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Article

Ruderal Plants in Cruzeiro do Sul, Acre, Brazil: Presence, Collection Status and Attributions

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Abstract: Ruderal plants designate native or exotic plant species that grow spontaneously in anthropized environments, being important from an ecological succession perspective. The present study aimed to identify ruderal plants that occur in an anthropized area of the Campus Floresta of the Federal University of Acre (UFAC), in the municipality of Cruzeiro do Sul, in the Southwest Amazon. Toward this end, botanical material was collected and herborized, and identified based on consultation of the specialized literature, virtual herbariums, and by comparison with the Campus Floresta Herbarium (CFCZS) collection. Finally, these data were incorporated to the referred collection, according to the usual plant systematics procedures. The results revealed 28 species and 28 genera, distributed in 14 families. The most representative families were Fabaceae, Malvaceae and Poaceae, with four species each; followed by Asteraceae with three; Cyperaceae, Rubiaceae and Amaranthaceae with two each; and the others, Plantaginaceae, Ochnaceae, Urticaceae, Verbenaceae, Iridaceae, Lamiaceae and Dennstaedtiaceae with one species each. The occurrence of predominant species in planted pastures, agricultural use, and mining area ecosystems is highlighted, such as *Pteridium aquilinum* (L.) Kuhn., *Andropogon bicornis* L., and *Crotalaria micans* Link.

Keywords: Botanical collections; Taxonomy; Weeds

1. Introduction

The term ruderal comes from the Latin *ruderis* meaning "debris" which, by extension, refers to native or exotic plants that grow spontaneously in anthropized environments, such as vacant lots, edges and cracks of sidewalks, walls and roofs, and which may also participate in the ecological succession process [1,2].

It is a broad concept, since such plants can occupy different areas and may be called harmful, invasive, undesirable, bad or bad grass; however, despite these many misleading and dismissive classifications, these plants have a known variety of beneficial uses for humans, including positive uses such as forage, medicines, soil protection, nutrient recycling, nectar supply for bees, among others [3].

There are few studies on such plants for the Brazilian Amazon. Regarding the state of Acre, records are even scarcer. The main contribution was made by [4], expanding the collection effort and compiling everything that had been recorded until then into a catalog. More recently, [5] was updated, and 2,110 determinations were added, including 347 new records.

In this context, we shift our attention to the Upper Juruá Region, in the far west of Brazil, which includes five municipalities in the state of Acre (Porto Walter, Marechal Thaumaturgo, Cruzeiro do

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Sul, Rodrigues Alves and Mâncio Lima) and one municipality in the state of Amazonas (Guajará). This region is considered one of the most biodiverse on the planet, for which knowledge not only related to the flora, but to all lines of research, is still incipient [6].

Given the above, the objective was to detect the presence of ruderal plants at the UFAC/Campus Floresta, in the municipality of Cruzeiro do Sul, indicating their state of collection, origin and attributions to help fill the gaps in the knowledge of the flora of that region.

2. Materials and Methods

The study was conducted at the Federal University of Acre, Floresta Campus, located in the municipality of Cruzeiro do Sul, in the Upper Juruá Region, located in the extreme west of Brazil (www.cruzeirodosul.ac.gov.br), whose central coordinates correspond to 07° 33'S and 072°43'W (Datum WGS 84), located an average altitude of 205 m above sea level (Figure 1).

