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A REVISION OF RUST GENERA (UREDINALES) WITH REDUCED LIFE CYCLES

A Thesis

Submitted to the Faculty

of

Purdue University

by

Pablo Buriticá

In Partial Fulfillment of the

Requirements for the Degree

of

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TABLE OF CONTENTS

		Page
LIST OF FIGURES		iv
ABSTRACT		viii
I.	INTRODUCTION	1
II.	MATERIALS AND METHODS	2
III.	TAXONOMIC TREATMENT	4
IV.	TELIOSPORE DEVELOPMENT AND EVOLUTION	101
	1. Development	101
	2. Evolution	107
V.	CONCLUSIONS	111
LITERATURE CITED		112
VITA		114

LIST OF FIGURES

Figure		Page
1-4.	Teliospores and peridial cells of *Endophyllum* spp.	16
1.	*E. heliotropii*	16
2.	*E. decoloratum*	16
3.	*E. sempervivi*	16
4.	*E. euphorbiae-silvatica*	16
5-8.	Teliospores and peridial cells of *Endophyllum* spp.	25
5.	*E. lacus-regis*	25
6.	*E. macowani*	25
7.	*E. pavettae*	25
8.	*E. griffithiae*	25
9-12.	Teliospores and peridial cells of *Endophyllum* spp.	31
9.	*E. centranthi-rubri*	31
10.	*E. valerianae-tuberosae*	31
11.	*E. stachytarphetae*	31
12.	*E. circumscriptum*	31
13-15.	Teliospores and peridial cells of *Dietelia* spp.	39
13.	*D. portoricensis*	39
14.	*D. verruciformis*	39
15.	*D. holwayi*	39

LIST OF FIGURES (Continued)

Figure		Page
16-17.	Teliospores and peridial cells of *Dietelia* spp.	43
16.	*D. duguetia*	43
17.	*D. emasculatum*	43
18-19.	Teliospores and intercalary cells of *Ceratocoma* spp.	46
18.	*C. jacksoniae*	46
19.	*C. guineensis*	46
20-23.	Teliospores and pedicels of *Chardoniella* spp.	51
20.	*C. hasta*	51
21.	*C. gynoxidis*	51
22.	*C. capitata*	51
23.	*C. andina*	51
24-26.	Teliospores of *Cionothrix* spp.	55
24.	*C. praelonga*	55
25.	*C. usneoides*	55
26.	*C. basicrassa*	55
27-30.	Teliospores and peridial cells of *Pucciniosira* spp.	62
27.	*P. clemensiae*	62
28.	*P. gambleola*	62
29.	*P. cornuta*	62
30.	*P. massee*	62
31-35.	Teliospores and peridial cells of *Pucciniosira* spp.	68
31.	*P. anthocleistae*	68

LIST OF FIGURES (Continued)

Figure		Page
32.	P. tuberculata	68
33.	P. solani	68
34.	P. cumminsiana	68
35.	P. holwayi	68
36-42.	Teliospores and peridial cells of Pucciniosira spp.	
36.	P. biornamentata	75
37.	P. dorata	75
38.	P. pallidula	75
39.	P. brickellae	75
40.	P. deightonii	75
41.	P. dissotidis	75
42.	P. arthurii	75
43-47.	Teliospores of Didymopsora spp.	81
43.	D. paraguayensis	81
44.	D. chuquiraguae	81
45.	D. solani-argentei	81
46.	D. triumfettae	81
47.	D. africana	81
48-54.	Teliospores of Baeodromus spp.	88
48.	B. eupatorii	88
49.	B. dominicana	88
50.	B. tranzschelii	88
51.	B. senecionis	88
52.	B. holwayi	88

LIST OF FIGURES (Continued)

Figure		Page
53.	B. albertensis	88
54.	B. californicus	88
55-56.	Teliospores of Alveolaria spp.	92
55.	A. andina	92
56.	A. cordiae	92
57.	Teliospores and pedicel of Trichopsora tournefortiae	92
58-61.	Teliospores of Chrysocyclus spp.	97
58.	C. senecionis	97
59.	C. sydowiana	97
60.	C. cestri	97
61.	C. mikaniae	97
62-66.	Initial stages of teliospore development in five genera of microcyclic rusts	104
62.	Chardoniella	104
63.	Trichopsora	104
64.	Ceratocoma	104
65.	Pucciniosira	104
66.	Didymopsora	104
67.	Sequential stages of teliospore development in Chrysocyclus	106
68.	Evolutionary relationships of some microcyclic rust genera	110

ABSTRACT

Buriticá, Pablo. Ph.D., Purdue University, December, 1974. A Revision of Rust Genera (Uredinales) With Reduced Life Cycles. Major Professor: Joe F. Hennen.

The present work is a taxonomic revision of 19 genera of rusts with reduced life cycles and a study of their teliospore development. The following genera are reduced to synonymy: Kulkarniella = Endophyllum, Endophylloides = Dietelia, Jacksoniella = Dietelia, Gambleola = Pucciniosira, Chrysella = Chrysocyclus, Kernella = Puccinia. A new genus is described, Ceratocoma Buritica & Hennen. The following species are reduced to synonymy: Endophyllum cassiae Nagaraj et al = E. cassiae Stevens et al, Pucciniosira hyphoperidiata Viegas = P. holwayi Jackson, Alveolaria duguetiae Viegas = Dietelia duguetiae (Thurston) Buritica & Hennen, Cionothrix cupaniae Arthur = Skierka cristata (Speg.) Mains. The following new combinations are made: Endophyllum pavettae (Gokhale & Patel) Buritica & Hennen, Dietelia portoricensis (Whetzel & Olive) Buritica & Hennen, Dietelia aequatoriensis (Sydow) Buritica & Hennen, Dietelia holwayi (Jackson & Holway) Buritica & Hennen, Dietelia duguetiae (Thurston) Buritica & Hennen, Dietelia emasculatum (Arthur & Cummins) Buritica & Hennen, Ceratocoma jacksoniae (P. Hennings ex McAlpine) Buritica & Hennen, Ceratocoma

guineensis (Viennot-Bourgin) Buritica & Hennen, Chardoniella andina (Lagerheim) Buritica & Hennen, Crossopsora gilgiana (P. Hennings) Buritica & Hennen, Pucciniosira cornuta (Massee) Buritica & Hennen, Pucciniosira tuberculata (Ellis & Kellerman) Buritica & Hennen, Chrysocyclus sydowiana Buritica & Hennen, and Puccinia kernella Buritica & Hennen. The following species are described as new; Chardoniella hasta Buritica & Hennen, Chardoniella capitata Buritica & Hennen, Cionothrix basicrassa Buritica & Hennen, Pucciniosira gambleola Buritica & Hennen, Pucciniosira massee Buritica & Hennen, Pucciniosira biornamentata Buritica & Hennen, Pucciniosira dorata Buritica & Hennen, Pucciniosira arthurii Buritica & Hennen, Baeodromus albertensis Conners ex Buritica & Hennen.

Teliospore development in all genera were studied and eight types were established. An Aecidium-type of structure is theoretically ancestral and a phylogenetic tree is proposed.

I. INTRODUCTION

The order Uredinales has about one hundred genera. About 19 of these genera have reduced life cycles and only produce spermogonia and telia or only telia. They are distributed world wide but their greatest diversity is in the tropics. There is no definitive concept for some of these genera and the taxonomic position of some species remains obscure. There is no previous treatment of this group on a world wide basis.

This paper presents a taxonomic revision of these rusts, a study of their teliospore development, the relationship between genera, and a discussion of their possible origin and evolution.

II. MATERIALS AND METHODS

Specimens mainly from the Arthur Herbarium (PUR) were used for study. All specimens were examined microscopically by using free-hand sections and scrape mounts of the sori. Free-hand sections and spores were examined mostly mounted and heated either in chloral hydrate or lactophenol but cotton blue and lacto-fucsin stains were used occasionally. Chloral hydrate proved to be the best mounting medium because it provides the best clearing conditions for compact telia. A problem with this medium is that slides are not permanent and observations must be made within a few days after they are prepared.

The taxonomic treatment of each species is presented in the following order: 1. The recognized binomial, authority, bibliographic reference, and figure. All figures are from type material in the Arthur Herbarium except for a few, which are indicated in the text. All figures are at the same scale of magnification, ca X800, and were traced from Polaroid photomicrographs that are deposited in the Arthur Herbarium. 2. The synonyms are in chronological order, 3. The description, beginning with spermogonia (0) if present, followed by telia (III). 4. A designation of the nomenclatorial type specimen. When type

material was studied, it is indicated by recording the Arthur Herbarium accession number preceeded by PUR or PURF.

5. Hosts and distribution. The records presented in this section are not exhaustive but are the records found in the Arthur Herbarium. No attempt was made to verify host identifications and therefore authorities are not listed.

6. Observations. When appropriate special observations are recorded.

Terminology follows the ontogenic concepts most recently outlined by Hiratsuka (1973).

III. TAXONOMIC TREATMENT

A synoptic key of rust genera with reduced life cycles.

1. Teliospores pedicelate.
   2. Basidia external.
      3. Teliospores one celled ..... 5. Chardoniella.
      3. Teliospores two celled ..... 12. Chrysocyclus.
   2. Basidia internal.
      4. Teliospores one celled ..... 11. Trichopsora.
      4. Teliospores two celled ..... 13. Chrysopsora.
1. Teliospores not pedicelate.
   5. Telia with peridia, sometimes evanescent or breaking up by development of telia.
      6. Teliospores one celled.
         7. Telia Aecidium-like, powdery, teliospores mainly verrucose ..... 1. Endophyllum.
         7. Telia compact, teliospores usually smooth, or echinulate ..... 3. Dietelia.
      6. Teliospores two celled ..... 7. Pucciniosira.
   5. Telia without peridia, sometimes deep seated within pseudoparenchymatous enclosures.
      8. Teliospores one celled.
         9. Telia powdery, Caeoma-like ..... 2. Kunkelia.
         9. Telia compact.

10. Telia hair-like.

11. Telia with intercalary cells ..... 4. Ceratocoma.

11. Telia without intercalary cells.

12. Teliospores not organized into layers ..... 6. Cionothrix.

12. Teliospores organized into horizontal layers ..... 10. Alveolaria.

10. Telia in short columns ..... 9. Baeodromus.

8. Teliospores two celled ..... 8. Didymopsora.

1. ENDOPHYLLUM Leveille, Mem. Soc. Linn. Paris 4: 208. 1825.

Syn.: Kulkarniella Gokhale & Patel, Indian Phytopath. 4: 172. 1952.

Spermogonia subepidermal, subcuticular or wanting. Aecia and uredinia not produced. Telia subepidermal in origin, erumpent, with peridium, Aecidium-like; teliospores 1-celled, catenulate, with intercalary cells, only loosely or not adherent, usually finely verrucose, sometimes with refractive granules, metabasidium external with 4 or 2 basidiospores. Teliospore development Endophyllum-type.

Type species: Endophyllum sempervivi deBary. (E. persoonii Leveille)

Observation: Endophyllum is an example of a "convenience" genus of rusts. In theory, all Endophyllum

species are reduced life cycle variants of expanded parental forms that produce aecidiod-aecia. The telial function is transferred to the aecium and the uredinial and regular telial stages are omitted. Rusts that produce other morphological forms of aecia, such as caeomoid, peridermioid, etc., may also undergo this kind of change. So when basidiospores are produced from what are usually considered as aecial structures and no other kinds of spores are formed, the life cycle is called the endo-type.

Taxonomically, these rusts are problems because: first, they are obviously more closely related to their parental species than they are to each other (some uredinologists prefer to place the endo-forms within the parental taxon when known); second, they have the same morphological features as the aecia of the parental species except for their type of germination; and third, aecial stages of many rusts are noted for the great similarity of their morphological characteristics. Thus, when only an aecial stage is collected and placed in the herbarium, it may be impossible to determine positively its taxonomic position. The type of spore germination must be determined to identify endo-forms with certainty.

Because of these theoretical and practical problems, the treatment of Endophyllum presented here is not critical, but mainly a compilation from the literature with some study of important specimens in the Arthur Herbarium. It is

important to have a concept of this genus, however, because it forms the starting point for considering the relationships of the other genera considered here. Because of the close morphological similarity and other problems mentioned above it is not feasible at this time to separate most species of Endophyllum except by using host relationships.

Host index key to the species of Endophyllum.

Boraginaceae ..... 1. E. heliotropii.

Convolvulaceae ..... 2. E. kaernbachii.

Compositae

Clibadium ..... 3. E. decoloratum.

Emilia ..... 4. E. emiliae-sonchifoliae.

Spilanthes ..... 5. E. spilanthes.

Crassulaceae ..... 6. E. sempervivi.

Elaeagnaceae ..... 7. E. elaeagni-latifoliae.

Euphorbiaceae

1. Teliospores oblong (15-26x14-18μ).. 8. E. euphorbiae-characiatis.

1. Teliospores rounded.

2. Outer peridial cell wall 8-10μ thick, inner 3μ thick ..... 9. E. euphorbiae-nicaeensis.

2. Outer peridial cell wall 6-7μ thick, inner 1-2μ thick ..... 10. *E. euphorbiae-silvatica*.

Hydrangeaceae ..... 11. *E. dichroae*.

Lauraceae ..... 12. *E. machili*.

Leguminosae ..... 13. *E. cassiae*.

Malvaceae ..... 14. *E. blumeae*.

Onagraceae ..... 15. *E. alaskanum*.

Portulacaceae ..... 16. *E. lacus-regis*.

Rhamnaceae

Rhamnus prinoides

1. Teliospores 23-34x18-25μ ..... 17. *E. macowani*.

1. Teliospores 18-25x15-17μ ..... 18. *E. striato-sporum*.

Rubiaceae

Ixorae ..... 19. *E. ixorae*.

Paederia ..... 20. *E. paederiae*.

Pavetta ..... 21. *E. pavettae*.

Randia ..... 22. *E. griffithiae*.

Schizandraceae ..... 23. *E. maheshwarii*.

Solanaceae ..... 24. *E. pampeanum*.

Valerianaceae

Centranthus ..... 25. *E. centranthi-rubri*.

Valeriana ..... 26. *E. valerianae-tuberosae*.

Verbenaceae

Clerodendron ..... 27. E. superficiale.

Stachytarpheta ..... 28. E. stachytarphetae.

Vitaceae ..... 29. E. circumscriptum.

1. Endophyllum heliotropii Thirumalachar & Narasimhan, New Phytologist 49: 119. 1950. Fig. 1.

O. Spermogonia subepidermal.

III. Telia hypophyllous, developed on slightly hypertrophied spots in leaves and stems, golden-yellow cupulate, erumpent and pulverulent. Peridia firm, reflexed, cells angularly globoid to polygonal, densely rugose, wall 1.5-2μ thick, 12-25x13-17μ. Teliospores angularly globoid, 14-17x12-16μ, golden yellow, thin walled, minutely verrucose, refractive granules present, germ pores obscure.

Type: On Heliotropium indicum L., Mysore, India, Leg. B. A. Razi & H. C. Govindu, 28 Dec 1948. PURF 11917

Host and distribution: (Boraginaceae); Heliotropium indicum, India.

Observation: Thirumalachar et al (l c) described 5-8 germ pores. They are obscure but the presence of refractive granules is evident.

2. Endophyllum kaernbachii Stevens & Mendiola, The Phillipine Agriculturist 20: 7-8. 1931.

Syn.: Aecidium kaernbachii P. Hennings, Engler Bot. Jahr. 15: 5. 1892.

O. Spermogonia usually none, sometimes many, puntiform, honey-yellow, epiphyllous.

III. Telia strictly hypophyllous, usually few in the centers of spots, sometimes circularly arranged, at first covered then erumpent, reddish, cup shaped, nearly globose in section, 225-255μ across, 225μ deep. Peridium very slightly elevated, about 30μ above the leaf surface; peridial cells similar to spores but more angular and less colored. Teliospores catenulate, hyaline or slightly orange tinted, slightly roughened, ovoid or slightly angular, 17x11μ (Henning's description reads 10-23μ).

Type: On Merremia umbellata, College of Agriculture, Los Baños, Phillippine, 8 Sep 1930. F. L. Stevens 480.

Observation: Specimens not seen, description from the original.

3. Endophyllum decoloratum Whetzel & Olive, Amer. J. Bot. 4: 49. 1917. Fig. 2.

Syn.: Aecidium pumilio Kunze apud Weigelt, Exsicc. sine. no. 1827.

Aecidium deoloratum Schweinitz apud Berkeley & Curtis, J. Phila. Acad. Nat. Sci. II. 2: 283. 1853.

Aecidium wedeliae Earle, Muhlenbergia 1: 16. 1901.

Aecidium clibadii Sydow, Ann. Myc. 1: 333. 1903.

Endophyllum wedeliae (Earle) Whetzel & Olive, Amer. J. Bot. 4: 49. 1917.

Endophyllum pumilio (Kunze ex Weigelt) H. & P. Sydow, Ann. Myc. 28: 179. 1920.

O. Spermogonia unknown.

III. Telia hypophyllous in rounded or sometimes irregular spots 2-7mm in diam. Peridia evanescent, sometimes short cylindrical, cells rhombic, with incised margin, 15-22x25-32μ, wall hyaline, outer smooth or finely striate, 4-7μ thick, inner finely reticulate-verrucose 3-4μ thick. Teliospores ellipsoid globoid or more or less angular from pressure, 11-15x15-20μ, wall hyaline, 1μ or less thick, finely verrucose.

Type: On Clibadium surinamense var asperum (Aubl.) Surinam.

Host and distribution: (Compositae) Clibadium asperum, Panama; C. arboreum, Mexico; C. donnell-smithii, Guatemala; C. erosum, Puerto Rico; C. grandiflorum, Costa Rica; C. polygonum, Nicaragua; C. surinamense, Colombia, Panama, Surinam, Trinidad; Clibadium sp., Colombia, Costa Rica; Wedelia trilobata, Dominican Republic, Grenada, Honduras, Jamaica, Panama, Puerto Rico, Trinidad; W. carnosa, Puerto Rico.

Observation: For this rust, the binomial E. decoloratum Whetzel & Olive is treated as a name attributed to Whetzel & Olive alone, not as a new combination of Aecidium decoloratum Schw. as Whetzel & Olive originally published it. Whetzel and Olive were the first to determine by germination that the spores were teliospores.

4. Endophyllum emiliae-sonchifoliae Nagaraj, Govindu & Thirumalachar, Sydowia 25: 159. 1971.

O. Spermogonia unknown.

III. Telia amphigenous, subepidermal, cupulate, 170-250x170-310μ. Peridial cells strongly developed, angular to polygonal, rugose on the outer side, 17-23x11-17μ, thick walled. Teliospores globose to polygonal, 15-21x14-19μ, orange-yellow when fresh, verrucose, germ pores indistinct, germinating with a two celled epibasidium bearing globular basidiospores 8-12x5.5-8μ.

Type: On Emilia sonchifolia DC., Coffee Research Station, Balehonnur, Mysore, India, 10 Dec 1960. Leg. T. R. Nagaraj.

Observation: Specimen not seen, description from the original.

5. Endophyllum spilanthes Thirumalachar & Govindu, Bot. Gaz. 115: 390. 1954.

O. Spermogonia subepidermal, abortive.

III. Telia amphigenous, golden-yellow, cupulate, erumpent, pulverulent, 65-100x100-165μ. Peridial cells angularly globoid to polygonal, 5.5-10x10-14μ, wall 1.5μ thick, rugose. Teliospores globoid to spherical, 7-10x 10-14μ, wall thin, smooth.

Type: On Spilanthes acmella, Hebbal, Bangalore, India, 10 Nov 1952. Leg. H. C. Govindu.

Observation: Specimen not seen, description from the original.

6. Endophyllum sempervivi deBary, Ann. Sc. Nat. 4 serie. 20:86. 1863. Fig. 3.

Syn.: Uredo sempervivi Alb. & Schw. Consp. Fung. p. 126. 1805.

Uredo sedi DC. Flor. Franc. 2: 227. 1815.

Endophyllum persooni Lev. Mem. Soc. Linn. Paris 4: 208. 1825.

Caeoma sempervivi Lk. Spec. Plant. 2: 27. 1825.

Erysibe insculpta Wallr. var sempervivorum Wallr. Fl. Crypt. Germ. 2: 202. 1833.

Endophyllum sedi (DC) Wint. Pilze 1: 252. 1884.

Puccinia sempervivi (Alb. & Schw.) Jorstad. Skr. N. Vidensk. Akad. Oslo 1(9): 151. 1933.

O. Spermogonia amphigenous, mainly epiphyllous, mixed with the telia, flask-shaped, dark, 110-180μ diam.

III. Telia amphigenous, with irregular distribution, immersed, 300-750μ diam, pulverulent, brown. Peridium well developed, dehiscent, white; peridial cells weakly adherent, subglobose to ellipsoid, 25-38x23-34μ, wall 6-8μ thick, verrucose reticulate, colorless. Teliospores globose, subglobose or irregularly angular, 20-32x18-26μ, verrucose, light-brown, wall 2-4μ thick.

Type: Not designated.

Host and distribution: Sempervivum punctatum, S. tectorum, Sempervivum sp., U. S. A.; S. montanum, Europe.

Observation: Known all over Europe and probably introduced to the U.S., Illustration on Sempervivum montanum, Leg. M. Raciborsky, Sydow Uredineen 545. PURF 8643.

7. Endophyllum elaeagni-latifoliae Gokhale, Thirumalachar, & Patel, Curr. Sci. 24: 125-126. 1955.

Syn.: Aecidium elaeagni-latifoliae Petch, Ann. Roy. Bot. Gard. Peradeniya 4: 302. 1909.

O. Spermogonia subepidermal, honey-yellow, flask-shaped, ostiolate, poorly developed periphyses.

III. Telia subepidermal, erumpent, white. Peridia strongly developed, reflexed; cells densely rugose, 25-32x 19-20μ. Teliospores subglobose to polygonal, 15-24x12-19μ; wall densely verrucose.

Type: Not designated.

Observation: Specimen not seen, description adapted from Gokhale et al (l c).

8. Endophyllum euphorbiae-characiatis Liou, Bull. Soc. Myc. France 45: 106. 1929.

O. Spermogonia epiphyllous or hypophyllous.

III. Telia globular, 300-800μ diam, orange. Peridia fragile. Teliospores oblong-angular, rarely ovoid-globose, 15-26x14-18μ, finally striate; wall 1μ thick.

Type: On Euphorbia characias, France Meridionale.

Observation: Specimen not seen, description adapted from the original.

9. Endophyllum euphorbiae-nicaeensis Liou, Bull. Soc. Myc. France 45: 112. 1929.

O. Spermogonia unknown.

III. Telia globular, hypophyllous, 300-350μ across, orange. Peridia strong and persistent. Teliospores angular, oblong or globose, 15-25x12-20μ, finely striate; wall 1μ thick.

Type: On Euphorbia nicaeensis, France.

Observation: Specimen not seen, description from the original. Dupias (1946) gave the dimensions for the walls of the peridium cells and new measurements to the teliospores as outer wall of peridium cells 8-10μ, inner wall 3μ, teliospores 19-23.5x17-20μ.

