

TABLE 11. Measurements of the uredospores of *Melampsorium Alni* (THÜM.) DIET. on various host plants

Hosts	Materials	Length (in μ)	Width (in μ)
<i>Alnus alnobetula</i> var. <i>fruticosa</i>	Ienisseisk, Siberia, leg. KYTAMANOW	30~41.25	10~15
<i>Alnus alnobetula</i> var. <i>fruticosa</i>	Kansk, Siberia, Sept., 1926, leg. KATAJEMSKAJA	30~42	10~15
<i>Alnus alnobetula</i> var. <i>fruticosa</i>	Sapporo, Ishikari, Japan, Aug., 1925, leg. HIRATSUKA, f.	32.5~42.5	11.25~15
<i>Alnus alnobetula</i> var. <i>sachalinensis</i>	Shisuka, S. Saghalien, Japan, Aug., 1928, leg. HIRATSUKA, f.	30~41.25	10~13.75
<i>Alnus firma</i> var. <i>hirtella</i>	Mt. Hakkôda, Mutsu, Japan, Sept., 1926, leg. S. Itô & HIRATSUKA, f.	27.5~40	10~15
<i>Alnus firma</i> var. <i>Sieboldiana</i>	Mt. Tsurugi, Awa, Japan, Aug., 1928, leg. T. YOSHINAGA	30~45	11.25~17.5
<i>Alnus firma</i> var. <i>Sieboldiana</i>	Tottori, Inaba, Japan, Nov., 1931, leg. HIRATSUKA, f.	30~42	10~15
<i>Alnus firma</i> var. <i>Sieboldiana</i>	Mt. Tsubakuro-dake, Shinano, Japan, Aug. 1930, leg. HIRATSUKA, f.	30~45	10~17.5
<i>Alnus pendula</i>	Zenibako, Shiribeshi, Japan, Dec., 1925, leg. HIRATSUKA, f.	27.5~42.5	10~13.75
<i>Alnus pendula</i>	Kyoto, Yamashiro, Japan, Oct., 1924, leg. K. TOGASHI	23.75~38.75	10~15

Melampsorium Alni was also confused with another species on *Alnus*, *Melampsorium Hiratsukanum* Itô for a long time. But it differs distinctly from the latter species in respect to the shorter ostiolar cells of peridia in the uredosori and the longer uredospores with a spineless portion.

This species was first recorded from this country by KUSANO in 1902 based upon a collection on *Alnus firma* var. *Sieboldiana* in the province of Idzu. The writer from 1927 to 1935 reported collections of this species from various districts of Hokkaidô, Honshû, Shikoku, Kiushû and South Saghalien. This is one of the most widely distributed species in Japan.

In 1925, 1926 and 1927, the writer made successful inoculation experiments on the needles of *Larix dahurica* var. *japonica*, *L. euro-*

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paea and *L. Kaempferi* with sporidia from *Alnus alnobetula* var. *fruticosa*. And he also succeeded in inoculating the sporidia from *Alnus pendula* on *Larix Kaempferi* in 1927 and 1931.

2. *Melampsorium betulinum* (DESM.) KLEBAHN in Zeitschr. f. Pflanzenkr. IX, p. 22, 1899; Kryptogamenfl. Mark Brandenbr. Va, p. 816; ARTHUR, Manual of the rusts in United States and Canada, p. 22; BUBÁK, Rostpilze Böhmens, p. 210; CUNNINGHAM in Transact. New Zealand Inst. IV, p. 29, 1924; Rust fungi of New Zealand, p. 115; DIETEL in ENGLER-PRANTL, Natürl. Pflanzenfam. I, 1. Abt.***, p. 550, 1900; II. Aufl. VI, p. 41, 1928; FISCHER, Ured. Schw. p. 512; FRAGOSO, Fl. Ibér. Ured. II, p. 246; GROVE, Brit. Rust Fungi, p. 358; HARIOT, Ured. p. 264; MIGULA, Krypt.-Fl. III, 1, p. 487; SACCARDO, Syll. Fung. XVII, p. 464; P. & H. SYDOW, Monogr. Ured. III, p. 425; TROTTER, Fl. Ital. Crypt. Ured. p. 421.

Syn. *Uredo populina* PERSOON var. *betulina* PERSOON, Syn. Fung. p. 219, 1801.

Uredo Betulae SCHUMACHER, Enum. Pl. Saell. II, p. 228, 1803.

Uredo ovata STRAUSS var. *Betulae* STRAUSS in Ann. Wett. Ges. II, p. 93, 1810.

Uredo longicapsula de CANDOLLE var. *betulina* de CANDOLLE in Fl. franç. VI, p. 84, 1815.

Sclerotium betulinum FRIES, Syst. Myc. II, p. 262, 1822.

Caeoma betulinum SCHLECHTENDAL in Fl. Berol. II, p. 119, 1824.

Caeoma cylindricum LINK, Sp. Pl. II, p. 39, 1825, p.p.

Erysibe betulina WALLROTH, Fl. Crypt. Germ. II, p. 196, 1833.

Sclerotium Betulae LIBERT in Pl. Crypt. Arn. Cent. IV, no. 336, 1837.

Melampsora betulina DESMAZIÈRES, Pl. Crypt. no. 2047, 1850; COOKE, Handb. Brit. Fung. II, p. 522, 1871; KARSTEN, Myc. Fenn. IV, p. 53, 1879; KICHX, Fl. Crypt. Flandr. p. 50, 1869; LIRO, Ured. Fenn. p. 522; OUDEMANS, Rév. Champ. I, p. 507, 1892.

Melampsora betulina TULASNE in Ann. Sci. Nat. IV. Sér. II, p. 97, 1854; DIETEL in ENGLER-PRANTL, Natürl. Pflanzenfam. I, 1. Abt.***, p. 44, 1897; FÜCKEL, Symb. Myc. p. 44, 1870; SACCARDO, Syll. Fung. VII, p. 592; SCHRÖTER, Pilze Schles. I, p. 363.

Melampsora betulina WINTER in Pilze Deutschl. I, p. 238, 1881; MASSALONGO, Ured. Veron. p. 55, 1883; PLOWRIGHT, Monogr. Ured. & Ustil. p. 243.

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Aecidium Laricis KLEBAHN in Zeitschr. f. Pflanzenkr. IX, p. 18 & 21, 1899.

Peridermium Laricis ARTHUR et KERN in Bull. Torr. Bot. Club, XXXIII, p. 436, 1906.

Melampsorium Betulae ARTHUR in N. Amer. Fl. VII, p. 110, 1907.

Icon. ARTHUR, Manual of the rusts in United States and Canada, fig. 32; BRIOSI & CAVARA, Fung. parass. no. 31; BUBÁK, l. c. fig. 58; CLINTON in Rept. Connecticut Agric. Exper. Stat. (1907-1908), pl. XXXI (b), 1908; COOKE, l. c. fig. 212; CUNNINGHAM in Transact. New Zealand Inst. LV, fig. 100; Rust fungi of New Zealand, fig. 18 (b) & fig. 24; DELACROIX & MAUBLANC, Malad. pl. cult. malad. parasit. pl. XXX, fig. 8, 1909; DIETEL in Jahresber. Ver. f. Naturk. Zwickau (1928-1930), p. (5), text-fig., 1930; FISCHER, l. c. fig. 320; FRAGOSO, l. c. fig. 119 & 120; GROVE, l. c. fig. 37, 267 & 268; HARIOT, l. c. fig. 35; HILLEY, Fung. Dis. of Common Larch, fig. 72, 1919; KLEBAHN in Zeitschr. f. Pflanzenkr. IX, p. 19, fig. 1, 1899; Kryptogamenfl. Mark Brandenbr. Va, p. 828, fig. P, 1 (I-X); MIGULA, l. c. pl. XI, B, fig. 1 & 2; PLOWRIGHT, l. c. pl. IV, fig. 8; ROSTRUP, Plantepat. fig. 118, 1902; SAPPIN-TROUFFY in Le Botaniste, V, p. 166, fig. 56 & p. 168, fig. 57, 1896; TROTTER, l. c. fig. 35 & 108; TULASNE, l. c. pl. VII, fig. 8 & 9; pl. VIII, fig. 10-12; WINTER, l. c. p. 138, fig. 1 & 2.

Spermogonia on needles of current season, amphigenous, rather numerous, scattered, subcuticular, pale yellow, flattened-conical, $50 \sim 65 \times 20 \sim 30 \mu$; spermatia oval, $1.5 \sim 2 \mu$.

Aecidia on needles of current season, hypophyllous, subepidermal, solitary or in rows on one or both sides of the midrib, flattened laterally or subcylindrical, $0.1 \sim 1.5$ mm wide, $0.3 \sim 1$ mm long, $0.3 \sim 0.5$ mm high; peridia light reddish-orange fading to white, rupturing along the apical line; peridial cells small, rhomboidal in longitudinal section, $25 \sim 30 \mu$ long, somewhat overlapping, inner walls finely verrucose, transversely striate, $2 \sim 3 \mu$ thick, outer of equal thickness, smooth; aecidiospores globose, subglobose or broadly ellipsoidal, $16 \sim 25 \times 12 \sim 18 \mu$; epispore colourless, rather thin ($1 \sim 1.5 \mu$), closely and evenly verrucose, except a small area on one side which is smooth and slightly thinner.

Uredosori hypophyllous, subepidermal, scattered or aggregate, sometimes over the whole surface of the leaf, round, small, $0.12 \sim 0.5$ mm across, yellow to reddish yellow in colour, at last somewhat

pulverulent; peridia hemispherical, firm; upper peridial cells small, isodiametrically to irregularly polygonal, $8 \sim 18 \mu$ across, lateral ones radially elongate, walls of peridial cells smooth, rather thin; ostiolar cells ovate-conical, extending into an acute spiny apex; uredospores ellipsoidal, oblong or oblong-clavate, sometimes somewhat polygonal, $19.8 \sim 36 \times 9 \sim 14.4 \mu$; epispore rather thin, sparsely echinulate except which is naked; rudimentary paraphyses intermixed.

Teleutosori hypophyllous, subepidermal, scattered or often covering the surface of the leaf, waxy yellow to yellowish brown and finally brownish black in colour; teleutospores one celled, oblong, oblong-clavate or prismatic in a palisade-like layer beneath the epidermis, $32.4 \sim 48.5 \times 7.2 \sim 16.2 \mu$; epispore nearly colourless, thin, $1 \sim 1.2 \mu$ thick, slightly thicker at apex, smooth. (Plate VII, fig. 5)

Hosts and Distribution

FOR THE AECIDIAL STAGE:

Larix europaea DC. (*L. decidua* MILL.) (ARTHUR & KERN 1906, p. 437; BUBÁK 1908, p. 210; FRAGOSO 1925, p. 248; GROVE 1913, p. 359; KLEBAHN 1914, p. 818; MIGULA 1910, p. 488; SEYMOUR 1929, p. 49; P. & H. SYDOW 1915, p. 427; TROTTER 1914, p. 422; WILSON 1934, p. 424)—Germany, Great Britain.

Larix Kaempferi SARG. (*L. leptolepis* GORD.) (WILSON 1934, p. 424)—Great Britain.

Larix laricina KOCH (*L. americana* MICHX.) (ARTHUR 1925, p. 680; 1934, p. 22; DAVIS 1914, p. 913; RHOADS, HEDGCOCK, BETHAL & HARTLEY 1918, p. 330; SEYMOUR 1929, p. 49)—Connecticut, Wisconsin.

Larix sibirica LEDEB.—Altai (W. Siberia).