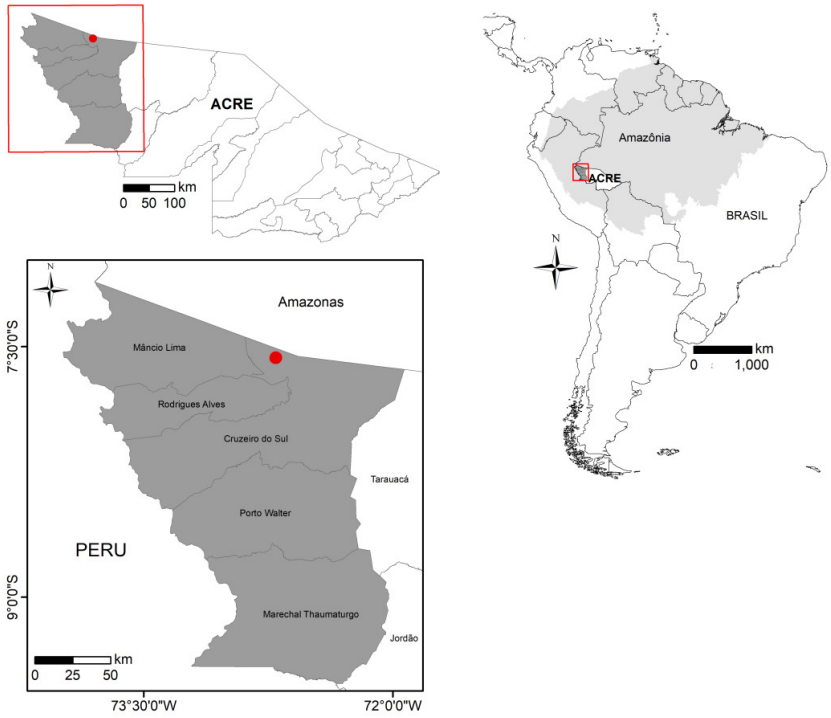

Figure 1. Upper Juruá Region. The red circle indicates the study site location, Cruzeiro do Sul, Acre. Credits LABGAMA/UFAC.

The study area spans about 47.1 ha, of which about 28% are pastures (fallow) and experimental areas, 55% secondary forest, and 12% anthropized areas [7], located in the Cruzeiro do Sul Formation ecoenvironment, originating from the deposition of sandy sediments in the Quaternary period [8]. The soils derived from these materials gave rise to sandy soils on the surface and medium texture in the subsoil, of low natural fertility and belonging to the class of yellow Argisols found in the areas of the upper and upper third of the landscape; red-yellow Argisols in the middle third; and Gleissols in the Baixadas [7]. The climate of the region, according to Köppen, is classified as warm and humid equatorial Af with 1 to 2 dry months [9]. The average annual precipitation is 2166 mm; March is considered the rainiest month and July the least rainy; temperature and relative humidity are, respectively, 24.5ºC and 85% [10].

For the present study, samples of botanical material in reproductive state were collected between January and December, 2017 and taken to the Plant Taxonomy Laboratory for herborization and cataloging. Taxonomic identification was performed by consulting the specialized literature [1,11], by comparison with the collection of the Campus Floresta Herbarium (CFCZS), and by consulting the virtual herbaria of the Missouri Botanical Garden (www.mobot.org), SpeciesLink (www.splink.org), and the New York Botanical Garden (www.nybg.org). Species author names were

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confirmed by accessing the websites www.tropicos.org and www.floradobrasil.org. Subsequently, the identified material was incorporated to the collection of said Herbarium, according to the usual procedures in plant systematics.

For each species identified, the status of the collection and origin were verified by consulting the specialized literature [1,4,5] and online databases [12,13]. Assigned uses were obtained from digital platforms (ScienceDirect 2020; Europe PMC, 2020).

3. Results

The results revealed 28 species, 28 genera and 14 families in the Floresta Campus. For the Fabaceae family, there were records only for the subfamily Faboideae; Malvaceae and Poaceae were represented by four species each. Next, Asteraceae with three, followed by Amaranthaceae, Cyperaceae and Rubiaceae, with two species each; and the others, Plantaginaceae, Ochnaceae, Urticaceae, Verbenaceae, Iridaceae, Lamiaceae and Dennstaedtiaceae, with one species each. The presence of predominant species in planted pasture, agricultural use and mining area ecosystems, such as *Pteridium aquilinum*, *Andropogon bicornis* and *Crotalaria micans* (Table 1), is noteworthy.

Table 1. Ruderal species from Cruzeiro do Sul, Acre. U= unknown.

