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Diversity, taxonomy, and ecology of plant parasitic smut fungi in Bolivia*

Diversidad, taxonomía y ecología de hongos carbones parasíticos de Bolivia

Meike Piepenbring

Botanisches Institut, J. W. Goethe-Universität Frankfurt am Main,
Senckenberganlage 31-33, 60054 Frankfurt am Main, Germany
FAX: 0049 69 798 24822, Correo electrónico: piepenbring@em.uni-frankfurt.de

Abstract

Plant parasitic smut fungi were recently collected in Bolivia and looked for in herbarium collections of fungi and higher plants. Together with records found in literature the resulting check list contains 46 different species of smut fungi on about 55 species of host plants. Among the smut fungi, *Bauerago boliviana* is a species new for science, *Sporisorium braziliensis*, *Sporisorium paspali-notati*, and *Sporisorium tristachyae* are new combinations. 25 species of smut fungi are new for Bolivia, nine species of higher plants are reported for the first time as host species for known species of smut fungi. Depending on the altitudinal level the composition of smut species diversity changes, but apparently not the number of different species in a given area. Smut fungi were mainly found in humid environment, except *Ustilago hypodytes*. Ecological and morphological aspects related to this observation are discussed.

Key words: Basidiomycota, *Bauerago boliviana*, *Sporisorium* new combinations, Ustilaginales, Tilletiales.

Resumen

Recientemente, se buscaron en Bolivia hongos carbones fitopatógenos en el campo, en muestras de herbarios de hongos y plantas superiores. Junto con algunas especies citadas de la literatura, la lista de carbones de Bolivia cuenta con 46 especies diferentes de carbones en aproximadamente 55 especies de plantas hospederas. Entre los carbones, *Bauerago boliviana* es una especie de carbón nueva para la ciencia, mientras que *Sporisorium braziliensis*, *Sporisorium paspali-notati* y *Sporisorium tristachyae* son combinaciones nuevas. Hay 25 especies de carbones que se citan por primera vez para Bolivia y nueve especies de plantas superiores que se reportan por primera vez como hospedantes para sus respectivas especies de carbón. Según los distintos pisos altitudinales cambia la composición de la diversidad de especies de carbón, pero aparentemente no cambia el número de especies distintas en un área. La mayoría de los carbones se encontraron en áreas húmedas, excepto *Ustilago hypodytes*. Se discuten aspectos ecológicos y morfológicos relacionados con esta observación.

Palabras clave: Basidiomycota, *Bauerago boliviana*, *Sporisorium* nuevas combinaciones, Ustilaginales, Tilletiales.

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Introduction

In the past, plant parasitic smut fungi were classified in Ustilaginales and Tilletiales (Basidiomycota). Now, most of them are placed in several orders within the Ustilaginomycetes and some in the Microbotryales of the Urediniomycetes (Bauer et al. 2001).

Smut fungi live on higher plants, especially on herbs and among these mainly on grasses belonging to Poaceae and Cyperaceae. They form sori with usually powdery dark masses of spores (Fig. 1), which are dispersed by the wind. In humid environment, the spores germinate with basidia and basidiospores (Fig. 2). Basidiospores can bud forming a yeast-stage. Yeast cells conjugate and the resulting dikaryotic hyphae are able to infect susceptible host plants. About 1.300 species of smut fungi are known worldwide, but there are certainly still many unknown species to be discovered, because the sori are often inconspicuous and easily overlooked. Some species of smut fungi like *Ustilago scitaminea* H. Sydow on sugar cane and *U. maydis* (DC.) Corda on corn are of economic importance, but many species in this group occur on wild plants with rather low frequency of infection and without economic importance. These are further reasons for the fact that this group is poorly known in many countries all over the world, especially in tropical latitudes.

In spite of the high diversity of higher plants known from Bolivia, hitherto only 21 records of different species of smut fungi were published for this country (e.g. Stevenson & Cárdenas 1949, Farr & Stevenson 1963, Piepenbring 2000). Species diversity of smut fungi in Bolivia is certainly much higher, the poor state of knowledge being due to the fact that hitherto nobody focused on smut fungi in this country.