10. Endophyllum euphorbiae-silvaticae Winter, Pilze Deutschl. p. 251. 1881. Fig. 4.

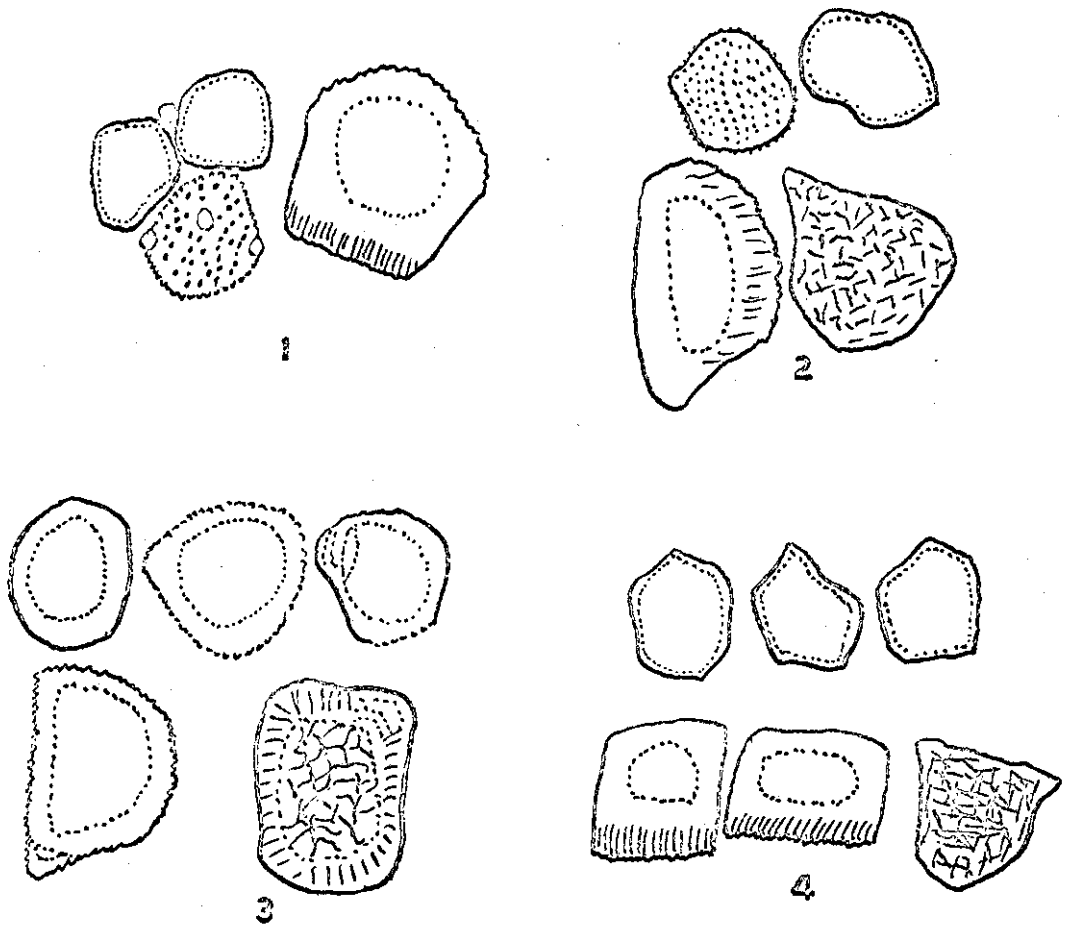
Syn.: Aecidium euphorbiae-silvaticae DC, Fl. Franc. 2: 241. 1805.

Endophyllum euphorbiae Plowright, Monogr. Ured. Brit. p. 228. 1889.

Endophyllum uninucleatum M.F. Moreau, Bull. Soc. Myc. France. 27: 489. 1913.

O. Spermogonia amphigenous, mainly epiphyllous, well developed, subepidermal, 120-200μ, yellow-brown.

III. Telia hypophyllous, rarely epiphyllous, distributed over the complete leaf surface, 200-500μ diam. Peridia well developed, initially cupulate, afterwards reflexed;



Figs. 1-4. Teliospores and peridial cells of Endophyllum spp. Fig. 1. E. heliotropii. Fig. 2. E. decoloratum. Fig. 3. E. sempervivi. Fig. 4. E. euphorbiae-silvatica.

peridium cells rhomboid, 23-35x18-25μ, verrucose, outer wall 4-7μ thick, inner wall 1.5-2.5μ thick. Teliospores obtuse angular-globoid, 16-25x13-18μ, minutely verrucose, colorless; wall less than 1μ thick.

Type: Not designated.

Host and distribution: Euphorbia amygdaloides, E. silvatica, Europe.

Observation: Illustration on Euphorbia amygdaloides, Neuchatel, Switzerland, Leg. E. Mayor. Sydow Exsiccati 2497.

11. Endophyllum dichroae Raciborski, Bull. Acad. Sci. Cracovie p. 274. 1909.

O. Spermogonia unknown.

III. Telia hypophyllous, in round spots 3-4mm across, yellow and hypertrophied, located usually in the margin, cylindric, deep-seated, 400x160μ, surrounded by the peridium. Teliospores ovate-angular, 28-38x18-20μ, light golden; wall thin.

Type: On Dichroae cyanitis, Pangerango, Java.

Observation: Specimen not seen, description from Sydow (1915).

12. Endophyllum machili Stevens, Nat. and App. Sc. Bull. Univ. of the Phillippines 2: 442. 1932.

Syn.: Aecidium machili P. Henn. Hedwigia 41: 21. 1902. Aecidium nakanishikii P. Henn. Engl. Bot. Jahrb. 37: 159. 1905.

O. Spermogonia epiphyllous, few, bright-black, 120-180μ across.

III. Telia hypophyllous, in round or irregular spots, irregular in size, up to 1cm across, yellow-dark, few to many, deep-seated, cupulate, 200μ diam, epidermis elevated above the surface. Peridium cells rounded, not compressed, 24-35x22-30μ, outer wall minutely striate, 3-4μ thick, inner wall minutely verrucose, 3μ thick. Teliospores globose, angular-globose to ellipsoidal, 20-28x18-24μ, wall 1.5-2μ thick.

Type: On Machilus phillippinensis, Mount Santo Tomas, Benguet, Phillippines, 31 Dec 1930. Leg. F.L. Stevens 1309.

Observation: Description adapted from Sydow (1915).

13. Endophyllum cassiae Stevens & Mendiola, The Phillippine Agric. 20: 16.11931.

Syn.: Aecidium cassiae Bres. Rev. Myc. 13: 66. 1891.

Aecidium torae P. Henn. Engler Bot. Jahrb. 34: 42. 1904.

Endophyllum cassiae Nagaraj, Govindu & Thirumalachar, Sydowia 25: 158. 1971.

O. Spermogonia unknown.

III. Telia almost strictly hypophyllous, rarely a few epiphyllous, roughly circularly arranged, 150-225μ diam, cup-shaped, shallow, 150μ high. Peridium extending somewhat above the leaf surface, 75-150μ; cells irregularly angular, 28x21μ, hyaline, rough. Teliospores yellow, globose to oblong, 18μ diam or 18-21μ, thin walled, minutely verrucose.

Type: On Cassia tora, College of Agriculture, Los Banos Laguna, Phillippines, 8 Dec 1930, Leg. F. L. Stevens 1100.

Observation: Specimen not seen, description from the original. E. cassiae Nagaraj et al was not seen also, but from the description it seems the same as E. cassiae Stevens & Mendiola.

14. Endophyllum blumeae Stevens & Mendiola. The Phillippine Agriculture, 20: 5. 1931.

Syn.: Aecidium blumeae P. Henn. Hedwigia 47: 252. 1908.

O. Spermogonia punctiform, honey-yellow, few to many.

III. Telia strictly hypophyllous in clusters, sparse or gregarious, pale, cup-shaped. Peridium fimbriate, elevated above the surface; cells hyaline, irregular, 14-21μ, minutely rough. Teliospores subglobose to angular, 14μ diam or 14-17μ, minutely rough, subhyaline to slightly orange.

Type: On Blumea balsamifera, College of Agriculture, Los Banos, Laguna, Phillippines, 5 Sep 1930, Leg. F. L. Stevens 475.

Observation: Specimen not seen, description from the original.

15. Endophyllum alaskanum Savile, Can. J. Bot. 40: 1393. 1962.

O. Spermogonia amphigenous, flask-shaped, from systemic mycelium.

III. Telia mainly hypophyllous, peridia cupulate; peridium cells 21-31.5x14-25μ, outer wall 6μ thick, slightly striate, inner wall 0.8μ thick, verrucose, 2.5μ tall and 1.0μ wide. Teliospores 14-20x11-18μ, wall hyaline, 1-1.3μ thick (including warts), warts 0.2-0.5μ tall, 0.3-0.7μ wide, 0.8-1.4μ from center to center; 5-7 germ pores, obscure but with cuticular cap evident.

Type: On Epilobium anagallidifolium Lam., Head of Palmer Creek Valley, Kenai Pen., Alaska, Calder 6282A. DAOM 55713.

Observation: Description from the original.

16. Endophyllum lacus-regis Savile & Parmelee, Mycologia 48: 577. 1956. Fig. 5.

O. Spermogonia epiphyllous, subepidermal, flask-shaped but not completely round, 100-130μ wide.

III. Telia epiphyllous, subepidermal, deep-seated, pulverulent, not cupulate, white. Peridium not persistent; cells weakly joined, globoid to compressed angularly-ellipsoid, 14-20x12-30μ, verrucose-reticulate; wall 3.5-4μ, colorless. Teliospores globoid to slightly angular, 16-26x18-30μ, colorless; wall 0.5-1.5μ thick, minutely verrucose.

Type: On Claytonia caroliniana Michx., Gatineau Co., Quebec, Canada, DAOM 46405. PUR 64913.

Host and distribution: C. caroliniana, Canada.

17. Endophyllum macowani Pole-Evans, Rept. S. Afr. Ass. for Adv. Sc. p. 252. 1909. Fig. 6.

Syn.: Aecidium elegans Diet. Hedwigia 28: 180. 1889.

O. Spermogonia epiphyllous, subepidermal, flask-shaped, 110-150μ across, black.

III. Telia hypophyllous, solitary or in small groups, up to 2mm diam, narrow cilindrical, about 1mm long, rather deeply immersed and 150-200μ diam. Peridia firm, slightly recurved, white; cells firmly joined together, 28-48x18-24μ, rhomboid or polygonal, strongly angular, outer wall 4-8μ thick, inner wall 3-6μ thick. Teliospores irregularly polyhedral, 23-34x18-25μ, wall hyaline, 2-4μ thick and 8-12μ thicker at the apex.

Type: Not designated.

Host and distribution: Rhamnus prinoides, Sudan, Rhodesia, South Africa.

Observation: Illustration from Rhamnus prinoides, Gilo, Sudan, C. M. I. 59739, PURF 15958. The original description gives 40-60x24-35 to the peridium cells.

18. Endophyllum striatosporum Wakefield, Proc. Linnean Soc. London. 161: 188. 1949.

O. Spermogonia unknown.

III. Telia in groups on leaves, stems and fruits, in swollen areas, sori on leaves amphigenous but mainly hypophyllous, in crowded groups 7mm diam, deep-seated, cylindric, narrowed. Peridia white, 0.5mm in length, margin lobes curved; peridial cells firmly united, elongate-rhomboid to polygonal, 25-35x20-22μ, outer wall verrucose 3-4μ thick, inner wall striate-verrucose, 2.5-3μ thick. Teliospores angular subglobose to rhomboid, 18-25x 15-17.5μ; wall hyaline, 2.5-3μ thick, slightly thicker apically, longitudinally striate.

Type: On Rhamnus prinoides L'Herit. Sabei, Elgon, Uganda, Dec. 1933, Handsford 1680.

Observation: Specimen not seen. Germination of the spores has been not observed. This species is differentiated from E. macowani by the size and striation of the teliospores. Its placement in Endophyllum will remain questionable until spore germination is determined.

19. Endophyllum ixorae Gaumman, Bull. Jard. Bot. Buitenzorg 5: 7. 1922.

O. Spermogonia unknown.

III. Telia hypophyllous, in round or irregular, hypertrophied spots 3cm across, rounded, 200-300μ diam, Peridium cells verrucose. Teliospores angular ellipsoid to globoid, 17-21x12-15μ, densely minutely verrucose.

Type: On Ixora javanica DC. Java.

Observation: Description adapted from original.

20. Endophyllum paederiae Stevens & Mendiola. The Philippine Agric. 20:11. 1931.

Syn.: Aecidium paederia Diet. Hedwigia 36: 297. 1897.

O. Spermogonia few, epiphyllous, dark.

III. Telia mainly hypophyllous, occasionally epiphyllous, especially on the veins, frequently few or even solitary on a spot, or when on large spots very numerous, yellow or reddish, cupulate, about 180µ across and 300µ deep. Peridia elevated above the leaf surface, 50-120µ, fimbriate; cells angular, rough, hyaline. Teliospores ovoid, irregular or subglobose, 16-21x 12-17µ; wall slightly rough, thicker at the apex 4-5µ.

Type: On Paederia tomentosa, College of Agriculture, Los Banos, Laguna, Philippines, 11 Sep 1930. F. L. Stevens 516.

Observation: Specimen not seen.

21. Endophyllum pavettae (Gokhale & Patel) Buritica & Hennen, comb. nov. Fig. 7.

Syn.: Aecidium pavettae Barklay, J. Asiatic Soc. Bengal 56: 350-376. 1887.

Kulkarniella pavettae Gokhale & Patel, Indian Phytopath. 4: 172. 1951.

O. Spermogonia amphigenous, mainly epiphyllous, black, subcuticular, 150-190µ wide.

III. Telia amphigenous, mainly hypophyllous, sub-epidermal, cupulate, pulverulent. Peridium well developed,

white; cells rhomboid, angular, 18-22x22-28μ, colorless; wall 3-4μ thick, verrucose-reticulate. Teliospores globoid or more or less angular, 20-25x17-21μ, yellow; wall less than 1μ thick, minutely verrucose.

Type: On Pavetta tomentosa Roxb., Mahableshwar, Bombay, India, Indian Uredinales 64. PURF 15881.

Host and distribution: P. tomentosa, India.

Observation: The genus Kulkarniella is considered synonymous with Endophyllum by Cummins (1959) but no formal transfer has been made before.

22. Endophyllum griffithiae Raciborski, Paras. Algen u Pilze, Java 1: 20. 1900. Fig. 8.

Syn.: Aecidium griffithiae P. Henn. Monsunia 1: 4. 1899.

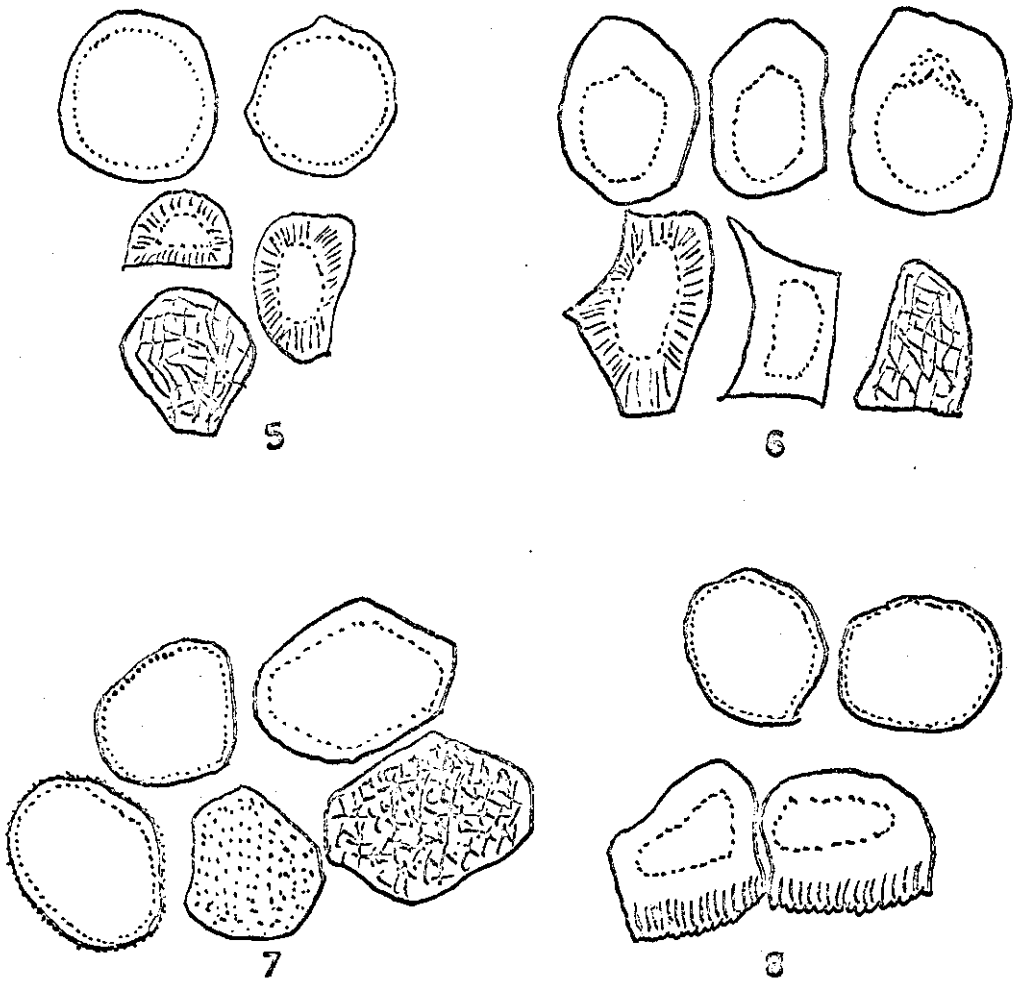
O. Spermogonia unknown.

III. Telia hypophyllous, in rounds or irregular spots, 0.5-1.5cm diam. 125-300μ diam. Peridia well developed, cupulate, opening by a pore; cells polygonal, verrucose, 20-32x14-19μ, outer wall 3-4.5μ thick, inner wall 2-3μ thick. Teliospores globose to ellipsoid, somewhat angular, 18-21x14-18μ, minutely verrucose, yellow-brown; wall 1μ thick.

Type: Not designated.

Host and distribution: Randia sinensis, China.

Observation: Illustration from Randia sinensis, Canton, China, C. W. Howard, Nov 1920. PURF 15790.



Figs. 5-8. Teliospores and peridial cells of Endophyllum spp. Fig. 5. E. lacus-regis. Fig. 6. E. macowani. Fig. 7. E. navettae. Fig. 8. E. griffithiae.

23. Endophyllum maheshwarii Singh & Jalan, Indian Phytopath. 18: 32. 1964.

O. Spermogonia subepidermal, flask-shaped.

III. Telia arising in groups around a center of discolored area of the fruits, 680µ long and 133µ across; basal cells 40µ long. Peridium persistent and single layered; cells adhere to each other. Teliospores angular and isodiametric 20µ across, cell wall thin and verrucose; prominent pore thickenings.

Type: On Schizandra grandiflora Hook & Thom. Rambara Charwall, India, Leg. M. A. Rau, Sep 1958.

Observation: Specimen not seen, description from the original.

24. Endophyllum pampeanum Lindquist, Bol. Soc. Argentina Bot. 10: 114. 1963.

Syn.: Aecidium pampeanum Speg., Anal. Soc. Cient. Argentina 9: 292. 1880.

O. Spermogonia epiphyllous and in stems, globose, reddish, from systemic mycelium.

III. Telia hypophyllous in stems, cylindric, erumpent, 500-600µ across. Peridium with the borders lacerate and curved; cells polygonal; outer wall smooth, inner wall striate. Teliospores globose, ellipsoid, ovoid or polygonal by pressure, 14-16x17-24µ; wall hyaline, 1.5-2µ thick, verrucose, with minute and crowded warts.

Type: On Salpichroa origanifolia Thell., Capital Federal, Chacarita, Argentina, 2 May 1880. L. P. S. 1988.

Observation: This rust presents an interesting situation because Lindquist (l c) reports that pucciniod teliospores are also produced. It can then be classified as Puccinia pampeana Speg. This is an example of a rust with two "perfect stages".

25. Endophyllum centhranti-rubri Poirault, Bull. Soc. Myc. France 18: 42. 1902. Fig. 9.

Syn.: Aecidium centhranti Thuem, Verzeichnis des Schles. Bot. Tauschvereins 1874.

O. Spermogonia mixed with telia, scattered, minutely, yellowish.

III. Telia hypophyllous, scattered around the leaf, 250-500μ diam, yellowish. Peridia evanescent, aggregate, hemispheric to cupulate; cells angular rhomboid, 18-27x 25-41μ, minutely verrucose; outer wall 5-8μ thick, inner wall 3-5μ thick. Teliospores subglobose or angular, 13-18x15-23μ; wall 1.5-2μ thick, minutely verrucose.

Type: Not designated.

Host and distribution: Centhranthus ruber, C. calcitripae, C. angustifolius, South Europe.

Observation: Illustration from Aecidium centhranthi Thuem, Otto Jaap Exsiccati 631, on Centhranthus ruber, Italy.

26. Endophyllum valerianae-tuberosae R. Maire, Bull. Soc. Myc. France 16: 67. 1900. Fig. 10.

O. Spermogonia amphigenous, mainly epiphyllous, 100-160μ wide.

III. Telia amphigenous, mainly hypophyllous, scattered on the leaves, round, 250-600μ, deep-seated. Peridia well developed, cupuliform initially, not persistent; cells polyhedrical, angularly ellipsoid, 26-36x16-25μ, verrucose, hyaline; inner wall 2-3μ thick, outer wall 4-6μ thick. Teliospores globoid, angular, 16-22x10-14μ; wall 1-2μ thick, hyaline, minutely verrucose.

Type: Not designated.

Host and distribution: Valeriana tuberosa, Gold Coast.

Observation: Illustration from Valeriana tuberosa, Gold Coast, Gevrey-Chambertain. Leg. R. Maire. 4 Apr 1898. PURF 8660.

27. Endophyllum superficiale Stevens & Mendiola, The Philippine Agric. 20: 13. 1931.

Syn.: Aecidium superficiale Karst & Roum. Rev. Myc. 12: 78. 1890.

Aecidium clerodendri P. Henn. Engler Bot. Jahrb. 15: 6. 1892.

O. Spermogonia epiphyllous, punctiform, sparse, often arranged in circles.

III. Telia red, almost strictly hypophyllous. Peridium cupulate, arising above the surface, 75μ tall; cells angular

by compression, size same as spores. Teliospores polygonal to sphaeroid or ovoid, 16-25μ diam, smooth, slightly orange tinted.

Type: On Clerodendron intermedium, College of Agriculture, Los Banos, Laguna, Philippines, 3 Sep 1930. F. L. Stevens 448.

Observation: Specimen not seen, description from the original.

28. Endophyllum stachytarphetae Whetzel & Olive, Amer. J. Bot. 4: 50. 1917. Fig. 11.

Syn.: Aecidium stachytarphetae P. Henn. Hedwigia (Beibl.) 38: 71. 1899.

O. Spermogonia unknown.

III. Telia hypophyllous, in rounded or somewhat irregular inconspicuous pulvinate areas. Peridia evanescent, aggregated, hemispheric to cupulate; cells polyhedrical, 15-20x20-26μ, colorless, wall 3-6μ thick, reticulate-echinulate. Teliospores globoid or more or less angular, 12-17x15-20μ, wall 1μ or less thick, colorless, minutely echinulate.

Type: Not designated.

Host and distribution: Stachytarpheta cayennensis, Bolivia, Panama, Puerto Rico, Santo Domingo, Trinidad; S. dichotoma, Brazil.

Observation: Illustration from Stachytarpheta dichotoma Vahl., Sao Paulo, Brazil, Reliquiae Holwayanae 411. PURF 8656.

Several collections show telia of Puccinia urbaniana associated with the telia of E. stachytarphetae.

29. Endophyllum circumscriptum Whetzel & Olive var circumscriptum Amer. J. Bot. 4: 49. 1917. Fig. 12.

Syn.: Aecidium guttatum Kunze, Weigelt Exsicc. sine no. 1827.

Aecidium circumscriptum Schw. ex Berk. & Curtis, J. Phil. Acad. Nat. Sci. 2: 283. 1853.

Aecidium cissi Wint. Hedwigia 23: 168. 1884.

Endophyllum guttatum Sydow, Ann. Myc. 17: 179. 1920.

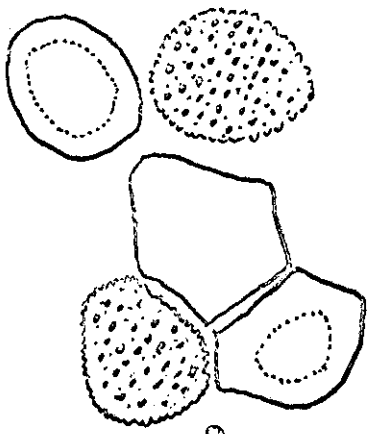
O. Spermogonia epiphyllous, in groups of 2-5, subepidermal, flask-shaped, 80-85μ wide.

III. Telia amphigenous but mainly hypophyllous, numerous, borne in rounded, somewhat hypertrophied, pulvinate areas, cupulate. Peridia recurved, yellowish, somewhat dehiscent; cells angular, 18-28x15-20μ, wall 2.5-4μ thick, minutely verrucose. Teliospores more or less rounded angular or irregular from pressure, 15-21x12-16μ, wall 1-2μ thick, minutely verrucose.

Type: Not designated.

Host and distribution: Cissus sicyoides, Costa Rica, Cuba, Ecuador, Guatemala, Honduras, Mexico, Nicaragua, Jamaica, Panama, Puerto Rico, El Salvador, Santo Domingo, Surinam, Trinidad, Dominican Republic.