FOR THE UREDO- AND TELEUTOSTAGE:

Betula alba L. & var. (*B. aetnensis* RAFIN., *B. carpathica* WALDST. et KIT., *B. glutinosa* WALLR., *B. laciniata* BLOM., *B. odorata* BECHST., *B. pubescens* EHRH., *B. verrucosa* EHRH.) (BECK 1889, p. 600; BUBÁK 1897, p. 4; 1898, p. 4 & 18; 1899, p. 20; 1908, p. 210; CONSTANTINEANU 1920, p. 441; COOKE 1871, p. 522; CUNNINGHAM 1924, p. 29; 1931, p. 115; DIETEL 1890, p. 47; ELIASSON 1897, p. 4; FISCHER 1904, p. 514 & 515; FRAGOSO 1925, p. 248; FÜCKEL 1870, p. 44; GOBI & TRANZSCHEL 1891, p. 104; GREBELSKY 1915, p. 646; GROVE 1913, p. 359; JAAP 1900, p. 264; 1904, p. 130; 1907b, p. 172; 1911, p. 334; 1914a, p. 20; 1914b, p. 432; 1917, p. 115; JØRSTAD 1921, p. 15; 1923b, p. 18; 1925, p. 124; 1935, p. 64; KARSTEN 1879, p. 54;

KICHX 1867, p. 50; KLEBAHN 1899, p. 20; 1914, p. 818; KLIKA 1926, p. 30; LAMBOTTE 1880, p. 67; LARSEN 1932, p. 511; LAUBERT 1921, p. 241; LEPIK 1928, p. 24; LIND 1913, p. 292; 1934, p. 107; LIRO 1908, p. 524; MAGNUS 1892, p. 3; 1890, p. 30; 1894, p. 54; MASSALONGO 1883, p. 58; MIGULA 1910, p. 488; OUDEMANS 1892, p. 507; PETRAK 1920, p. 132; 1927, p. 345; PICBAUER 1929, p. 11; PLOWRIGHT 1889, p. 244; POEVERLEIN 1926, p. [39]; POEVERLEIN & BERTSCH 1927, p. 194; RAINIO 1926, p. 254; SCHRÖTER 1887, p. 363; SEYMOUR 1929, p. 222; SIEMASZKO 1923a, p. 23; 1923b, p. 14; P. & H. SYDOW 1915, p. 427; THÜMEN 1878, p. 226; TRANZSCHEL 1900, p. 189; TRAVERSO 1912, p. 17; TROTTER 1914, p. 422; TURCONI 1908, p. 118; VOSS 1876, p. 111; 1878, p. 90; 1889, p. 335; WETTSTEIN 1885, p. 550; WILSON 1934, p. 424; WINTER 1881, p. 238; WRÓBLEWSKI 1916, p. 101)—Norway, Sweden, Denmark, Germany, Finland, Russia, Switzerland, Czechoslovakia, Italy, France, Belgium, Great Britain, Poland, Rumania, Austria, Caucasus; New Zealand.

Betula davurica PALL. (KLEBAHN 1914, p. 818)—Germany.

Betula excisa (P. & H. SYDOW 1915, p. 427)

Betula Ermani CHAM. & var. (DIETEL 1905b, p. 104; HIRATSUKA, f. 1929c p. 61; 1930a, p. 80; 1933a, p. 147; ITÔ & HIRATSUKA, f. 1927, p. 268; JØRSTAD 1934, p. 21; TOGASHI & ÔNUMA 1934, p. 16; TRANZSCHEL 1914, p. 555)—Kamtchatka, Japan.

Betula glandulosa MICHX. (ARTHUR 1907, p. 110; 1927, p. 818; 1934, p. 22; HOTSON 1925, p. 293; 1934, p. 22; SEYMOUR 1929, p. 223; P. & H. SYDOW 1915, p. 427)—Washington, Idaho, Montana.

Betula Gmelini BUNGE (*B. fruticosa* PALL.) (KLEBAHN 1914, p. 819; LIND 1913, p. 292; P. & H. SYDOW 1915, p. 427)—Denmark, Germany.

Betula humilis SCHRANK (GOBI & TRANZSCHEL 1891, p. 104; KLEBAHN 1914, p. 818; POEVERLEIN & BERTSCH 1927, p. 194; P. & H. SYDOW 1915, p. 427; TRANZSCHEL 1900, p. 189; WINTER 1881, p. 239)—Germany, Poland, Russia; Altai.

Betula japonica SIEB. (*B. alba* L. var. *japonica* MIQ., *B. verrucosa* var. *japonica* HENRY) (HIRATSUKA, f. 1927b, p. 235; 1927c, p. 301; 1928a, p. 29; 1929c, p. 61; 1930a, p. 80; P. & H. SYDOW 1913, p. 110)—Japan.

Betula kenaica W. H. EVANS (ARTHUR 1925, p. 680; 1934, p. 22; SEYMOUR 1929, p. 223)—Alaska.

Betula lenta L. (SEYMOUR 1929, p. 224)

Betula lutea MICHX. (ARTHUR 1907, p. 110; 1927, p. 818; 1934, p. 22; SEYMOUR 1929, p. 224; P. & H. SYDOW 1915, p. 427)—Indiana, Maine, Ohio, New Hampshire, Vermont.

Betula Maximowicziana RGL. (HIRATSUKA, f. 1928b, p. 504; P. & H. SYDOW 1913, p. 110; 1915, p. 427)—Japan.

Betula Middendorffii TRAUTV. et MEY. (HIRATSUKA, f. 1928a, p. 29; 1929c, p. 61; 1930a, p. 80)—North Saghalien, Japan.

Betula nana L. (GREBELSKY 1915, p. 646; JØRSTAD 1923b, p. 18; 1925, p. 124; 1935, p. 64; KARSTEN 1879, p. 54; KLEBAHN 1914, p. 818; LIND 1934, p. 107; LIRO 1908, p. 524; MIGULA 1910, p. 488; OUDEMANS 1892, p. 508; RAINIO 1926, p. 254; P. & H. SYDOW 1915, p. 427)—Norway, Sweden, Germany, Switzerland, Finland.

Betula nana × *pubescens* (LIRO 1908, p. 524)—Finland.

Betula occidentalis HOOK. (ARTHUR 1925, p. 680; 1934, p. 22; HOTSON 1934, p. 22; SEYMOUR 1929, p. 226)—Idaho, Montana, Washington.

Betula papyrifera MARSH. (ARTHUR 1925, p. 680; 1934, p. 22; LIRO 1908, p. 524; POVAH 1935, p. 136; SEYMOUR 1929, p. 223; P. & H. SYDOW 1915, p. 427)—Michigan, Connecticut, New Hampshire, Maine; Nova Scotia.

Betula pendula ROTH. (PICBAUER 1933b, p. 66)—Yugoslavia, Switzerland.

Betula platyphylla SUK. (JØRSTAD 1934, p. 21; TRANZSCHEL 1914, p. 555, sub *Betula japonica*)—Kamtchatka.

Betula populifolia MARSH. (ARTHUR 1907, p. 110; 1927, p. 818; 1934, p. 22; CLINTON 1908b, p. 386; PATTERSON 1902, p. 9; SEYMOUR 1929, p. 227; P. & H. SYDOW 1915, p. 427)—Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York; Nova Scotia.

Betula pumila L. (ARTHUR 1907, p. 110; 1934, p. 22; DAVIS 1914, p. 913; KLEBAHN 1914, p. 819; SEYMOUR 1929, p. 228; P. & H. SYDOW 1915, p. 427)—Michigan, Massachusetts; Newfoundland; Germany.

Betula shikokiana NAKAI (HIRATSUKA, f. & YOSHINAGA 1935, p. 258)—Japan.

Betula Soccolowii JACZ. (*B. humilis* var.) (KLEBAHN 1914, p. 819; P. & H. SYDOW 1915, p. 427)—Germany.

Betula tristis WORMSK. (P. & H. SYDOW 1915, p. 427)

Betula turkistanica (P. & H. SYDOW 1915, p. 427)

Exsiccati. FOR THE UREDO- AND TELEUTOSTAGE: ALLESCHER & SCHNABL, Fung. bavar. no. 318; BARTHOLOMEW, Fung. Columb. no. 2534; BARTHOLOMEW, N. Amer. Ured. no. 2213; BRIOSI & CAVARA, Fung. parass. no. 31; COOKE, Fung. brit. I, no. 124; II, no. 62; DESMAZIÈRES, Pl. Crypt. de France, no. 2047; EHRHART, Crypt. exs. no. 219; ELLIS & EVERHART, N. Amer. Fung. no. 2724; ELLIS & EVERHART, Fung. Columb. no. 1374; FÜCKEL, Fung. rhen. no. 299; JAAP, Fung. sel. exs. no. 526; KARSTEN, Fung. fenn. no. 592 & 694; KLOTZSCH, Herb. myc. no. 194; KRIEGER, Fung. saxon. no. 221; KUNZE, Fung. sel. no. 547; LIBERT, Fl. Crypt. Ard. no. 336; LINHART, Fung. hung. no. 333; OUDEMANS, Fung. neerl. no. 12; PETRAK, Fung. Eichl. no. 96; PETRAK, Fl. Bohem. no. 345; RABENHORST, Herb. myc. ed. II, no. 384; RABENHORST, Fung. eur. no. 191; RACIBORSKI, Fung. polon. no. 93; ROUMÈGUÈRE, Fung. gall. no. 320; D. SACCARDO, Myc. ital. no. 440 & 694; SCHMIDT & KUNZE, Crypt., no. 40; SCHNEIDER, Herb. no. 714 & 715; SCHRÖTER, Pilze Schles. no. 640; SEYMOUR & EARLE, Econ. Fung. no. 212 & 213 (a, b); SIEMASZKO, Fung. Bialowiezienses, no. 52; P. & H. SYDOW, Myc. germ. no. 157; P. & H. SYDOW, Myc. march. no. 229, 1813, 3032, 3347, 3348, 4223 & 4224; P. & H. SYDOW, Ured. no. 343, 387, 388, 534, 535, 846, 939, 940, 941, 1629, 1629, 2192 & 2736; THAXTER, Rel. FARL. no. 232 (a, b, c); THÜMEN, Fung. austr. no. 359; THÜMEN, Myc. univ. no. 1047; VESTERGREN, Micromyc. rar. sel. no. 378 & 1360; VIZE, Micr. Fung. no. 140; VIZE, Micr. Fung. brit. no. 230; WESTENDORP, Crypt. no. 1276; Fl. Romaniae exs. no. 8; Fl. exs. Austr.-Hung. no. 3547.

Habitat in Japan

On *Betula Ermani* CHAM. var. *communis* KOIDZ. (*B. Ermani* CHAM. var. *nipponica* MAXIM.) (*Dake-kamba*). Honshû:—Mutsu (Mt. Hakkôda). Rikuchû (Mt. Iwate, Mt. Hayachine). Shimotsuke (Mt. Shirane). Shinano (Mt. Yatsugatake, Mt. Komagatake [Kiso], Mt. Tsubakuro-dake).

On *Betula Ermani* CHAM. var. *genuina* WINKL. (*Yezo-no-dake-kamba*). S. Saghalien:—Shisuka (Shisuka). Motodomari (Shiritori). Hokkaidô:—Ishikari (Sapporo). Shiribeshi (Zenibako). Iburi (Mt. Makkari-nupuri, Numanohata).