Fig. 1. ***Stipa ichu*** **infected by** ***Ustilago hypodytes*** **(Piepenbring et al. 2588). Note dark masses of teliospores around the internodes of the sterile host plant.**

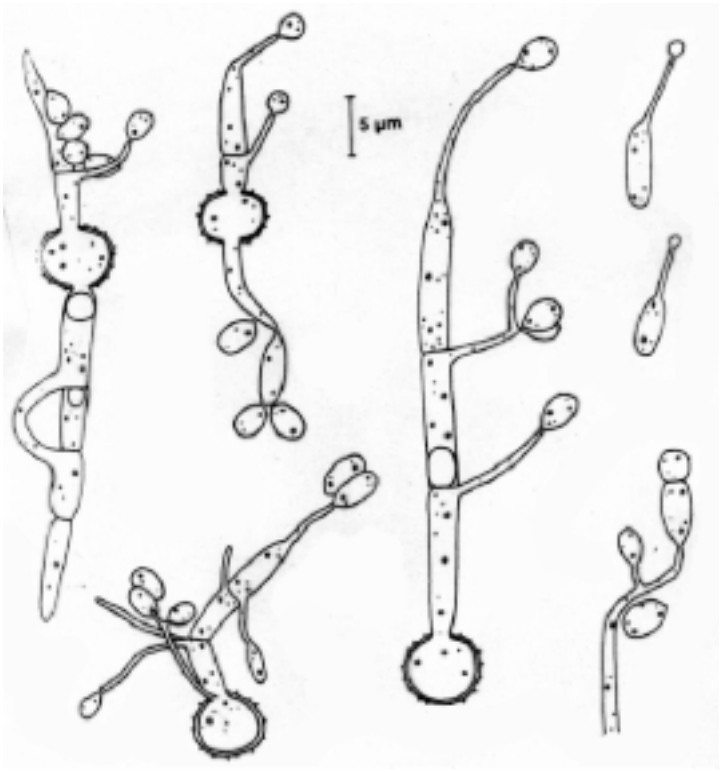

Fig. 2. Teliospores of *U. hypodytes* (Piepenbring et al. 2588) with basidia which develop basidiospores on sterigmata. For germination, the teliospores were placed on the water agar 8 days ago.

Field research for smut fungi was carried out in Bolivia during the elaboration of a volume of the Flora Neotropica on this group. Four species from Bolivia were published as species new for science by Piepenbring (2000). The present publication includes ecological observations and the check list, while descriptions of species, collection data, illustrations, and keys for identification will be included in the Flora Neotropica.

Area of the study

Smut fungi were collected in Bolivia in January and February in 2000, in the states La Paz, Santa Cruz, and Chuquisaca. In addition to the fieldwork, host plants (mainly Poaceae and Cyperaceae) kept in the herbaria LPB, USZ (Herbario del Oriente Boliviano), and HSB (Herbario del Sur Boliviano) were examined for infection by smut fungi.

Material and Methods

Infected plants collected in the field were herbarium dried, studied, and deposited in LPB (Herbario Nacional de Bolivia). Duplicates are included in the personal collection of the author (Frankfurt, Germany). From infected herbarium specimens of higher plants kept in LPB and USZ, fragments with sori were separated and integrated in the fungus collection of LPB. Several specimens of smut fungi from Bolivia were found in BPI (Beltsville, USA) and B (Berlin, Germany).

Results

During 19 days of intensive research for smut fungi in the field, 30 specimens of 22 different species of smut fungi were collected (table 1 and check list). 16 collections of 11 different species of smut fungi were found on specimens of higher plants in the herbaria LPB and USZ. Together with data from literature and specimens from BPI and B, the check list of smut fungi contains 46 species including 25 new records for Bolivia.

The 46 species of smut fungi infect about 55 different species of host plants in Bolivia. Among the host plants, there are nine which hitherto were not known as a host plant for the respective smut species (check list). While most species of smut fungi are known from a single host species in this country, *Ingoldiomyces hyalosporus* (Massee) Vánky occurs on five different species of host plants belonging to the closely related genera *Nassella*, *Piptochaetium*, and *Stipa* (Poaceae). *Ustilago hypodytes* (Schlecht.) Fries is known from five different species of *Nassella* and *Stipa* in Bolivia.

