

RUSTS OF PASTURES IMPLANTED IN THE PARAGUAYAN CHACO

Humberto J. Sarubbi

Facultad de Ciencias Agrarias de Universidad
Nacional de Asunción. San Lorenzo.
Paraguay

María Mercedes Godoy

Facultad de Ciencias Agrarias de Universidad
Nacional de Asunción. San Lorenzo.
Paraguay

Mercedes Jara

Facultad de Ciencias Agrarias de Universidad
Nacional de Asunción. San Lorenzo.
Paraguay

Humberto Albertini

Estancia Montanía. Teniente Montanía,
Chaco. Paraguay

All content in this magazine is licensed under a Creative Commons Attribution License. Attribution-Non-Commercial-Non-Derivatives 4.0 International (CC BY-NC-ND 4.0).



INTRODUCTION

The Paraguayan cattle herd currently consists of 13.9 million heads, where 57% of the animals are found in the Chaco. Paraguay has achieved important markets in recent years, ranking as the seventh exporter of beef in the world (ARP 2017). The Paraguayan Chaco has an area of 8.8 million hectares of pastures for meat production, these being the main source of livestock feed (Glatzle and Stosiek 2001). Pastures are exposed to phytosanitary problems, where different pathogens can be a negative factor in production, causing qualitative and quantitative damage to the vegetative mass (Sarubbi 2014). Cummins (1971), Lenné (1990) report several genera of rusts parasitizing forage grasses, which are used in animal feed. Rusts are highly host-specific biotrophic pathogens, which attack, especially damaging the leaves of their hosts, causing necrosis and accelerated defoliation, having a highly destructive potential (Pardo-Cardona 2003, Zuluaga et al. 2009, Bettenhauser et al. 2014). Therefore, an adequate identification of the fungi that can affect the quality of the biomass is of the utmost importance, since it constitutes the first step for the development of management strategies. The objective of this work is to present the main findings of rusts that attack forage grasses implanted in the Paraguayan Chaco. The identification of the uredinal fungi and hosts was carried out, as well as the characterization of the spores found, symptomatology in the plants and time of incidence.

MATERIALS AND METHODS

During the years 2015-2018, sampling was carried out in the Departments of Villa Hayes, Boquerón and Alto Paraguay in the Western region (Chaco) of Paraguay. The collections were carried out in the different 4 seasons of the year, to allow observing rust symptoms in different cycles of the implanted pastures

of different species of poaceae in open areas of pastures destined for cattle grazing. The samples of pastures collected were of the species: *Megathyrsus maximum* cv. Gatton Panic, *Digitaria eriantha*, *Cenchrus ciliaris*, *Chloris elata* y *Cynodon nlemfuensis*.

The collected material consisted preferably of leaf blades and symptomatic canes, both fresh and senescent, since they can present different types of fungus spores. Said materials were photographed and immediately deposited in small plastic laboratory containers (100 ml) for identification. To avoid dehydration and decomposition of the green material collected in the field, the plastic containers were refrigerated at a temperature of 8 °C. The collected material was taken to the phytopathology laboratory of the Faculty of Agrarian Sciences of the UNA, where the affected tissues and spores were analyzed with the help of a stereoscope and an optical microscope. The spores found were characterized and measured (a minimum of 50 per species), with the help of the Leica ICC50 microscope and the LAS EZ program, determining the morphology, size, color, type of pedicel and roughness of the cell wall of the urediniospores and teliospores.

The identification of the rust species was carried out taking into account the host, type of uredinia, telia and characteristics of the spores, with the help of technical and descriptive materials for rusts by Cummins (1971), Pardo-Cardona (2003), Hennen et al. (2005) and Salazar and Carvalho Junior (2011). All samples are deposited in the pasture rust herbarium of the FCA-UNA Plant Protection Area.