Family	Species	Popular name	Collection Number	Origin
Cyperaceae	*Scleria gaertneri* Raddi	U	CP. Silva 01	Native
	Rhynchospora pubera (Vahl) Boeckeler	U	CP. SILVA 17	Native
Fabaceae (Faboideae)	*Centrosema brasilianum* (L.) Benth	U	CP. Silva 02	Native
	Zornia reticulata Sm	U	CP. Silva 03	Native
	Crotalaria micans Link	"crotalaria"	ASouza s/n	India
	Desmodium adscendens (Sw) Dc.	"carrapicho"	CP. Silva 24	Native
Asteraceae	*Praxelis difusa* (Rich.) Pruski	U	C.P. Silva 07	Native
	Emilia fosbergii Nicolson	"emilia"	C.P.Silva s/n	Native
	Eclipta prostrata (L.) L.	U	M.C.Souza s/n	Native
Plantaginaceae	*Scoparia dulcis* L.	"vassourinha de botão"	C.P. Silva 10	Native
Malvaceae	*Sida rhombifolia* L.	U	C.P. Silva 11	Native
	Urena lobata L.	"malva"	A.Souza 05	Asia
	Waltheria indica L.	"malva"	A.Fernandes 01	Native
	Pavonia sp	U	C.P.Silva 23	Native
Poaceae	*Leptochloa* cf. *virgata*	U	C.P. Silva 12	Native
	Luziola cf. *peruviana*	U	C.P. Silva 13	Native
	Andropogon bicornis L.	"rabo de burro"	Manasseis 02	Native
	Paspalum cf. *conspersum*	U	Manasseis 03	Native
Ochnaceae	*Sauvagesia erecta* L.	U	A.Souza 03	Native
Rubiaceae	*Borreria verticillata* (L.) G. Mey	"vassourinha de botão"	C.P. Silva 25	Native
	Diodia kuntzei K. Schum	U	M.C.Souza 781	Native
Amaranthaceae	*Amaranthus blitum* L.	"bredo"	M.C.Souza 766	Native
	Alternanthera tenella Colla	U	C.P.Silva 27	Native
Verbenaceae	*Stachytarpheta cayennensis* (Rich.)Vahl	"rinchão"	C.P.Silva 16	Native
Urticaceae	*Pilea microphylla* (L.) Liebm.	U	M.C. Souza 776	Native
Iridaceae	*Cipura paludosa* Aubl.	U	C.P.Silva 14	Native
Lamiaceae	*Hyptis atrorubens* Poit.	U	M.C. Souza s/n	Native
Euphorbiaceae	*Euphorbia thymifolia* L.	U	M.C. Souza 793	Native
Dennstaedtiaceae	*Pteridium aquilinum* (L.) Kuhn.	"pluma"	M.C. Souza 753	Native

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4. Discussion

The identification of Fabaceae and the subfamily Faboideae in this survey has been repeated for the Brazilian Amazon, being part of several qualitative and quantitative studies [14]. The presence of subfamily Faboideae was also highlighted, namely in Amazon Savannas along the estuaries between the states of Pará and Amapá [15]. Here, attention is drawn to the species *Centrosema brasilianum* and *Zornia reticulata*, as they are two new records for the state of Acre. In the case of *C. brasilianum*, a prostrate-stemmed, lilac-flowered species, it turned out to be quite common along the forest edges of the Floresta Campus. Despite the competitive nature of this plant, it contributes to ground cover, and is indicated as forage and green manure [16]. Its occurrence has also been reported in estuarine savannas, between the states of Pará and Amapá [15].

In light of its wide distribution throughout the country, and since it is a herbaceous, prostrate, yellow-flowered, potentially invasive and forage species [1], *Zornia reticulata* suggests that collection efforts should be expanded throughout the state of Acre.

The *Crotalaria micans* species was collected at an exposed location on the Campus, subject to trampling, cutting and competition with other plants. It is not new among the records of the municipality, the first possibly being in 1984, whose specimen is deposited in the Herbarium of the New York Botanical Garden (Cid Ferreira, 5158 NY! Visa). Its occurrence in the state of Acre was confirmed by [5], referring to a specimen deposited in the Herbarium of the New York Botanical Garden (H.MEDEIROS, 19 NY). However, this specimen was not found. Within the genus, up until then, [4] only the *Crotalaria pallida* Ailton had been recorded, and only for the municipality of Sena Madureira.

