank the reviewers for their comments and suggestions, which contributed to the quality of the manuscript.

This work was supported by the Agencia de Promoción Científica y Tecnológica (ANPCyT) with the PICT project Nº 0186 and Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET) wih the PUE project 22920160100098CO.

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How to cite

YAÑEZ A, GUTIÉRREZ DG & PONCE MM. 2020. Weedy ferns (Polypodiopsida) in Argentina: diversity, distribution and impact on human activities and ecosystems. An Acad Bras Cienc 92: e20180983. DOI 10.1590/0001-3765202020180983.

Manuscript received on September 19, 2018; accepted for publication on March 11, 2019

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M. Mónica Ponce: Data analysis, manuscript revision.