The results of the collecting activity in the field varied substancially depending on the type of vegetation visited. In arid areas of the altiplano (Depto. La Paz), in La Paz, close to Sucre (Depto. Chuquisaca), or close to Samaipata (Depto. Santa Cruz), no to one collection, rarely two collections could be obtained during a day of collecting activity (table 1). Better results were obtained at humid roadsides in the Yungas, close to Chulumani, with six collections of six different species within two days and in the humid parts of the "dunas de arena" close to Santa Cruz, where four different species of smut fungi were collected within a few hours. In dry areas, smut fungi generally were found at locally wet places, like cultivations on riversides (in and close to Sucre) or at “curiches” (ponds) and in ditches on roadsides (close to Santa Cruz). At higher altitudes smut hunting was more successful in the Valle del Río Zongo (paramo) than on the altiplano.

At different altitudes above sea level, smut fungi can be found as long as the vegetation of higher plants is well developed. Depending on the altitude, species composition differs (table 1).

Ustilago hypodytes is the only species repeatedly collected in arid areas. Sori of *U. hypodytes* develop around several distal internodes of the stems of the host plants which are sterile by the presence of the fungus (Fig. 1). Masses of young teliospores are covered by sheaths of adjacent leaves. They are liberated over long periods of time by gradual separation of the leaf sheaths from the stems. Successful infection, however, seems to be rare, because the density of tussocks infected by the smut is usually very low in a given area of vegetation. Close to Copacabana, for example, a single tussock of *Stipa ichu* was found infected by *U. hypodytes* in a rather large area dominated by this grass. The teliospores of *U. hypodytes* germinate rather quickly, within a few days (Fig. 2).

Taxonomy

Among the smut fungi cited for Bolivia (see check list below) there are one new species and three species which are placed into the genus *Sporisorium* as new combinations.

Bauerago boliviana M. Piepenbr., **sp. nov.** Type. On *Commelina* sp. (Commelinaceae). Bolivia. La Paz: Pongo de Quime, 12 or 21 Jul 1921, *White 2256* (holotype, BPI 159668; isotype, BPI 159669).

Differt ab *Ustilagine commelinae* (Komarov) Zundel teliosporis obscurioribus reticuloque inferiore, densiore et ab *Ustilago combensis* Vánky teliosporis forma regulariore obscurioribus.

Ustilago commelinae, known from China, Japan, and Russia, is similar to *B. boliviana* with respect to the genus of the host, sori in hypertrophied ovaries and the size of the reticulate teliospores [(13-)14-17(-18) x (14-)15-18(-19) µm]. *B. boliviana* differs from *U. commelinae* by darker teliospores ornamented by a lower, denser reticulum. *Ustilago combensis* Vánky (1994), known on *Commelina benghalensis* L. from Pakistan, has teliospores with a reticulation similar to the one of *B. boliviana*, but its teliospores are lighter colored and are of more irregular shape than those of *B. boliviana*. *Ustilago commelinae* and *U. combensis* also belong to the genus *Bauerago* (pers. com. R. Bauer).

Table 1: Number of collections and species of smut fungi collected in the field in Bolivia per day (ca. 3-6 hours in the field) in areas at different altitudes and with different annual precipitation (according to Ibisch 1996). For abbreviated names of genera see check list.

Altitude above sea level	Annual precipitation	Locality	Days of collecting	Nº of collections	Collections/day	Species (collected once, otherwise indicated)
3.000 -4.700 m	500 -700 mm	La Paz, altiplano	6	5	0.8	*Sporisorium andropogonis* *Ustilago hordei* *Ustilago hypodytes* (2) *Ustilago quitensis*
2.000 -3.600 m	500 -700 mm	Sucre (Chuquisaca)	3	4	1.3	*Entyloma zinniae* *Ustilago hypodytes* (2) *Ustilago maydis*
3.500 -3.700 m	2.500 -> 5.000 mm	Valle del Río Zongo (La Paz)	1	3	3	*Ingoldiomyces hyalosporus* (2) *Kuntzeomyces ustilaginoidea*
1.300- 2.000 m	2.500 -> 5.000 mm	Sud Yungas (La Paz)	2	6	3	*Aurantiosporium pallidum* *Entyloma bidentis* *Entyloma zinniae* *Farysia chardoniana* *Sporisorium holwayi* *Thecaphora haumani*
1.200- 1.900 m	500 -2.500 mm	Samaipata (Santa Cruz)	3	3	1	*Entyloma zinniae* *Sporisorium tristachyae* *Sporisorium cordobensis*
400 - 500 m	1.000 -1.500 mm (locally wet)	Santa Cruz (Santa Cruz)	4	9	2.3	*Cintractia axicola* *Melanops.pennsylvanicum* (2) *Microbotryum tenuisporum* *Moreaua bulbostylidis* *Sporisorium paspali-notati* *Sporisorium elionuri* *Ustancio* sp. *taubertianum* (2)