On *Betula japonica* SIEB. (*Shira-kamba*). S. Saghalien:—Shisuka (Shisuka). Hokkaidô:—Oshima (Mt. Komagatake, Ônuma). Shiribeshi (Zenibako, Raiden-tôge). Ishikari (Sapporo, Maruyama,

Mt. Moiwa, Hirakishi-mura, Jôzankei, Makomanai, Kotoni-mura, Garugawa, Misumai, Iwamizawa, Sôunkei). Tokachi (Yamuwakka). Kushiro (Shirikomabetsu [Akan]). Honshû:—Shimotsuke (Nikkô-Senjôgahara). Shinano (Karuisawa).

On *Betula Maximowicziana* BGL. (*Udai-kamba*). Hokkaidô:—Oshima (Ônuma, Okushiri). Ishikari (Jôzankei, Sapporo, Sôunkei). Honshû:—Rikuchû (Morioka).

On *Betula Middendorffii* TRAUTV. et MEY. (*Poronai-kamba*). S. Saghalien:—Shisuka (Mt. Hayabusa, Shisuka).

On *Betula shikokiana* NAKAI (*Shikoku-dakekamba*). Shikoku:—Tosa (Heike-daira).

This species is rather common and wide-spread throughout the northern hemisphere. Moreover, it was also recorded by CUNNINGHAM (1924 & 1931) from New Zealand. He stated that this fungus had been introduced with the host into New Zealand from the northern hemisphere.

The life history of this species was first worked out by PLOWRIGHT, who in 1890, after unsuccessful trials discovered that this fungus on *Betula alba* was connected with the aecidial form on *Larix*. He performed experiments in both directions. His conclusions were confirmed by KLEBAHN eight years later. From Prof. K. E. MURASHKINSKY of the Siberian Agricultural Academy (Omsk), the writer has received a specimen of an aecidial stage of *Melampsorium* on *Larix sibirica* which was identified by MURASHKINSKY with *Melampsorium betulinum* KLEB. This specimen was collected by ANTONOV at Shebalino in the Altai in July 1925. But, as the specimen is incomplete, it can not be determined with certainty whether it belongs to *Melampsorium betulinum* or not.

The overwintering of this species has been known to European and American mycologists. In 1907, LIRO reported for the first time that the uredospores or the mycelium are capable of wintering over in the tissues of the leaves and buds of seedlings but not in those of older trees, and that from these infections on the seedlings the rust spreads to the leaves higher up on the larger trees finally infecting the entire tree. In 1917, WEIR and HUBERT also reported having found positive evidence of its overwintering. Moreover, field observations made by the writer in the vicinity of Sapporo, Ishikari Province (Japan), would indicate that the present fungus is capable of overwintering in the uredostage.

The first report of the occurrence of this species from this country was made by DIETEL in 1905. His report is based upon a specimen on *Betula Ermani* var. *communis* which was collected by S. KUSANO on Mt. Shirane (Nikkô) in the province of Shimotsuke. Since then, this fungus was recorded by the SYDOWS, ITÔ, YOSHINAGA and the writer on *Betula Ermani*, *B. japonica*, *B. Maximowicziana*, *B. Middendorffii* and *B. shikokiana* from northern Japan.

The description of spermogonia and aecidia given above is partly founded upon the descriptions by FLOWRIGHT, KLEBAHN and ARTHUR.

3. *Melampsorium Carpini* (FUCK.) DIETEL in ENGLER-PRANTL, Natürl. Pflanzenfam. I, 1. Abt.***, p. 551, 1900; ARTHUR in N. Amer. Fl. VII, p. 680; Manual of the rusts in United States and Canada, p. 23; FRAGOSO, Fl. Ibér. Ured. II, p. 248; KLEBAHN in Kryptogamenfl. Mark Brandenbr. Va, p. 819; SACCARDO, Syll. Fung. XXI, p. 605; P. & H. SYDOW, Monogr. Ured. III, p. 428.

Syn. *Caeoma Carpini* NEES von ESENBECK, Syst. Pilze u. Schwämme, p. 16, 1817.

Uredo longicapsula forma *Carpini* RABENHORST, Herb. myc. no. 95, 1832.

Uredo Carpini DESMAZIÈRES, Pl. Crypt. no. 674, 1834.

Melampsora Carpini FUCKEL, Symb. Myc. p. 44, 1870; SACCARDO, Syll. Fung. VII, p. 593; WINTER in Pilze Deutschl. I, p. 240.

Melampsorium Carpini FISCHER, Ured. Schw. p. 515, 1904; HARIOT, Ured. p. 265; MIGULA, Krypt.-Fl. III, 1, p. 488; TROTTER, Fl. Ital. Crypt. Ured. p. 422.

Melampsorium Carpini KLEBAHN (HENNINGS in ENGL. Bot. Jahrb. XXXI, p. 734, 1902).

Icon. ARTHUR, Manual of the rusts in United States and Canada, fig. 34; BRIOSI & CAVARA, Fung. parass. no. 209; DIETEL in ENGLER-PRANTL, Natürl. Pflanzenfam. II. Aufl. VI, fig. 30, 1928; FISCHER, l. c. fig. 321; FRAGOSO, l. c. fig. 121; MIGULA, l. c. pl. XI, B, fig. 3.

Uredosori hypophyllous, subepidermal, scattered or loosely aggregate on small yellow spots, sometimes thickly scattered over the whole surface of the leaf, round or broadly ellipsoidal, minute, 0.1~0.25 mm in diameter, covered by the epidermis which finally ruptures at a centrally placed stomatic pore, at last often somewhat pulverulent, orange-yellow to yellow in colour; peridia hemispherical,

firm; upper peridial cells irregularly polygonal, small, 8~15 μ across, lateral peridial cells radially elongate, walls of peridial cells rather thin, smooth; ostiolar cells extending into long sharp points; uredospores ovate-oblong or oblong-clavate, 18~28 \times 8~15 μ ; epispore colourless, rather thin, 1~1.5 μ thick, sparsely and finely echinulate except for the apex which is smooth.

Teleutosori hypophyllous, subepidermal, rather minute, yellow or pale yellowish brown in colour; teleutospores one celled, oblong, oblong-clavate or prismatic, compacted laterally, 27~46.8 \times 9~16.2 μ ; epispore uniformly thin, about 1 μ , smooth, pale yellow in colour.

Hosts and Distribution

FOR THE UREDO- AND TELEUTOSTAGE:

Carpinus Betulus L. (CAVARA 1894, p. 318; FISCHER 1904, p. 516; FRAGOSO 1925, p. 249; FUCKEL 1870, p. 44; KLEBAHN 1914, p. 819; MAYOR 1933, p. 31; MIGULA 1910, p. 488; PICBAUER 1927, p. 442; POEVERLEIN 1926, p. [39]; SIEMASZKO 1923a, p. 23; P. & H. SYDOW 1915, p. 430; TROTTER 1914, p. 423; TURCONI 1908, p. 118; VOSS 1878, p. 90; WETTSTEIN 1885, p. 550; WINTER 1881, p. 240)—Germany, France, Switzerland, Italy, Czechoslovakia, Yugoslavia, Caucasus.

Carpinus cordata BL. (HIRATSUKA, f. 1927c, p. 301)—Japan.

Carpinus cordifolia (P. & H. SYDOW 1915, p. 430)

Carpinus laxiflora BL. (TOGASHI & ÔNUMA 1934, p. 16)—Japan.

Carpinus orientalis LAM.—Caucasus (Asara, Abchasia, Oct., 1915, leg. W. SIEMASZKO).

Carpinus yedoensis MAXIM. (*C. Tschonoskii* MAXIM.) (DIETEL 1905a, p. 587, as *Carpinus* sp.; 1905b, p. 105; HENNINGS 1900a, p. 262; 1902, p. 734, as *Carpinus* sp.; 1905a, p. 597, sub *Ostrya carpini-folia* W.; HIRATSUKA, f. 1930d, p. 328; 1932b, p. 39; 1935f, p. 282; HIRATSUKA, f. & YOSHINAGA 1935, p. 258; KUSANO 1902, p. [203]; NAITÔ & YAGI 1933, p. 17; P. & H. SYDOW 1915, p. 430; YOSHINAGA & HIRATSUKA, f. 1930, p. 653)—Japan.

Ostrya virginiana KOCH (*Carpinus virginiana* MILL.) (ARTHUR 1925, p. 680; 1934, p. 23)—New York.

Exsiccati. FOR THE UREDO- AND TELEUTOSTAGE: ALLESCHER & SCHNABL, Fung. bavar. no. 422; BRIOSI & CAVARA, Fung. parass. no. 209; FUCKEL, Fung. rhen. no. 294; KUNZE, Fung. sel. no. 308; LINHART, Fung. hung. no. 239; RABENHORST, Herb. Myc. no. 95; RABENHORST, Fung. eur. no. 1194; D. SACCARDO, Myc. ital. no. 900; P. & H.

SYDOW, Ured. no. 2486 & 2737; THÜMEN, Fung. austr. no. 225; THÜMEN, Myc. univ. no. 1138; Bad. Krypt. no. 408; Schweiz. Krypt. no. 5.

Habitat in Japan

On *Carpinus cordata* BL. (*Sawa-shiba*). Hokkaidô:—Oshima (Ônuma). Iburi (Tomakomai).

On *Carpinus laxiflora* BL. (*Aka-shide*). Honshû:—Rikuchû (Mt. Hayachine).

On *Carpinus yedoensis* MAXIM. (*C. Tschonoskii* MAXIM.) (*Inu-shide*). Honshû:—Musashi (Tokyo). Shimotsuke (Nikkô). Idzu (Mt. Amagi). Ise (Uji-Yamada). Sado (Akadomari). Echigo (Nii-gata). Kaga (Kanazawa). Tajima (Hamasaka). Inaba (Tottori, Ôkaya-mura, Mt. Okinosen). Hôki (Mitokusan, Kurayoshi). Oki (Nakamura). Shikoku:—Tosa (Mt. Yokogura). Awa (Mt. Kôtsu). Kiushû:—Higo (Hitoyoshi-sandô). Satsuma (Yoshino-mura). Ôsumi (Mt. Takakuma).

This species is clearly distinguishable from other species of the genus by the smaller size of uredospores.

In this country, the present species was first recorded by HENNINGS in 1900 based upon a specimen on *Carpinus yedoensis* which was collected by M. SHIRAI in the province of Ise, under the name of *Melampsora Carpini* (NEES) FUCK. Two years later, he also reported a rust fungus on *Carpinus* sp. (*C. yedoensis*) collected by T. YOSHINAGA in the province of Tosa, as *Melampsorium Carpini* (NEES) KLEB. Further, this fungus on *Carpinus yedoensis*, *C. cordata* and *C. laxiflora* was recorded by DIETEL, HENNINGS, YOSHINAGA, TOGASHI & ÔNUMA, NAITÔ & YAGI and the writer from Hokkaidô, Honshû, Shikoku and Kiushû.

No successful culture work has been conducted with this species, as here interpreted, in any country. From field observations it is quite evident that in this country at least it overwinters in the uredo-stage.

This species has not previously been recorded on *Carpinus orientalis* LAM. so far as the writer is aware.

4. *Melampsorium Hiratsukanum* ITÔ in HIRATSUKA, f. in Jour. Facul. Agric. Hokkaidô Imp. Univ. XXI, p. 9, 1927; Jap. Jour. Bot. VI, p. 19, 1932.

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Syn. *Melampsora Alni* (not THÜMEN) HIRATSUKA in Bot. Mag. Tokyo, XI, p. 46, 1897.