Observation: Illustration from Cissus sicyoides L. Surinam (type of Aecidium circumscriptum) PURF 8655.



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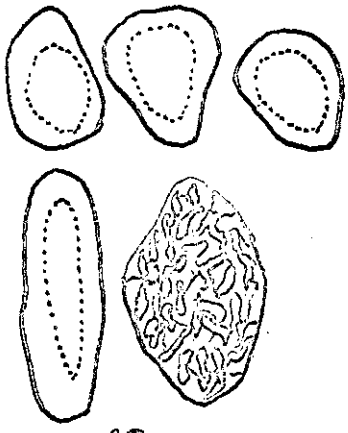

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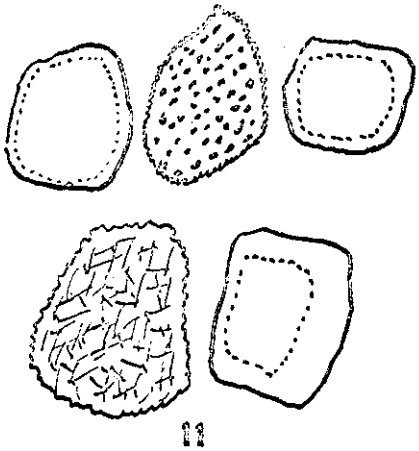

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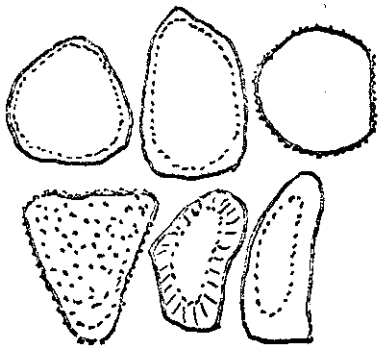


12

Figs. 9-12. Teliospores and peridial cells of Endophyllum spp. Fig. 9. E. centranthi-rubri. Fig. 10. E. valerianae-tuberosae. Fig. 11. E. stachytarphetae. Fig. 12. E. circumscriptum.

29A. Endophyllum circumscriptum var catamarcensis Lindquist, Rev. Fac. Agron. La Plata 43: 68. 1967.

III. Teliospores larger than in var circumscriptum, 21-24x21-27μ.

Type: On Cissus sicyoides L. Andagala, Catamarca, Argentina, 25 Dec 1951. Leg. Sleumer, L. P. S. 22001.

Host and distribution: Cissus sicyoides, Argentina.

2. KUNKELIA. Arthur, Bot. Gaz. 63: 504. 1917.

Spermogonia subcuticular or wanting. Aecia and uredinia not formed. Telia subepidermal in origin, erumpent, caeomoid, without peridia; teliospores catenulate with intercalary cells, 1-celled, usually finely verrucose. Epibasidia external with 4 or 2 basidiospores. Teliospore development Endophyllum-type.

Type species: Kunkelia nitens (Schw.) Arthur.

Observation: See under Endophyllum for discussion of endo-genera as "convenience" concepts.

1. Kunkelia nitens Arthur, Bot. Gaz. 63: 504. 1917.

Syn.: Aecidium nitens Schw., Schr. Nat. Ges. Leipzig 1: 69. 1822.

Caeoma luminatum Link, Willd. Sp. Pl. 6: 61. 1825.

Gymnoconia nitens Kern & Thurston, Bull. Penn. State Coll. 239: 16. 1929.

O. Spermogonia amphigenous, mainly epiphyllous, abundant or absent, scattered, prominent, 85-105μ wide.

III. Telia deep-seated, reddish-yellow or golden-yellow, hypophyllous, usually crowded over part or all of the under surface of the leaflets, often confluent, somewhat pulverulent. Teliospores globoid or ellipsoid or slightly angular, 18-34x16-28μ; wall colorless, 0.5-1.5μ thick, finely verrucose.

Type: On Rubus enslenii Walt. Salem, North Carolina U. S. A.; D. L. Schweinitz 2887. Isotype PUR 9230.

Host and distribution: Rubus argutus, R. canadiensis, R. cuneifolius, R. enslenii, R. frondosus, R. hispidus, R. nigrobaccus, R. parviflorus, R. procumbens, R. pubescens, R. tribialis, R. ursinus, R. vitifolius, United States.

Excluded species of Kunkelia;

Phragmidium rosae-californicae Diet. Hedwigia 44: 125. 1905.

Syn.: Caeoma rosae-gymnocarpae Diet. Hedwigia 44: 334. 1905.

Gymnoconia rosae-gymnocarpae Arth. N. Amer. Fl. 7: 181. 1912.

Kunkelia rosae-gymnocarpae (Diet.) Arth. Bot. Gaz. 63: 8. 1917.

In 1917 Arthur (l c) transferred this species from Caeoma to Kunkelia because of its great resemblance to K. nitens. The spores have been germinated but never have produced basidia. This species is now considered to be Phragmidium.

3. DIETELIA P. Hennings, Hedwigia 36: 215. 1897.

Syn.: Endophylloides Whetzel & Olive apud Olive & Whetzel, Amer. J. Bot. 4: 50. 1917.

Jacksonia Lindquist, Rev. Fac. Agron. La Plata 46: 202. 1970. Non R. Brown Act. Hort. Bol. Kew 2: 12. 1811.

Jacksoniella Lindquist, Rev. Fac. Agron. La Plata 47: 304. 1971. Non Kamat & Sathe, Indian Phytopath. 25: 78. 1972.

Spermogonia subepidermal, flask-shaped or wanting. Aecidia and uredinia not formed. Telia subepidermal in origin, erumpent, Aecidium-like but compact, cupulate or in columns. Peridia persistent and somewhat attached to the teliospores. Teliospores catenulate, one-celled, with intercalary cells evident at least in the base of the telia. Epibasidia external. Teliospore development Endophyllum-type.

Type species: Dietelia verruciformis (P. Henn.) P. Hennings.

Observation: This genus is most clearly defined by the following set of characteristics.

1. Telia cupulate or somewhat columnar with evident peridium.

2. Teliospores catenulate and somewhat united, with intercalary cells evident at least in the base of the telium.

3. Teliospores more "teliod" than Endophyllum as shown

by the smooth or minutely verrucose, pigmented and thicker wall.

These characteristics also show that Dietelia is intermediate between Endophyllum and other more highly evolved rusts with reduced life cycle. Cummins (1959) stated that Endophylloides and Dietelia were perhaps synonymous. The absence of intercalary cells in Dietelia was used to separate it from Endophylloides but careful search of young telia of Dietelia show their presence. Therefore, the separation of these two genera can no longer be justified. See under D. holwayi for reasons for inclusion of Jacksoniella Lindquist in Dietelia.

Key to the species of Dietelia

1. Telia in columns.
   2. Teliospores 18-32x14-24μ ..... 1. D. portoricensis.
   2. Teliospores 15-25x12-16μ ..... 2. D. aequatoriensis.
1. Telia cupulate.
   3. Teliospores yellow-brown.
      4. Telia compact, not pulverulent 3. D. verruciformis.
      4. Telia compact, pulverulent when mature ..... 4. D. holwayi.
   3. Teliospores colorless.
      5. Telia compact, teliospores weakly united, deep-seated ..... 5. D. duguetiae.
      5. Telia strongly compact, teliospores strongly united, not deep-seated but subepidermal ..... 6. D. emasculatum.

1. Dietelia portoricensis (Whetzel & Olive) Buritica & Hennen, comb. nov. Fig. 13.

Syn.: Aecidium expansum Arthur, Mycologia 7: 317. 1915.

Endophylloides portoricensis Whetzel & Olive apud Olive & Whetzel, Amer. J. Bot. 4: 51. 1917.

Cronartium portoricensis (Whetzel & Olive) Saccardo & Trotter, Sylloge Fungorum 23: 851. 1925.

O. Spermogonia eopiphyllous, 90-120 wide.

III. Telia amphigenous, mainly hypophyllous, sometimes in stems and petioles, in groups, cupulate or more or less in waxy or horny columns. Peridia not strong, white, attached to the teliospore column; cells enlarged, rhomboid, 20-28x10-16μ; wall 4-6μ thick, colorless, minutely verrucose, almost smooth. Teliospores globoid or ovoid, 18-32x14-24μ; wall 0.5-1.5μ thick, colorless, smooth; intercalary cells evident, frequently attached to teliospores.

Type: On Mikania cordifolia (L.F.) Willd., Mayaguez, Puerto Rico, Whetzel & Olive 83. Isotype PUR 5724.

Host and distribution: (Compositae) Mikania cordifolia, Puerto Rico, Guatemala; M. fragilis, Puerto Rico; M. micrantha, Costa Rica; M. scandens, Guatemala, Panama; M. stevensiana, Puerto Rico; Mikania sp., Guatemala, Panama, Puerto Rico, Trinidad.

Observation: This rust is the type species for the genus Endophylloides but without any doubt it belongs to

Dietelia. Its telia are compact but clearly with peridia. The peridium has been reported as atrophied but in young telia it is clear and strong. Probably when the telia enlarge, the pressure of teliospore production separates the peridium cells.

Spermogonia are reported here for the first time from material from Guatemala on M. cordifolia (L. F.) Willd. PUR 5730.

2. Dietelia aequatoriensis (Sydow) Buritica & Hennen, comb. nov.

Syn.: Endophylloides aequatoriensis Sydow, Ann. Myc. 37: 317. 1939.

O. Spermogonia unknown.

III. Telia hypophyllous, in yellow or yellowish-brown spots, 2-8mm across, crowded in round groups, forming short, yellowish-brown, waxy, cylindric columns, two to four times higher than wide. Peridium rudimentary, cells united to the teliospores, somewhat verrucose. Teliospores irregular, angular-globose, ellipsoid, ovoid, 15-24x12-16μ; wall hyaline, 1-1.5μ thick, with some areas thicker, verrucose.

Type: On Clibadium terebinthacei (Sw.) DC. (Compositae), Mindo, Pichincha, Ecuador, 12 Jun 1937.

Observation: Specimen not seen, description from the original.

3. Dietelia verruciformis (P. Henn.) P. Hennings, Hedwigia 36: 215. 1897. Fig. 14.

Syn.: Aecidium pavoniae P. Henn. Name not published.

Cronartium verruciformis P. Henn. Hedwigia 35: 245. 1896.

O. Spermogonia unknown.

III. Telia hypophyllous, scattered or in groups, mainly covering the whole leaf surface, deep-seated, erumpent, 250-350μ wide, yellow-brown. Peridia well developed, cells hyaline, rhomboid to rectangular-angular, 32-40x16-22μ; wall linear verrucose, outer 3-6μ thick, inner 2-4μ thick. Teliospores elongated-ellipsoid to oblong, 25-35x16-20μ, colorless or slightly yellow-brown; wall 2.5-3μ thick, yellow-brown, minutely verrucose; sometimes with intercalary cell attached.

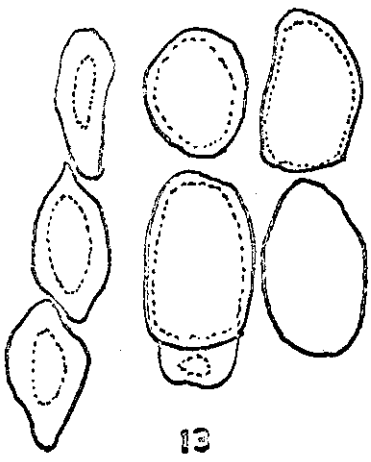
Type: On Sida flavescens var intermedia, Cordoba, Argentina, Leg. Hieronymus, 11 Nov 1881. PURF 8696.

Host and distribution: (Malvaceae) Sida flavescens, Pavonia sp., Argentina.

4. Dietelia holwayi (Jackson & Holway) Buritica & Hennen, comb. nov. Fig. 15.

Syn.: Endophyllum holwayi Jackson & Holway apud Jackson, Mycologia 24: 79. 1932.

Jacksonia holwayi (Jackson & Holway) Lindquist, Rev. Fac. Agron. La Plata 46: 202. 1970. name rejected.



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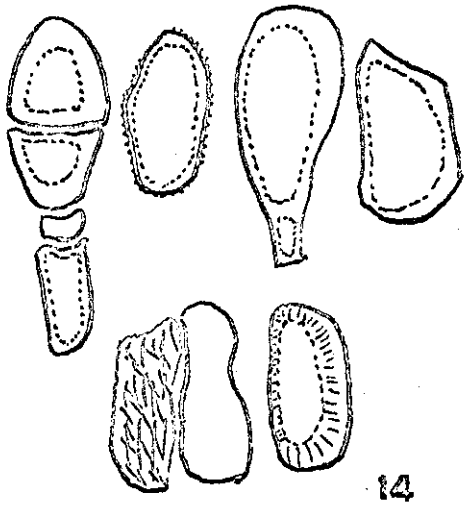

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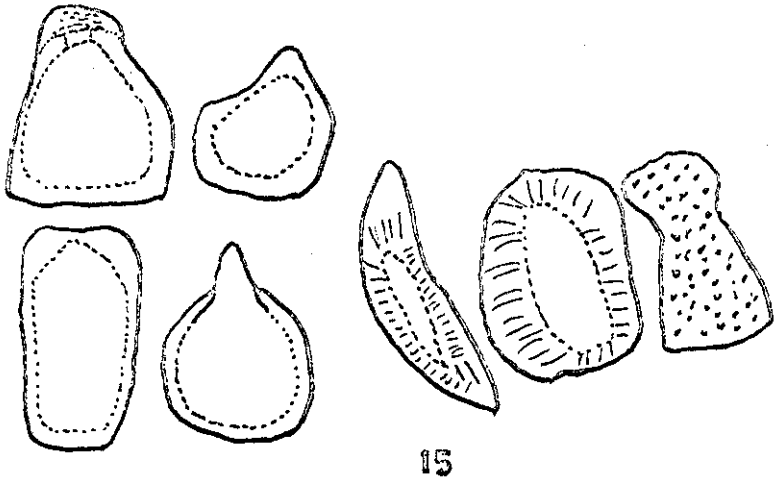

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Figs. 13-15. Teliospores and peridial cells of Dietelia spp. Fig. 13. D. portoricensis. Fig. 14. D. verruciformis. Fig. 15. D. holwayi.

Jacksoniella holwayi (Jackson & Holway) Lindquist, Rev. Fac. Agron. La Plata 47: 304. 1971. non J. holwayi (Jackson) Kamat & Sathe, Indian Phytopath. 25: 78. 1972. a later homonym for a different rust on Bignoniaceae.

O. Spermogonia amphigenous, mainly epiphyllous, in groups, 90-105μ wide.

III. Telia hypophyllous, in groups in spots 0.5-1cm diam, brown, cupulate. Peridium well developed, firm, white, reflexed in old sori; cells rhomboid, 9-13x30-38μ, verrucose, inner wall 3-4μ thick, outer wall 6-8μ thick. Teliospores weakly joined, ellipsoid to oblong, 24-38x 18-25μ; wall brown to yellow-brown, 2-3.5μ thick, 4-5μ thick at the apex, minutely verrucose, one germ pore at the top.

Type: On Salpichroa sp. Sorata, Bolivia, Reliquiae Holwayanae 448 (Holway 582). PURF 8658.

Host and distribution: (Solanaceae) Salpichroa sp., Bolivia.

Observation: Lindquist (l c) placed this rust in a new genus based in the pulverulent condition of the mature sorus. The characteristics of the young sorus are as in Dietelia, and even in the mature sorus teliospores remain somewhat adherent. The peridium is attached to the teliospores and opens by an apical aperture. The teliospores are evidently more developed than in Endophyllum.

5. Dietelia duguetiae (Thurston) Buritica & Hennen, comb. nov. Fig. 16.

Syn.: Endophylloides degueliae Thurston, Mycologia 32: 293. 1940.

Alveolaria duguetiae Viegas, Bragantia 5: 9. 1945.

O. Spermogonia epiphyllous, 100-120μ diam.

III. Telia in hypertrophied spots 3-20mm diam, deep-seated, forming columns 0.5-2mm long, white or light yellow. Peridia firm, strong; cells rhomboid-angular, 24-34x16-20μ, colorless, wall 2-4μ thick, verrucose-striate. Teliospores rhomboid or quadrangular, 20-28x14-20μ, wall 3.5-4.5μ thick, 8-10μ thick at the apex, minutely verrucose.

Type: On Duguetia furfuracea (St. Hill) Benth. & Hook. Uberlandia, Minas Gerais, Brazil. Leg. A. S. Muller. 18 May 1936. Penn. State Coll. 1065. PURF 18307.

Host and distribution: (Anonaceae) Duguetia furfuraracea, Brazil.

Observation: Viegas (1 c) and Thurston (1 c) did not described the peridium which has some resemblance to the teliospores. Thurston (1 c) issued the host as Deguelia, which is in the Leguminosae, but Viegas (1 c) determined his host as Duguetia, in the Anonaceae. In both cases the host is Duguetia in the Anonaceae. Evidently, the original spelling of the specific epithet in Thurston's paper is an error that we correct here.

6. Dietelia emasculatum (Arthur & Cummins) Buritica & Hennen, comb. nov. Fig. 17.

Syn.: Endophyllum emasculatum Arthur & Cummins, Philippine J. Sc. 61: 475. 1936.

O. Spermogonia unknown.

III. Telia hypophylous, in groups in spots 4mm diam, brown. Peridia firm, well developed; cells oblong to cuboid-angular, 12-30x10-14μ, inner wall 1.5-2.5μ thick, outer wall 3.5-6μ thick, verrucose. Teliospores globose-angular, 12-20x8-14μ; wall 1-1.5μ, colorless, minutely verrucose or apparently smooth.

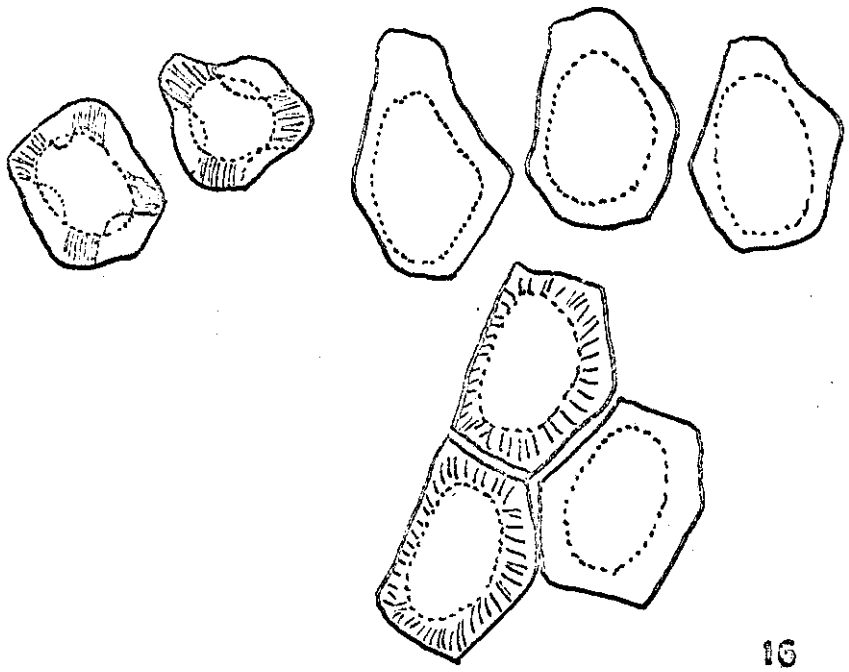
Type: On Breynia rhamnoides (Retz.) Muell. Zamboanga, Mindanoa, Philippines, 20 May 1924. Leg. Clemens 4916. PURF 8646.

Host and distribution: (Euphorbiaceae), Breynia rhamnoides, Philippines; Breynia sp., New Guinea.

4. CERATOCOMA. Buritica & Hennen, gen. nov.

Spermogonio subepidermali, profunde immerso, vel conico, vel globoso, vel plano. Aecidiis et urediis nullis. Soris teleutosporiferis erumpentibus, subepidermalibus, columellae filiformi similibus, peridio nullo. Teleutosporis catenatis, arcte coinunctis, unicellularibus, cellulis interstitialibus praeditis, semper patentibus, promycelio typico 4-cellulis. Teleutosporis evolventibus Ceratocomae similibus.

Type species: Cronartium jacksoniae P. Hennings ex Mcalpine.



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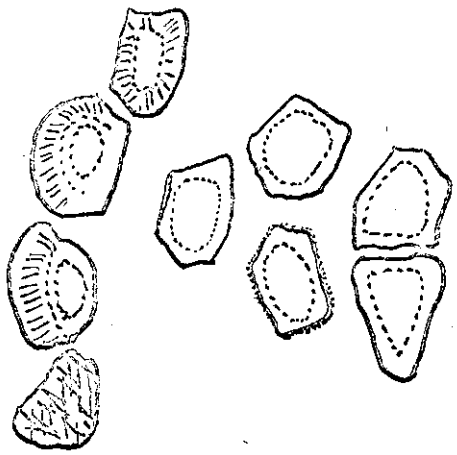

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Figs. 16-17. Teliospores and peridial cells of Dietelia spp. Fig. 16. D. duguetiae. Fig. 17. D. emasculatum.

Observation: The main characteristics of this new genus are : 1. no evident peridium, 2. teliospores catenulate, united apically and laterally, forming columns, 3. intercalary cells evident in all parts of the telia. The base of the telia are set in well-developed pseudoparenchymatous rust tissue.

Key to the species of Ceratocoma

1. Telia in hair-like columns, teliospores cylindrical, brown ..... 1. C. jacksonia.
1. Telia in short columns, teliospores rounded, hyaline ..... 2. C. guineensis.

1. Ceratocoma jacksonia (P. Henn. & McAlpine) Buritica & Hennen, comb. nov. Fig. 18.

Syn.: Cronartium jacksoniae P. Henn. apud McAlpine, The Rusts of Australia. Dep. Agric. Victoria p. 190. 1906.

Cronartium leguminum McAlpine, in sched.

Cionothrix jacksoniae (P. Henn. & McAlpine) Sydow, Ann. Myc. 16: 243. 1918.

O. Spermogonia honey-yellow, crowded or in lines, 70-110μ wide.

III. Infections producing witches-brooms in the young tissue; telia of simple columns 2-2.5mm high, with blunt apex, ruddy-brown, straight or curved. Teliospores elongated, cylindrical to fusiform, with projections more or less at the middle, 30-45x8-14μ; intercalary cells evident

along the column, rounded or somewhat angular by pressure, 6-12x6-8μ.

Type: On Gompholobium latifolium Sm., Bateau Bay, New South Wales, Australia. Leg. N. H. White. Jun 1962. PURF 16868. Lectotype.

Host and distribution: (Leguminosae) Aotus villosa, Bossiaea cinerea, Gompholobium latifolium, G. grandiflorum, Jacksonia scoparia, Platylobium formosanum, Pultenaea daphnoides, Australia.

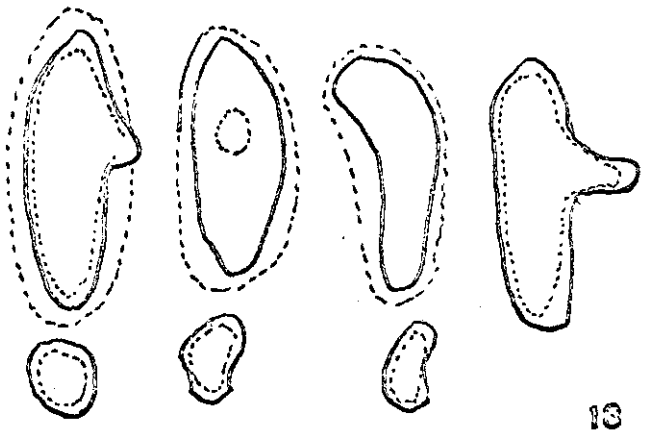
Observation: The first report of this species by Berkeley (1873) was under the name, Cronartium asclepidianum Fr. Later P. Hennings (1901) thought that the rust was a different species and transferred it to Cronartium jacksoniae but did not published a description. The first description was given by McAlpine (1 c). Neither McAlpine nor P. Hennings designated a type. Therefore, a lectotype is designated above for C. jacksonia.

2. Ceratocoma guineensis (Viennot-Bourgin) Buritica & Hennen, comb. nov. Fig. 19.

Syn.: Endophylloides guineensis Viennot-Bourgin, Ann. Inst. Nat. Agron. 45: 25. 1959.