Typical species in the genus *Sporisorium* infect members of the Poaceae and develop sori with columellae formed by host tissue and peridia which can be formed by host tissue and sterile fungal cells in inflorescences. Their teliospores are single or form balls, can be mixed with sterile fungal cells, and are ornamented by warts.

Sporisorium braziliensis (Zundel) M. Piepenbr., **comb. nov.** Basionym: *Sphacelotheca braziliensis* Zundel, Mycologia **23:** 297. 1931. Type. On *Andropogon leucostachyus* H.B.K. (Poaceae). Brazil. Minas Gerais: Serra do Cipo, 28 Mar - 1 Apr 1925, *Chase 9168* (holotype, BPI 177294; isotype, BPI 177295).

Sori of *S. braziliensis* develop in spikelets replacing flowers. The young spore mass is enclosed by peridia formed by host tissue and sterile fungal cells. One sorus has one thin columella. Teliospores are single, (7-)9-12(-13) x (9-)10-14(-15) µm, light to medium reddish brown, and ornamented with fine warts.

Sporisorium paspali-notati (Henn.) M. Piepenbr., **comb. nov.** Basionym: *Ustilago paspali-notati* Henn. *in* Herb. Holway (comp. Clinton, 1902: 140). Synonym: *Sphacelotheca paspali-notati* (Henn.) G. P. Clinton, J. Mycol. **8:** 140. 1902. Type. On *Paspalum notatum* Fluegge (Poaceae). Mexico. Jalisco: Guadalajara, 15 Sep 1899, *Holway s.n.* (holotype, BPI 165251; isotype, BPI 165250).

One sorus of *S. paspali-notati* replaces an entire inflorescence. Sori are elongated and have peridia formed by host tissue and few sterile fungal cells as well as two columellae. Teliospores are single, (6)7-9(-10) x (7-)8-10 µm, light yellowish to medium reddish brown, and finely warty.

Specimens of *Sporisorium paspali-notati* have been called *Sphacelotheca microspora* (J. Schröter & Henn.) Cif. or *Sporisorium microsporum* (J. Schröter & Henn.) M. Piepenbr. in the past. The type of the latter species (holotype, BPI 164452; isotypes, BPI 193313, HBG), however, is a species of *Ustilago* infecting *Stenotaphrum* sp. (Poaceae).

Sporisorium tristachyae (Vánky & C. Vánky) M. Piepenbr., **comb. nov.** Basionym: *Macalpinomyces tristachyae* Vánky & C. Vánky *in* Vánky, Mycotaxon **65:** 165. 1997. Type. On *Tristachya leucothrix* Trin. ex Nees (Poaceae). South Africa. KvaZulu-Natal: 20 km ENE Underberg, Swamp Nature Reserve, 2 km N Pevensey, 8 Jan 1997, *C. & K. Vánky s.n. in* Vánky, Ustil. Exs. 1010 (holotype, H.U.V. 18041 n.v.; isotypes, BPI 749430, M). Paratype. On *T. leucothrix*. South Africa. Mpumalanga: 10 km NE Graskop, 21 Jan 1997, *C. & K. Vánky s.n.* (paratype, BPI 749431).

Masses of teliospores of *S. tristachyae* develop in stems suppressing the development of inflorescences. Sori are elongated, tube-shaped, and enclosed by sheaths of leaves and peripheral host tissue of stems. Teliospores form irregular, easily separating groups and are mixed with sterile cells. Teliospores are mostly polyhedral, (5-)7-9 x (7-)9-10(-11) µm, light to medium greenish reddish brown, and finely warty.