Melampsorium Alni (not DIETEL) P. & H. SYDOW, Monogr. Ured. III, p. 430, 1915, p.p; ARTHUR in N. Amer. Fl. VII, p. 680, p.p.

Melampsorium Alni (not DIETEL) WILSON in Transact. Brit. Myc. Soc. IX, p. 140, 1924; Transact. Bot. Soc. Edinb. XXXI, p. 425, 1934.

Icon. ARTHUR, Manual of the rusts in United States and Canada, fig. 33; HIRATSUKA, l. c. pl. IV, fig. 4~11; P. & H. SYDOW, l. c. pl. XVIII, fig. 158.

Spermogonia on needles of current season, amphigenous, mostly hypophyllous, subcuticular, minute, lenticular-form, $90\sim 126 \times 30\sim 55 \mu$, honey-yellow in colour; spermatia ellipsoidal to oblong, $5\sim 9 \times 2.5\sim 4.2 \mu$, colourless.

Aecidia on needles of current season, hypophyllous, on yellowish discoloured portions of affected needles, cylindrical, $0.5\sim 2$ mm across, up to 1.4 mm high; peridia colourless, rupturing at the apex; peridial cells quadrilateral or hexagonal in face view, $23.4\sim 36 \times 14.4\sim 20 \mu$, overlapping, the side walls $4\sim 12 \mu$ thick, the inner walls closely verrucose with papillae, colourless; aecidiospores ovate, broadly ellipsoidal or ellipsoidal, $18\sim 26.1 \times 15\sim 19.8 \mu$; epispore verrucose, rather thick, $1.8\sim 2.5 \mu$ thick, with a smooth area on some spores; contents orange-yellow in colour.

Uredosori hypophyllous, subepidermal, scattered or in groups, sometimes thickly scattered over the whole surface of the leaf, small, round or ellipsoidal, $0.2\sim 0.4$ mm in diameter, covered by the epidermis which finally ruptures at a centrally placed pore, often somewhat powdery, orange-yellow in colour; peridia hemispherical, firm, strongly developed; upper peridial cells small, isodiametrically to irregularly polygonal, $8\sim 18 \mu$ across, lateral ones somewhat radially elongate; walls of peridial cells rather thin, $1.2\sim 2.5 \mu$ thick, the inner ones somewhat thicker, colourless, smooth; ostiolar cells extending into long sharp spines, $32.4\sim 55.8 \mu$ long; uredospores broadly ovate, ellipsoidal or oblong, $21\sim 34.2 \times 10.4\sim 18 \mu$; epispore colourless, thin, $1.2\sim 1.8 \mu$ thick, sparsely and finely echinulate.

Teleutosori hypophyllous, subepidermal, scattered or somewhat grouped, in dark orange-yellow or yellowish brown crusts, slightly elevated; teleutospores one celled, oblong, clavate or prismatic, com-

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pacted laterally, $32.4 \sim 45 \times 10.8 \sim 16.2 \mu$; epispore pale cinnamon-brown in colour, rather thin, $1 \sim 1.2 \mu$ thick, smooth. (Plate VII, fig. 6)

Hosts and Distribution

FOR THE AECIDIAL STAGE:

Larix dahurica TURCZ. var. (HIRATSUKA, f. 1932a, p. 21)—Japan (cultures).

Larix europaea DC. (HIRATSUKA, f. 1932a, p. 21)—Japan (cultures).

Larix Kaempferi SARG. (HIRATSUKA, f. 1932a, p. 19, 20 & 21)—Japan (cultures).

FOR THE UREDO- AND TELEUTOSTAGE:

Alnus acuminata H. B. K. (ARTHUR 1918, p. 334; 1925, p. 680; SEYMOUR 1929, p. 231)—Guatemala.

Alnus glutinosa MED. (WILSON 1924, p. 140; 1934, p. 425)—Great Britain.

Alnus hirsuta TURCZ. & var. (*A. incana* WILLD. var. *hirsuta* SPACH, *A. sibirica* var. *hirsuta* KOIDZ.) (DIETEL 1902b, p. 51; 1905a, p. 587; HIRATSUKA 1897, p. 46; HIRATSUKA, f. 1927a, p. 10; 1927b, p. 235; 1927c, p. 300; 1928a, p. 29; 1928d, 695; 1929c, p. 61; 1930a, p. 80; 1930d, p. 328; 1932a, p. 19; 1932b, p. 40; 1935f, p. 282; HIRATSUKA, f. & YOSHINAGA 1935, p. 259; KAWAI & ÔTANI 1931, p. 239; P. & H. SYDOW 1913, p. 110; 1915, p. 431; TOGASHI & ÔNUMA 1934, p. 17; YOSHINAGA & HIRATSUKA, f. 1930, p. 635)—Japan, Manchuria.

Alnus incana DC. (WILSON 1924, p. 140; 1934, p. 425)—Great Britain.

Alnus jorullensis H. B. K. (ARTHUR 1918, p. 334; 1925, p. 680; SEYMOUR 1929, p. 232)—Guatemala.

Alnus Matsumurae CALL. (HIRATSUKA, f. 1934d, p. 471)—Japan.

Alnus Mirbelii SPACH (JACKSON 1927, p. 52)—Ecuador.

Alnus oregana NUTT. (*A. rubra* BONG.) (ARTHUR 1925, p. 680; 1934, p. 23; SEYMOUR 1929, p. 232)—California.

Alnus rhombifolia NUTT. (ARTHUR 1925, p. 680; 1934, p. 23; SEYMOUR 1929, p. 232)—California.

Alnus sp. (JACKSON 1927, p. 52; P. & H. SYDOW 1915, p. 431)—Ecuador.

Alnus sp. (ARTHUR 1918, p. 335)—Guatemala.

Exsiccati. FOR THE UREDO- AND TELEUTOSTAGES JACZEWSKI, KOMAROV & TRANZSCHEL, Fung. Ross. no. 325; P. & H. SYDOW, Ured. no. 2292.

Habitat in Japan

On *Larix Kaempferi* SARG. (*Kara-matsu*). *Hokkaidô*:—Ishikari (Sapporo). *Honshû*:—Shinano (Mt. Yatsugatake).

On *Alnus hirsuta* TURCZ. (*Ke-yamahannoki*). *S. Saghalien*:—Toyohara (Toyohara, Mt. Suzuya, Manui, Hakuchô-ko). Motodomari (Shiritori). Tomarioro (Kushunnai). Shisuka (Nayoro, Shisuka). *Hokkaidô*:—Oshima (Junsai-numa, Mt. Komagatake). Iburi (Numanohata, Lake side of Shikotsu-ko, Mt. Yoichi-dake, Chitose). Shiribeshi (Zenibako, Asari, Otaru, Raiden-tôge). Ishikari (Sapporo, Maruyama near Sapporo, Mt. Moiwa, Misumai, Jôzankei, Mt. Sapporo-dake, Garugawa, Mt. Teine, Sôunkei, Mt. Kuro-dake). Teshio (Nayoro). Tokachi (Makubetsu, Yamuwakka). Hidaka (Mt. Apoi). Kushiro (Yûbetsu-tanzan, Pirikanepu [Akan], Mt. Meakan-dake, Rubeshibe [Akan], Akubetsu, Shirikomabetsu [Akan], Kawayu, Nipushi [Lake side of Kutcharo-ko], Shibetcha). *Honshû*:—Mutsu (Ishie). Rikuchû (Gosho-mura). Kôzuke (Mt. Myôgi). *Shikoku*:—Tosa (Hatayama-mura). Iyo (Ochiai-yama).

On *Alnus hirsuta* TURCZ. var. *sibirica* SCHNEID. (*A. tinctoria* SARG. var. *glabra* CALL.) (*Yama-hannoki*). *S. Saghalien*:—Ôdomari (Ôdomari). Toyohara (Toyohara, Mt. Suzuya). Tomarioro (Kushunnai). *Hokkaidô*:—Oshima (Mt. Komagatake). Iburi (Numanohata, Lake side of Shikotsu-ko). Ishikari (Sapporo, Mt. Moiwa, Makomanai, Sôunkei). Kushiro (Onne-moshiri [Akan]). *Honshû*:—Rikuchû (Takizawa near Morioka, Mt. Hayachine). Idzu (Mt. Amagi). Shinano (Mt. Komagatake [Kiso], Mt. Yatsugatake). Inaba (Mt. Hyônosen). Hôki (Mt. Daisen).

On *Alnus Matsumurae* CALL. (*A. hirsuta* TURCZ. var. *emarginata* KUDÔ) (*Yahazu-hannoki*). *Honshû*:—Shimotsuke (Mt. Shirane). Shinano (Mt. Yatsugatake).

In 1897, Naoharu HIRATSUKA identified the present fungus on *Alnus incana* var. *glauca* (*A. hirsuta*), collected by himself at Sapporo, Hokkaidô, with *Melampsora Alni* THÛM. So far as the writer knows, this seems to be the first record of this species. Two years later, KOMAROV published this species on *Alnus incana*, collected in the province of Amur by him, under the name of *Melampsora Alni* THÛM. in JACZEWSKI, KOMAROV & TRANZSCHEL, Fungi Rossiae exsiccati, no. 325. In 1902, DIETEL reported this fungus on *Alnus incana* var. *glauca* (*A. hirsuta*), collected by S. KUSANO on Mt. Myôgi in the province of Kôzuke, as *Melampsorium Alni* (THÛM.) DIET.

Then, this fungus was also identified by the SYDOWS, and by YOSHINAGA with *Melampsoridium Alni* (THÜM.) DIET.

In 1927, the writer made a comparative study on the *Melampsoridium* parasitic on different species of *Alnus* in this country, and concluded that the present fungus on *Alnus hirsuta* is clearly different from *Melampsoridium Alni* (THÜM.) DIET. It was named as *Melampsoridium Hiratsukanum* ITÔ. The writer also recorded it from various districts of S. Saghalien, Hokkaidô, Honshû and Shikoku in 1927 to 1930. In northern Japan, the present fungus is commonly met with wherever the host plant is found.

In 1925 to 1927, the writer first determined that the present species has its aecidial stage on leaves of *Larix* spp. He inoculated with sporidia from the teleutospores of this fungus on needles of *Abies Mayriana*, *Larix dahurica* var. *japonica*, *L. europaea* and *L. Kaempferi*, and got positive results on the three species of *Larix*. He also transferred the aecidiospores onto *Alnus hirsuta* and *A. hirsuta* var. *sibirica*, not on *Alnus alnobetula* var. *fruticosa*.

LAVROV in 1926 described a *Peridermium* on *Larix sibirica* LEDEB. collected by W. REWERDATTO at Plachino along the Yenisei river in Siberia, as a new species, under the name of *Peridermium Krylowianum*. He stated that his species is distinguished clearly from the aecidial stage of *Melampsoridium betulinum* KLEB. described by KLEBAHN. Its diagnosis is as follows:—"Spermogoniis et maculis nullis. Pseudoperidiis foliicolis, solitariis vel innumerosis, expallidis (in sicco), 1.5~2.5 mm. longis, 0.5 mm. latis, 1 rarius 1.5 mm. altis. Cuticula peridermii vertice irregulariter crenulato-dilacerata, membranacea, ex cellulis angulatis: 25~28 × 15~22 μ ., margine solute leniter punctatis, circiter 0.5~1.5 μ ., pariete crassis, uniserialis, uniforme tenuiter contexta. Aecidiosporis sine isthmis concatenatis, rotundatis, ellipsoideis vel subangulatis, hyalinis (cub vitro): 18~21 × 13~16 μ ., minutissime, intervalo 1~1.3 μ ., verruculosis, 1/6~1/8 hemisphaerae nuda areola, episporio 2.5 μ . crasso tectis." Although the writer has not been able to examine an authentic specimen for comparison, LAVROV's specimen seems to be the aecidial stage of the present species or of *Melampsoridium Alni*.