O. Spermogonia epiphyllous, subepidermal, flattened, 180-200 wide, 70-80 tall.

III. Telia hypophyllous or amphigenous, crowded groups in spots, reddish-brown, cupulate, cylindric, horn-like, waxy, 130-300μ long, 120-160μ wide. Teliospores hyaline, ovoid to



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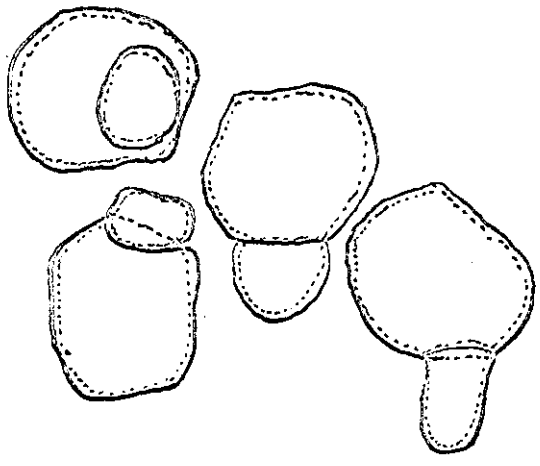


19

Figs. 18-19. Teliospores and intercallary cells of Ceratocoma spp. Fig. 18. C. jacksoniae. Fig. 19. C. guineensis.

oblong-ellipsoid, somewhat cuboid, 18-25μ diam; intercalary cells evident.

Type: On Xylopia aethiopica A. Rich., Bokaria, Guinea, Africa. Leg. Viennot-Bourgin 305, Jan 1957. PURF 18317.

Host and distribution: (Anonaceae) Xylopia aethiopica, Guinea.

Observation: Illustration from pictures given by Viennot-Bourgin to The Arthur Herbarium.

5. CHARDONIELLA. Kern, Mycologia 31: 375. 1939.

Spermogonia subepidermal, globoid. Aecia and uredinia not formed. Telia subepidermal in origin, becoming erumpent as hair-like columns of adherent spores. Teliospores one-celled, in chains; mature spores of a single chain widely separated by pedicels that originate from intercalary cell; epibasidia external. Teliospore development as Chardoniella-type.

Type species: Chardoniella gynoxidis Kern.

Key to the species of Chardoniella

1. Upper part of the interior of the teliospores narrowed at the top.
   2. Interior apex sharp pointed ..... 1. C. hasta.
   2. Interior apex rounded ..... 2. C. gynoxidis.
1. Upper part of the interior of the teliospores swollen.
   3. Interior apex globoid ..... 3. C. capitata.
   3. Interior apex slightly papillatae. 4. C. andina.

1. Chardoniella hasta Buritica & Hennen, sp. nov. Fig. 20.

O. Spermogoniis epiphyllis, 2-3 aggregatis in centro maculae decoloratae, sitis, profunde insidentibus, globosis vel piriformibus, 150-250μ latis, periphysibus fasciculatis.

III. Soris teleutosporiferis hypophyllis, in greges 1-3mm diam dispositis, 3-5 columellis elongatis similibus, 1-2mm longis, flavis. Teleutosporis hastatis, 70-90x18-23μ; membrana hyalina, 0.5-1.5μ crassa, in basi minutissima et in apice incrassata parum verrucosa, 30-42x20-30μ; pedicelo hyalino 100-136x6-8μ.

Type: On Compositae unidentified, Sur Yungas, Bolivia. Leg. E. D. Holway 620. 19 May 1920. PURF 18310.

Host and distribution: Compositae. Bolivia.

2. Chardoniella gynoxidis Kern, Mycologia 31: 375. 1939. Fig. 21.

O. Spermogonia epiphyllous, in groups, 175-225μ wide.

III. Telia hypophyllous or in branches, in groups as crowns 1-5mm diam, forming elongated cylindric columns 2-2.5mm long, yellow or golden-yellow. Teliospores from ellipsoid to obovoid, 24-32x55-69μ, round at the bottom, narrow at the top; wall hyaline 1-1.5μ thick at the bottom, 19-26μ at the top; pedicel hyaline 12-15μ wide at the insertion, atenuate beneath, about twice length of spores.

Type: On Gynoxis sp., Cerro Monserrate, Bogota, Colombia. Leg. Carlos E. Chardon 829. Mar 1937. PURF 17810.

Hosts and distribution: (Compositae) Eupatorium pomaderrifolium, E. popayanensis, Eupatorium sp, Gynoxis sp., Colombia.

Observation: Several collections made by me in Colombia show some variations in this species. Collections on Eupatorium have shorter teliospores. Most of Mayor's collections on Eupatorium have shorter teliospores. Most of Mayor's collections in PUR, identified as Cionothrix praelonga, belong to this species or to this genus.

3. Chardoniella capitata Buritica & Hennen, sp. nov.

Fig. 22.

O. Spermogoniis epiphyllis, aggregatis in centro maculae decoloratae, sitis, profunde insidentibus, globosis vel piriformis, 150-230μ latis; periphysibus fasciculatis, prominentibus.

III. Soris teleutosporiferis hypophyllis, in greges 4-8 membrorum 0.8-1.5cm diam dispositis, columellis elongatis similibus 1.5-3mm longis, flavis. Teleutosporis ovalibus cum apice glanduloso, 50-60x24-30μ; membrana hyalina 0.5-1.5μ crassa in basi minutissima et in apice incrassata parum verrucosa 30-42x11-17μ; pedicelo hyalino 50-120 x9-15μ.

Type: On Eupatorium exerto-venosum Klatt var crenatodentatum (Hier.) Rob. (Compositae) Chachapoyas, Peru. PURF 17873.

Host and distribution: Known only from type.

4. Chardoniella andina (Lagerheim) Buritica & Hennen, comb. nov. Fig. 23.

Syn.: Cronartium andinum Lagerh. apud Sydow, Monographia Uredinearum 3: 581. 1915.

Cionothrix andina (Lagerh.) Sydow, Ann. Myc. 16: 243. 1918.

Cionothrix andina (Lagerh.) Jackson & Holway, Mycologia 14: 122. 1932.

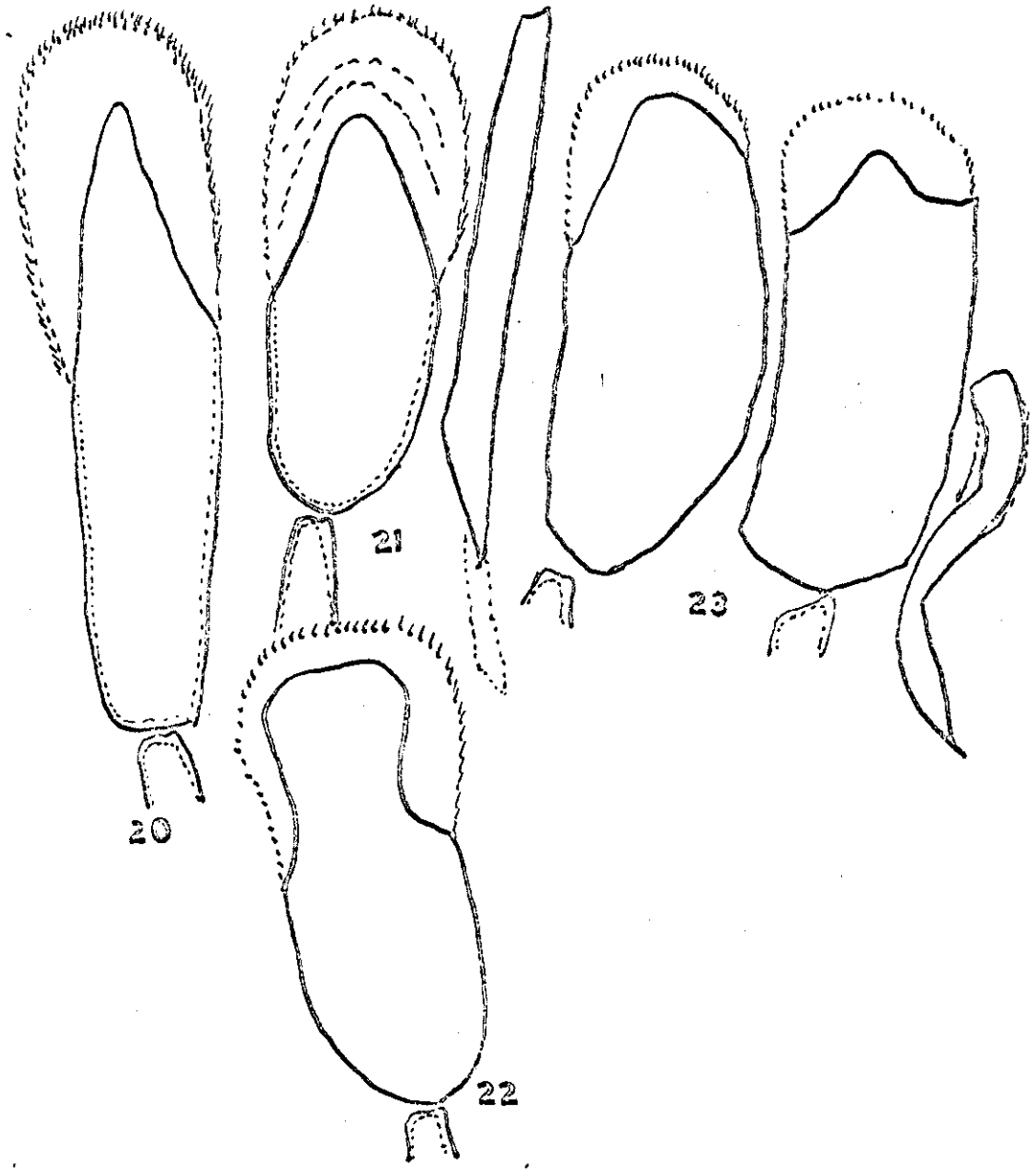
O. Spermogonia epiphyllous in round or irregular spots 0.5-1cm diam, few, aggregated, honey-yellow, globose, 100-150µ diam.

III. Telia amphigenous, mainly hypophyllous, crowded, forming columns 1cm long, 120-180µ across, straight or curved, brown or yellow-brown. Teliospores cylindric, attenuate at both ends, 57-78x18-54µ, sybhyaline; wall 1µ thick at the bottom, 12-24µ thick at the top; pedicels 68-120x13-18µ.

Type: On Eupatorium sp., Pichincha, Ecuador. Leg. Lagerheim, Jun 1890. PURF 8744.

Host and distribution: (Compositae), Eupatorium glutinosi, E. pseudochila, Eupatorium sp., Ecuador.

Observation: Compared with other members of the genus, this species has teliospores that are broadest and with the least thickness at the top. When pedicels are formed at the edge of the telia, they could be confused with a peridium.



Figs. 20-23. Teliospores and pedicels of Chardoniella spp. Fig.20. C. hasta. Fig. 21. C. gymoxidis. Fig. 22. C. capitata. Fig. 23. C. andina.

6. CIONOTHRIX. Arthur, N. Amer. Fl. 7: 124. 1907.

Spermogonia subepidermal, globoid. Aecia and uredinia not formed. Telia subepidermal in origin, deep-seated, bulbous with ostiolar paraphyses, becoming erumpent as hair-like columns of strongly adherent spores, without cementing material. Teliospores 1-celled, without intercalary cells all over the telium. Epibasidia external. Teliospore development as Cionothrix-type.

Type species: Cionothrix praelonga (Winter) Arthur.

Key to the species of Cionothrix

1. Cell wall uniform in thickness.
   2. Teliospores 20-24x29-35μ ..... 1. C. praelonga.
   2. Teliospores 10-15x25-40μ ..... 2. C. usneoides.
1. Cell wall thicker at the base 3. C. basicrassa.

1. Cionothrix praelonga (Winter) Arthur, N. Amer. Fl. 7: 124. 1907. Fig. 24.

Syn.: Cronartium praelongum Winter, Hedwigia 26: 24. 1887.

Cronartium eupatorium Spegazzini, Anal. Mus. Nac. Buehos Aires 19: 314. 1909.

O. Spermogonia epiphyllous, in small groups of two to six, honey-yellow fading to whitish, flask-shaped, 90-110μ across.

III. Telia hypophyllous, crowded in small groups, 1-2mm across, on yellow spots, deep-seated, bulbous, ostiolar paraphyses present. Telial column filiform, slender 2-3mm

long, 50-75μ wide, flexoulous, pale yellowish. Teliospores ovoid, 20-24x29-35μ; wall uniformly 1μ thick, nearly colorless, smooth.

Type: On Compositae unidentified, St. Catharina, Brazil. Leg. E. Ule. Winter-Fungi Europeai 3419. PURF 8740.

Host and distribution: (Compositae) Eupatorium daleoides, Costa Rica; E. odoratum, Bolivia, Colombia, Costa Rica, Guatemala, Panama, Mexico, Venezuela; E. thyrsigerum, Colombia; E. vernale, Guatemala; Eupatorium sp., Brazil, British Honduras, Costa Rica, Ecuador, Guatemala, Mexico, Panama, Venezuela.

Observation: Cronartium eupatorium Speg. was made synonymous with C. praelonga by Peterson (1973).

2. Cionothrix usneoides (P. Henn.) Sydow, Ann. Myc. 16: 243. 1918. Fig. 25.

Syn.: Cronartium usneoides P. Henn. Hedwigia 34: 95. 1895.

O. Spermogonia epiphyllous, few 1-4 in little spots 1-2mm diam, colored, conspicuous, 90-130μ across.

III. Telia hypophyllous, in groups more or less dense, filiform, flexuous, yellow, 3cm long, 50-80μ thick, ostiolar paraphyses present. Teliospores ovoid-oblong to oblong, partly obtuse, 25-40x10-15μ, nearly smooth, colorless; wall uniformly 0.8-1μ thick.

Type: On Conyza sp. Meiaponte, Brazil, Leg. E. Ule 1912. Aug 1892. PURF 18311.

Host and distribution: (Compositae) Conyza sp., Brazil.

3. Cionothrix basicrassa Buritica & Hennen, sp. nov. Fig. 26.

O. Spermogoniis epiphyllis, plenis maculis fuscis, orbicularibus vel irregularibus 0.5-2cm latis, insidentibus, melleis, rotundatis, 100-180μ diam.

III. Soris teleutosporiferis hypophyllis, in greges parum densos dispositis, filiformibus, flexuosis, flavis, usque ad 1cm longis, 60-90μ latis. Teleutosporis oblongis, subclavatis vel fusiformibus, 14-20x38-52μ; membrana hyalina 1-1.5μ ad apicem, ad basim incrassata 2-5μ.

Type: On Eupatorium morifolium Mill., Guatemala City, Guatemala, E. D. Holway 688. PUR 5682.

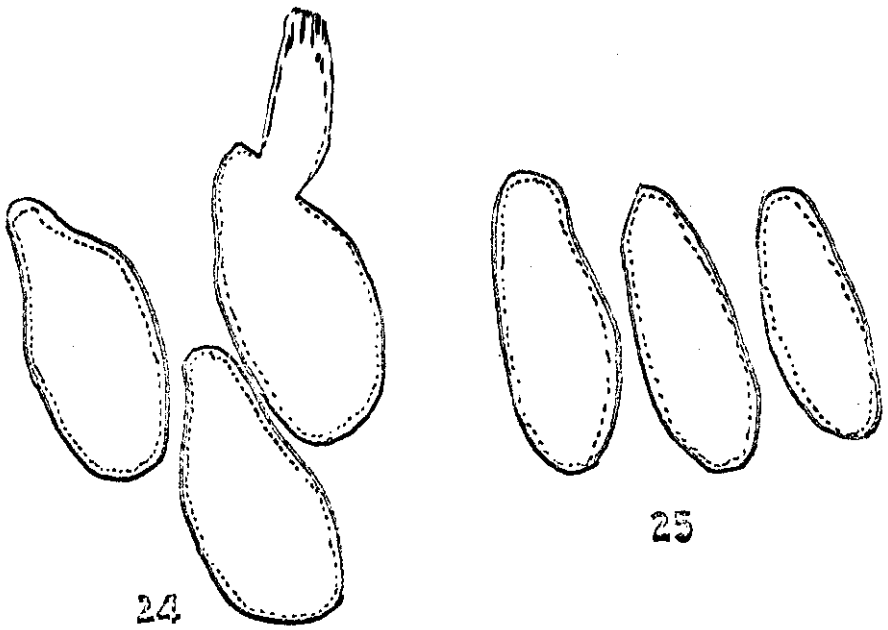
Hosts and distribution: (Compositae) Eupatorium morifolium, Costa Rica, Guatemala, Mexico; E. populifolium, Guatemala.

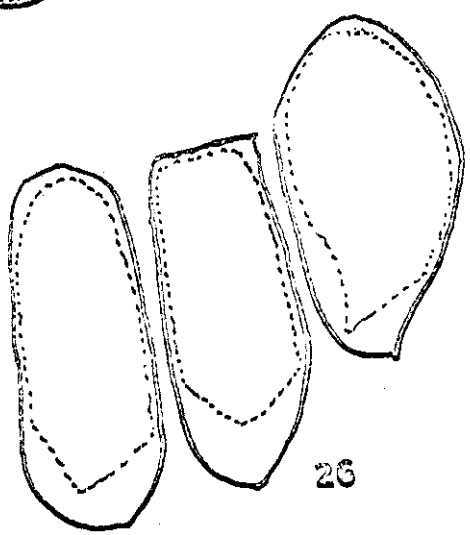
Excluded and transferred species of Cionothrix

1. Cionothrix egenula (Sydow) Sydow, Ann. Myc. 16: 243. 1918.

Syn.: Cronartium egenulum Syd. Ann. Myc. 10: 405. 1912.

Examination of the type specimen on Mikania theezantis from Brazil, showed that this specimen is not a rust, but malformed host epidermal cells caused by eriophidae mites.





Figs. 24-26. Teliospores of Cionothrix spp. Fig. 24. C. praelonga. Fig. 25. C. usneoides. Fig. 26. C. basicrassa.

2. Cionothrix andina (Lagerh.) Sydow, see Chardoniella andina.

3. Cionothrix jacksoniae (P. Henn. ex McAlpine) Sydow, see Ceratocoma jacksonia.

4. Crossopsora gilgiana (P. Henn.) Buritica & Hennen, comb. nov.

   Syn.: Cronartium gilgianum P. Hennings, Engl. Jahrb. 22: 83. 1895.

   Cronartium bresadoleanum P. Hennings, Pilze Ostafrikas in A. Engler: Die pflanzenwelt ostafrikas und der Nachabargebiete, Berlin, teil C. p 51. 1895.

   Cionothrix gilgiana (P. Henn.) Sydow, Ann. Myc. 16: 243. 1918.

This rust has subepidermal, flat spermogonia and paraphyses in the telia. Teliospores are oblong, with an equatorial germ pore. Cell walls are thick and pigmented. There are no intercalary cells. For these reasons, this rust fits better in the genus Crossopsora. It is differentiated from Ceratocoma by the paraphyses in the telia and the absence of intercalary cells. Emerging germ tubes can be confused with intercalary cells. It is differentiated from Cionothrix by the type of paraphyses, the pigmented telia and teliospore characteristics.

5. Skierka cristata (Speg.) Mains, Mycologia 31: 182. 1939.

   Syn.: Cionothrix cupaniae Arthur, Mem. Torrey Bot. Club 17: 115. 1918.

A study of the type collection on Cupania glabra Sv. from Cuba, showed that this rust is the same as Skierka cristata. It is on the same host and from the same locality as Uromyces cupaniae Arthur & Johnston, which is considered by Mains (l c) as Skierka cristata.

7. PUCCINIOSIRA Lagerheim, Ber. Deutsh. Bot. Ges. 9: 34. 1891.

Syn.: Schizospora Dietel, Ber. Deutsch. Bot. Ges. 13: 334. 1895.

Aecidiella Ell. & Kell., Bull. Torrey Bot. Club 24: 208. 1897.

Gambleola Massee, Bull. Miscel. Inform. Kew 138: 115. 1898.

Didymosira Clements, Genera of Fungi p 99. 1931.

Spermogonia subepidermal, globoid. Aecia and uredinia not formed. Telia subepidermal in origin, teliospores 2-celled by horizontal septum, catenulate in sessile chains with intercalary cells, germ pore one or several, obscure.

Telia either: deep-seated, powdery, spores not adherent and easily dividing into two cells (schizosporoid section); or forming short erumpent columns, spores weakly adherent and easily dividing into two cells (pucciniosiroid section); or forming long erumpent columns, spores strongly adherent and not dividing into two cells (gambleoloid section).

Teliospore development as Pucciniosira-type.

Type species: Pucciniosira triumphettae Lagh.

Observation: Gambleola is made synonymous with Pucciniosira because it has an evident peridium and 2-celled teliospores. It was reported to have two germ pores but there is only one on the middle part of the spores.

Key to the species of Pucciniosira

1. Telia forming long columns, teliospores adhered laterally and longitudinally (section Gambleoloid).
   2. Telia colorless, teliospores hyaline 1. P. clemensiae.
   2. Telia brown.
      3. Columns 1-3 in each group, 8-14mm long, teliospores 52-68μ long .... 2. P. gambleola.
      3. Columns 3-30 in each group, 2-12mm long, teliospores 38-55μ long .... 3. P. cornuta.
      3. Columns 3-9 in each group, 1-5mm long, teliospores 17-32μ long ..... 4. P. massee.
1. Telia powdery, deep-seated, teliospores not adhered, easily divided into two cells (section Schizosporoid).
   4. Teliospores 38-56x14-20μ..... 5. P. anthocleistae.
   4. Teliospores 42-58x20-24μ..... 6. P. mitragynes.
   4. Teliospores 16-34x14-25μ..... 7. P. tuberculata.
1. Telia erumpent forming short columns, teliospores weakly united (section Pucciniosiroid).
   5. Teliospore wall more than 1μ thick and pigmented.
      6. Teliospores smooth.
         7. Teliospores thicker at the apex.. 8. P. solani.

7. Teliospores not thicker at the apex

8. Teliospores 26-40x18-28μ.....9. P. cumminsiana.

8. Teliospores 35-48x18-30μ....10. P. holwayi.

6. Teliospores ornamented.

9. Teliospores 30-42x18-24μ....11. P. biornamentata.

9. Teliospores 18-30x16-22μ....12. P. dorata.

5. Teliospore wall less than 1μ thick and hyaline.

10. Teliospores smooth

11. Teliospores 20-28x10-18μ.....13. P. pallidula.

11. Teliospores 28-35x18-24μ.....14. P. brickelliae.

10. Teliospores ornamented.

12. Teliospores 22-30x10-20μ.....15. P. deigtonii.

12. Teliospores 23-38x8-17μ.....16. P. dissotidis.

12. Teliospores 24-36x14-24μ.....17. P. arthurii.

1. Pucciniosira clemensiae Arthur & Cummins, Philippine J. Sci. 61: 465. 1936. Fig. 27.

O. Spermogonia unknown.

III. Telia hypophyllous, one or several in each spot, whitish, 1-3mm long, 150-210μ across. Peridium cells irregular, oblong, 28-40x10-14μ, verrucose. Teliospores oblong, 26-32x14-19μ, rounded on both ends, constricted at septum, colorless, easily divided into two cells; wall 1-1.5μ thick; intercalary cells conspicuous.

Type: On Berberis barandana Vid., Luzon, Benguet, Mount Pulog, Philippines, Feb 1925. Clements 4974. PURF 8674.

Host and distribution: (Berberidaceae) Berberis barandana. Philipines.

Observation: Easily separated from other species of Pucciniosira on Berberidaceae by the absence of pigmentation in the telia and teliospores.

2. Pucciniosira gambleola Buritica & Hennen, sp. nov. Fig. 28.

O. Spermogoniis epiphyllis, solitariis, nigricantibus, subepidermicis, 110-160μ diam.

III. Soris teleutosporiferis hypophyllis, 1-3μ membrorum aggregatis, filiformibus, 8-14mm longis, 120-200μ crassis, flexuosis, brunneis. Cellulis peridii oblongis, 50-90x6-10μ. Teleutosporis oblongis, cylindraceis, 52-68x11-16μ, medio septo valde constricto divisis; episporio levibus, pallide brunneis 2.5-3.5μ crasso, poro germinationis laterali.

Type: On Mahonia acanthifolia G. Don. (Berberidaceae) Sikkim, India. PURF 18014.