Except for the location of the sori inside stems, there are no morphological differences with species of *Sporisorium*. Therefore, *Macalpinomyces tristachyae* is placed in this genus.

Discussion

From the comparison of the number of collections per day with the annual precipitation of the respective areas (table 1), the preference of smut fungi for moist places is evident. This was also observed by Piepenbring (1996) for smut fungi in Costa Rica. On the altiplano and close to Sucre, scarce infection by smut fungi may also be due to intense grazing which does not only affect the species composition of higher plants (Beck & García 1991) but also reduces the number of inflorescences – the most important part of the plants for the development of sori by smut fungi.

The altitude above sea level apparently does not affect the frequency of smut fungi but species composition. While *Ustilago hypodytes* and *Ustilago hordei* (Pers.) Lagerh., both also reported from latitudes with temperate climate, as well as *Ingoldiomyces hyalosporus* and *Kuntzeomyces ustilaginoidea* (Henn.) Sacc., which is a typical species of paramo-vegetation, are characteristic for high altitudes (> 3.000 m), species like

Cintractia axicola (Berk.) Cornu and *Ustanciosporium taubertianum* (Henn.) M. Piepenbr. & Begerow are typical for altitudes below 1.500 m.

Data in table 1, however, do not allow further statistical analysis, because they are based on few days of research, each with quite different working conditions, different numbers of hours available each day, and quite different humidity conditions within a given area.

Ustilago hypodytes is the only species of smut fungi repeatedly collected in Bolivia and evidently able to survive in dry climate. By systemic infection of entire tussocks of members of the genera *Stipa* and *Nassella*, it may survive as long as the host individuals. Apparently it is not easy for the smut to infect healthy host plants, because usually only few tussocks were found infected in a given area. Infection requires humidity for a certain period of time for the germination of the spores, the growth of yeast cells, and the growth of hyphae. In addition to this, the fungus probably needs young meristematic tissue or an injury to penetrate into the host. Long term survival of *U. hypodytes* is probably assured by systemic infection of the perennial host plants and liberation of numerous small spores over a long period of time.

While *U. hypodytes* infects many different genera of Poaceae worldwide, *Ingoldiomyces hyalosporus* only infects species of *Nassella*, *Piptochaetium*, and *Stipa*, showing a close systematic relationship of these genera which is also evident by morphological characteristics.

Four species of smut fungi were described as new based on material from Bolivia in the past (Hennings 1896, Massee 1899, Zundel 1930, Lindquist 1953), four were described recently (Piepenbring 2000). In no other country visited by the author in the neotropics a few weeks of work yielded as many new species and new host plants as in Bolivia. The Bolivian flora therefore seems to be very rich with respect to smut fungi and the list presented here is certainly very far from complete. This publication is meant to encourage future activities in this area, which will yield many interesting results.

Conclusions

The diversity of smut fungi in Bolivia is documented by a check list of 46 different species including 25 new records and nine new species of host plants for known species of smut fungi. One species, *Bauerago boliviana*, is new, *Sporisorium braziliensis*, *S. paspali-notati*, and *S. tristachyae* are new combinations. The diversity of smut fungi apparently does not depend on the altitudinal level as long as populations of potential host species are present. In the field, smut fungi are usually found in humid places, except for *Ustilago hypodytes*, which was repeatedly collected in arid areas. The diversity of smut fungi in Bolivia seems to be quite high, but generally difficult to assess because of low incidence of infection.

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Check list for smut fungi in Bolivia

Names of new records for Bolivia are underlined, those studied with material from Bolivia by the author are written in bold letters. New host species for known smut fungi are underlined. The word "ex ..." means that the infection was found on a specimen of the respective host plant integrated in a herbarium, "leg." means that material was collected by the author and her companions in the field if not otherwise indicated.