This species closely resembles *Melampsoridium betulinum*, but, it differs in having smaller uredospores and much longer ostiolar cells of the peridia in the uredosori.

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Melampsorella SCHRÖTER, 1874

Spermogonia amphigenous, subcuticular, minute.

Aecidia hypophyllous, minute, short cylindrical, ruptured at the apex; peridia colourless or pale yellowish coloured, firm; peridial cells small, irregularly polygonal, colourless or subhyaline; aecidiospores globose, subglobose to ellipsoidal; contents orange-yellow in colour.

Uredosori hypophyllous, subepidermal, minute; peridia hemispherical, nearly colourless, firm; peridial cells small, isodiametrically or irregularly polygonal; uredospores subglobose, ovate or ellipsoidal; contents orange-yellow in colour.

Teleutosori hypophyllous, intracellular, developed with in the epidermal cells; teleutospores one celled, subglobose, ovate or oblong, or somewhat angular; episporium smooth, uniformly thin, nearly colourless.

TYPE SPECIES: *Melampsorella Caryophyllacearum* SCHRÖTER.

Key to species

Uredospores comparatively large, 22.5~33.5 × 18.5~25 μ . On Boraginaceae (*Symphytum*).

1. *Melampsorella Symphyti* (p. 199)

Uredospores comparatively small, 16~30 × 12~21 μ . On Caryophyllaceae.

2. *Melampsorella Caryophyllacearum* (p. 202)

1. *Melampsorella Symphyti* BUBÁK in Ber. Deutsch. Bot. Ges. XXI, p. 356, 1903; Centralbl. f. Bakt. II. Abt. XII, p. 423, 1904; Rostpilze Böhmens, p. 213; FISCHER, Ured. Schw. p. 523; FRAGOSO, Fl. Ibér. Ured. II, p. 250; GROVE, Brit. Rust Fungi, p. 363; HARIOT, Ured. p. 268; KLEBAHN in Kryptogamenfl. Mark Brandenbr. Va, p. 825; MIGULA, Krypt.-Fl. III, 1, p. 489; P. & H. SYDOW, Monogr. Ured. III, p. 438; TROTTER, Fl. Ital. Crypt. Ured. p. 424.

Syn. *Uredo Symphyti* de CANDOLLE in Encycl. Bot. VIII, p. 232, 1808; Fl. franç. VI, p. 87, 1815; MASSALONGO, Ured. Veron. p. 63; OUDEMANS, Rév. Champ. I, p. 586; PLOWRIGHT, Monogr. Ured. & Ustil. p. 255; RABENHORST, Krypt.-Fl. I, p. 11; SACCARDO, Syll. Fung. VII, p. 861; SCHRÖTER, Pilze Schles. I, p. 374; WINTER in Pilze Deutschl. I, p. 254.

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Caeoma Symphyti SCHLECHTENDAL, Fl. Berol. II, p. 122, 1824.

Caeoma Symphyti LINK, Sp. Pl. II, p. 14, 1825.

Erysibe Symphyti WALLROTH, Fl. Crypt. Germ. II, p. 200, 1833.

Trichobasis Symphyti LÉVEILLÉ in Ann. Sci. Nat. III. Sér. VIII, p. 374, 1847; BERKELEY, Outl. Brit. Fung. p. 332; COOKE, Handb. Brit. Fung. p. 529.

Coleosporium Symphyti FÜCKEL, Symb. Myc. p. 43, 1870.

Icon. FRAGOSO, l. c. fig. 122; GROVE, l. c. fig. 271; GROVE & CHESTERS in Transact. Brit. Myc. Soc. XVIII, p. 272, text-fig. 2 (D, E, F), 1934; KLEBAHN, l. c. p. 828, fig. Q, 2; P. & H. SYDOW, l. c. pl. XVIII, fig. 159; TROTTER, l. c. fig. 109.

Spermogonia on needles of current season, chiefly hypophyllous, crowded, often spread over the whole surface of leaf, minute, orange-yellow in colour.

Aecidia on needles of current season, hypophyllous, in two rows parallel to the midrib, not crowded, short cylindrical, 0.5~0.8 mm high; peridia colourless, firm, opening at the summit by a cleft, at length torn to the base into 3~5 segments; peridial cells irregularly polygonal, 25~55 μ long, 17~22 μ wide, walls 2~2.5 μ thick, colourless; aecidiospores globose, subglobose, ovate or oblong, 20~40 \times 18~29 μ ; epispore rather thin, 1.5~2 μ thick, verrucose; contents orange-yellow in colour.

Uredosori hypophyllous, subepidermal, scattered or gregarious, often covering the whole surface of leaf, small, round, 0.08~0.3 mm across, covered by the epidermis which finally ruptures at a centrally placed pore, often somewhat pulverulent, rich golden yellow in colour; peridia hemispherical, firm; peridial cells small, isodiametrically or irregularly polygonal, 8~20 μ across, walls thin, smooth, colourless or subhyaline; uredospores obovate, broadly ellipsoidal or ellipsoidal, 22.5~33.5 \times 18.5~25 μ ; epispore sparsely and coarsely echinulate, rather thin, 1.2~1.5 μ thick.

Teleutosori hypophyllous, developed within the epidermal cells, forming large whitish or pinkish patches, many crowded in each cell, pale yellow in colour; teleutospores one celled, subglobose, ovate or oblong, occasionally somewhat angular, 8~20 μ across; epispore uniformly thin, less than 1 μ thick, smooth, nearly colourless. Basidiospores globose or ovate, 7~10 μ across.

Hosts and Distribution

FOR THE AECIDIAL STAGE:

Abies alba MILL. (*A. pectinata* DC.) (BUBÁK 1903a, p. 356; 1904, p. 423; 1906, p. 155; 1908, p. 213; FRAGOSO 1925, p. 252; KLIKA 1926, p. 30; MIGULA 1910, p. 490; P. & H. SYDOW 1915, p. 439; TROTTER 1914, p. 425)—Czechoslovakia, Bulgaria.

FOR THE UREDO- AND TELEUTOSTAGE:

Symphytum asperrimum DONN. (*S. peregrinum*) (GROVE & CHESTERS 1934, p. 274; SIEMASZKO 1923, p. 22)—Great Britain, Caucasus.

Symphytum bulbosum SCHIMP. (P. & H. SYDOW 1915, p. 439; TROTTER 1914, p. 425; WINTER 1881, p. 254)—Italy.

Symphytum cordatum WALDST. et KIT. (CONSTANTINEANU 1920, p. 442; P. & H. SYDOW 1915, p. 439; WRÓBLEWSKI 1916, p. 101)—Rumania, Poland.

Symphytum ibericum STEV.—Caucasus (Suchum, leg. W. SIEMASZKO).

Symphytum officinale L. & var. (BECK 1883, p. 237; 1889, p. 601; BUBÁK 1898, p. 20; 1908, p. 213; 1916, p. 146; CONSTANTINEANU 1920, p. 442; DIETEL 1890, p. 48; FISCHER 1904, p. 524; FRAGOSO 1925, p. 252; GROVE 1913, p. 363; GROVE & CHESTERS 1934, p. 275; HARIOT 1908, p. 268; JAAP 1914b, p. 432; KICKX 1867, p. 88; KLEBAHN 1914, p. 826 & 827; LAMBOTTE 1880, p. 72; MAGNUS 1894, p. 56; MASSALONGO 1883, p. 64; MIGULA 1910, p. 490; NIESSL 1864, p. 104; OUDEMANS 1892, p. 587; PETRAK 1923, p. 108; 1927, p. 345; PLOWRIGHT 1889, p. 255; POEVERLEIN 1926, p. [40]; POEVERLEIN & BERTSCH 1927, p. 195; SCHRÖTER 1887, p. 374; P. & H. SYDOW 1915, p. 439; TROTTER 1914, p. 425; TURCONI 1908, p. 134; VOSS 1876, p. 132; 1878, p. 94; 1889, p. 343; WETTSTEIN 1885, p. 547; 1888, p. 172; WILSON 1934, p. 427; WINTER 1881, p. 254)—Germany, France, Holland, Belgium, Great Britain, Austria, Italy, Rumania, Poland, Switzerland, Czechoslovakia.

Symphytum tauricum WILLD. (POEVERLEIN 1926, p. [40]; P. & H. SYDOW 1915, p. 439; WINTER 1881, p. 254)—Germany.

Symphytum tuberosum L. (BECK 1880, p. 28; 1883, p. 237; 1889, p. 601; BUBÁK 1903a, p. 356; 1904, p. 423; 1906, p. 155; 1908, p. 213; 1909, p. 60; CONSTANTINEANU 1920, p. 442; FRAGOSO 1925, p. 252; KLEBAHN 1914, p. 827; MAGNUS 1910, p. 17; PETRAK 1922, p. 126; PICBAUER 1927, p. 442; 1929, p. 11; 1931, p. 11; 1933, p. 7; P.

& H. SYDOW 1903b, p. 248; 1915, p. 439; TROTTER 1914, p. 425; VOSS 1876, p. 132; 1889, p. 343; WILSON 1934, p. 427; WINTER 1881, p. 254)—Great Britain, Germany, Spain, Austria, Czechoslovakia, Italy, Rumania.

Symphytum sp. (TROTTER 1914, p. 425)—Italy.

Exsiccati. FOR THE AECIDIAL STAGE: P. & H. SYDOW, Ured. no. 1843. FOR THE UREDO- AND TELEUTOSTAGE: ALLESCHER & SCHNABL, Fung. bavar. no. 123; BERKELEY, Brit. Fung. no. 320; FÜCKEL, Fung. rhen. no. 403; JAAP, Fung. sel. no. 659; KRIEGER, Fung. saxon. no. 520, 957 & 1712; OUDEMANS, Fung. neerl. no. 61; PETRAK, Fl. Bohem. no. 344; RABENHORST, Herb. myc. no. 200 & 285; RABENHORST, Fung. eur. no. 2187, 4142 & 4210; ROUMEGUÉRE, Fung. gall. no. 2146; D. SACCARDO, Myc. ital. no. 266; SCHMIDT & KUNZE, no. 16; SCHRÖTER, Pilze Schles. no. 664; P. & H. SYDOW, Myc. germ. no. 106 & 1495; P. & H. SYDOW, Myc. march. no. 139 & 3556; P. & H. SYDOW, Ured. no. 48, 91, 645, 1635, 1744 & 2640; THÜMEN, Fung. austr. no. 627; Erb. critt. ital. no. 50; Fl. exs. Austr.-Hung. no. 3171.

As far as the writer knows, this fungus has been recorded only from Europe. The genetic connection of this species was first demonstrated by BUBÁK (1903), who inoculated with sporidia from *Symphytum officinale* on leaves of *Abies alba*.

Recently, the writer received from Prof. SIEMASZKO a specimen of the present fungus on *Symphytum ibericum* STEV. which had been collected by him in Suchum, Caucasus. This species has not been previously recorded on *Symphytum ibericum*.

The description of spermogonia and aecidia given above is partly founded upon the descriptions of BUBÁK and the SYDOWS.