Observation: Known only from type. The main characteristic of this species are the longer (8-14mm) and fewer (1-3) telia per spot, and longer teliospores.

3. Puciniosira cornuta (Massee) Buritica & Hennen, comb. nov. Fig. 29.

Syn.: Gambleola cornuta Massee, Bull. Misc. Inform. Kew 138: 155. 1898.

O. Spermogonia epiphyllous, one or two, dark, 100 across.

III. Telia hypophyllous or epiphyllous, rarely in branches, in groups of 3-30, hair-like, 2-12mm long, 120-250μ across, brown. Peridium cells elongate, minutely verrucose, 30-70x6-12μ. Teliospores irregular, oblong, cylindric to subclavate, slightly attenuate, 38-55x10-19μ, light-brown or yellow-brown; wall 1.5-2.5μ thick, 4-6μ thick at the base; germ pore at the middle or top part of each cell.

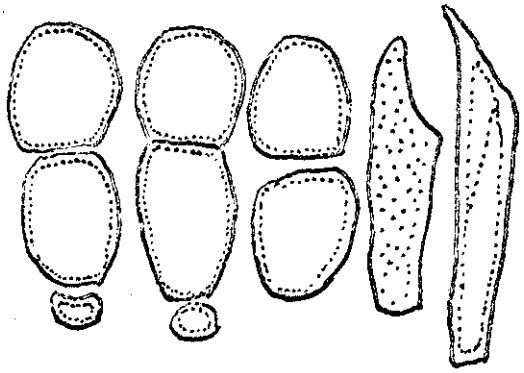
Type: On Berberis nepalensis Spreng., Chakrata, India, Leg. Gamble 24387. May 1893. PURF 8762.

Host and distribution: Berberis nepalensis, India; Mahonia behalei, M. sheridaniana, China.

Observation: This species is the type of the genus Gambleola, which has been recognized by long hair-like telia and the presence of two germ pores in each cell of the teliospores. No peridium was reported in the original description. Using different types of microscopy and mounting media it was impossible to detect the two germ pores for each cell reported in the original description by Massee (l c). Only one germ pore occurs. It is located usually at the middle part of each cell. Therefore, the separation of Gambleola from Pucciniosira can no longer be justified.

4. Pucciniosira massee Buritica & Hennen, sp. nov. Fig. 30.

O. Spermogoniis epiphyllis, solitariis, nigricantibus, subepidermicis, 100-150μ diam.



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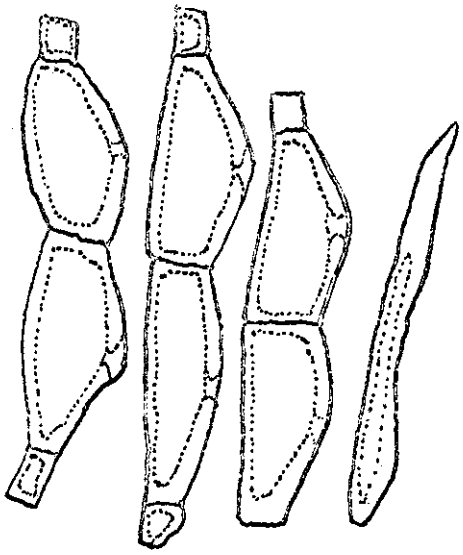

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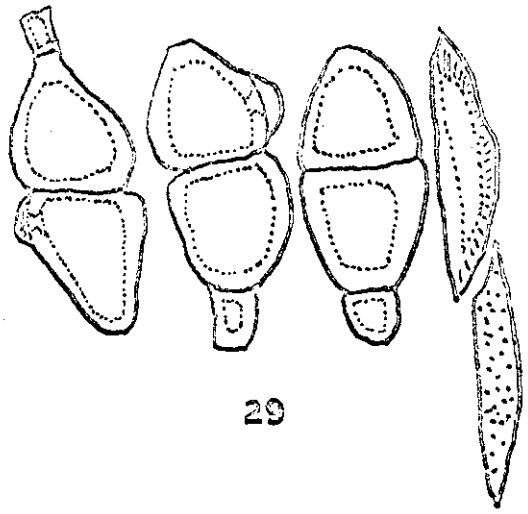

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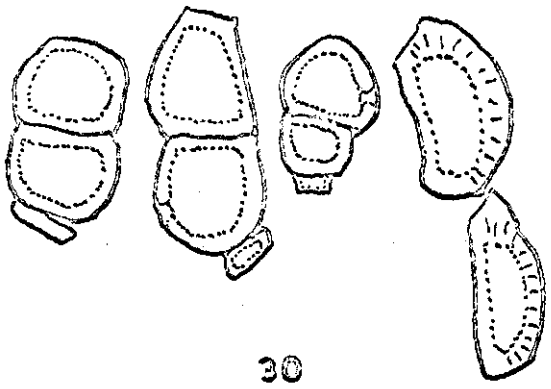

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Figs. 27-30. Teliospores and peridial cells of Pucciniosira spp. Fig. 27. P. clemensiae. Fig. 28. P. gambleola. Fig. 29. P. cornuta. Fig. 30. P. massee.

III. Soris teleutosporiferis hypophyllis, in densos greges 3-9 membrorum dispositis raro solitariis, filiformibus, 1-5mm longis, 130-240μ crassis, erectis, brunneis quasi atris. Cellulis peridii oblongis, 15-30x12-14μ. Teleutosporis ovatis vel oblongis, fere semper utrinque rotundatis, mediis leniter constrictis, 17-32x12-14μ, leviter brunneis; episporio crasso 2-2.5μ; poro germinationis laterali.

Type: On Mahonia borealis Takeda, Musoorie, N. W. Himalaya, Landour, India. PURF 18015.

Observation: Known only from type. This rust has shorter and straighter telia and shorter teliospores than the other Pucciniosira on Berberidaceae.

5. Pucciniosira anthocleistae P. Hennings, Engl. Bot. Jahrb. 38: 104. 1905. Fig. 31.

Syn.: Schizospora anthocleistae P. Henn. Engl. Bot. Jahrb. 34: 41. 1904.

O. Spermogonia amphigenous, subepidermal, in scattered groups, 100-150μ diam.

III. Telis amphigenous, mainly hypophyllous, in spots 1cm diam, yellow or whitish, in groups around spermogonia, deep-seated. Peridium cells oblong, 45-62x15-22μ, wall 10-14μ thick at the top, inner wall verrucose, densely verrucose at the top. Teliospores oblong, obtuse on both sides, 38-56x14-20μ, minutely verrucose, colorless, easily separated into two cells; wall 1.5-3μ thick.

Type: On Anthocleista orientalis, Amani, Africa.

Host and distribution: (Loganiaceae) Anthocleista orientalis, Belgium Congo; A. tresoulsii, A. vogelli, Sierra Leone; Anthocleista sp. Northern Rhodesia.

Observation: Illustration from Anthocleista vogelli, Rokupr, Sierra Leone, Leg. Deighton 1573. PURF 9612.

6. Pucciniosira mitragynes Dietel, Engler-Prantl, Naturl. Pflanzenfam. 1. Teil Abt. 1: 549. 1900.

Syn.: Schizospora mitragynes Diet., Berd. Deutsch. Bot. Ges. 13: 334. 1895.

O. Spermogonia amphigenous, in scattered groups, surrounded by telia, flask-shaped, 110-150μ diam.

III. Telia mainly epiphyllous, in rounded spots 1cm diam, yellow, arranged in the spot, deep-seated, subepidermal in origin, opening by a pore, white, 0.15-0.2mm diam, margin straight irregularly denticulate. Peridium cells oblong, 45-55x16-25μ; inner wall dense verrucose, outer wall smooth. Teleutospores oblong, round on both sides, not constricted at the middle, 42-58x20-24μ, verrucose, hyaline, easily divided into two cells; wall 1μ thick.

Type: On Mitragynes macrophyllae, Sierra Leone.

Observation: Specimen not seen, description adapted from Sydow (1915).

7. Pucciniosira tuberculata Buritica & Hennen, comb. nov. Fig. 32.

Syn.: Aecidium tuberculatum Ellis & Kellerman, J. Myc. 4: 26. 1888.

Endophyllum tuberculatum (Ell. & Kell.) Arthur & Fromme, Bull. Torrey Bot, Club 42: 58. 1915.

Puccinia neotuberculata Laundon, Trans. Br. Mycol. Soc. 50: 194. 1967.

O. Spermogonia unknown.

III. Telia aecidiod, hypophyllous and caulicolus, diffused, from a perennial mycelium, following the veins or covering large areas, round or elliptical, bullate, large, 0.5-1mm broad by 0.5-1.5mm long, yellowish or orange. Peridia colorless, opening at first by a small apical pore, soon disappearing; cells oblong, 28-42x25-34μ, verrucose-reticulate; outer wall 3-6μ thick, inner wall 1-3μ thick. Teliospores angularly globoid or oblong, 16-34x14-25μ; wall 0.5-1.5μ thick, pale yellow or hyaline, minutely verrucose.

Type: On Callirhoe involucrata (T. & G.) A. Gray, Rooks Co., Kansas, U. S. A. Leg. E. Bartholomew 25. 15 Sep 1887.

Host and distribution: (Malvaceae) Althaea rosea, Callirhoe involucrata, Sidalcea candida, S. neomexicana, S. malvaeflora, U. S. A.; Lavatera kashmiriana, Western Kashmir.

Observation: Illustration from Callirhoe involucrata, Rooks Co., Kansas, Kellerman & Swingle Kansas Fungi 30. 30 May 1889. PUR 5878.

This species belongs to the genus Pucciniosira because of the two celled teliospores. This character is evident in only a few teliospores. It remains an open question as to whether all of the teliospores are two celled. Probably most spores appear one celled because they are so easily separated. But the presence of a few two-celled teliospores provides us with confidence that this species belongs to Pucciniosira. It may also indicate an early stage in the evolution of two celled teliospores from one celled teliospores.

8. Pucciniosira solani Lagerheim, Ber. Deutsch Bot. Ges. 9: 345. 1891. Fig. 33.

O. Spermogonia amphigenous, mainly epiphyllous, aggregated in groups, 110-160μ diam.

III. Telia hypophyllous, in round spots 0.5-1.5cm diam, whitish, in groups forming rings, 100-250μ across, dome-shaped or somewhat columnar, deep-seated. Peridia colorless, adherent, membranous; cells oblong, 38-54x15-24μ; inner wall verrucose, 3-5μ thick, hyaline. Teliospores oblong, 42-54x21-30μ, apex flat or conic, hyaline, easily divided into two cells; wall 1-3μ thick, thicker at the apex 8-14μ, pale yellow, one apical germ pore.

Type: On Solanum sp., Chimborazo, Ecuador, Leg. G. Lagerheim, Sep 1891. PURF 8692.

Host and distribution: (Solanaceae) Solanum sp, Ecuador.

9. Pucciniosira cumminsiana Buritica & Hennen, sp. nov.

Fig. 34.

O. Spermogonia ignota.

III. Soris teleutosporiferis hypophyllis, maculis flavis vel brunneis insidentibus, in breves greges cylindricos dispositis, pallide flavis, diu clausis ante apicem aperiendum. Cellulis peridii ovatis fere oblongis, ubique verrucosis, 20-28x10-14µ; episporio 3-4µ crasso, flavo. Teleutosporis ellipsoideis vel oblongis, utrinque rotundatis vel obtusis, 26-40x18-28µ, mediis non constrictis, subhyalinis; episporio 1µ crasso, irregulariter incrassato usque ad 3-6µ.

Type: On Eupatorium sp., Lagos de los Pinos, Depto. Santa Rosa, Guatemala, Standley 60457. PUR 49008.

Host and distribution: (Compositae) Eupatorium sp., Guatemala, Honduras, Mexico.

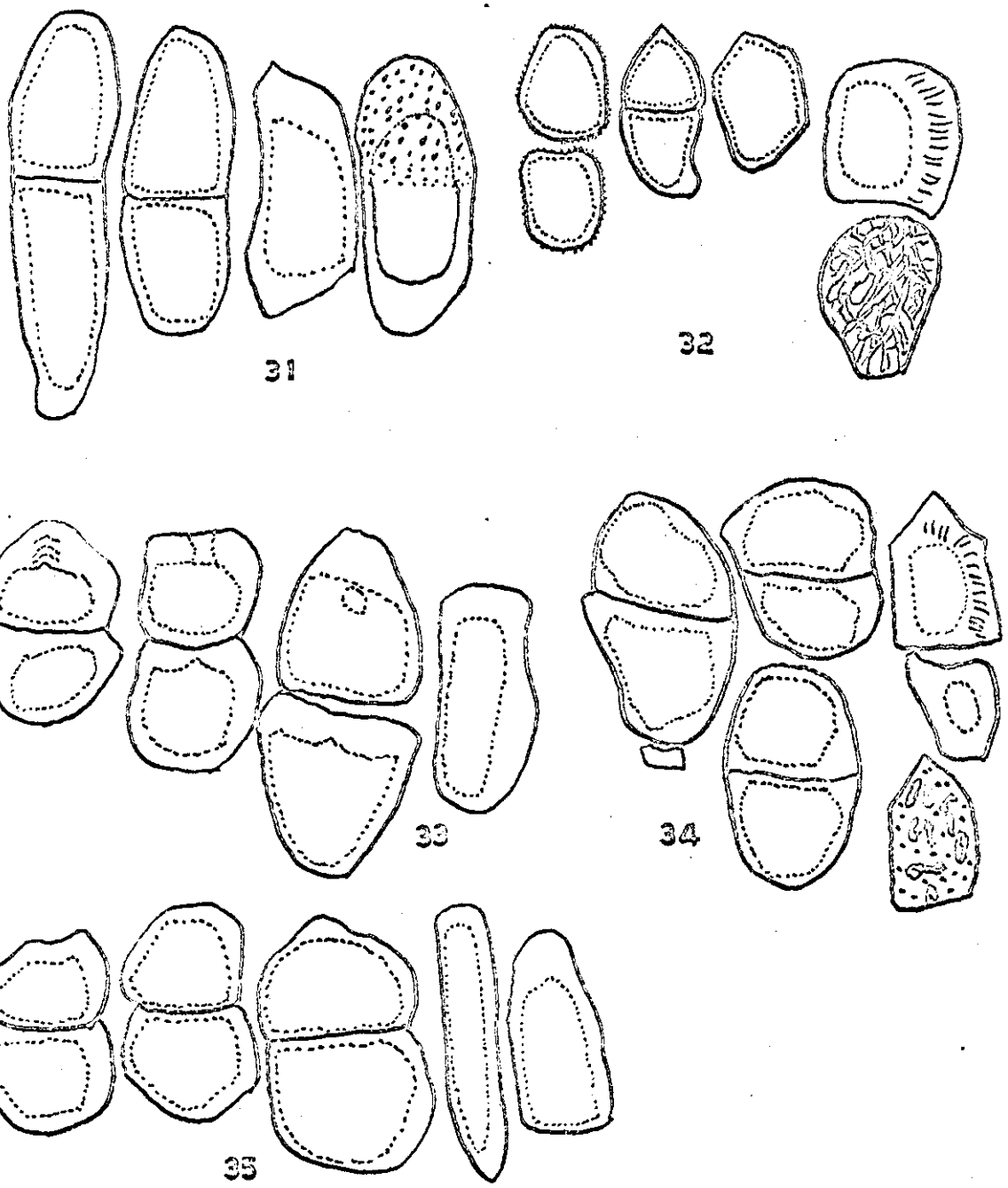
Observation: Teliospore form, dimensions and cell wall thickness differentiates this species from P. arthurii. Smooth teliospores is the main characteristic to separate it from P. biornamentata.

10. Pucciniosira holwayi Jackson, Mycologia 26: 84. 1932.

Fig. 35.

Syn.: Pucciniosira hyphoperidiata Viegas, Bragantia 5: 51. 1945.

O. Spermogonia subepidermal, deep-seated, flask-shaped, epiphyllous, 100-150µ across.



Figs. 31-35. Teliospores and peridial cells of Puccinio-sira spp. Fig. 31. P. anthocleistae. Fig. 32. P. tubercu-lata. Fig. 33. P. solani. Fig. 34. P. cumminsiana. Fig. 35. P. holwayi.

III. Telia in leaf or branches, hypophyllous, in circular groups, 1.5-4mm diam, deep-seated, dome-shaped, white or pale yellow. Peridia membranaceous, adherent, not well developed, colorless; cells oblong, 40-59x8-21μ, wall 1-3μ thick. Teliospores irregular-ellipsoid, 35-48x 18-30μ; wall 1.3μ thick, thicker at the base or at one side 8-12μ; pale yellow, easily divided into two cells.

Type: On Solanum laxiflorum Sendt. Rio de Janeiro, Brazil. Reliquiae Holwayanae 457. PURF 8693.

Host and distribution: (Solanaceae) Solanum laxiflorum, Solanum sp., Brazil.

Observation: Viegas' species does not have any major differences with P. holwayi. The kind of peridium is the same in both species, and the teliospores are easily separated into two cells.

11. Pucciniosira biornamentata Buritica & Hennen, sp. nov. Fig. 36.

O. Spermogonia non visa.

III. Soris teleutosporiferis hypophyllis, maculis flavis, diu clausis ante apicem aperiendum. Cellulis peridii ovatis fere oblongis, 20-32x12-20μ, ubique verrucosis; episporio flavo, 2-3μ crasso. Teleutosporis ellipsoideis vel oblongis, 30-42x18-24μ, utrinque rotundatis, mediis leniter constrictis, subhyalinis, aliquibus minoribus 20-26x12-14μ, episporio 1μ crasso, irregulariter incrassato 2-3μ, aliis echinulatis aliis levibus.

Type: On Eupatorium sp. (Compositae), San Ramon, Costa Rica. Plants of Central America, E. W. D. Holway 429. 13 Jan 1916. PUR 57714.

Observation: Known only from type. Two sizes of teliospores and kinds of ornamentation are the main characteristics of this species.

12. Pucciniosira dorata Buritica & Hennen, sp. nov. Fig. 37.

O. Spermogonia non visa.

III. Soris teleutosporiferis hypophyllis, raro epiphyllis, maculis flavis vel brunneolis, insidentibus, in greges minutos vel solitarios dispositis, cylindraceis, 0.1-0.15mm diam, 1-3mm longis, flavis vel brunneolis. Cellulis peridii oblongis, 22-28x12-16μ; pariete interiore cum papillis tenuibus dense obsitis, 2.5-3.5μ crassa, exteriore 3.5-4.5μ incrassata. Teleutosporis ovatis vel ellipsoidalibus, 18-30x16-22μ, utrinque rotundatis, flavidis cel brunneolis, facillime ex loculis secedentibus; episporio crasso 2.5-3.5μ, ad apicem 3-4μ incrassato, minute verrucosis dense dispositis.

Type: On Heliocarpus polyandrus S. Wats. (Tilliaceae), Alamos, Sonora, Mexico. Cummins 71-663. PUR 63993.

Observation: Known only from type. The main characteristics of this species are, telia in groups or alone, telial columns larger and brownish; teliospore walls thicker and verrucose and teliospores larger. These characteristics

separate this species from other Pucciniosira spp. on Tilliaceae.

13. Pucciniosira pallidula (Speg.) Lagerheim, Tromso Mus. Aarsh 16: 122. 1894. Fig. 38.

Syn.: Coleosporium pallidulum Spegazzini, Fungi Guaranici 1: 55, in Anal. Soc. Cient. Argentina 17. 1883.

Pucciniosira triumphettae Lagerheim, Ber. D. Deutsch. Bot. Ges. 9: 344. 1891.

Pucciniosira dussii Patouillard in sced.

Aecidium triumphettae P. Hennings, Hedwigia 35: 259. 1896.

Aecidiella triumphettae Ellis & Kellerman, Bull. Torr. Bot. Club 24: 208. 1897.

O. Spermogonia epiphyllous, in groups, subepidermal, 75-100 diam.

III. Telia hypophyllous, in small yellow-brown spots, in groups 1-2.5mm across, crowded, cupulate or in short columns 0.1-0.15mm diam, pale yellow, margin erect, not complete. Peridia adherent, colorless; cells oblong, 16-24x10-16μ; inner wall 2-3μ thick, outer wall 5-8μ thick, minutely verrucose. Teliospores ovoid to ovoboid-oblong, rounded in both ends or one conical, slightly constricted at septum, 20-28x10-18μ, smooth to minutely punctate; wall 1μ thick, hyaline.

Type: On Triumphetta sp., Puente del Chimbo, Ecuador. Leg. G. Lagerheim, Sep 1891. PURF 8683.

Host and distribution: (Tilliaceae) Heliocarpus mexicanus, Honduras; H. popayanensis, Costa Rica; Heliocarpus sp, Guatemala; Triumphetta bartramia, Puerto Rico; T. calderoni, Honduras; T. dumetorum, Guatemala, Mexico; T. grandiflora, West Indies; T. lappula, Puerto Rico, Colombia, El Salvador, Guatemala, Tobago; T. rhomboides, Puerto Rico; T. semitriloba, Bolivia, Cuba, Ecuador, Guatemala, Jamaica, Mexico, Puerto Rico, Santo Domingo; T. speciosa, El Salvador, Honduras; Triumphetta sp., Brazil, British Honduras, Colombia, Costa Rica, Ecuador, Guatemala, Honduras, Mexico, Panama, Paraguay, Puerto Rico, Trinidad, Venezuela, West Indies.

14. Pucciniosira brickelliae Dietel & Holway, Bot. Gaz. 24: 34. 1897. Fig. 39.

Syn.: Aecidium montanoae Dietel & Holway, Bot. Gaz. 24: 36. 1897.

Aecidium guadalajarae Sydow, Oest. Bot. Zeits. 52: 183. 1902.

O. Spermogonia epiphyllous, aggregate in round spots, 120-150 diam.

III. Telia on stems, pedicels, forming irregular, mostly curved swellings, on leaves produced along the veins; hypophyllous, dome-shaped or forming short columns, pale yellow. Peridia shortly cylindrical, with margins irregularly toothed, pale yellow; cells irregular to oblong,

28-42x20-26μ, easily separated, verrucose; inner wall 1-3μ thick, outer wall 7-12μ thick. Teliospores ellipsoid to oblong, 28-35x18-24μ, at first not constricted, finally separating into two cells; wall 0.5-1μ thick, hyaline, smooth.

Type: On Brickellia sp., Rio Hondo, City of Mexico, Mexico, 4 Oct 1896. PUR 6034.

Host and distribution: (Compositae) Ageratum sp., El Salvador; Brickellia adenocarpa, Guatemala, Mexico; B. cavanillesii, Guatemala; B. paniculata, Mexico; B. pendula, Mexico; B. hebecarpa, Mexico; Brickellia sp. Mexico; Eupatorium sp., El Salvador; Montanoa sp. Mexico.

15. Pucciniosira deightonii Cummins, Bull. Torrey Bot. Club 72: 218. 1945. Fig. 40.

O. Spermogonia unknown.

III. Telia hypophyllous, grouped on yellowish-brown spots up to 8mm diam, yellowish, forming columns 0.5-3mm long. Peridia more or less adherent, colorless; cells oblong, 24-44x8-20μ, wall 3-5μ thick, finely verrucose. Teliospores ellipsoid to oblong, 22-30x10-20μ; wall 0.5-1.5μ thick, pale yellowish or hyaline, minutely verrucose.

Type: On Jasminum pauciflorum, Hill station, Sierra Leone, Leg. Deighton 717. 25 May 1935. PURF 10804.

Host and distribution: (Oleaceae) Jasminum pauciflorum, Sierra Leone.

16. Pucciniosira dissotidis Wakefield, Kew Bull. 1917: 313. 1917. Fig. 41.

Syn.: Aecidium dissotidis Cooke, Grev. 10: 124. 1882.

Uredo dissotidis Cooke, Grev. 10: 124. 1882.

Uredo dissotidis-longicaudae P. Hennings, in H. Baum. Bot. Ergebnisse der Kunene-Sambesi Exped. p. 159. 1902.

Puccinia dissotidis P. Hennings, in Flore de Baset-Moy. Congo. In Ann. Mus. Congo 2: 222. 1908.

O. Spermogonia unknown.

III. Telia in groups in spots decolorate, hypophyllous, common on petioles, dome-shaped, 120-200μ across. Peridia colorless, firm; cells irregular to oblong, 23-38x8-17μ; inner wall 2-4μ thick, outer wall 6-12μ thick, minutely verrucose. Teliospores hyaline, ellipsoid to oblong, 23-38x15-20μ, constricted at the septum, wall 1-1.5μ thick, easily divided into two cells.