1. *Anthracoidea uleana* (H. & P. Sydow) Vánky on *Carex bonplandii* Kunth; ex LPB.
2. *Aurantiosporium pallidum* M. Piepenbr. on *Scleria bracteata* Cav.; leg. This is a new species described recently from Bolivia (Piepenbring 2000).
3. *Bauerago boliviana* M. Piepenbr. on *Commelina* sp.; BPI. This is a new species described in the present publication.
4. *Cintractia axicola* (Berk.) Cornu on *Fimbristylis dichotoma* (L.) Vahl; leg., ex LPB.
5. *Entyloma australe* Speg. on *Physalis peruviana* L.; ex LPB.
6. *Entyloma bidentis* Henn. on *Bidens pilosa* L.; leg.
7. *Entyloma zinniae* Sydow on *Zinnia peruviana* L.; leg. This species is hitherto only known from South Africa.
8. *Farysia chardoniana* Zundel on *Carex polystachya* Swartz ex Wahlenb.; leg.
9. *Ingoldiomyces hyalosporus* (Massee) Vánky, in Vánky & Bauer on *Nassella pubiflora* (Trin. & Rupr.) Desv.; type from Bolivia, described as *Tilletia hyalospora* Massee (1899). On *Nassella* sp.; ex LPB. On *Piptochaetium indutum* Parodi; ex LPB. On *Piptochaetium panicoides* (Lam.) Desv.; leg., ex LPB. On *Stipa* cf. *conspicua* J. Presl; B, ex LPB. On *Stipa leptostachya* Griseb.; ex LPB.
10. *Kuntzeomyces ustilaginoidea* (Henn.) Sacc. on *Rhynchospora macrochaeta* Steud.; leg.
11. *Leucocintractia scleriae* (DC.) M. Piepenbr. et al. on *Rhynchospora corymbosa* (L.) Britton; leg. M. Orellana, lit.: probably mentioned by Farr & Stevenson (1963) as *Cintractia leucoderma* (Berk.) Henn. on *Rhynchospora* sp.
12. *Melanopsichium pennsylvanicum* Hirschhorn on *Polygonum hispidum* H.B.K.; leg.
13. *Microbotryum tenuisporum* (Cif.) Vánky on *Poygonum* cf. *hydropiperoides* Michx.; ex LPB. On *Polygonum punctatum* Ell.; leg., ex LPB.
14. *Moreaua bulbostylidis* M. Piepenbr. on *Bulbostylis capillaris* (L.) C. B. Clarke; leg. This is a new species described recently from Bolivia (Piepenbring 2000).
15. *Mycosyrinx cissi* (DC.) G. Beck on *Cissus* sp.; BPI, lit.: Stevenson & Cárdenas (1949).
16. *Sphacelotheca* cf. *hydropiperis* (Schum.) de Bary on *Polygonum acuminatum* H.B.K.; BPI, lit.: Stevenson & Cárdenas (1949).
17. *Sporisorium andropogonis* (Opiz) Vánky on *Bothriochloa saccharoides* (Sw.) Rydb. or *B. barbinodis* (Lag.) Herter; BPI, leg., lit.: probably reported as *Sphacelotheca andropogonis-hirtifolii* (Henn.) Clinton on *Bothriochloa saccharoides* (=*Andropogon saccharoides* Sw.) by Stevenson & Cárdenas (1949).
18. *Sporisorium braziliensis* (Zundel) M. Piepenbr. on *Bothriochloa* sp. (?); LPB. This is a new combination proposed in the present publication. The specimen from Bolivia differs from typical *S. braziliensis* by a different host genus and smaller warts covering the teliospores. It is similar with respect to other characteristics which justify its classification in this species.
19. *Sporisorium cenchri* (Lagerh.) Vánky on *Cenchrus myosuroides* Kunth; BPI, lit.: probably reported as *Sorosporium syntherismae* (Pk.) Farlow by Stevenson & Cárdenas (1949).
20. *Sporisorium confusum* (H. S. Jacks.) Vánky on *Aristida mendozina* Phil.; ex USZ.
21. *Sporisorium cordobensis* (Speg.) Vánky on *Digitaria insularis* (L.) Fedde; leg.
22. *Sporisorium elionuri* (Henn. & Pole-Evans) Vánky on *Elionurus muticus* (Spreng.) Kuntze; leg., ex USZ.
23. *Sporisorium holwayi* (Clinton & Zundel) Vánky on *Andropogon bicornis* L.; type from Bolivia, described as *Sphacelotheca holwayi* Clinton & Zundel, in Zundel (Zundel 1930); leg.
24. *Sporisorium paspali-notati* (Henn.) M. Piepenbr. on *Paspalum notatum* Flügge; leg. This is a new combination proposed in the present publication.
25. *Sporisorium tristachyae* (Vánky & C. Vánky) M. Piepenbr. on *Loudetiopsis chrysothrix* (Nees) Conert; leg. This is a new combination proposed in the present publication. This species is hitherto only known from South Africa. The Bolivian specimen differs by somewhat larger spores from the material from South Africa but other characteristics are similar.
26. *Testicularia minor* (Juel) L. Ling on *Rhynchospora gigantea* Link; ex LPB.
27. *Thecaphora burkartii* Lindquist on *Delilea biflora* (DC.) Spreng.; type from Bolivia (Lindquist 1953).
28. *Thecaphora haumani* Speg. on *Iresine diffusa* Humb. & Bonpl. ex Willd.; leg.
29. *Thecaphora solani* (Barrus ex Thirum. & O'Brien) Vánky on *Solanum* sp.; lit.: Farr & Stevenson (1963).
30. *Tilletia boliviana* M. Piepenbr. on *Bromus catharticus* Vahl; ex LPB. This is a new species described recently from Bolivia (Piepenbring 2000).
31. *Tilletia* cf. *rugispora* Ell. & Ev. on *Paspalum lineispatha* Mez; ex LPB. The identification of this smut is preliminary.