2. *Melampsorella Caryophyllacearum* SCHRÖTER in Hedwigia, XIII, p. 85, 1874; BUBÁK in Centralbl. f. Bakt. II. Abt. XII, p. 422, 1904; Rostpilze Böhmens, p. 211; FISCHER, Ured. Schw. p. 516; FRAGOSO, Fl. Ibér. Ured. II, p. 252; GROVE, Brit. Rust Fungi, p. 360; HARIOT, Ured. p. 266; KARSTEN, Myc. Fenn. IV, p. 60; KLEBAHN in Kryptogamenfl. Mark Brandenbr. Va, p. 821; MIGULA, Krypt.-Fl. III, 1, p. 489; P. & H. SYDOW, Monogr. Ured. III, p. 433; TROTTER, Fl. Ital. Crypt. Ured. p. 425.

Syn. *Uredo pustulata* PERSOON var. *Cerastii* PERSOON, Syn. Fung. p. 219, 1801.

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Aecidium elatinum ALBERTINI et SCHWEINITZ, Consp. Fung. Nisk. p. 121, 1805; PLOWRIGHT, Monogr. Ured. & Ustil. p. 270; SACCARDO, Syll. Fung. VII, p. 825; SCHRÖTER, Pilze Schles. I, p. 381; WINTER in Pilze Deutschl. I, p. 261.

Uredo pustulata PERSOON var. *Cerastiorum* de CANDOLLE in Fl. franç. VI, p. 85, 1815.

Hypodermium (Uredo) Stellariarum LINK in Ges. Naturforsch. Freunde Berlin Mag. VII, p. 28, 1815.

Caeoma Stellariae LINK, Observ. II, p. 28, 1816.

Peridermium elatinum SCHMIDT et KUNZE, Deutsch. Schwämme, no. 141, 1817; ARTHUR & KERN in Bull. Torr. Bot. Club, XXXIII, p. 434, 1906; COOKE, Handb. Brit. Fung. p. 535, 1871; LAMBOTTE, Fl. Myc. Belg. II, p. 76, 1880.

Uredo Cerastii MARTIUS, Prodrum. Fl. Mosq. II, p. 231, 1817.

Caeoma Cerastii SCHLECHTENDAL, Fl. Berol. II, p. 121, 1824.

Caeoma Caryophyllacearum LINK, Sp. Pl. II, p. 26, 1825.

Caeoma elatinum LINK, Sp. Pl. II, p. 66, 1825.

Uredo elatina SPRENGEL, Syst. Veg. IV, p. 573, 1827.

Uredo pustulata PERSOON var. *Caryophyllacearum* DUBY in Bot. Gall. II, p. 894, 1830.

Uredo Caryophyllacearum JOHNSTON, Fl. Berw. II, p. 199, 1831; COOKE, Handb. Brit. Fung. p. 526, 1871.

Erysibe pustulata WALLROTH var. *Caryophyllacearum* WALLROTH, Fl. Crypt. Germ. II, p. 198, 1833.

Uredo Caryophyllacearum UNGER, Einfluss d. Bodens, p. 214, 1836.

Uredo Caryophyllacearum RABENHORST, Krypt.-Fl. I, p. 11, 1844.

Aecidium (?) Stellariae KIRCHNER in Lotos, VI, p. 180, 1856; SACCARDO, Syll. Fung. VII, p. 832; P. & H. SYDOW, Monogr. Ured. IV, p. 354.

Uredo Stellariae FÜCKEL, Fung. Nassov. p. 81, 1860.

Aecidium Cerastii OTTH in Mitteil. Naturforsch. Ges. Bern (1863), p. 89, 1863; SACCARDO, Syll. Fung. XIV, p. 372; P. & H. SYDOW, Monogr. Ured. IV, p. 354.

Melampsorella Cerastii WINTER in Hedwigia, XIX, p. 56, 1880; LIND, Danish Fungi, p. 295; LIRO, Ured. Fenn. p. 490; OUDEMANS, Rév. Champ. II, p. 508.

Melampsora Cerastii WINTER in Pilze Deutschl. I, p. 242, 1881; DIETEL in ENGLER-PRANTL, Natürl. Pflanzenfam. I, 1. Abt.***, p. 45, 1897; PLOWRIGHT, Monogr. Ured. & Ustil. p. 247.

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Melampsorella Cerastii SOHRÖTER, Pilze Schles. I, p. 366, 1887; ARTHUR, Manual of the rusts in United States and Canada, p. 20; DIETEL in ENGLER-PRANTL, Natürl. Pflanzenfam. II. Aufl. VI, p. 40, 1928; SACCARDO, Syll. Fung. VII, p. 825.

Aecidium coloradense DIETEL in ENGLER-PRANTL, Natürl. Pflanzenfam. I, 1. Abt.**, p. 78, 1897; SACCARDO, Syll. Fung. XIV, p. 388.

Exobasidium Stellariae P. SYDOW in Hedwigia, XXXVIII, p. (134), 1899.

Peridermium boreale ARTHUR et KERN in Bull. Torr. Bot. Club, XXXIII, p. 425, 1906; N. Amer. Fl. VII, p. 647; SACCARDO, Syll. Fung. XXI, p. 747.

Peridermium coloradense ARTHUR et KERN in Bull. Torr. Bot. Club, XXXIII, p. 426, 1906; N. Amer. Fl. VII, p. 647; P. & H. SYDOW, Monogr. Ured. IV, p. 14.

Melampsorella elatina ARTHUR in N. Amer. Fl. VII, p. 111, 1907.

Pucciniastrum Caryophyllacearum NEGER, Krankh. Waldb. p. 204, 1919.

Icon. ALBERTINI & SCHWEINITZ, l. c. pl. V, fig. 3; ANDERSON in Bot. Gaz. XXIV, pl. XIV & XV, 1897; ARTHUR, Manual of the rusts in United States and Canada, fig. 31; BELL in Bot. Gaz. LXXVII, pl. IV, fig. 29 & 30, 1924; BRIOSI & CAVARA, Fung. parass. no. 165; BUBÁK, l. c. fig. 59; DELACROIX & MAUBLANC, Malad. pl. cult. malad. parasit. pl. XXXI, fig. 1-3, 1909; DIETEL in ENGLER-PRANTL, Natürl. Pflanzenfam. I, 1. Abt.**, fig. 52 & 53 (A); II. Aufl. VI, fig. 29 (A, B); FISCHER, Ured. Schw. fig. 322-326; Zeitschr. f. Pflanzenkr. XI, p. 328-331, fig. 1-3, 1901; XII, pl. III & IV, 1902; FRAGOSO, l. c. fig. 123-126; GREBELSKY in Centralbl. f. Bakt. II. Abt. XLIII, p. 651, text-fig., 1915; GROVE, l. c. fig. 269 & 270; HARIOT, l. c. fig. 36 & 37; HARTIG, Lehrb. Pflanzenkr. fig. 138-142, 1900; HIRATSUKA, f. in Agric. & Hort. V, p. 157, fig. 1 & 2, 1930; HUNTER in Bot. Gaz. LXXXIII, pl. I, fig. 2-4; pl. II, fig. 5, 1927; KLEBAHN, l. c. p. 828, fig. Q, 1 (I-V); MAGNUS in Ber. Deutsch. Bot. Ges. XVII, pl. XXVI, fig. 1-10, 1899; MIGULA, l. c. pl. XI, B, fig. 4; MOSS in Ann. Bot. LX, p. 830, text-fig. 13 & 14; p. 840, text-fig. 21 (J); pl. XXXIV, fig. 3-5 & 36-38, 1926; NEGER, Krankh. Waldb. fig. 178 & 179, 1919; PAMMEL in Proc. Iowa Acad. Sci. XIII, pl. VII, fig. 3, pl. VIII & pl. IX, fig. 3 & 4, 1906; RICHARDSON in Gard. Chron. LXXIII, fig. 6, 1923; ROSTRUP, Plantepat. fig. 132-135, 1902; TUBEUF, Pflanzenkrankh. fig. 16, 218 & 219, 1895.

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Spermogonia amphigenous, mostly epiphyllous, scattered, subcuticular, minute, depressed hemispherical, 100-320 μ broad, 25-60 μ high; spermatia ellipsoidal or oblong, 3.6-5 \times 1.8-3.5 μ , colourless.

Aecidia from perennial mycelium, forming witches' brooms often of great size; hypophyllous, in two rows, one on each side of the midrib, hemispherical, short cylindrical or compressed, 0.4-1 mm long, 0.2-0.8 mm across, reddish yellow in colour; peridia colourless, delicate, rupturing at the apex; peridial cells irregularly polygonal, 25-55 \times 15-30 μ , elongated vertically, somewhat overlapping; inner walls rather thin, verruculose, outer walls rather thin, smooth; aecidiospores subglobose, ellipsoidal, oblong or somewhat polygonal, 16-30 \times 14-20 μ ; epispore rather thin, 1.2-2 μ thick, densely verrucose, colourless; contents orange-yellow in colour when fresh.

Uredosori hypophyllous, rarely epiphyllous or on petioles or stems, subepidermal, scattered or in groups or sometimes covering the whole surface of the leaf, minute, round, 0.08-0.4 mm in diameter, often somewhat pulverulent, orange-yellow to yellow in colour; peridia hemispherical, delicate, dehiscent from a small apical pore; upper peridial cells small, isodiametrically or irregularly polygonal, 10-20 μ across, somewhat overlapping; lateral ones radially elongated; walls of peridial cells thin, 1.5-3 μ thick, smooth, nearly colourless; uredospores ovate, ellipsoidal, obovate or oblong, 16-30 \times 12-21 μ ; epispore rather thin, 1-1.5 μ thick, sparsely echinulate, colourless; contents orange-yellow in colour.

Teleutosori hypophyllous, often covering the whole surface of the leaf, on whitish or pale reddish areas of indefinite extent; teleutospores one celled (very rarely 2 celled), within the epidermal cells, solitary or in groups, globose, subglobose or ellipsoidal, sometimes somewhat angular, 12-25 μ across; epispore thin, less than 1 μ thick, nearly colourless, smooth. Basidiospores globose, 7-10 μ in diameter; epispore thin, smooth. (Plate I, fig. 1, 2 & 3)

Hosts and Distribution

FOR THE AECIDIAL STAGE:

Abies alba MILL. (*A. pectinata* DC., *Pinus Picea* L.) (BAUDYŠ & PICBAUER 1925, p. 184; PECK 1883, p. 237; BUBÁK 1908, p. 211; 1915, p. [48]; BUBÁK & KABÁT 1906, p. [5]; CAVARA 1894, p. 319; CONSTANTINEANU 1920, p. 442; COOKE 1871, p. 535; FISCHER 1901, p.

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397; 1904, p. 522; GROVE 1913, p. 361; HARIOT 1908, p. 267; JAAP 1906, p. 123; 1907a, p. 264; 1908, p. 201; 1911, p. 334; 1917, p. 115; KLEBAHN 1914, p. 824; KLIKA 1926, p. 30; LAMBOTTE 1880, p. 76; LAUBERT 1927, p. 46; LIND 1913, p. 296; MAGNUS 1913, p. 46; MAYOR 1919, p. 413; PICBAUER 1927, p. 441; 1930, p. 136; 1931, p. 11; 1933b, p. 67; PLOWRIGHT 1889, p. 271; POEVERLEIN & BERTSCH 1927, p. 195; RANOJEVIĆ 1910, p. 366; 1914, p. 399; RICHARDSON 1923, p. 11; SCHRÖTER 1887, p. 381; H. SYDOW 1921, p. 249; P. & H. SYDOW 1915, p. 436; TRAVERSO 1903a, p. 303; TROTTER 1914, p. 426; TURCONI 1908, p. 135; VOSS 1878, p. 93; 1889, p. 344; WETTSTEIN 1888, p. 171; WILSON 1934, p. 426; WINTER 1881, p. 261)—Great Britain, France, Belgium, Germany, Denmark, Italy, Czechoslovakia, Rumania, Bulgaria, Poland, Switzerland.