RESULTS AND DISCUSSION

Uromyces setariae-italicae Yoshino
= *Uromyces leptodermus* H. Sydow & P. Sydow, in Sydow & Butler, Ann. Mycol. 4: 430. 1906

TYPE: *Megathrysus maximus* cv. Gatton Panic, poaceae

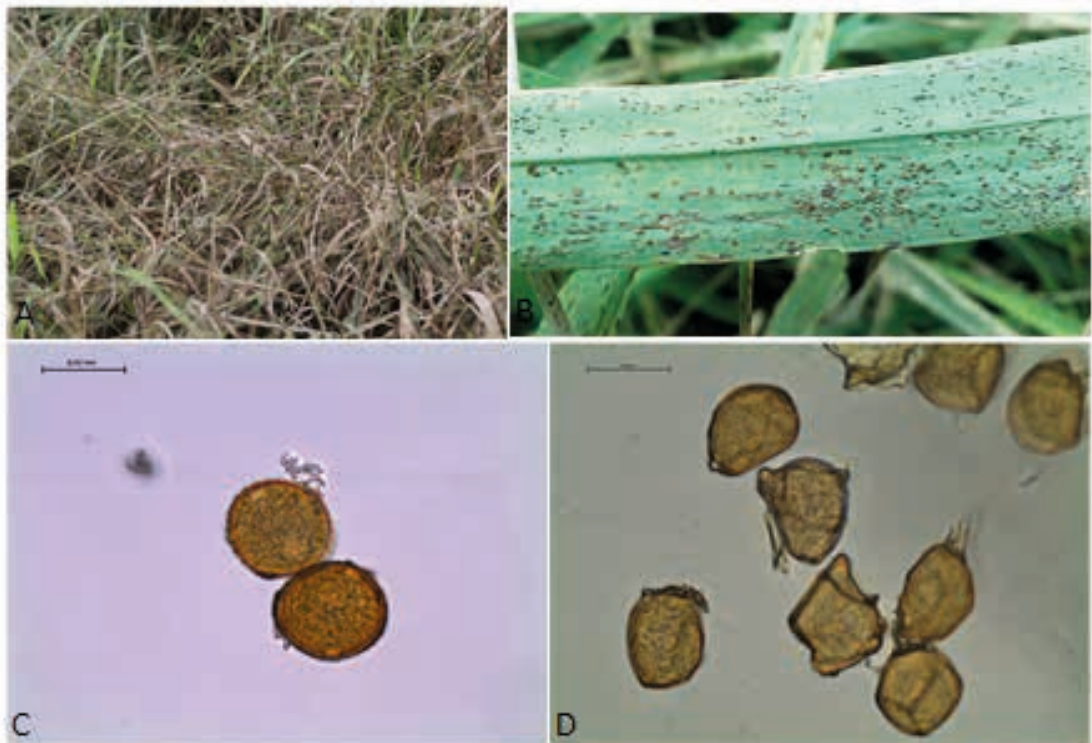
Paraguay, Pirizal, Boquerón, May 2015, coord. S 23°16'02.8", W 60°44'16.2"

Paraguay, Lieutenant Montanía, Boquerón, May 2015, coord. S 21° 58' 55.9", W 60° 02' 54.6".

The occurrence of this rust is observed preferably in the autumn and winter months, and with rare incidence in the summer months. The leaves have small pustules (Uredinia), powdery, cinnamon brown, located along the veins and covering a large surface area of the blade (Fig. 1 A-B). The Uredinians are anphigenous, although mostly in the abaxial part, confluent, with a conspicuous rupture of the epidermis. Urediniospores are obovoid, finely equinulate, light brown in color, 23-40 x 20-29 μm in size and 2 to 3 equatorial pores (Fig. 1 C). Telios are small, inconspicuous, dark, remain covered by the epidermis, and

are anphigenous, preferentially in the abaxial part. Teliospores are unicellular, have a variable shape, angular, globoid or obovoid with 23-29 x 21-27 μm , smooth walls, brown in color, deciduous pedicel up to 20 μm long, but normally breaking close to the spore (Fig. 1D). It is possible to observe hyperparasitism of the uredinia by the fungus:

Darcula sp., forming conspicuous dark pycnidia. The incidence of this rust is in the autumn and winter months, especially with high humidity. Hennen et al. (2005) and Salazar and Carvalho Júnior (2011) report that this rust is the only one known in Brazil parasitizing *Megathysus maximus* (*Panicum maximum*). The same authors point out an obovoid morphology, light brown color and urediniospores size of 27-39 x 24-27 μm and unicellular teliospores, angular globoids with 16-28 x 14-20 μm in size, which correspond to those described in this research.



cv Gatton panic with pustules of *Uromyces setariae-italicae*. C. urediniospores of *U. setariae-italicae*. D. unicellular teliopores of *U. setariae-italicae*.