Crotalaria micans has also been mentioned for that same location [17], where the development of the species was evaluated under cultivation conditions and stated that although the plant survived and served as ground cover in the driest period, its life cycle was long with deteriorated phytomass yield. Other reports stated that the plant is a forage, but toxic at the fruiting stage [1].

Desmodium adscendens, commonly known as "carrapicho", has been recorded for the municipalities of Cruzeiro do Sul and Mâncio Lima, within the Upper Juruá Region, and outside Sena Madureira and Tarauacá [4]. However, it is still underrepresented because it is a widely distributed plant. There are also indications of its use in traditional medicine in several countries, with antibacterial, antiviral, antidiabetic and antioxidant actions; its effects have been evaluated in renal cells and hepatocytes, through continuous use [18].

Within the Malvaceae family, with the same representativeness as Fabaceae (Table 1), the record of *Sida rhombifolia* at the study site revealed the need to expand collection efforts, since, until then, reports had only been made for the municipality of Xapuri, in Alto Acre [4]. This plant, besides occurring spontaneously in anthropic environments, is considered a severe weed in annual, perennial and grazing crops, mainly in cereal cultivations, due to the deep root system it presents [1]. However, it also has medicinal properties, as it has secondary metabolites with vasodilator actions [19].

In relation to *Urena lobata*, its record for the municipality of Cruzeiro do Sul adds to two previous records made in Rodrigues Alves and Porto Walter [4,5]. Additional data reinforce the presence of this species in the State without mentioning the location, noting that it is a weed, difficult to control in areas deforested for pasture, and competing with forages; it slows the succession process, which hinders the establishment of pioneer tree species [20]. However, it is a plant that provides fiber [1]. It is also used in traditional medicine by the population of Nigeria to treat diabetes, whose action was confirmed in laboratory tests in that country, but continued use revealed toxicity, and researchers are drawing attention to the frequency of consumption and dosage regulation [21].

Waltheria indica, another Malvaceae present on the Campus, found in cracks along the Campus sidewalks, was also seen nearby in vacant lots. The species is not on the Flora do Acre list [4,5], although it is cited for the State [12]. It is another potentially infesting plant, found in orchards and pastures. However, its flowers are melliferous [1] and are also used in traditional medicine, with proven antifungal, antibacterial and antioxidant actions [22]. Other reports demonstrate the isolation of alkaloids from its roots with inhibitory actions on the protozoan *Trypanossoma cruzi* Chagas 1913 [23,24].

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Regarding the family Asteraceae, the record in this study of *Praxelis diffusa* (Figure 2a) is the first for Acre, with previous records only in the Northern Region of the states of Amazonas and Pará [12]. This plant has a preference for sandy soils with low fertility, and is also considered a weed, although it is used in traditional medicine [1].

Figure 2. Some of the ruderal species recorded in Cruzeiro do Sul, Acre: *Praxelis difusa* (**a**); *Rhynchospora pubera* (**b**); *Diodia kuntzei* (**c**); *Cipura paludosa* (**d**) . Credits: Camilo Pereira.

The record of *Eclipta prostrata* on the Floresta Campus adds another municipality to the four already reported: Bujari, Manoel Urbano, Brasiléia and Rio Branco [4]. The plant was found on the edges of sidewalks; but it is also a weed in rice fields, pastures and crops in general [1]. However, it is used in traditional medicine to cure different diseases, and several compounds have already been isolated, showing antioxidant, antiphallic, antimalarial actions [25].

Emilia forsbergii, a pantropical species, was the first record for the municipality of Cruzeiro do Sul. Prior to these two, one for the municipality of Acrelândia (TB Croat 85875) [5], and a more recent one for the municipality of Rio Branco, it was identified as a weed in banana cultivations [26]. Here is another call to expand the collection effort in the state, considering that there are 22 municipalities and that it is a common plant. It is considered a weed plant in gardens, pastures and orchards [1].