Abies amabilis FORBES (*Picea amabilis* DOUGL.) (ARTHUR 1925, p. 681; 1934, p. 21; HOTSON 1925, p. 292; 1934, p. 114; SEYMOUR 1929, p. 62)—Washington.

Abies balsamea MILL. (ARTHUR 1907, p. 111; 1927, p. 819; 1934, p. 21; ARTHUR & KERN 1906, p. 434; DAVIS 1914, p. 913; HEDGCOCK 1912, p. 145; POVAH 1935, p. 136; RHOADS, HEDGCOCK, BETHAL & HARTLEY 1918, p. 331; SEYMOUR 1929, p. 63; STONE 1920, p. 315; P. & H. SYDOW 1915, p. 436)—Maine, Massachusetts, Michigan, New Hampshire, New York, Vermont, Wisconsin; Prince Edward Island, Manitoba, Ontario, New Brunswick, Nova Scotia.

Abies cephalonica LOUD. (P. & H. SYDOW 1915, p. 436)

Abies concolor LINDL. et GORD. (ARTHUR 1934, p. 21; GARRETT 1925, p. 203; HEDGCOCK 1912, p. 145; HOTSON 1934, p. 114; RHOADS, HEDGCOCK, BETHAL & HARTLEY 1918, p. 331; SEYMOUR 1929, p. 64)—Oregon, Utah.

Abies firma SIEB. et ZUCC. (HENNING 1900a, p. 266; HIRATSUKA, f. 1930d, p. 328; 1930e, p. 158; 1932b, p. 40; 1935g, p. 209; HIRATSUKA, f. & YOSHINAGA 1935, p. 259; NAITÔ & YAGI 1933, p. 15; P. & H. SYDOW 1915, p. 436; TOKUBUCHI 1911, p. [307]; YOSHINAGA & HIRATSUKA, f. 1930, p. 653)—Japan.

Abies grandis LINDL. (ARTHUR 1925, p. 681; 1934, p. 21; HEDGCOCK 1912, p. 145; HOTSON 1925, p. 292; 1934, p. 114; JACKSON 1918b, p. 213; RHOADS, HEDGCOCK, BETHAL & HARTLEY 1918, p. 331; SEYMOUR 1929, p. 65)—Idaho, Oregon, Washington; British Columbia.

Abies homolepis SIEB. et ZUCC. (*A. brachyphylla* MAXIM.) (HIRATSUKA, f. 1930e, p. 158; 1933a, p. 146; 1935g, p. 209)—Japan.

Abies lasiocarpa NUTT. (*A. subalpina* ENGELM.) (ARTHUR 1907, p. 111; 1912, p. 58 & 65; 1927, p. 819; 1934, p. 21; ARTHUR & KERN 1906, p. 435; HEDGCOCK 1912, p. 145; 1913, p. 17; HOTSON 1925, p. 292; 1934, p. 114; JACKSON 1918b, p. 213; RHOADS, HEDGCOCK, BETHAL & HARTLEY 1918, p. 331; SEYMOUR 1929, p. 66; P. & H. SYDOW 1915, p. 436)—Montana, New Mexico, Colorado, Utah, Wyoming, Oregon, Washington; British Columbia.

Abies magnifica MURR. (ARTHUR 1934, p. 21; HEDGCOCK 1912, p. 145; RHOADS, HEDGCOCK, BETHAL & HARTLEY 1918, p. 331; SEYMOUR 1929, p. 66)—California.

Abies Mariesii MAST. (HIRATSUKA, f. 1930e, p. 158; 1935g, p. 209)—Japan.

Abies Mayriana MIYABE et KUDÔ (HIRATSUKA, f. 1927c, p. 299; 1930e, p. 158; 1932a, p. 22; 1935g, p. 209)—Japan.

Abies nobilis LINDL. (HEDGCOCK 1912, p. 145; RHOADS, HEDGCOCK, BETHAL & HARTLEY 1918, p. 331; SEYMOUR 1929, p. 67)

Abies Nordmanniana SPACH (HARIOT 1908, p. 267; P. & H. SYDOW 1915, p. 436; WILSON 1924, p. 140; 1934, p. 426)—France, Great Britain.

Abies pinsapo BOISS. (HARIOT 1908, p. 267; KLEBAHN 1914, p. 802; P. & H. SYDOW 1915, p. 436)—Switzerland.

Abies religiosa LINDL. (ARTHUR 1907, p. 111; ARTHUR & KERN 1906, p. 435; RHOADS, HEDGCOCK, BETHAL & HARTLEY 1918, p. 331; SEYMOUR 1929, p. 67; P. & H. SYDOW 1915, p. 436)—Vera Cruz.

Abies sachalinensis Fr. SCHM. (HIRATSUKA, f. 1928a, p. 28; 1928b, p. 504; 1928c, p. 565; 1929d, p. 103; 1930a, p. 80; 1930e, p. 158; 1935g, p. 209)—Japan.

Abies sibirica LEDEB. (*A. Pichta* FORBES) (P. & H. SYDOW 1915, p. 436)

Abies Veitchii LINDL. (HIRATSUKA, f. 1930e, p. 158; 1935g, p. 209)—Japan.

Abies sp. (GARRETT 1919, p. 204)—Utah.

Picea albertiana S. BROWN (ARTHUR 1924c, p. 647; 1934, p. 21)—Alberta, British Columbia.

Picea canadensis B. S. P. (*P. alba* LINK, *Abies canadensis* MILL.) (ARTHUR 1924c, p. 647; 1934, p. 21; HOTSON 1925, p. 377; 1934, p. 122)—Michigan, South Dakota, Washington; Saskatchewan, Yukon, Alberta.

Picea Engelmanni ENGELM. (ARTHUR 1924c, p. 647; 1934, p. 21; ARTHUR & KERN 1906, p. 425 & 426; DIETEL 1897b, p. 78; HOTSON 1925, p. 377; 1934, p. 122; JACKSON 1918b, p. 285; P. & H. SYDOW 1923, p. 14; WEIR 1918, p. 12)—Colorado, Idaho, Montana, Oregon, Utah, Washington, Wyoming; Saskatchewan.

Picea excelsa LINK (ARTHUR 1924c, p. 647; 1934, p. 21; HOTSON 1925, p. 377; 1934, p. 122)—Montana, Washington; Manitoba.

Picea mariana B. S. P. (ARTHUR 1924c, p. 647; 1934, p. 21; ARTHUR & KERN 1906, p. 427; P. & H. SYDOW 1923, p. 14)—Maine, Michigan, Wisconsin; Alberta, Quebec, Newfoundland.

Picea pungens ENGELM. (*P. Parryana* PARRY) (ARTHUR 1924c, p. 647; 1934, p. 21; ARTHUR & KERN 1906, p. 425; P. & H. SYDOW 1923, p. 14)—Colorado, New Mexico, South Dakota, Wyoming.

Picea rubens SARG. (ARTHUR 1924c, p. 647; 1934, p. 21)—Maine, New York.

Picea sitchensis CARR. (ARTHUR 1924c, p. 647; 1934, p. 21; HOTSON 1925, p. 377)—Alaska; Washington.

FOR THE UREDO- AND TELEUTOSTAGE:

Arenaria serpyllifolia L. (FRAGOSO 1925, p. 255; P. & H. SYDOW 1915, p. 436)

Arenaria trinervia L. (*Moehringia trinervia*) (FRAGOSO 1925, p. 255; P. & H. SYDOW 1915, p. 436)

Cerastium alpinum L. & var. (ARTHUR 1925, p. 681; 1934, p. 21; HIRATSUKA, f. 1935g, p. 209; JØRSTAD 1925, p. 112; LARSEN 1932, p. 511; RAINIO 1926, p. 253; SEYMOUR 1929, p. 301)—British Columbia; Finland, Norway, Iceland; Japan.

Cerastium arcticum LANGE (WILSON 1934, p. 426; WILSON & WALDIE 1927, p. 114)—Great Britain.

Cerastium arvense L. (ARTHUR 1925, p. 681; 1934, p. 21; BUBÁK 1898, p. 19; 1899, p. 20; 1908, p. 212; CRUCHET 1918, p. 3 & 9; FRAGOSO 1925, p. 255; GROVE 1913, p. 361; HOTSON 1934, p. 25; JAAP 1900, p. 264; KARSTEN 1879, p. 60; KLEBAHN 1914, p. 825; LIND 1913, p. 296; MAGNUS 1894, p. 54; 1899, p. 338; 1900, p. 19; NISSL 1864, p. 104; OUDEMANS 1892, p. 509; PATTERSON 1902, p. 10; PICBAUER 1927, p. 441; 1929, p. 11; PLOWRIGHT 1889, p. 248; POEVERLEIN 1926, p. [39]; SCHRÖTER 1887, p. 366; SEYMOUR 1929, p. 301; STANDLEY 1920, p. 145; P. & H. SYDOW 1915, p. 436; TROTTER 1914, p. 426; WILSON 1934, p. 426; WINTER 1881, p. 243)—Alaska; Alberta,

Saskatchewan; Montana; Norway, Denmark, Germany, Great Britain, Spain, Czechoslovakia, Switzerland, Italy, Russia, Finland.

Cerastium beeringianum CHAM. et SCHLECHT. (ARTHUR 1925, p. 681; 1934, p. 21; GARRETT 1914, p. 242; HOTSON 1934, p. 25; P. & H. SYDOW 1915, p. 436)—Colorado, Montana, Utah, Wyoming; British Columbia.

Cerastium campestre GREENE (ARTHUR 1907, p. 111; 1934, p. 21; HOTSON 1934, p. 26; SEYMOUR 1929, p. 301; P. & H. SYDOW 1915, p. 436)—Colorado, Montana, South Dakota.

Cerastium glomeratum THUILL. (KLEBAHN 1914, p. 825; LIND 1913, p. 296)—Germany, Denmark.

Cerastium glutinosum FR. (FRAGOSO 1925, p. 255)

Cerastium latifolium L. (FISCHER 1904, p. 523)—Switzerland.

Cerastium occidentale GREENE (ARTHUR 1907, p. 111; 1927, p. 817; 1934, p. 21; HOTSON 1934, p. 26; SEYMOUR 1929, p. 301; P. & H. SYDOW 1915, p. 436)—Montana, Colorado.

Cerastium oreophilum GREENE (ARTHUR 1907, p. 111; 1912, p. 58 & 65; 1927, p. 819; 1934, p. 21; SEYMOUR 1929, p. 301; P. & H. SYDOW 1915, p. 436)—Colorado, South Dakota.

Cerastium pumilum (FRAGOSO 1925, p. 255)—Spain.

Cerastium schizopetalum MAXIM. (HIRATSUKA, f. 1935g, p. 161 & 209)—Japan.

Cerastium scopulorum GREENE (ARTHUR 1925, p. 681; 1934, p. 21; GARRETT 1914, p. 242; SEYMOUR 1929, p. 301; P. & H. SYDOW 1915, p. 436)—Utah.

Cerastium semidecadrum L. (KLEBAHN 1914, p. 825; POEVERLEIN 1926, p. [36]; P. & H. SYDOW 1915, p. 436; WILSON 1934, p. 426)—Germany, Great Britain.