Bar: C and D = 20 μm

Puccinia oahuensis Ellis & Everhart
 = *Puccinia digitariae* pole-Evans, Ann. Bolus Herb. 2: 111. 1917
 = *Puccinia digitariae-velutinae* Viennot-Bourgin, Bull Soc. Mycol. France 65: 432. 1951

TYPE: *Digitaria eriantha* Steud., poaceae
 Paraguay, La Blanca, Villa Hayes, August 2018, coord. S 24°46'57.5", W 57°49' 07.1".

The leaf blades had a large number of yellow-orange uredinia (pustules), covering a large area (Fig.2 A-B). The morphology of the Uredinians is oval to slightly elongated, conspicuous, following the line of the veins, anphigenous, powdery, irruptive, with conspicuous rupture of the epidermis and presents paraphysis. Urediniospores are finely equinulent, cinnamon brown in color, ovoid to globose, with a size of 27-31 x 23-28 μm (Fig. 2 C). The Telios are elongated, arranged along

the veins, black in color, slightly conspicuous, covered by the epidermis and preferably hypophilous, although they are also observed adaxially on the leaves. The teliospores are oblong ellipsoids, with a truncated apex and attenuated base, cinnamon brown in color, 45-47 x 18-28 μm , and have a short and deciduous stalk (Fig. 2D). There may be an incidence throughout the year when there is a high humidity environment, in times of drought it is absent. Cummins (1971), Salazar and Buriticá (2004), Hennen et al. (2005), and Salazar and Carvalho Júnior (2011) point to the genre:

Digitaria as host of this rust and that the urediniospores have a brown-yellow color of 24-30 x 21-24 μm in size, and cinnamon brown teliospores of 36-48 x 18-27 μm in size, descriptions similar to those reported in this job.