As for Cyperaceae, *Scleria gaertneri*, it is the first record for the municipality of Cruzeiro do Sul, in addition to those already reported for the municipalities of Porto Walter, Rodrigues Alves and Tarauacá [4], but it has been identified as *Scleria melaleuca* Rchb ex Schltdl. & Cham. This name is

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synonymous [12]. Although it is collected on dry land, along the edges of sidewalks, it can also be found in flooded areas, considered an amphibious plant [27], and is another plant that invades crops and pastures [1]. Despite this, there is indication that its roots are used in traditional medicine [13] (MIRR 10559).

Also within this family, *Rhynchospora pubera* (Figure 2b), found both on land and in occasional flooded environments, was a new record for the municipality of Cruzeiro do Sul [4], and is another species that should be better represented in herbaria, mainly because of its wide distribution inside and outside Brazil, including different environments [12].

Another very common record at the collection site, this time for the family Amaranthaceae, was *Alternanthera tenella*, mainly along sidewalks. This species is not listed in Flora do Acre [4,5]. However, [12] cites its occurrence for the State. Despite this, no records were found in the online databases (www.nybg.org; www.splink.org, www.mobot.org). It is considered an invader of maize and sorghum crops [1]. However, a greenhouse study with this species demonstrated its ability to absorb cadmium and zinc, revealing its potential for the environmental restoration of areas where these elements are in high concentrations, such as mining areas [14].

Regarding *Amaranthus blitum*, it is the first record for the state of Acre. It is a very common plant in the study site, found along the edges of sidewalks; being known mainly for its potential invasion of orchards, perennial crops, coffee plantations, gardens, among others [1]. Other studies, however, indicate that this plant has an antioxidant action [28].

Sauvagesia erecta, which represents Ochnaceae, is another record for the municipality of Cruzeiro do Sul, and is another plant that draws attention due to the lack of representativeness in the State, since before Cruzeiro do Sul, there was only one collection in the municipality of Mâncio Lima [4].

For the Rubiaceae family, the record of *Borreria verticillata*, herbaceous and very common in the study site, seen at edges of forest and on sidewalks, was also named by [4]. It is a plant best known as an invasive grass, which retains many mineral nutrients that prevent the development of various forages, such as brachiaria grass [29]. Despite this, it is used in traditional medicine [1]. There are indications that its roots have antibacterial action against resistant strains of *Pseudomonas aeruginosa* [30].

Also present in the Campus, representing the Rubiaceae, was the species *Diodia kuntzei* (Figure 2c). A species of prostrate habit, adapted to sun-exposed, occasionally flooded environments, recently marked as the first record for the state of Acre [31]. Other authors revealed that the species has an acaricidal action on the larvae of *Rhipicephalus microplus* Canestrini, 1888, with action greater than 95% [32].

The Verbenaceae represented by the species *Stachytarpheta cayennensis* are easily found in the Campus and nearby locations, but have not yet been recorded for the Upper Juruá Region, and thus should be better represented. This record added three more for the municipalities of Rio Branco, Senador Guiomard and Tarauacá. It is considered a plant of infestation of orchards, annual and perennial crops, sugarcane fields, etc. [1]; but it is also used in traditional medicine [33].

Scoparia dulcis, which represents the Plantaginaceae family, is the first record for the municipality of Cruzeiro do Sul. However, there are other records for the Upper Juruá Region, with collections in Porto Walter and Marechal Thaumaturgo; in addition to Acrelândia, Rio Branco, Xapurí and Brasiléia, being one of the best represented species for the State [4]. It is another ruderal plant with invasive potential, which can be found in crops, annual crops, coffee plantations, orchards, among others [1]. However, it is also used in traditional medicine for urinary infections, rheumatism and inflammation treatments [33], and laboratory tests suggest actions for the treatment of osteoarthritis [34], among others.

The Urticaceae family, represented by the species *Pilea microphylla*, is another common plant at the study site, on the edges and cracks of sidewalks. It is the first record for the Upper Juruá Region, and only one other occurrence is known for the municipality of Rio Branco (H. Medeiros 557 NY) [5], revealing that it is very rarely collected. The plant is also another example of invasive potential, but without causing large infestations [1]. There are reports of competition of this plant with orchids

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belonging to the genus *Rhynchostylis* Blume, with the option of controlling oxyfluorfen and flumioxazin molecules, with an efficiency of over 90% [35].