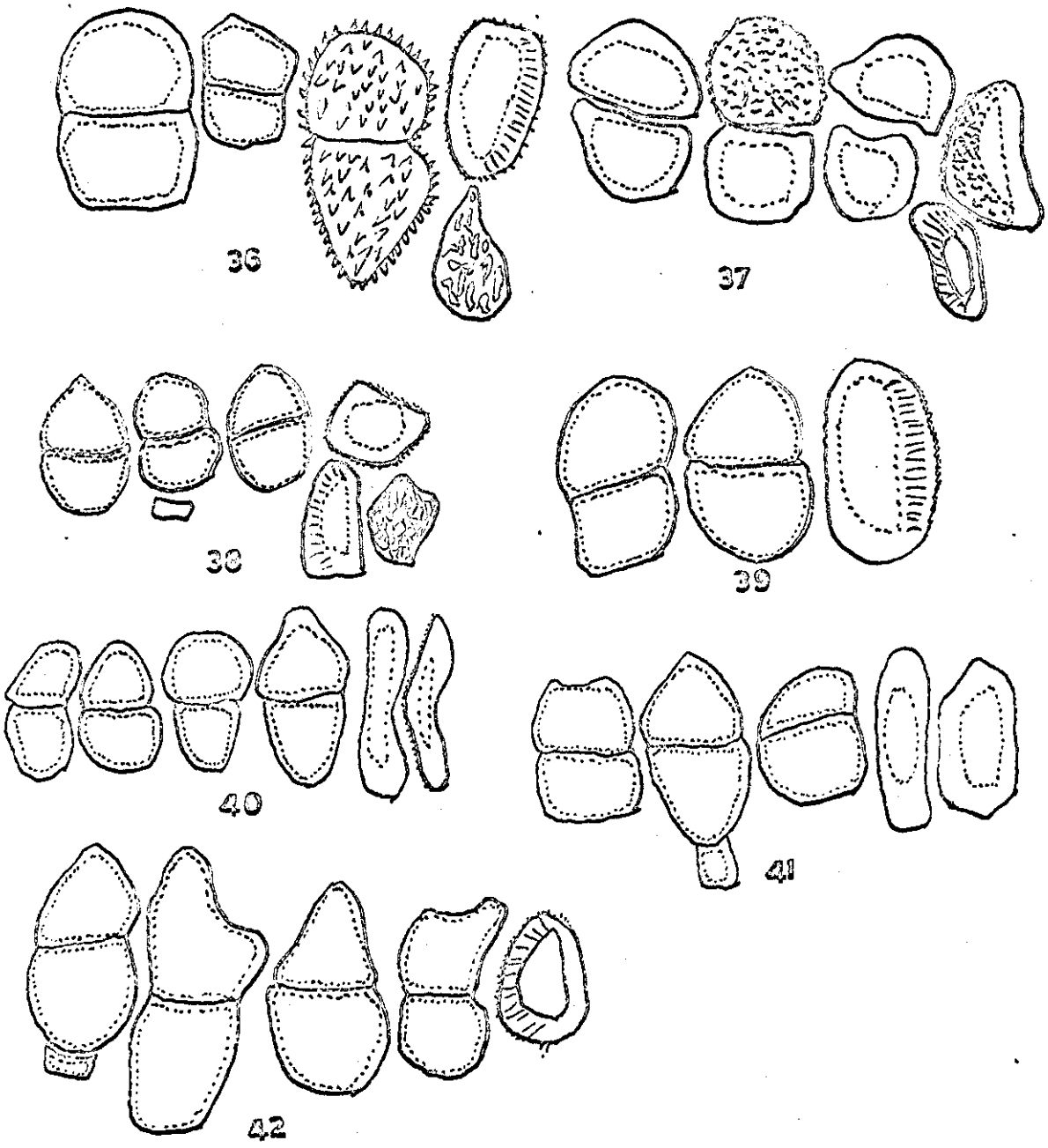
Type: On Dissotis incana Triana, Uganda, R. Dummer 2157.

Host and distribution: (Melastomataceae) Dissotis incana, Uganda, South Africa; D. longicauda, South Africa; D. princeps, South Africa; Dissotis sp., Africa.

17. Pucciniosira arthuri Buritica & Hennen sp. nov. Fig. 42.

Syn.: Pucciniosira eupatorii Lagh. apud Arthur, Amer. J. Bot. 5: 435. 1918. nomen nudum.

O. Spermogonia non visa.



Figs. 36-42. Teliospores and peridial cells of Puccinio-sira spp. Fig. 36. P. biornamentata. Fig. 37. P. dorata. Fig. 38. P. pallidula. Fig. 39. P. brickellae. Fig. 40. P. deightonii. Fig. 41. P. dissotidis. Fig. 42. P. arthu-rii.

III. Soris teleutosporiferis hypophyllis, maculis flavis 2-5mm diam, in breves greges dispositis, cylindraceis. Peridio adherenti flavo; cellulis peridii oblongis vel ellipsoideis, 18-26x12-16μ; pariete interiore 2-3μ crassa, exteriore 4-6μ crassa, verrucosis. Teleutosporis oblongis in apice irregularibus, 24-36x14-24μ; episporio 0.5-1μ crasso, hyalino, ad marginem subtilissime serrato vel verrucoso.

Type: On Eupatorium sp., Pichincha, Ecuador, Leg. Lagerheim, Jun 1892. PURF 9533.

Host and distribution: (Compositae) Eupatorium glechonophyllum, Eupatorium sp. Ecuador.

Observation: Arthur (l c) did not describe teliospores from Lagerheim's type, but probably the spores he described were from Baeodromus eupatorii Arthur. Later, Cummins (1940) redescribed P. eupatorii Lagerh. ex Arth. from other collections from Guatemala. These collections actually represent a different species (P. cumminsiana) from Lagerheim's type collection from Ecuador, therefore Lagerheim's species has never had a description.

8. DIDYMOPSORA Dietel, Hedwigia 38: 254. 1899.

Spermogonia subepidermal. Aecia and Uredinia not formed. Telia subepidermal in origin, erumpent, without peridia, forming short or more or less long columns. Teliospores 2-celled, produced in loosely adherent chains, intercalary cells evident only at the base of the telia, germ

pore one or several, obscure; epibasidia external. Teliospore development as Pucciniosira-type.

Type species: Didymopsora solani-argentei (P. Henn.) Dietel.

Key to the species of Didymopsora

1. Teliospores yellow-brown.
   2. Teliospores 21-30x17-27µ ..... 1. D. paraguayensis.
   2. Teliospores 50-65x23-28µ ..... 2. D. chuquiraguae.
1. Teliospores hyaline.
   3. Teliospores ornamented ..... 3. D. solani-argentei.
   3. Teliospores smooth.
      4. Teliospores 18-32x9-14µ ..... 4. D. triumphettae.
      4. Teliospores 30-35x19-25µ ..... 5. D. solani.
      4. Teliospores 33-45x19-22µ ..... 6. D. africana.

1. Didymopsora paraguayensis (Speg.) Cuningham, Mycologia 60: 774. 1968. Fig. 43.

Syn.: Cronartium paraguayensis Spegazzini, Ann. Soc. Sci. Argentina 26: 13. 1888.

O. Spermogonia subepidermal, flask-shaped.

III. Telia hypophyllous, in clusters, columnar or hair-like, reddish-brown. Teliospores 21-30x17-27µ, pale golden-brown, easily separated into two cells but adhering in masses; cell wall 1.5µ thick, sometimes up to 4µ at extreme tips, pale brown, smooth.

Type: On Barnadesia sp. (Compositae), C. Roumeguere, Fungi Selecti Exsiccati 5216. Guarapi, Paraguay, Leg. B. Balansa. Aug 1883. PURF 8742.

Observation: Known only from type.

2. Didymopsora chuquiraguae Dietel, Hedwigia 38: 255. 1899. Fig. 44.

O. Spermogonia subepidermal, epiphyllous, in groups, flask-shaped, 100-160μ diam.

III. Telia hypophyllous, in spots 1 cm across, brown to golden-brown, columnar, 1mm or more long. Teliospores ellipsoid to oblong, weakly constricted at septum, 50-65x23-28μ, light brown; wall 1-2μ thick; one germ pore in each cell.

Type: On Chuquiragua tomentosa Baker, Santa Catharina, Brazil, Leg. E. Ule 1319. Apr 1889.

Host and distribution: (Compositae) Chuquiragua glabra-multiflora, C. tomentosa, Brazil.

Observation: Illustration from Chuquiragua glabra-multiflora Baker, Therezopolis, Brazil. Plants of South America, E. W. D. Holway 1218. PURF 8760.

3. Didymopsora solani-argentei (P. Henn.) Dietel, Hedwigia 38: 254. 1899. Fig. 45.

Syn.: Aecidium solani-argentei P. Hennings, Hedwigia 35: 260. 1896.

Didymopsora orthosticha Dietel, in sched.

O. Spermogonia epiphyllous, subepidermal, 100-150μ diam.

III. Telia hypophyllous, in round spots 0.3-1cm diam, in circular groups, colorless or light yellow, columnar 1-5mm long. Teliospores ellipsoid to ellipsoid-oblong, round at both ends, 45-70x30-40μ; wall 1.5-2.5 thick, colorless to light brown, irregularly verrucose.

Type: On Solanum argentum, Serra dos Orgaos, Rio de Janeiro, Leg. E. Ule 2157. Aug 1895. PURF 8756.

Host and distribution: (Solanaceae) Solanum argenteum, S. swartzianum, Solanum sp., Brazil.

4. Didymopsora triumphetae Jackson & Holway, apud Jackson Mycologia 23: 476. 1931. Fig. 46.

O. Spermogonia unknown.

III. Telia hypophyllous, occurring singly or in closely aggregate groups on slightly hypertrophied areas, deep-seated, waxy, forming columns 1mm long 200-275μ across. Teliospores oblong constricted at septum, 18-32x9-14μ, easily divided in two cells, cell wall 1μ thick, colorless, smooth or minutely verrucose.

Type: On Triumphetta longicornis St. Hill., Juiz de Fora, Minas Gerais, Brazil. 17 Dec 1921, Reliquiae Holwayanae 347. PURF 8754.

Host and distribution: (Tilliceae) Known only from type.

5. Didymopsora solani Dietel, Hedwigia 38: 255. 1899.

O. Spermogonia epiphylllous, in discolored or dark round spots.

III. Telia hypophyllous, in circular groups, crowded, forming very short columns 0.15-0.2mm wide. Teliospores ellipsoid, 30-35x19-25μ; wall pale brown, thin.

Type: On Solanum sp. (Solanaceae), Nova Friburgo, Brazil, Leg. E. Ule 2540. Jan. 1898.

Observation: Specimen not seen. Following Dietel (l c), the main characteristics of this species are the shorter telial column, the teliospore size, and the lack of ornamentation.

6. Didymopsora africana Cummins, Bull. Torrey Bot. Club 87: 33. 1960. Fig. 47.

O. Spermogonia epiphyllous, 100-150μ diam.

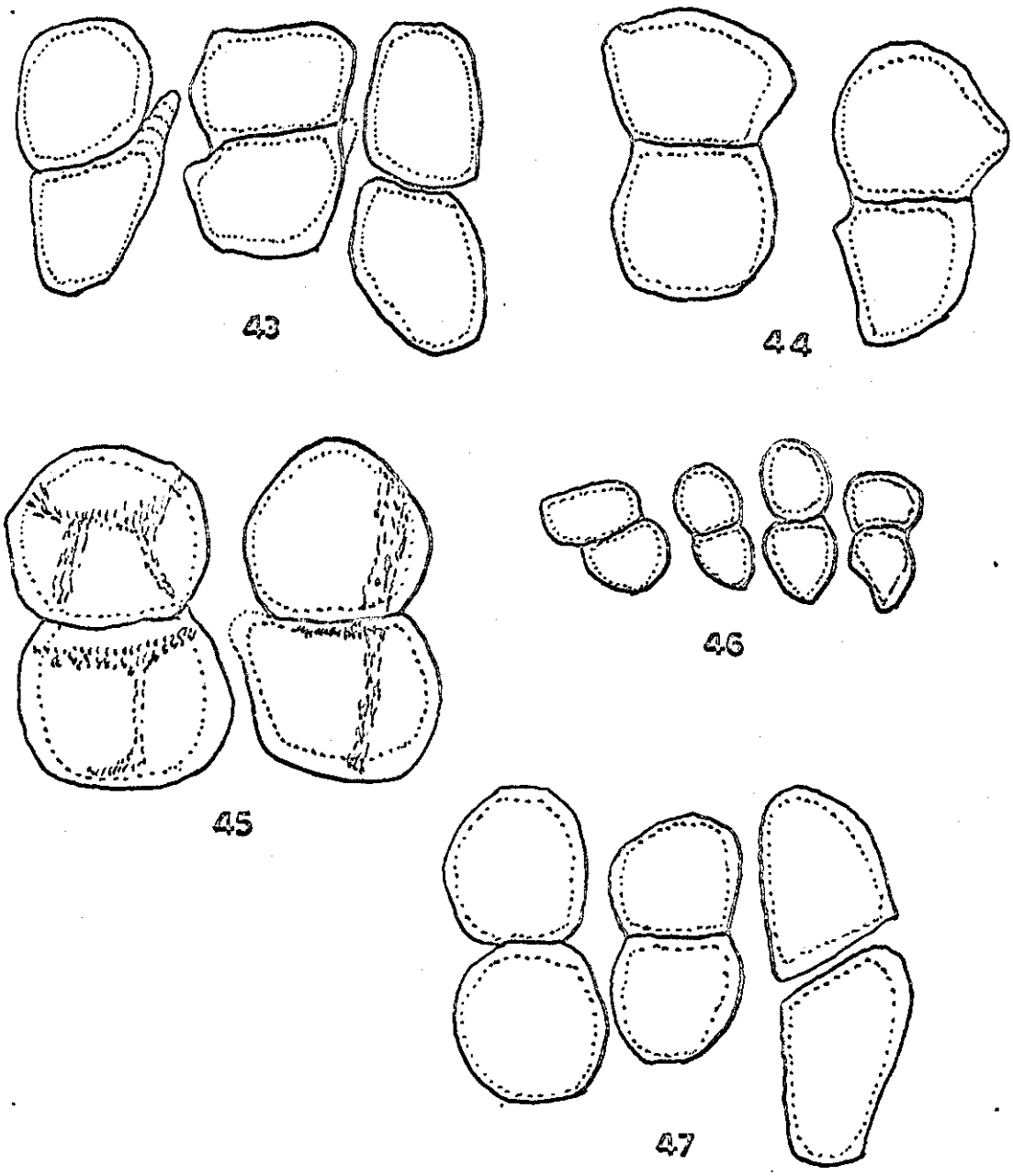
III. Telia hypophyllous, in spots 1cm diam, in groups erumpent, columnar, colorless to light-brown. Teliospores oblong-ellipsoid, 33-45x19-22μ; wall 1 1.5μ thick, smooth, hyaline.

Type: On Dissotis sp. (Melastomataceae), near headwaters of the Lunga river, Kakoma, Mwinilunga Dist., N. Rhodesia, 30 Sep 1954. Leg. A. Angus M76. PURF 16010.

Host and distribution: Known only from type.

9. BAEODROMUS Arthur, Ann. Mycol. 3: 19. 1905.

Spermogonia subepidermal, globoid. Aecia and uredinia not formed. Telia subepidermal in origin, usually becoming



Figs. 43-47. Teliospores of Didymopsora spp. Fig. 43. D. paraguayensis. Fig. 44. D. chuquiraguae. Fig. 45. D. solani-argentei. Fig. 46. D. triumfettae. Fig. 47. D. africana.

erumpent. Teliospores catenulate in few spored chains, strongly adherent laterally and vertically to form compact telia; teliospores 1 or sometimes 2 celled, no peridium. Teliospore development irregular.

Type species: Baeodromus holwayi Arthur.

Observation: The placement of some of the species in this genus is dubious. With more information, the relationships of these species may be better established.

Key to the species of Baeodromus

1. Telia deep-seated, covered by the host epidermis ..... 1. B. eupatorii.
1. Telia erumpent.
  2. Teliospores forming definite chains.
    3. Cell wall 1-3μ thick ..... 2. B. dominicana.
    3. Cell wall 2-4μ thick ..... 3. B. tranzschelii.
  2. Teliospores forming a compact sorus without identifiable chains.
    4. Teliospores hyaline ..... 4. B. senecionis.
    4. Teliospores golden-brown.
      5. Cell walls more or less uniformly thick.
        6. Wall 1-2.5μ ..... 5. B. holwayi.
        6. Wall 2.5-3.5μ ..... 6. B. albertensis.
      5. Cell wall thicker at the apex. 7. B. californicus.

1. Baeodromus eupatorii Arthur, N. Amer. Fl. 7: 125. 1907. Fig. 48.

Syn.: Dietelia eupatorii Arthur, Bot. Gaz. 40: 197. 1905.

O. Spermogonia amphigenous, numerous, densely crowded, punctiform, 100-150 diam.

III. Telia hypophyllous and caulicolous, crowded, punctiform in circular groups 1-4mm diam, often encircling the spermogonia, on stem causing small swelling upto 1cm long, on discolored spots, very small, 0.2-0.3mm diam, round somewhat waxy, covered by the host's epidermis, deep-seated, opening at the apex, later erumpent. Teliospores broadly ellipsoid, more or less angular and irregular by pressure, 16-32x13-21μ, wall golden-brown, smooth, 1.5-3.5μ thick.

Type: On Eupatorium patzcuarense H. B. K., Amecameca, Mexico. Leg. E. W. D. Holway 5205. 21 Oct 1903. PUR 5777.

Host and distribution: (Compositae) Eupatorium adenophorum, Mexico; E. aschenbornianum, Guatemala, Honduras; E. mairetianum, Guatemala; E. paztcuarense, Mexico; E. pycnocephalum, Guatemala; Eupatorium sp., Guatemala, Mexico.

2. Baeodromus dominicana (Kern) Thirumalachar & Kern, Mycologia 41: 284. 1949. Fig. 49.

Syn.: Phakopsora dominicana Kern, Mycologia 20: 63. 1928.

O. Spermogonia unknown.

III. Telia hypophyllous gregarious, on hypertrophied spots 1-2mm in diameter, pulvinate, black. Teliospores united into a compact mass, appearing catenulate, with 2 or more cells in a series; teliospores elliptical or cuboidal, 18-32x13-18μ; wall smooth, pale brown, 1-3μ thick.

Type: On Croton angustatus Urban, San Jose de las Matas, Santiago, Santo Domingo. Leg. C. Chardon 397. PUR 44006.

Host and distribution: (Euphorbiaceae) Croton angustatus, Santo Domingo; C. ciliato-glandulosus, Mexico.

Observation: The position of this species in Baeodromus is doubtful. It is probably related with Physopella or Phakopsora. In Mexican collections, teliospore chains are shorter (3-5 cells) and the upper cells are rounded and almost black.

3. Baeodromus tranzschelii Azbukina, Bot. Inst. Noy. Sist. Niz. Rast. 7:230. 1970. Fig. 50.

Syn.: Baeodromus urticae Tranzschel, ad interim Tranzschel, Consp. Ured. URSS, Moscow p. 162-163. 1939. nomem nudum.

O. Spermogonia epiphyllous, subepidermal, round, 100-200μ diam.

III. Telia hypophyllous, subepidermal in origin, afterwards erumpent, in groups of 3-5, brown, 250-300μ across, 200-300μ tall. Teliospores in rows of 5 or 6 in each row, oblong to angularly-oblong, 17-28x14-18μ; wall 2-4μ thick, irregularly thicker 3-6μ.

Type: On Urtica laetevirens Max., Ternejskij, Primorskensis, Russia, Leg. Z. M. Azbukina. 10 Jul 1957.

Host and distribution: (Urticaceae) Urtica laetevirens, URSS.

Observation: Illustration from Urtica laetevirens Max., Far east, Primozskaja, Yhkotov, URSS. Leg. Tranzschel. 14 Sep 1929 (Paratype) PURF 9772.

4. Baeodromus senecionis Sydow, Monographia Uredinearum 3: 549. 1915. Fig. 51.

Syn.: Chrysomyxa senecionis Lagerheim, in sched.

O. Spermogonia subepidermal, globoid, 80-120μ diam.

III. Telia hypophyllous, in round spots 2-8mm in diam, whitish, in groups 1-5mm diam, individual sori 100-150μ diam. Teliospores in rows of 3-5 in each row, subglobous, ovoid, ellipsoid to oblong, angular, hyaline; upper cells mainly globoid, 34-40x23-28μ; lower cells elongated and narrowed at the base, 60-75x14-20μ; wall hyaline 1-2.5μ thick, smooth.

Type: On Senecio sp., Provincia Chimborazo, Yerbas Buenas, Ecuador, Leg. Lagerheim, Sep 1891. PURF 8722.

Host and distribution: (Compositae) Senecio betonicaefolius, Senecio sp., Ecuador.

5. Baeodromus holwayi Arthur, Ann. Mycol. 3: 19. 1905. Fig. 52.

O. Spermogonia epiphyllous, subepidermal, globose, 100-140μ diam.

III. Telia hypophyllous, densely crowded in circular groups 3-5mm across, golden-brown, becoming chestnut-brown. Teliospores united into a solid mass, catenulate, 5-8 in a row, smooth, short cylindrical or oblong, 20-38x20-28μ;

wall golden brown, uniformly thick 1-2.5μ.

Type: On Senecio cinerareoides H. B. K., Nevado de Toluca, Mexico, Leg. E. W. D. Holway 5160. 15 Oct 1903. PUR 57688.

Host and distribution: (Compositae) Senecio cinerareoides, S. argustus, Mexico; S. warscewiczii, Guatemala.

Observation: This species has the largest pigmented spores of Baeodromus on Senecio.

6. Baeodromus albertensis Conners. Buritica & Hennen sp. nov. Fig. 53.

O. Spermogonia non visa.

III. Soris teleutosporiferis hypophyllis vel caulinis, in greges rotundatos vel oblongos 3-9mm, dense dispositis, melleis usque ad brunneum colorem evolventibus minutis, cupulatis, 200-250x100-400μ. Teleutosporis catenatis 6-14 superimpositis, ellipsoideis vel ovatis, 24-30x18-22μ, levibus, pallide brunneis; episporio crasso 2.5-3.5μ.

Type: On Senecio eremophilus, Rich., Delia, Alta, Canada, A. H. Brinkman 5017. 8 Jul 1940. PUR 49724. DAOM 6778.

Host and distribution: (Compositae) Senecio eremophillus, Canada.

Observation: This species has the smallest spores of Baeodromus on Senecio, and the thickest overall cell wall.

7. Baeodromus californicus Arthur, Ann. Mycol. 3: 19. 1905.

Fig. 54.

O. Spermogonia unknown.

III. Telia amphigenous and caulicolous, densely crowded in more or less circular groups, 2-7mm across, golden-brown becoming cinnamon-brown, centrifugal in development. Teliospores united into a solid mass, catenulate 4-8μ spores in a series, smooth, ellipsoid or ovate, 16-20x23-38μ; wall pale cinnamon-brown, 2-3μ thick, 5-8μ above.