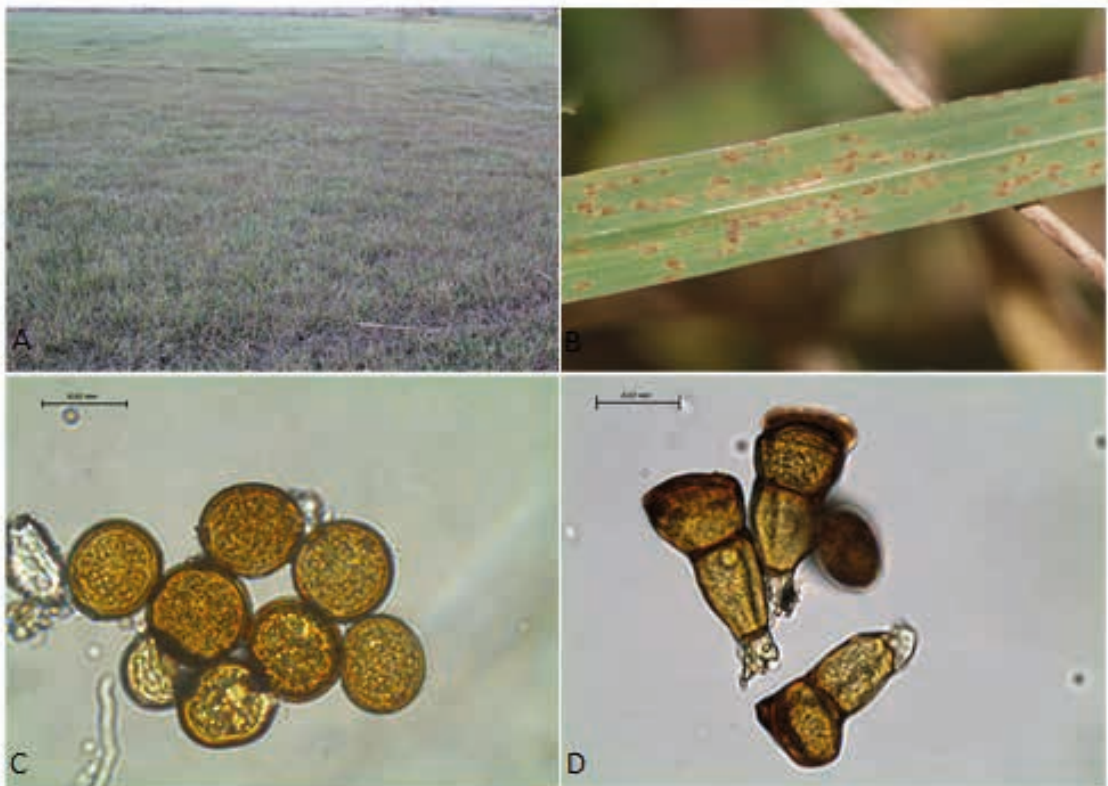


Fig. 2 A. Rust field damage. B. Abxial section of a *Digitaria eriantha* leaf with *Puccinia oahuensis* pustules.
 C. Urediniospores of *U. setariae-italicae*.
 D. unicellular teliospores of *U. setariae-italicae*. Bar: C - D = 20 μm

Puccinia cenchri Dietel & Holway

TYPE: Sobre *Cenchrus ciliaris* L., poaceae
Paraguay, Lieutenant Montanía, May 2016,
coord. S 21° 58' 17.5", W 59° 59' 42.4".

This rust infects plants especially in the fall and winter months. The examined leaves presented Uredinia in the form of cinnamon-brown points and they are conspicuous, irruptive, slightly elongated, powdery, with conspicuous rupture of the epidermis and anphigenous (Fig 3 A-B). Urediniospores are finely echinulate, cinnamon brown, ovoid to globose, with 2-3 pores and 28-38 x 22-27 µm in size (Fig. 3C). Telios are elongated, arranged along the veins, black in color, conspicuous, hyphilous and remain

covered with the epidermis. The teliospores are oblong ellipsoids, with a truncated apex and attenuated base, cinnamon brown in color, 45-47 x 18-28 µm, and have a short (10-30 µm) and deciduous stalk (Fig. 3D).

This rust is observed in the chaco in the autumn and winter months, especially with weeks of high humidity.

Cummins (1971), Hernandez et al. (2005) and Hennen et al. (2005), report the pathogen from Mexico to Argentina, with a description of light brown urediniospores, 45-47 x 20-30 µm, and oblong to clavate teliospores, cinnamon brown in color, 40-50 x 20-27 µm. size, agreeing with the descriptions made in this work.