32. *Urocystis agropyri* (Preuss) A. A. Fisch. Waldh. on *Agropyron attenuatum* Roem. & Schult.; BPI.
33. *Urocystis hieronymi* Schröter, in Henn. on *Solanum lilacinum* Rusby; type from Bolivia (Hennings 1896).
34. *Urocystis oxalidis* Pazschke on *Oxalis tuberosa* Molina; BPI.
35. *Urocystis reinhardii* M. Piepenbr., de la Quintana, & Garret, in Piepenbring on *Aciachne acicularis* Laegaard; leg. This is a new species described recently from Bolivia (Piepenbring 2000).
36. *Ustanciosporium taubertianum* (Henn.) M. Piepenbr. & Begerow on *Rhynchospora tenuis* Link; leg., ex LPB.
37. *Ustilago* cf. *elegans* Griffiths on *Chloris beyrichiana* Kunth; BPI.
In contrast with typical infection caused by *U. elegans*, the specimen from Bolivia has sori growing as pustules on leaves.
38. *Ustilago halophila* Speg. on *Distichlis spicata* (L.) Greene; BPI.
39. *Ustilago hordei* (Pers.) Lagerh. on *Hordeum vulgare* L.; leg., BPI, lit.: Stevenson & Cárdenas (1949). On *Hordeum muticum* J. & C. Presl; BPI, lit.: Stevenson & Cárdenas (1949).
40. *Ustilago hypodytes* (Schlecht.) Fries on *Nassella pubiflora* (Trin. et Rupr.) Desv.; leg. On ***Stipa curviseta*** Hitchc.; in B. On *Stipa ichu* (Ruiz & Pav.) Kunth; leg. (Figs. 1-2). On *Stipa mucronata* Kunth, in H.B.K.; leg., lit.: Stevenson & Cárdenas (1949). On *Stipa neesiana* Trin. & Rupr.; BPI, lit.: Fischer & Hirschhorn (1945).
41. *Ustilago maydis* (DC.) Corda on *Zea mays* L. cult.; leg., lit.: Farr & Stevenson (1963).
42. *Ustilago nuda* (Jensen) Rostrup on *Hordeum vulgare* L.; lit.: Farr & Stevenson (1963).
43. *Ustilago quitensis* Lagerheim on *Cortaderia jubata* (Lam.) Stapf; leg.
44. *Ustilago scitaminea* H. Sydow on *Saccharum officinarum* L.; lit.: Farr & Stevenson (1963). This is a species of *Sporisorium* (Piepenbring et al. 2002).
45. *Ustilago tritici* (Pers.) Rostrup on *Triticum aestivum* L.; BPI, lit.: Stevenson & Cárdenas (1949).
46. *Ustilago ulei* Henn. on *Chloris beyrichiana* Kunth (*C. radiata* Sw.); BPI, lit.: Stevenson & Cárdenas (1949).