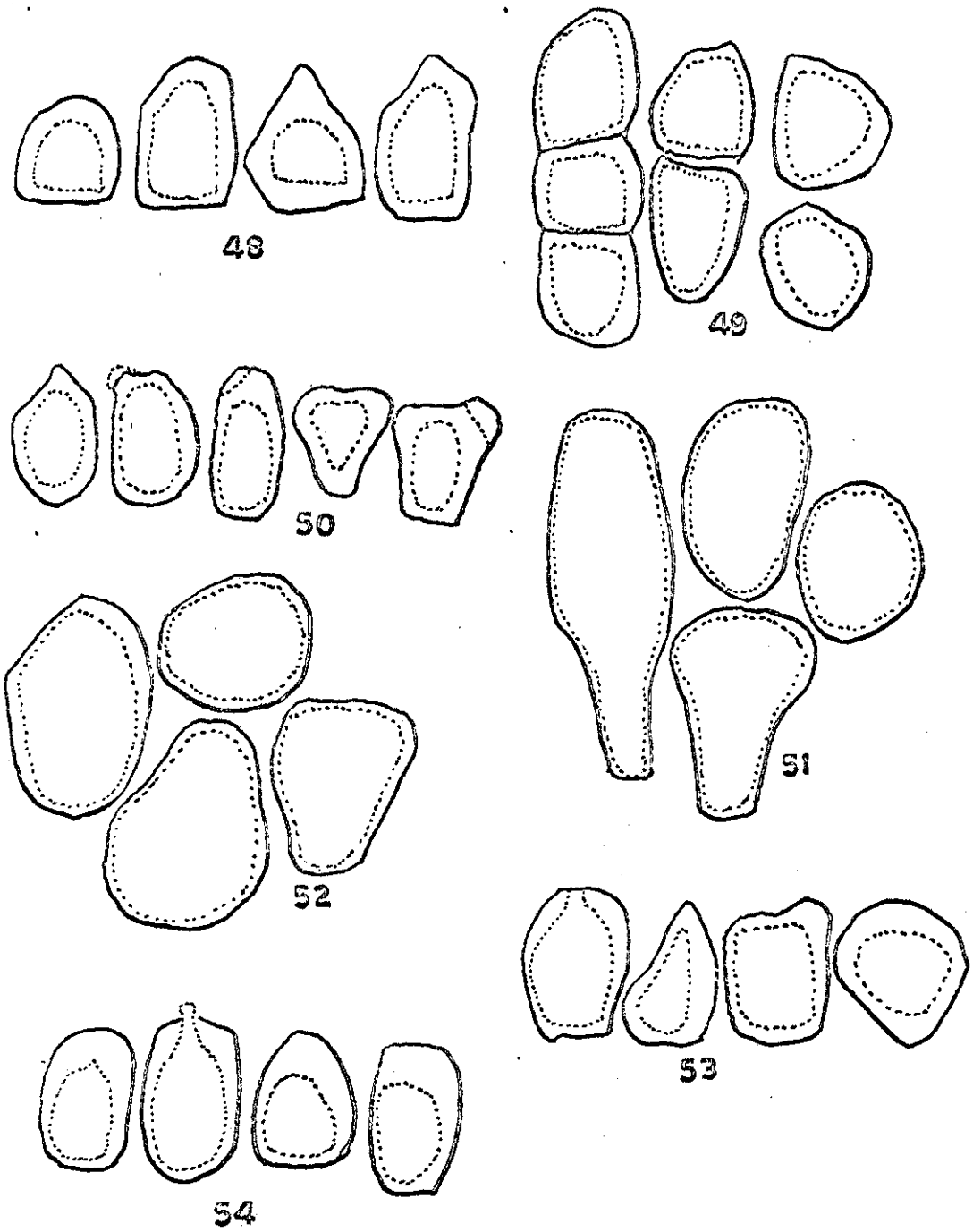
Type: On Senecio douglasii DC., Little Creek, San Bernardino, California, USA, S. B. Parish 2562. 25 Apr 1885. PUR 5785.

Host and distribution: (Compositae) Senecio douglasii, USA.

Observation: Easily differentiated by the thick apical wall of the teliospores.

10. ALVEOLARIA Lagerheim, Ber. Deutsch. Bot. Ges. 9: 346. 1891 (issued 1892).

Spermogonia in the upper surface subcuticular, flat, in the lower surface conical, subepidermal atrophied. Aecia and Uredinia not formed. Telia subepidermal in origin, becoming erumpent as short columns of adherent teliospores; teliospores 1-celled, loosely united terminally but firmly united laterally forming discs of teliospores 1-spore in thickness, germ pore one; epibasidium external. Teliospore development as Alveolaria-type.



Figs. 48-54. Teliospores of Bacodromus spp. Fig. 48. B. eupatorii. Fig. 49. B. dominicana. Fig. 50. B. tranzscheelii. Fig. 51. B. senecionis. Fig. 52. B. holwayi. Fig. 53. B. albertensis. Fig. 54. B. californicus.

Type species: Alveolaria cordiae Lagerheim.

Observation: The spermogonia described by Viegas (l c) from Alveolaria duguetiae on Anonaceae are now known to belong to Dietelia as was mention before. The spermogonia described now are from material of Alveolaria cordiae. They are subcuticular and flat, with spermatia in the upper surface, but conical suepidermal and without spermatia in the lower surface.

Key to the species of Alveolaria

1. Teliospores up to 65µ long ..... 1. A. andina.
1. Teliospores 35-60µ long ..... 2. A. cordiae.

1. Alveolaria andina Lagerheim, Ber. Deutsch. Bot. Ges. 9: 347. 1891. Fig. 55.

O. Spermogonia in lower surface conical, in groups 3-5, without spermatia, surrounded by the telia.

III. Telia hypophyllous, in brown spots 5-10mm diam, subepidermal and later erumpent, arranged in concentric groups, cylindric 0.3-0.8mm long, 150-200µ wide, brown.

Teliospores oblong, 65-90x18-24µ, yellowish, forming discs of 40-100 spores, 1-spore deep; wall 1-2µ thick, 2-4µ at the top.

Type: On Cordia sp., Corazon, Ecuador, Leg. Lagerheim. Oct 1891. PURF 8753.

Host and distribution: (Boraginaceae) Cordia sp., Ecuador.

Type species: Alveolaria cordiae Lagerheim.

Observation: The spermogonia described by Viegas (l c) from Alveolaria duguetiae on Anonaceae are now known to belong to Dietelia as was mention before. The spermogonia described now are from material of Alveolaria cordiae. They are subcuticular and flat, with spermatia in the upper surface, but conical suepidermal and without spermatia in the lower surface.

Key to the species of Alveolaria

1. Teliospores up to 65µ long ..... 1. A. andina.
1. Teliospores 35-60µ long ..... 2. A. cordiae.

1. Alveolaria andina Lagerheim, Ber. Deutsch. Bot. Ges. 9: 347. 1891. Fig. 55.

O. Spermogonia in lower surface conical, in groups 3-5, without spermatia, surrounded by the telia.

III. Telia hypophyllous, in brown spots 5-10mm diam, subepidermal and later erumpent, arranged in concentric groups, cylindric 0.3-0.8mm long, 150-200µ wide, brown.

Teliospores oblong, 65-90x18-24µ, yellowish, forming discs of 40-100 spores, 1-spore deep; wall 1-2µ thick, 2-4µ at the top.

Type: On Cordia sp., Corazon, Ecuador, Leg. Lagerheim. Oct 1891. PURF 8753.

Host and distribution: (Boraginaceae) Cordia sp., Ecuador.

2. Alveolaria cordiae Lagerheim, Ber. Deutsch. Bot. Ges. 9: 346. 1891. Fig. 56.

O. Spermogonia amphigenous, in the upper surface subcuticular, flat, up to 100μ long; in the lower surface usually conical, atrophied; spermatia 19-22x4-5μ.

III. Telia hypophyllous or in petioles, subepidermal in origin, erumpent, columnar 0.1-0.5mm long, 100-150μ wide, in spots 1-5mm wide. Teliospores adhered laterally forming discs 1-spore in thickness; teliospores oblong, 35-62x16-24μ, light-brown; wall 1-2.5μ thick, 2-3μ thick at the top.

Type: On Cordia sp. Playas, Guayas, Ecuador. Leg. Lagerheim, Oct 1890. PURF 8749.

Host and distribution: (Boraginaceae) Cordia corymbosa, Panama; C. cylindrostachya, Bolivia, Jamaica; C. ferruginea, British Honduras, Costa Rica, Guatemala, Mexico, Panama; C. riparia, Guatemala; C. tarmensis, Peru; C. laxiflorae, Colombia; Cordia sp., Bolivia, British Honduras, Costa Rica, Ecuador, Guatemala, Panama, Peru.

11. TRICHOPSORA Lagerheim, Ber. Deutsch. Bot. Ges. 9: 347. 1891 (issued 1892).

Spermogonia subepidermal, globoid. Aecia and uredinia not formed. Telia subepidermal in origin, becoming erumpent as gelatinous hair-like columns. Teliospores catenulate, 1-celled, without germ pores, with intercalary cells that elongate producing pedicel-like cells. Basidiospores

production after septation of the teliospore (internal basidium). Teliospore development as Chardoniella-type.

Type species: Trichopsora tournefortiae Lagerheim.

1. Trichopsora tournefortiae Lagerheim, Ber. Deutsch. Bot. Ges. 9: 347. 1891. Fig. 57.

O. Spermogonia epiphyllous, subepidermal, alone or in irregular groups.

III. Telia found in any part of the shoot, in leaves hypophyllous, in yellow or brown spots 0.5-1cm wide, 3-7 in concentric groups, columnar, hair-like 0.5-3mm long. Teliospores fusiform, 75-100x11-17μ; wall hyaline, 1-1.5μ thick, 5-12μ thicker on one side, minutely verrucose; intercalary cells elongated to form pedicels more than 25μ long, 3-10μ wide at the point of insertion.

Type: On Tournefortia sp., Quito, Ecuador. Leg. Lagerheim, Jan 1890. PURF 9719.

Host and distribution: (Tilliaceae) Tournefortia loxensis, Tournefortia sp., Heliostiospium lanceolatum, Ecuador.

12. CHRYSOCYCLUS Sydow, Ann. Mycol. 23: 322. 1925.

Syn.: Holwayella Jackson, Mycologia 18: 49. 1926.

Chrysella Sydow, Ann. Mycol. 24: 292. 1926.

Spermogonia subepidermal, globoid. Aecia and uredinia not formed. Telia waxy, subepidermal, erumpent. Teliospores 2-celled, producing basidia by prolongation of the cells (basidium neither completely internal nor external),

2. Alveolaria cordiae Lagerheim, Ber. Deutsch. Bot. Ges. 9: 346. 1891. Fig. 56.

O. Spermogonia amphigenous, in the upper surface subcuticular, flat, up to 100μ long; in the lower surface usually conical, atrophied; spermatia 19-22x4-5μ.

III. Telia hypophyllous or in petioles, subepidermal in origin, erumpent, columnar 0.1-0.5mm long, 100-150μ wide, in spots 1-5mm wide. Teliospores adhered laterally forming discs 1-spore in thickness; teliospores oblong, 35-62x16-24μ, light-brown; wall 1-2.5μ thick, 2-3μ thick at the top.

Type: On Cordia sp. Playas, Guayas, Ecuador. Leg. Lagerheim, Oct 1890. PURF 8749.

Host and distribution: (Boraginaceae) Cordia corymbosa, Panama; C. cylindrostachya, Bolivia, Jamaica; C. ferruginea, British Honduras, Costa Rica, Guatemala, Mexico, Panama; C. riparia, Guatemala; C. tarmensis, Peru; C. laxiflorae, Colombia; Cordia sp., Bolivia, British Honduras, Costa Rica, Ecuador, Guatemala, Panama, Peru.

11. TRICHOPSORA Lagerheim, Ber. Deutsch. Bot. Ges. 9: 347. 1891 (issued 1892).

Spermogonia subepidermal, globoid. Aecia and uredinia not formed. Telia subepidermal in origin, becoming erumpent as gelatinous hair-like columns. Teliospores catenulate, 1-celled, without germ pores, with intercalary cells that elongate producing pedicel-like cells. Basidiospores

production after septation of the teliospore (internal basidium). Teliospore development as Chardoniella-type.

Type species: Trichopsora tournefortiae Lagerheim.

1. Trichopsora tournefortiae Lagerheim, Ber. Deutsch. Bot. Ges. 9: 347. 1891. Fig. 57.

O. Spermogonia epiphyllous, subepidermal, alone or in irregular groups.

III. Telia found in any part of the shoot, in leaves hypophyllous, in yellow or brown spots 0.5-1cm wide, 3-7 in concentric groups, columnar, hair-like 0.5-3mm long. Teliospores fusiform, 75-100x11-17μ; wall hyaline, 1-1.5μ thick, 5-12μ thicker on one side, minutely verrucose; intercalary cells elongated to form pedicels more than 25μ long, 3-10μ wide at the point of insertion.

Type: On Tournefortia sp., Quito, Ecuador. Leg. Lagerheim, Jan 1890. PURF 9719.

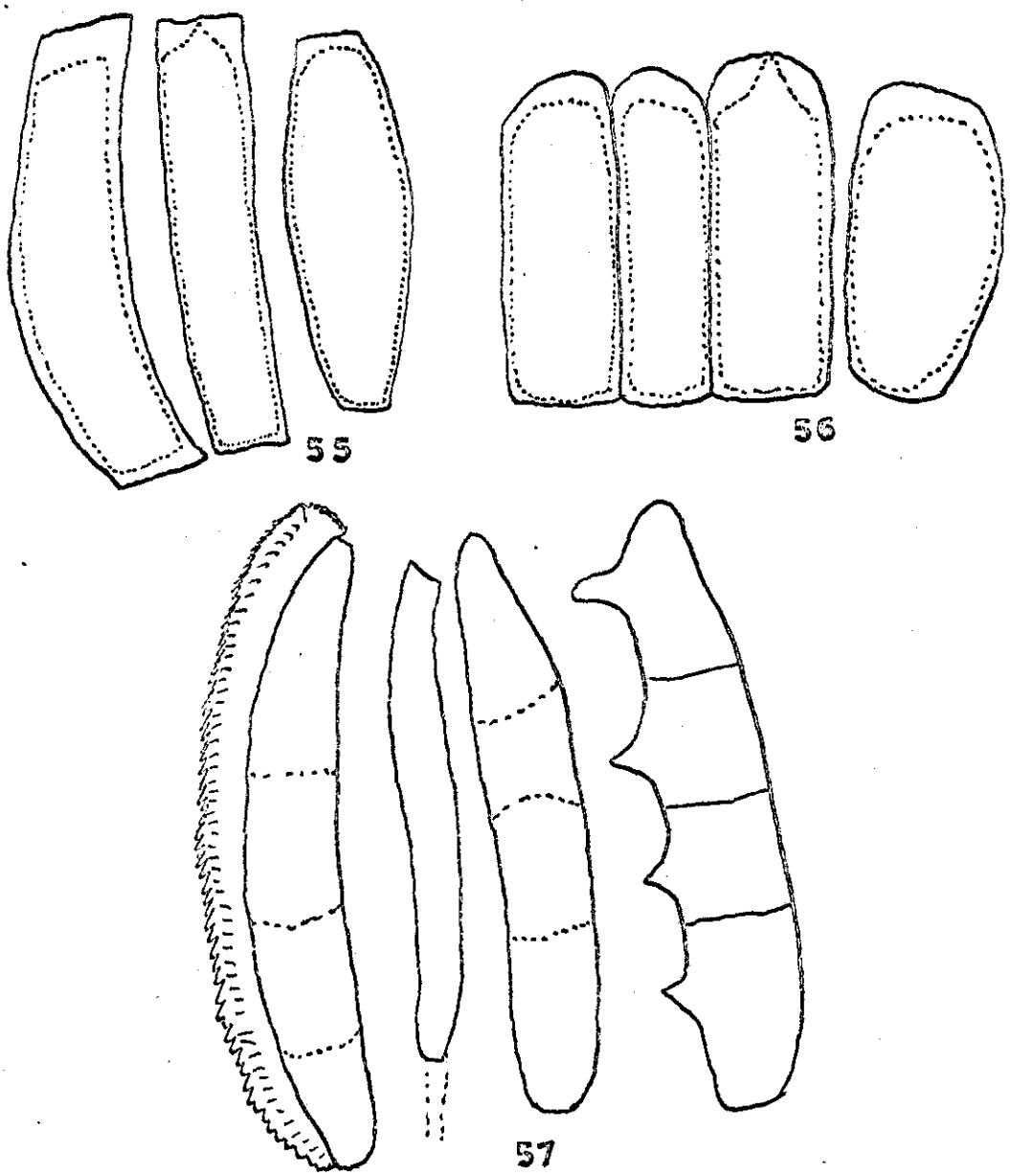
Host and distribution: (Tilliaceae) Tournefortia loxensis, Tournefortia sp., Heliostiospium lanceolatum, Ecuador.

12. CHRYSOCYCLUS Sydow, Ann. Mycol. 23: 322. 1925.

Syn.: Holwayella Jackson, Mycologia 18: 49. 1926.

Chrysella Sydow, Ann. Mycol. 24: 292. 1926.

Spermogonia subepidermal, globoid. Aecia and uredinia not formed. Telia waxy, subepidermal, erumpent. Teliospores 2-celled, producing basidia by prolongation of the cells (basidium neither completely internal nor external),



Figs. 55-56. Teliospores of Alveolaria spp. Fig. 55. A. andina. Fig. 56. A. cordiae. Fig. 57. Teliospores and pedicel of Trichopsora tournefortiae.

pedicelated. Teliospore development as Chrysocyclus-type.

Type species: Chrysocyclus cestri (Diet. & P. Henn.) Sydow.

Observation: Whether the basidium is internal or external has been controversial. The upper cell elongates to produce the basidium, some part remaining as internal. In the lower cell, the basidium is produced by elongation of the cell. In the genus Chrysella, the process of basidium formation is the same as in Chrysocyclus. In early stages of telial formation the two cells are clear, but later, by elongation of the tube that holds the basidium, this basidium is exposed and the articulation remains in the lower part of the sorus. In Chrysella the process of basidium formation is more quick, a characteristic that is not enough to support a separate genus.

Key to the species of Chrysocyclus

1. Teliospores golden, more than 80μ long. 1. C. senecionis.
1. Teliospores hyaline.
  2. Teliospores producing basidium rapidly in both cells ..... 2. C. sydowiana.
  2. Teliospores producing basidium first in the upper cell and later in the lower cell.
    3. Teliospores 60-100μ long ..... 3. C. cestri.
    3. Teliospores 50-60μ long ..... 4. C. mikaniae.

1. Chrysocyclus senecionis Davidson, Mycologia 24: 221. 1932. Fig. 58.

O. Spermogonia hypophyllous, subepidermal, large, globose, 220-300μ diam.

III. Telia hypophyllous on discolored spots 1-1.5cm across, subepidermal, forming concentric circles around the spermogonia, flat, slightly raised, dark cinnamon-brown, waxy in appearance. Teliospores large, biapical, 70-88x22-30μ, apices rounded, constricted at septum; wall uniformly, 2-3μ thick, light-golden; pedicel hyaline 12-18μ thick, once to twice length of spore.

Type: On Senecio sp., Trujillo, Venezuela. Christ 101. 1927. PURF 2276.

Host and distribution: (Composiate) Senecio sp., Venezuela.

Observation: Chrysocyclus sp. described by Jorstad (1959) on Compositae from Venezuela, seems to be C. senecionis. No material was available for comparisons.

2. Chrysocyclus sydowiana Buritica & Hennen, nom. et comb. nov. Fig. 59.

Syn.: Chrysella mikaniae Sydow, Ann. Mycol. 24: 292. 1926.

O. Spermogonia subepidermal, globose.

III. Telia hypophyllous, in brown spots 1-4mm diam, naked, waxy, golden yellow, ruptured epidermis usually conspicuous. Teliospores 2-celled at the beginning, rapid elongation and basidium production occurs in the upper cell, elongation in the lower cell to produce a basidium

supported by a pedicel-like cell, forming a fork-like structure, basidia 50-80x11-14μ, pedicel persistent, long; wall hyaline less than 1μ thick.

Type: On Mikania hirsutissima DC., Los Angeles de San Ramon, Costa Rica, 30 Jan 1925. Sydow, Fungi exotici exsicatti 606. PUR 64912.

Host and distribution: (Compositae) Mikania hirsutissima, Costa Rica.

3. Chrysocyclus cestri (Diet. & P. Henn.) Sydow, Ann. Mycol. 23: 322. 1925. Fig. 60.

Syn.: Puccinia cestri Dietel & P. Hennings, Hedwigia 41: 295. 1902.

Chrysopsora cestri (Diet, & P. Henn.) Arthur, Bull. Torrey Bot. Club 51: 53. 1924.

Puccinia magnifica Lagerheim, in sched.

O. Spermogonia subepidermal, globose, 120-250μ diam.

III. Telia on round spots 2-5mm diam, forming concentric rings, erumpent, waxy, naked, bright-orange. Teliospores fusoid-oblong, hyaline, 60-100x11-16μ; wall hyaline 1μ thick, sometimes 2-4μ thicker at the apex; pedicel long, 6-12μ across.

Type: On Cestrum sp., Serra da Cantareira, Sao Paulo, Brazil. Nov 1900.

Host and distribution: (Solanaceae) Cestrum auranticum, Panama; C. megalophyllum, Costa Rica; C. pubescens, Argentina; C. strigillatum, Peru; C. striolatum, Bolivia;

Cestrum sp., Brazil, Ecuador, Costa Rica, Panama; Solanum warmingi, Brazil.

Observation: Illustration from Cestrum megalophyllum Dun., San Pedro de San Ramon, Costa Rica. Sydow Fungi exotici exsiccati 605. 2 Feb 1925. PUR 47439.

4. Chrysocyclus mikaniae (Arth.) Sydow, Ann. Micol. 23: 324. 1925. Fig. 61.

Syn.: Chrysopsora mikaniae Arthur, Bull. Torrey Bot. Club 51: 54. 1924.

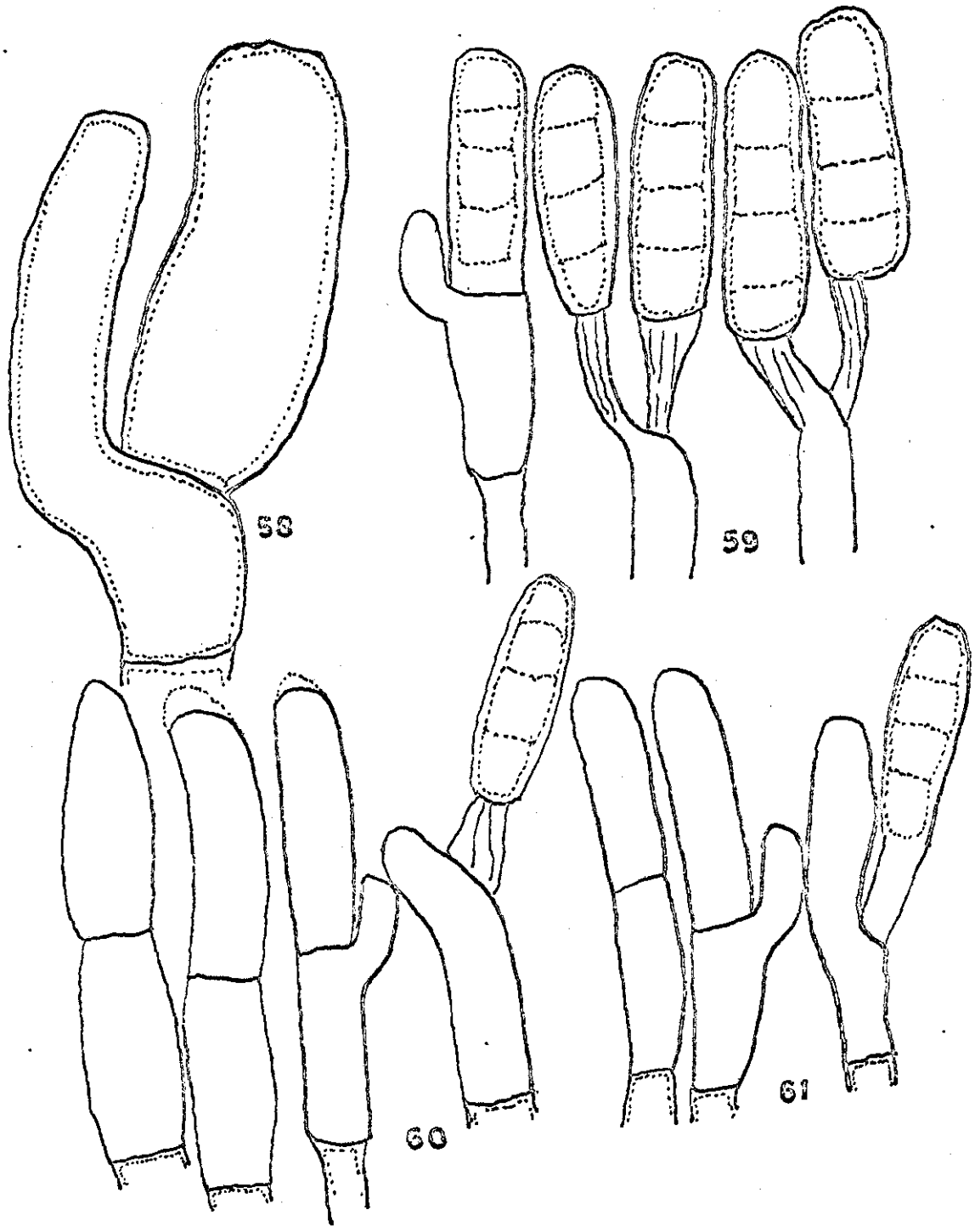
O. Spermogonia epiphyllous, subepidermal, globoid 110-130μ diam.