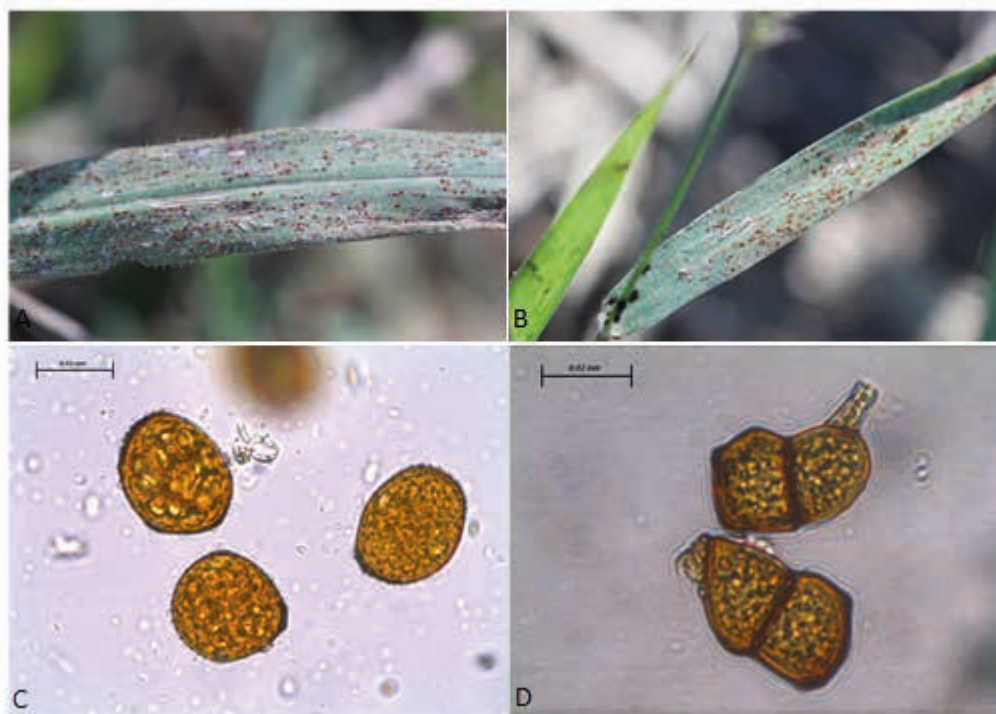


Fig. 3 A-B. Leaves of *Cenchrus ciliaris* with pustules of *Puccinia cenchri*.

C. urediniospores of *P. cenchri*. D. teliospores of *P. cenchri*.

Bar: C and D = 20 µm

Puccinia cacabata Arthur & Holway
= *Puccinia stakmanii* Presley in Presley &
King, *Phytopathology* 33: 385. 1943
= *Puccinia digitariae* Pole-Evans, *Ann.*
Bolus Herb. 2:111. 1917.

= *Puccinia digitariae-velutinae* Viennot-
Bourguin, *Bull. Soc. Mycol. France* 67:432.
1951

TYPE: *Chloris elata* Desv., poaceae
Paraguay, Lieutenant Montanía, May

2015, coord. S 21° 58' 46.8", O 60° 03' 28.7", deposited in the herbarium of the forage leaf rust collection of the FCA-UNA Plant Protection Area.

The leaf blades had small powdery spots (Uredinia) of a cinnamon brown color, scattered, and could cover a large surface area of the blade and also the cane (Fig. 4 A). These Uredinia are ovoid - elongated, conspicuous, anphigenous (initially only hypophilic), irruptive, confluent, taking on the appearance of elongated pustules, following the veins. Urediniospores are obovoid, light brown in color, echinulate, with 2-3 equatorial pores and a size of 23-28 x 19-25 μm . Pustules could also be observed on the grass culm (Fig. 4B). The Telios are black, conspicuous, anphigenous, with rupture of the epidermis, they develop preferentially when the leaf enters senescence (Fig. 4 C). The bicellular teliospores have a

cinnamon brown coloration, smooth cell wall with an apical thickness of 2.7-4.7 μm , slightly darker apex, elongated 33-40 x 20-25 in size, with a long persistent pedicel (60 to 110 μm) (Fig. 4D). The cell wall is smooth. Incidence of the fungus is observed only in the autumn and winter months, being irrelevant in the summer months. Farr and Stevenson 1964, Hennen et al. 2005 and Pardo-Cardona 2005 report it parasitizing grasses of the genus *Chloris* in Argentina, Brazil, Bolivia and Colombia, agreeing with the host studied in this research. Cummins (1971) and Hennen et al. (2005) report a morphology of obovoid and slightly ellipsoid urediniospores of cinnamon brown color and size of 22-32 x 17-25 μm , and cinnamon brown teliospores, ellipsoid to oblong of 27-44 x 17-26 μm in size, descriptions that agree with those presented in this work.



Fig. 4 A. Leaf of *Chloris elata* with reddish-brown pustules of *Puccinia cacabata*.