Hyptis atrorubens, representing Lamiaceae, is the first record for the Upper Juruá Region, and whose occurrence was only known previously for the municipality of Sena Madureira [4,12], revealing the need to expand the collection effort, since it is a very common plant, resistant to anthropogenic action, mainly in humid environments. The plant is also considered a weed in gardens, pastures, crops, orchards, among others [1,3]. It is also used in traditional medicine, with antimicrobial properties, some extracted from its essential oil [36].

Cipura paludosa (Figure 2d), belonging to the Iridaceae family, was another ruderal found on the Campus, never before recorded in the Upper Juruá Region. It has only been recorded for the municipality of Assis Brazil [4], and is another plant with little representation for the State. It occurs in occasional flooded environments, being resistant to cleaning. The bulbs of this plant are used in tea by the riparian communities of Rondônia to treat inflammation and pain, whose effectiveness has been confirmed by the identification of some components [37].

Finally, attention is drawn to the appearance of the Poaceae family, one of the most representative on the Campus, with a record of five species, still in the identification stage, highlighting only *Andropogon bicornis*, previously mentioned only for the municipality of Rio Branco [4]. This plant, despite being sought by cattle in the regrowth phase, is considered of low palatability and, in addition, is invasive of cultivated forage and difficult to control [3]. On the other hand, the plant has been tested for its allelopathic potential, and showed promise when tested on lettuce seedlings [38].

The Euphorbiaceae family was represented by *Euphorbia thymifolia*, a herbaceous plant of prostrate habit, easily found in sidewalk holes in the Upper Juruá Region, but only recently recorded for the first time in the state of Acre [39]. The plant is also used in traditional medicine, with some proven effects, such as blood depurative, antiviral, anti-inflammatory, among others [40,41].

As for the Pteridophyta, the only recorded representative is *Pteridium aquilinum*, which is very common at the edges of the Campus forest, a location that has changed significantly, typical of this plant's preference [42]. Prior to this record, another is known from Cruzeiro do Sul, collected by G.Prance (2864, INPA 18396) at Km 20 towards Vila Maitá in 1966 [13]. More recently, [4] mentioned the occurrence of *P. caudatum* (L.) Maxon, claiming to have as a synonym *P. aquilinum* var. *caudatum* (L.) recorded for the municipalities of Mâncio Lima, Cruzeiro do Sul and Marechal Thaumaturgo, citing a collection by J. Prado (1178).

These data are important because they serve as parameters. [12] reports that *P. aquilinum* does not occur in Brazil. However, [42], studying the Pteridophyta of Perú, recorded the presence of *P. aquilinum*, with two varieties, one of which, the aforementioned *P. aquilinum* var. *caudatum*, occurs both in that country and in northern Brazil. In addition, numerous samples have been collected in the Northern region, as well as throughout the country, identified by specialists as *P. aquilinum* which, according to the law of priority, prevails as such. Regarding attributions, [43] reported the invasive potential of this plant in pastures and its toxic effects on animals, mainly cattle, while [44] highlighted the repellent and insecticidal actions of the referred plant on the cabbage aphid - *Brevicoryne brassicae* L.

In the Upper Juruá Region, *P. aquilinum* frequently occurs in abandoned scrub areas and in chemically poor sandy soils with high levels of exchangeable aluminum. In areas of white sand ecosystems in the region, known as Campinaranas, after sand extraction, the abandoned areas are colonized by *P. aquilinum*, which spreads aggressively through rhizomes and forms a dense cover that prevents the natural succession process [45].

5. Conclusions

It is concluded that there is a significant diversity of ruderal plants on the Floresta Campus that occur frequently in pastures, agricultural ecosystems, and sand mining areas of the region. This occurrence, the state of collection, and the attributions of these species can subsidize soil use and management actions, as well as the recovery of degraded areas.

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Finally, it is worth noting that there is a need to expand the collection effort not only for the Upper Juruá Region, but for the entire state of Acre, considering that it comprises 22 municipalities and many of the plants reported were the first record.

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