III. Telia hypophyllous, in annular groups 1.5-4mm across, roundish or oblong, 0.3-1mm long, soon naked, at first waxy and reddish or golden yellow, becoming somewhat pulverulent in appearance and dirty white, ruptured epidermis usually conspicuous. Teliospores cylindric, 52-65x12-16μ, rounded at both ends, not constricted at septum; wall colorless, uniformly thin 1μ thick, smooth; pedicel colorless, fragile, short.

Type: On Mikania buddleiaefolia DC., Therezopolis Rio de Janeiro, Brazil. Leg. E. W. D. Holway 1159. Reliquiae Holwayanae 548. 28 Sep. 1921. PURF 2277.

Host and distribution: (Compositae) Mikania buddleiaefolia, Brazil, Bolivia; Mikania sp., Bolivia, Venezuela.

Observation: The shorter teliospores and pedicel easily separate this species from others.



Figs. 58-61. Teliospores of Chrysocyclus spp. Fig. 58. C. senecionis. Fig. 59. C. sydowiana. Fig. 60. C. cestri. Fig. 61. C. mikaniae.

13. CRYSOPSORA Lagerheim, Ber. Deutsch. Bot. Ges. 9: 345. 1891.

Spermogonia subepidermal, globoid. Aecia and uredinia not formed. Telia subepidermal in origin, becoming erumpent waxy when moist, Teliospores borne singly on pedicels, 2-celled by horizontal sptum, laterally free, basidiospores production by division of the protoplast into a 4-celled internal basidium. Teliospore development as Puccinia-type.

Type species: Chrysopsora gynoxidis Lageheim.

1. Chrysopsora gynoxidis Lagerheim, Ber. Deutsch. Bot. Ges. 9: 345. 1891.

O. Spermogonia epiphyllous, rounded, subepidermal, 120-240 diam.

III. Telia hypophyllous in round spots 2-8mm across yellow to yellow-brown, waxy, erumpent, elevated in concentric circles. Teliospores slightly gelatinous, oblong to cylindric, 120-200x27-38 ; wall hyaline 2-4 thick; pedicel very long more than 100 , basidium internal.

Type: Not designated. Original material on Gynoxis pulchella DC., Pichincha, Ecuador. Oct 1891; Gynoxis buxifolia DC., Chimborazo, Ecuador, Sep 1891; Gynoxis laurifoliae, Quito, Ecuador, Jan 1890.

Host and distribution: (Compositae) Gynoxis buxifolia, G. halii, G. laurifoliae, Ecuador; G. hypomalaca, Boliva; G. tomentosissima, Peru; Gynoxis sp., Peru, Ecuador.

14. Puccinia kernella Buritica & Hennen, comb. et nom. nov.

Syn.: Kernia lauricola Thirumalachar, Mycologia 38: 685. 1956. non Kernia Nieuwl. 1916.

Kernella lauricola Thirumalachar, Mycologia 41: 97. 1949.

Sydow (1920) established the genus Xenostele for two rusts that produce sterile aecia and teliospores on Litzea and Actinodaphne (Lauraceae). Teliospores are produced beneath the aecia, which they push out completely. The aecia are composed mainly of compact peridial elements and seem to be sterile. In 1949, Cummins described 10 new species of Puccinia on Lauraceae. These rusts present the same general features as the previous ones, except for the sterile aecia. Cummins (1959) considered the genus Xenostele as synonymous with Puccinia. Thirumalachar (1946, 1949) established the genus Kernella with one species, K. lauricola for another rust on Litzea. This rust produces teliospores in a long column. He stated that this rust does not produce a peridium but it develops as Puccinia. Search in the type material reveals that this rust also has the sterile aecia at the tip of the teliospore column. The deep-seated, non-peridiate telial characteristics and teliospore features place this rust in the same group as Sydow's and Cummins' species. Therefore we transfer Kernella lauricola to Puccinia but since the combination P. lauricola

is preempted by P. lauricola Cummins, we provide a new name, P. kernella, for this taxon.

Some of the taxonomic problems in this group of rusts on Lauraceae are probably due to lack of critical field observations and collections throughout the rust growing season. If sterile aecidioid caps over young telia are formed, they probably are produced only early in the growing season. As the season progresses, they are completely pushed off so that in mature sori, no signs of them remain. Also, telial development is probably highly influenced by environmental conditions, which greatly influences the length of telial columns.

IV. TELIOSPORE DEVELOPMENT AND EVOLUTION

1. Development

Recently studies of spore ontogeny in different fungi have progressed rapidly. These studies have had important implications in theories of classification and evolution. In rusts in general little is known about teliospore ontogeny.

During this taxonomic revision of rust genera with reduced life cycle, I determined some information about teliospore ontogeny in some genera. The information was collected by microscopic examination of free-hand sections mounted and heated to boiling in chloral hydrate, sometimes adding cotton-blue or lacto-fucshin. Based on these findings, I present an hypothesis of evolution for some of the genera.

In these genera, sporogenous cells form an hymenial layer located at the base of the telium. Teliospores are produced in chains by basipetal division of the sporogenous cells. The teliospore initial undergoes a further division to produce two unequal cells, a small proximal intercalary cell and a larger distal teliospore cell. The chain of teliospores is equivalent to catenulate meristem arthrospores (Hughes, 1953, 1970).

Further processes of differentiation and maturation of teliospores or intercalary cells vary, depending upon the particular species. The following eight types were found.

1. Endophyllum-type: This group includes Endophyllum, Kunkelia, and Dietelia. Teliospores are one-celled. Intercalary cells are evident in the early stages of the chain, but later disappear. I could not trace the process of disappearance of intercalary cells. I presume that they may either: 1. Aid in the dissemination of the teliospores, acting as disjunctive cells, or 2. provide the glue to maintain the compact telia, or 3. be transformed into auxiliary elements that are used in dissemination (refractive granules ?).

2. Ceratocoma-type: (Fig. 64). In this rust teliospores are one-celled but intercalary cells remain in the chain throughout the telia. In mature telia, teliospores and intercalary cells are cemented together.

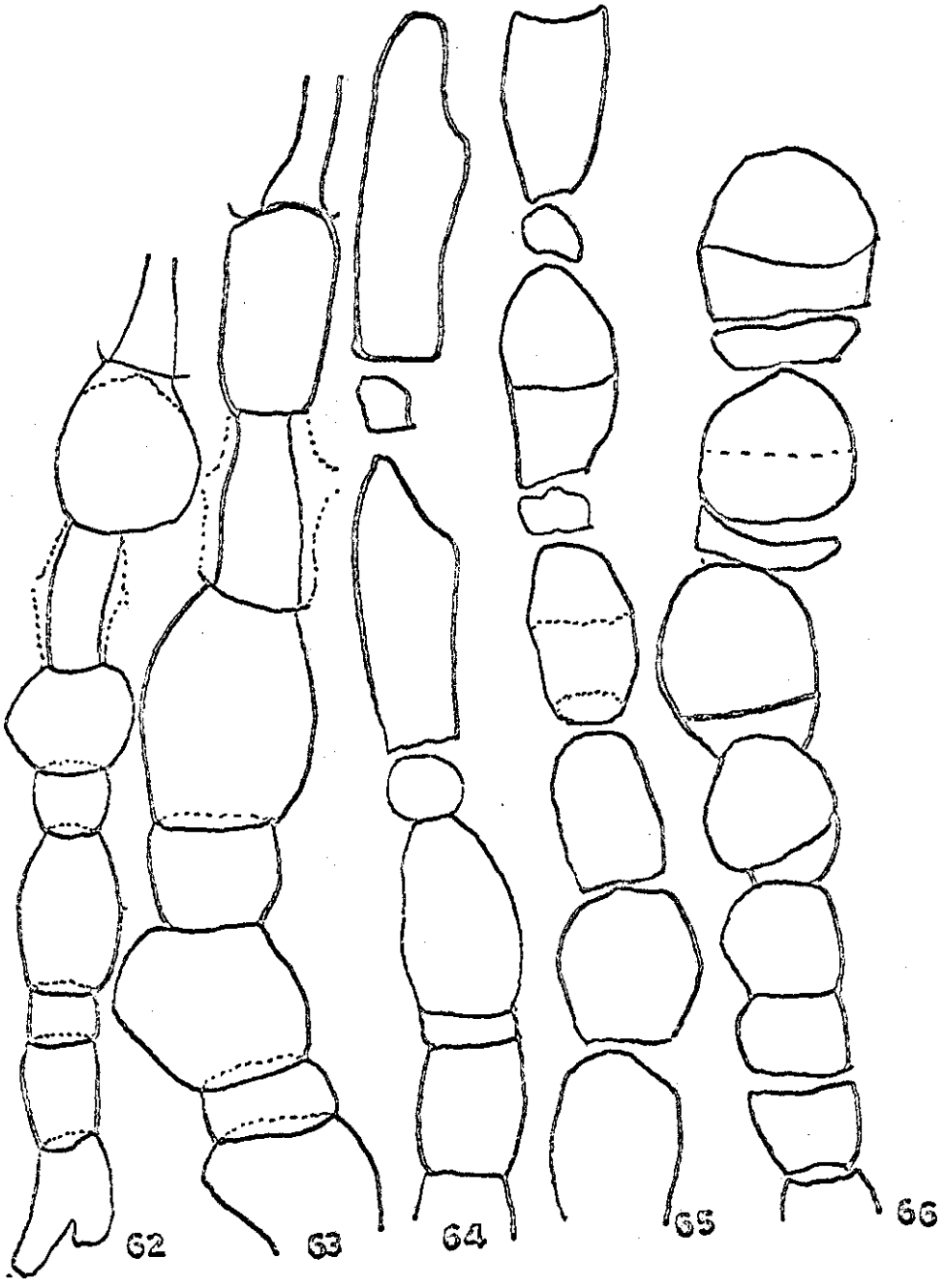
3. Chardoniella-type: (Figs. 62, 63). This group includes Chardoniella and Trichopsora. Teliospores are one-celled and after production they elongate. The outer wall of teliospores usually is thicker at the top, providing free space for the future germination of the teliospore. The intercalary cells undergo several changes. Initially they are globoid, later as they start to elongate along with the teliospore, the outer part of the cell wall breaks and the

inner part continues the process of elongation. They remain attached to the other teliospores above and below in the column. After the process of elongation, the intercalary cell has been transformed into a pedicel.

4. Pucciniosira-type: (Figs. 65, 66). This group includes Pucciniosira and Didymopsora. The teliospore initial undergoes two divisions. One, that produces the intercalary and the other that produces a two-celled teliospore. In this group, the two cells of the teliospores usually separate during the process of elongation. The intercalary cells usually dissappear, except in the species in Berberis, which produce a very compact telia.

5. Alveolaria-type: The mechanism in this rust does not differ from the Endophyllum-type, except that the teliospore initials are produced synchronously by the sporogenous cells, producing a telium with teliospores in horizontal layers. Teliospores are united laterally. Once teliospores germinate, the upper layer is pushed out.

6. Cionothrix-type: This group includes Cionothrix and Baeodromus, but is an arbitrary group. It includes species that have the same pattern as the Pucciniosira-type and others that are probably not related with the group. Intercalary cells were not found in some of them. The hymenium of sporogenous cells is not organized in layers. Thus, mature teliospores are located in the telia without a definite pattern. The fact that intercalary cells are



Figs. 62-66. Initial stages of teliospore development in five genera of microcyclic rusts. Fig. 62. Chardoniella. Fig. 63. Trichopsora. Fig. 64. Ceratocoma. Fig. 65. Puccioniosira. Fig. 66. Didymopsora.

absent in some of the species of Baeodromus shows that the genus probably contains species that have evolved telia that are similar to the telia of the Aecidium-line but by the process of convergent evolution.

7. Chrysocyclus-type: (Fig. 67). Teliospores of this rust are not produced in chains. The sporogenous cell branches producing two (or more) teliospore initials. A septum forms between the sporogenous cell and a teliospore initial. A teliospore initial undergoes one division to produce a lower cell, which after elongation forms the pedicel, and an upper cell, the teliospore itself. The young teliospore undergoes a new division to produce a two-celled teliospore. Once a septum appears in a teliospore, the spore may remain as such for a short time or both the upper and lower cell may begin elongation. The upper cell elongates and septates to form the epibasidium. The epibasidium is now separate from the lower part of the original cell. During the formation of the epibasidium 4 septa appear. The lowest cell formed is transformed into a pedicel-like structure, separating the upper part of the epibasidium from the lower part, and at the same time by elongation holds the epibasidium above the lower compact layer of young teliospores. The epibasidium, which holds the basidiospores, is not curved but remains straight. At the same time the lower cell has produced its internal epibasidium in a similar manner. The process described above does not fit the traditional concepts

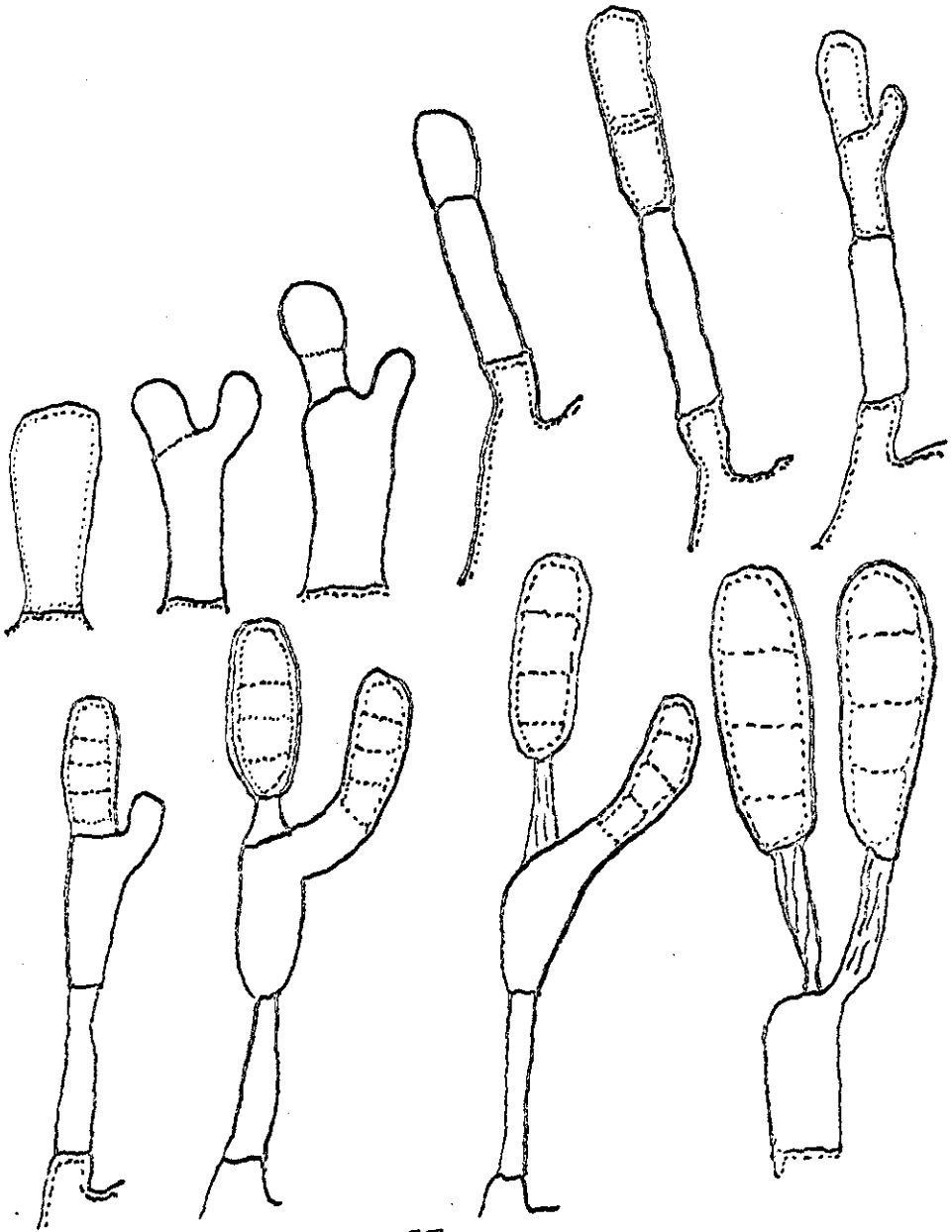


Fig. 67. Sequential stages of teliospore development in Chrysocyclus.

of teliospore germination, because in Chrysocyclus teliospores do not strictly germinate and the basidia are not strictly internal.

8. Chrysopsora-type: This type is similar to teliospore development in Puccinia but the cells of the teliospores septate to produce internal basidia.

2. Evolution

Usually, natural groups of rust fungi are determined mainly by comparative ontogeny and morphology. My taxonomic studies of rusts with reduced life cycle have necessarily involved comparative ontogeny and morphology and have led to the general hypothesis that the genera, Endophyllum, Dietelia, Trichopsora, Ceratocoma, Chardoniella, Alveolaria, Cionothrix, Pucciniosira, Didymopsora, and Baeodromus are related to a common acestral Aecidium-type of structure. Jackson (1931) previously suggested a similar hypothesis but did not detail the characteristics of the species.

This hypothesis may be expanded as follows. Once the teliospore function was present in Aecidium-like structures, evolution proceeded along the following line. At the beginning, these rusts were of the Endophyllum-type, with peridium, intercalary cells and Aecidium-type spores. The first change noted is in the peridium. It tends to disappear in tropical species or to be stronger in temperate species. Teliospores change also. Their cell walls become thicker and lose their ornamentation. Sometimes pigmentation

appears. Teliospores become larger and telia change to more compact structures. After these primary changes two lines appear; one producing teliospores with two cells and the other producing teliospores with one cell.

The line with two-celled teliospores includes Pucciniosira, Didymopsora and Baeodromus (in part). In Pucciniosira, the peridium is evident, but degenerate as compared to Endophyllum. The telial column is firm and compact in specimens of tropical high altitude or temperate areas but loose in tropical species.

In Didymopsora a peridium is not formed and teliospores have a tendency to separate. Characteristics that resemble Didymopsora occur in some of the species of Baeodromus, with the only difference being the strongly compact telia, which is common in species from a temperate climate. In these genera, species with compact telia produce teliospores that are not ornamented and species with pulverulent telia produce teliospores that are ornamented. The line is from species with peridium to species without peridium: Pucciniosira to Didymopsora to Baeodromus.

The line of one-celled teliospores is similar to the two-celled teliospore line. First, in Ceratocoma there is no peridium but intercalary cells are present throughout the telia. In Alveolaria the sporogenous cells produce teliospores and intercalary cells synchronously. The teliospores adhere laterally, intercalary cells become

loose; thus the teliospores appear as plates. Probably, these features are adaptative to environmental conditions.

Later, Chardoniella and Trichopsora have intercalary cells that are modified into pedicels. There is no peridium and the telia are compact. These rusts are prevalent at high altitudes in the tropics where a more temperate environment occurs, but without extreme conditions of temperature. Teliospores do not germinate immediately after formation. The hot and humid tropical version of this group is the genus Cionothrix, which has no peridium, intercalary cells are evident only at the base, and the teliospore cell walls are thin and hyaline. Germination occurs immediately after teliospore formation.

Figure 68 shows the theoretical phylogenetic relations of this group.

The phylogenetic position of the hosts of these rust genera provides additional support for this theory. The most advanced genera, Cionothrix, Chardoniella, and Baeodromus, parasitize members of the Compositae, while the Solanaceae or Tiliaceae support members of one or more less advanced genera, i.e. the progressive evolution of Puccinio-sira to Didymopsora can be seen in these plant families.

In summary this is a phylogenetically related rust group that shows evolutionary differentiation along several lines but each tracing back to a common ancestral form, Aecidium.

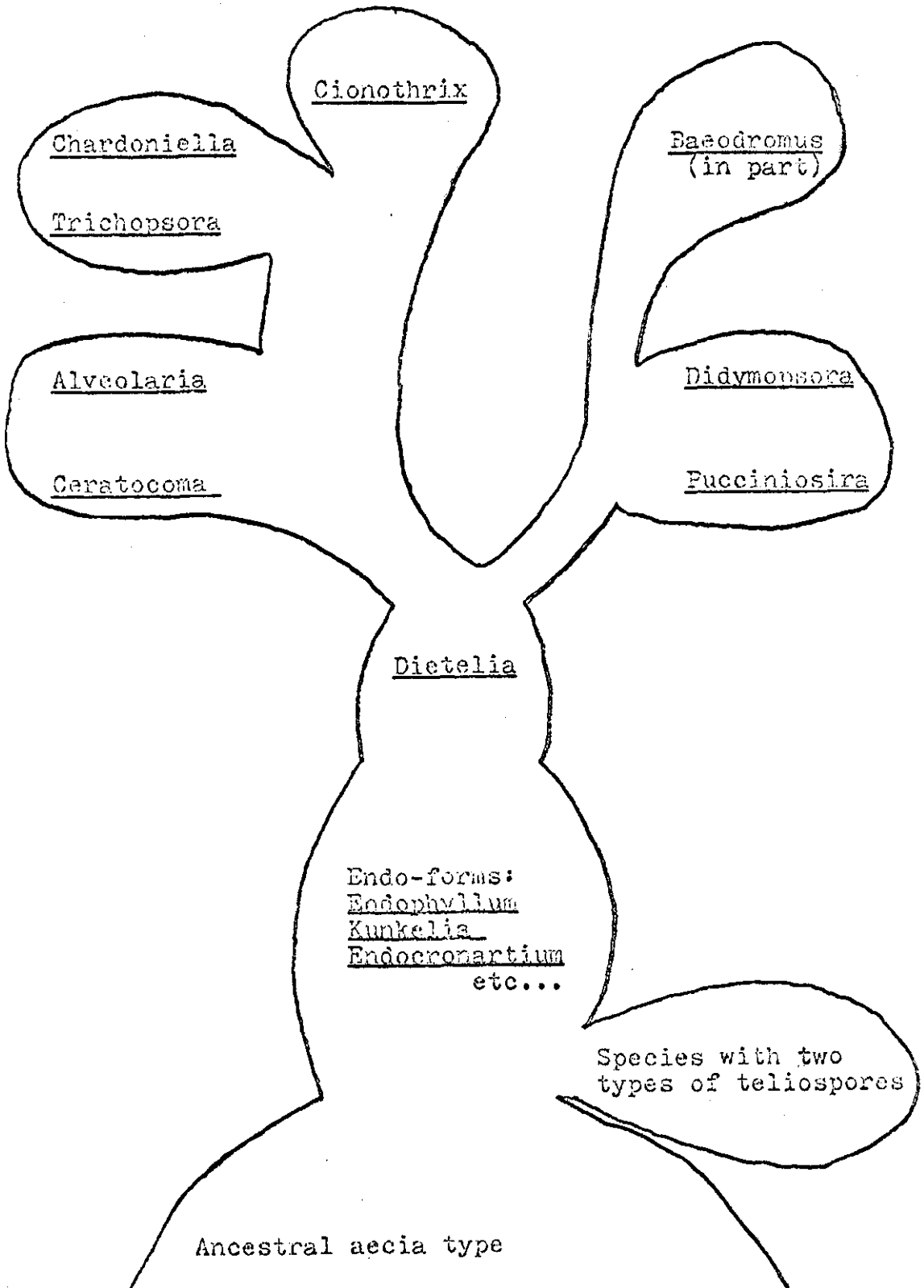


Fig. 68. Evolutionary relationships of some microcyclic rusts genera.

V. CONCLUSIONS

Definitive criteria were developed to give a clear taxonomic position for all of the genera studied. The following easily determinable, morphological characteristics proved to be the most useful: presence or absence of peridia, intercalary cells, and pedicels; the number of cells in the teliospores, and the type of basidium. Because some characteristics may vary depending upon the developmental stage of the rust and environmental conditions during development, it is important to attempt to study specimens with all stages present.

The telial developmental studies presented here show clearly the relationships of the genera treated in this group. Since they can all be shown to be related to the Aecidium-type of development, this group can be considered to be a phylogenetically related or "natural" group of rusts. These kinds of studies must be continued for other genera of rusts to determine more convincingly their relationships.

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VII. LITERATURE CITED

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VITA

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