B. Urediniospores of *P. cacabata*. C. Leaf of *C. elata* on black telios of *P. cacabata*. D. Telioporas of *P. cacabata*. Bar: B and D = 50 μm

Puccinia cynodontis Lacroix ex. Desmazieres

Type: *Cynodon nlemfuensis*, poaceae

Paraguay, La Blanca, Villa Hayes, August 2018, coord. S 24°46'59.5", O 57°49'51.2", deposited in the herbarium of the forage poaceae rust collection of the FCA-UNA Plant Protection Area.

The plants present leaves that quickly acquire a straw coloration (Fig. 5 A). The leaf blades had ovoid to elongated spots (Uredinia), located along the veins, cinnamon brown in color, confluent and covering a large leaf surface (Fig. 5 A). These Uredinia are

scattered, elongated ovoid (up to 3 mm long), powdery, conspicuous, hypophilic, irruptive, and have paraphyses (Fig. 5B). Urediniospores are ovoid, light brown, warty, 23-28 x 19-25 μm in size. No telia were observed in the samples (Fig. 5C). Cummins (1971) describes the Telios as dark, pulvinate and hypophilic, the teliospores being brown in color, 30-55 x 16-22 μm in size, ellipsoid and generally with pointed apex. Hyperparasitism of *Darluca* sp. in the Uredinians. The incidence of this rust is higher in the winter months and infrequent in the summer months, especially with a lack of rainfall.

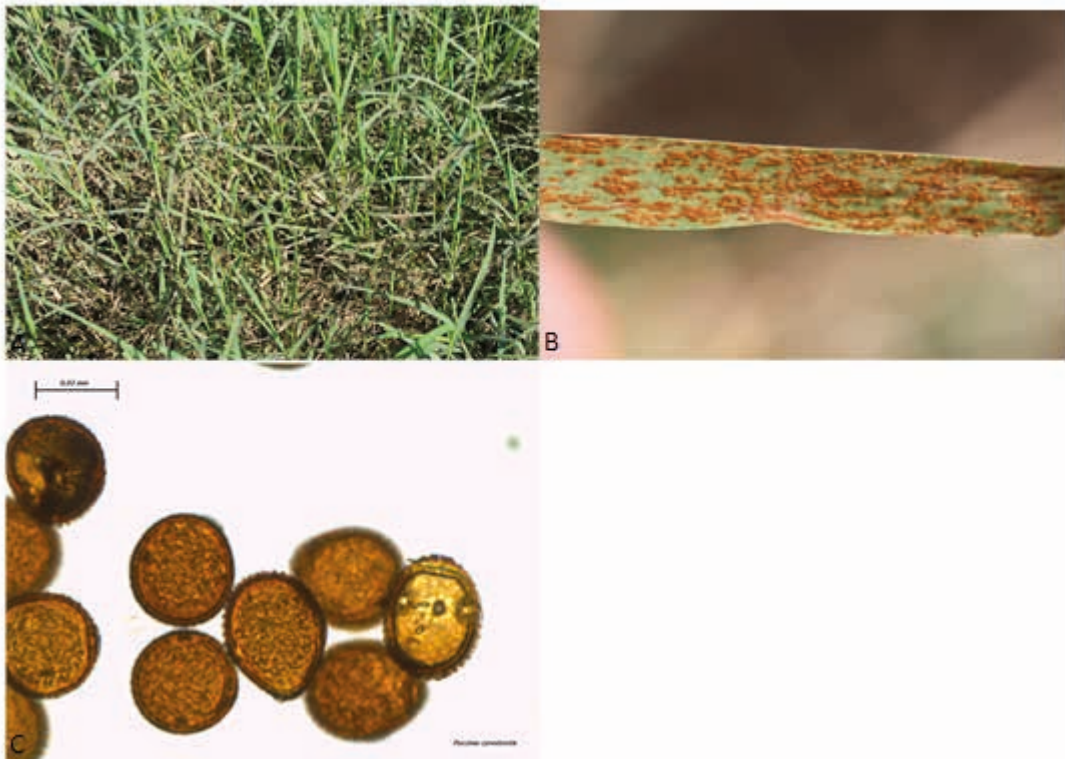
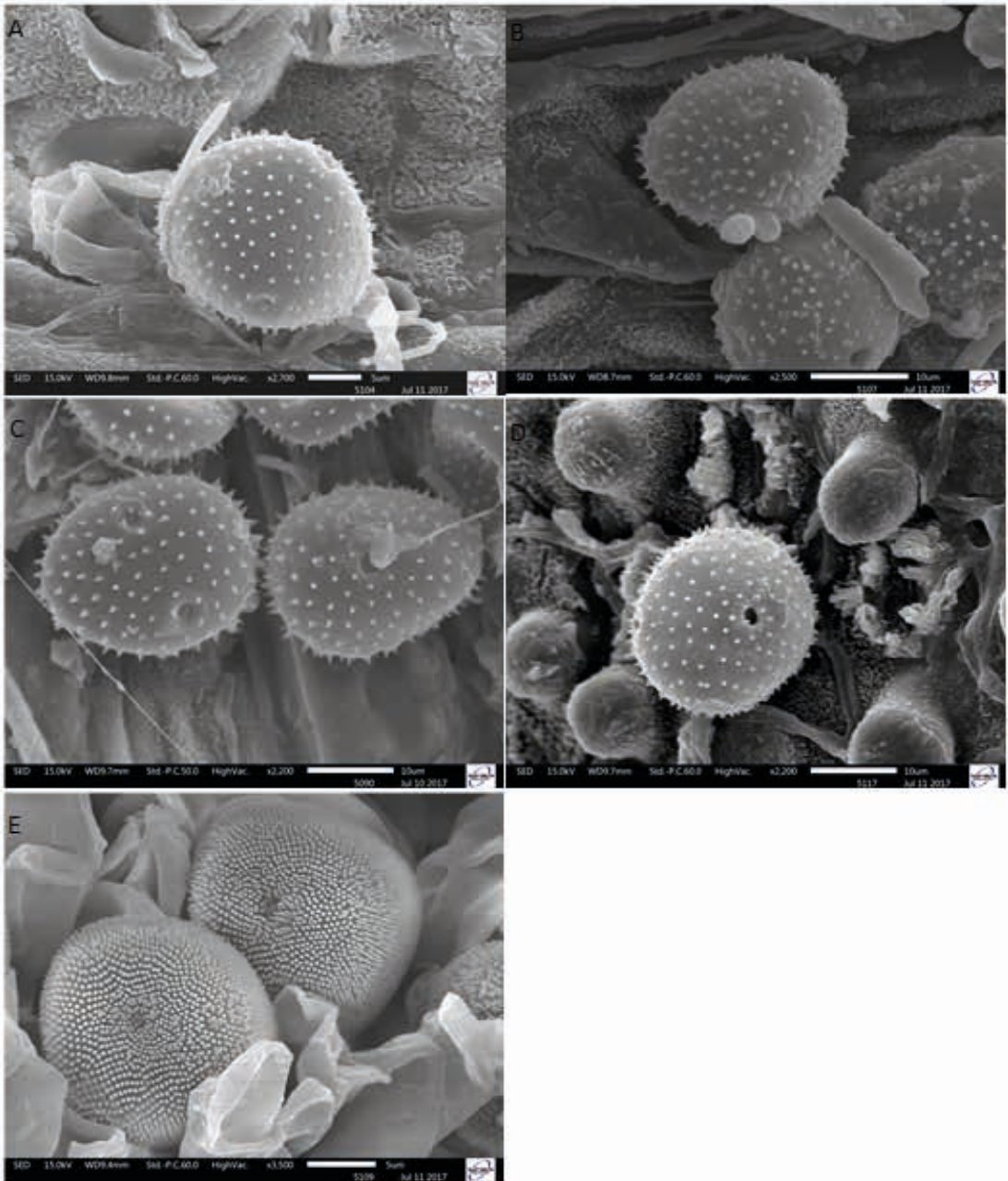


Fig. 5. A. Symptoms of *Puccinia cynodontis* in the field plants. B. Uredinios light brown located abaxially on the leaves. C. Urediniosporas de *P. cynodontis*. Bar: C = 20 μm



Electron microscopy of urediniospores of: A. *Uromyces setariae-italicae* B. *Puccinia oahuensis* C. *Puccinia cenchri* D. *Puccinia cacabata* E. *Puccinia cynodontis*

Bar: A and E = 5 μ m B-C-D = 10 μ m

CONCLUSION

In planted fodder poáceas of the Paraguayan Chaco, the presence of rusts is recorded: *Uromyces setariae-italicae* in *Megathyrus maximum* cv. Gatton panic, *Puccinia*

oahuensis in *Digitaria eriantha*, *Puccinia cenchri* in *Cenchrus ciliaris*, *Puccinia cacabata* in *Chloris elata* and *Puccinia cynodontis* in *Cynodon nlemfuensis*

REFERENCES

- ARP, 2017. <https://www.arp.org.py/images/Paraguay-y-el-Sector-Carnico.pdf>.
- Bettenhaueser, J; Gilbert, B; Ayliffe, M; Moscou, M. 2014. Nonhost resistance to rust pathogens – a continuation of continua. *Plant Science* 5: 664. <https://doi.org/10.3389/fpls.2014.00664>.
- Cummins, G. 1971. *The Rust Fungi of Cereals, Grasses and Bamboos*. New York, US, Springer-Verlag New York Inc. 571p.
- Glatzle, A; Stosiek, D. 2001. Perfiles por país del recurso pastura/forraje. Consultado el 2 de nov 2016. Disponible en http://www.fao.org/ag/AGP/AGPC/doc/Counprof/PDF%files/Paraguay_Spanish.pdf.
- Farr, M; Stevenson, J. 1964. Eine Ergänzungsliste bolivianischer Pilze (en línea). *Sydowia* 17: 37-69. Consultado el 14 de oct de 2016. Disponible en http://www.zobodat.at/pdf/Sydowia_17_0037-0069.pdf.
- Hennen, J; Figueiredo, M; Carvahlo, A; Hennen, P. 2005. Catalogue of the species of plants rust fungi (Uredinales) of Brazil. Consultado el 2 de jun de 2015. Disponible en http://aplicacoes.jbrj.gov.br/publica/livros_pdf/catalogue.pdf.
- Hernandez J; Aime, M; Henkel, T. 2005. The rust fungi (Uredinales) of Guyana. *Sydowia* 57(2): 189-222. https://www.zobodat.at/pdf/Sydowia_57_0189-0222.pdf.
- Lenné, J. 1990. *A World list of fungal diseases of tropical pasture species*. Wallingford, UK, University press Cambridge. 162 p.
- Pardo-Cardona, V. 2003. Nuevas especies y registros de uredinales para Colombia y Sudamérica. *Caldasia* 25(2): 283-296. <https://revistas.unal.edu.co/index.php/cal/article/view/39391>
- Pardo-Cardona, V. 2005. Novedades para la flora Uredinológica colombiana. *Caldasia* 27(2): 223-227. http://www.scielo.org.co/scielo.php?script=sci_abstract&pid=S0366-52322005000200005&lng=es&nrm=.pf&tlng=es.
- Salazar, M; Buriticá, P. 2004. Nuevos registros para la Uredobiota colombiana. *Caldasia* 26(1): 79-87. <https://revistas.unal.edu.co/index.php/cal/article/view/39339/0>.
- Salazar Yepes, M; Carvalho, A. 2010. *Ferrugens, Diversidade de Uredinales do Parque Nacional do Itatiaia, Brasil*. Rio de Janeiro, BR, Technical Books Editora. 201 p.
- Zuluaga, C; Buriticá, P; Marín-Montoya, M. 2009. Generalidades de los uredinales (fungi: basidiomycota) y de sus relaciones filogenéticas. *Acta biológica Colombiana* 14(1): 41-55. <http://www.scielo.org.co/pdf/abc/v14n1/v14n1a03.pdf>.