Cerastium strictum L. (SEYMOUR 1929, p. 301; STANDLEY 1920, p. 145)—Montana.

Cerastium trigynum VILL. (JØRSTAD 1925, p. 112)—Norway.

Cerastium triviale LINDL. (*C. caespitosum* GIL.) (BÄUMLER 1902, p. 16; FISCHER 1904, p. 523; FRAGOSO 1925, p. 25; GROVE 1913, p. 361; JAAP 1900, p. 264; 1904, p. 131; JØRSTAD 1935, p. 64; KLEBAHN 1914, p. 825; LIND 1913, p. 296; MAGNUS 1890, p. 30; MAYOR 1924, p. 389; OUDEMANS 1892, p. 509; PETRAK 1920, p. 132; POEVERLEIN & BERTSCH 1927, p. 195; SCHRÖTER 1887, p. 366; P. & H. SYDOW 1915, p. 436; TROTTER 1914, p. 426; VOSS 1889, p. 338; WILSON 1934,

p. 426; WINTER 1881, p. 243)—Norway, Germany, Denmark, Great Britain, Switzerland, Italy, Czechoslovakia.

Cerastium viscosum L. (GROVE 1913, p. 361; HOTSON 1925, p. 293; 1934, p. 26; JACKSON 1918b, p. 213; SEYMOUR 1929, p. 301)—Great Britain; Oregon, Washington.

Cerastium vulgatum L. & var. (ARTHUR 1907, p. 111; 1927, p. 819; 1934, p. 21; HIRATSUKA, f. 1927c, p. 299, as *Cerastium triviale* var. *glandulosum*; 1928a, p. 28; 1930a, p. 80; 1930e, p. 158; 1932a, p. 22; 1932b, p. 40; 1935b, p. 233; 1935g, p. 209; HOTSON 1934, p. 26; JACKSON 1918b, p. 213; JØRSTAD 1923b, p. 18; 1925, p. 112; LARSEN 1932, p. 511; MOSS 1926, p. 819; NAGAI & SHIMAMURA 1933, p. 84; PICBAUER 1933, p. 7; SEYMOUR 1929, p. 301; P. & H. SYDOW 1915, p. 436; TOGASHI 1924, p. 82, as *Cerastium triviale* var. *glandulosum*)—Manitoba, Ontario; Nebraska, Oregon; Sweden, Switzerland, Czechoslovakia, Norway, Iceland; Japan.

Cerastium sp. (FISCHER 1904, p. 523)—Switzerland.

Cerastium sp. (POEVERLEIN 1926, p. [39])—Germany.

Cerastium sp. (KLEBAHN 1914, p. 825)—Germany.

Cerastium sp. (TROTTER 1914, p. 426)—Italy.

Malachium aquaticum FR. (FISCHER 1904, p. 423; FRAGOSO 1925, p. 255; KLEBAHN 1914, p. 825; MAGNUS 1889, p. 341; P. & H. SYDOW 1915, p. 436; TROTTER 1914, p. 426)—Germany, Italy, Switzerland.

Stellaria borealis BIGEL. & var. (*Alsine borealis* BRITT.) (ARTHUR 1925, p. 681; 1934, p. 21; GARRETT 1910, p. 273; HOTSON 1925, p. 293; 1934, p. 27; JACKSON 1918b, p. 213; SEYMOUR 1929, p. 300; P. & H. SYDOW 1915, p. 436)—Montana, New York, Oregon, Utah, Washington, California.

Stellaria brachypetala BONG. (*Alsine brachypetala* HOWELL) (ARTHUR 1907, p. 111; 1934, p. 21; HOTSON 1934, p. 27; P. & H. SYDOW 1915, p. 436)—Washington.

Stellaria crassifolia EHRH. (JØRSTAD 1925, p. 112; P. & H. SYDOW 1915, p. 436)—Norway.

Stellaria florida FISCH. var. (HIRATSUKA, f. 1935g, p. 161 & 209)—Japan.

Stellaria glauca WITHER. (CONSTANTINEANU 1920, p. 442; P. & H. SYDOW 1915, p. 436; WINTER 1881, p. 243)—Rumania.

Stellaria graminea L. (BUBÁK 1909, p. 60; FISCHER 1904, p. 523; FRAGOSO 1925, p. 255; GROVE 1913, p. 361; JØRSTAD 1921, p. 15;

1923b, p. 18; 1925, p. 111; 1935, p. 64; KARSTEN 1879, p. 60; KLEBAHN 1914, p. 824; LIND 1913, p. 296; LIRO 1908, p. 491 & 582; MAGNUS 1899, p. 341; 1900, p. 19; MAYOR 1934, p. 299; MOSS 1926, p. 816; PICBAUER 1927, p. 442; PLOWRIGHT 1889, p. 248; RAINIO 1926, p. 253; SCHRÖTER 1887, p. 366; SEYMOUR 1929, p. 300; P. & H. SYDOW 1915, p. 436; WILSON 1934, p. 426; WINTER 1881, p. 243)—Norway, Germany, Denmark, Great Britain, France, Switzerland, Finland, Czechoslovakia, Austria.

Stellaria Holostea L. (BAUDYŠ & PICBAUER 1925, p. 184; BUBÁK 1899, p. 20; 1908, p. 212; DIETEL 1890, p. 47; FRAGOSO 1925, p. 255; JAAP 1914a, p. 20; KLEBAHN 1914, p. 824 & 825; LIND 1913, p. 296; MAGNUS 1900, p. 19; PICBAUER 1927, p. 442; 1931, p. 11; POEVERLEIN 1926, p. [40]; P. & H. SYDOW 1915, p. 436; WINTER 1881, p. 243)—Germany, Denmark, Czechoslovakia, Great Britain.

Stellaria longifolia MÜHL. (*Alsine longifolia* BRITT.) (ARTHUR 1925, p. 681; 1934, p. 21; HIRATSUKA, f. 1935g, p. 210; JØRSTAD 1925, p. 112; KAWAI & ÔTANI 1931, p. 239; SEYMOUR 1929, p. 300)—Ontario; Michigan, New York, Pennsylvania; Japan.

Stellaria longipes GOLDIE (*Alsine longipes* COV.) (ARTHUR 1925, p. 681; 1934, p. 21; SEYMOUR 1929, p. 300; P. & H. SYDOW 1915, p. 436)—Alaska; Alberta; California.

Stellaria media CYR. (*Alsine media* L., *A. brachypetala* OPIZ) (ARTHUR 1907, p. 111; 1925, p. 681; 1934, p. 21; FISCHER 1904, p. 523; FRAGOSO 1925, p. 255; GREBELSKY 1915, p. 646; GROVE 1913, p. 361; HIRATSUKA, f. 1927c, p. 299; 1930e, p. 159; 1935g, p. 210; HOTSON 1925, p. 293; 1934, p. 27; KLEBAHN 1914, p. 824; MOSS 1926, p. 816; OUDEMANS 1892, p. 509; POEVERLEIN 1926, p. [40]; SEYMOUR 1929, p. 301; P. & H. SYDOW 1915, p. 436; TROTTER 1914, p. 426; WINTER 1881, p. 243)—Ontario; Maine, New Hampshire, Washington; Germany, Great Britain, Switzerland, Italy; Japan.

Stellaria nemorum L. & var. (BUBÁK 1908, p. 212; 1915, p. [48]; FISCHER 1901, p. 397; 1904, p. 523; FRAGOSO 1925, p. 255; HIRATSUKA, f. 1928a, p. 28; 1930e, p. 159; LIRO 1908, p. 491; MAYOR 1919, p. 413; MAYOR & CRUCHET 1925, p. 4; SIEMASZKO 1923b, p. 14; P. & H. SYDOW 1915, p. 436; TROTTER 1914, p. 426; VOSS 1889, p. 338; WINTER 1881, p. 243)—Switzerland, Yugoslavia, Czechoslovakia, Finland, Italy, Poland; Siberia, North Saghalian.

Stellaria palustris RETZ. (LIND 1913, p. 296; LIRO 1908, p. 491; SCHRÖTER 1887, p. 366)—Denmark, Finland, Germany.

Stellaria radicans L. (HIRATSUKA, f. 1928a, p. 28; 1928b, p. 504; 1930a, p. 81; 1930e, p. 159; 1935g, p. 210; KAWAI & ÔTANI 1931, p. 239)—Japan.

Stellaria uliginosa MURR. (FRAGOSO 1925, p. 255; KLEBAHN 1914, p. 625; LIND 1913, p. 296; POEVERLEIN & BERTSCH 1927, p. 195; SCHRÖTER 1887, p. 366; P. & H. SYDOW 1915, p. 436; WINTER 1881, p. 243)—Denmark, Germany.

Stellaria umbellata TURCZ. (*Alsine baicalensis* COV.) (ARTHUR 1907, p. 111; 1934, p. 21; SEYMOUR 1929, p. 301; P. & H. SYDOW 1915, p. 436)—Wyoming.

Stellaria yezoensis MAXIM. (*S. Fenzlii* RGL.) (HIRATSUKA, f. 1927c, p. 299; 1930e, p. 159; 1935g, p. 144 & 210; TOGASHI 1924, p. 82)—Japan.

Stellaria sp. (KLEBAHN 1914, p. 825)—Germany.

Stellaria sp. (POVAH 1935, p. 136)—Michigan.

Stellaria sp. (LEPIK 1928, p. 25)—Russia.

Exsiccati. FOR THE AECIDIAL STAGE: ALLESCHER & SCHNABL, Fung. bavar. no. 429; BARTHOLOMEW, N. Amer. Ured. no. 112, 1213, 1620, 1729, 1820, 1921, 2022, 2024, 2123, 2215 & 2332; BARTHOLOMEW, Fung. Columb. no. 2740 & 3045; BRIOSI & CAVARA, Fung. parass. no. 165; DESMAZIÈRES, Pl. Crypt. no. 138; CLEMENTS, Crypt. Form. Col. no. 152; ELLIS, N. Amer. Fung. no. 1437; ELLIS & EVERHART, Fung. Columb. no. 1629 & 2223; FÜCKEL, Fung. rhen. no. 290; KRIEGER, Fung. saxon. no. 1155; KUNZE, Fung. sel. no. 555; MOUGEOT & NESTLER, Vog. Crypt. no. 285; RABENHORST, Herb. myc. no. 388; RABENHORST, Fung. eur. no. 896; D. SACCARDO, Myc. ital. no. 1265; SCHMIDT & KUNZE, no. 141; SCHNEIDER, Herb. no. 690 & 697; SEYMOUR & EARLE, Econ. Fung. no. 221; P. & H. SYDOW, Myc. germ. no. 879; P. & H. SYDOW, Ured. no. 348, 2093 & 2344; THAXTER, Rel. FARL. no. 236; THÜMEN, Herb. myc. oecon. no. 740; THÜMEN, Myc. univ. no. 1925; Fl. exs. Austr.-Hung. no. 3170. FOR THE UREDO- AND TELEUTOSTAGE: ALLESCHER & SCHNABL, Fung. bavar. no. 621; BARTHOLOMEW, Fung. Columb. no. 2232; BARTHOLOMEW, N. Amer. Ured. no. 1418, 1724, 1919, 2022, 2419, 2921 & 3118; COOKE, Fung. brit. I, no. 60; II, no. 75; ERIKSSON, Fung. parass. scand. no. 26; FÜCKEL, Fung. rhen. no. 363 (p.p.), 369, 409 & 2221; GARRETT, Fung. Utah, no. 127; KRIEGER, Fung. saxon. no. 519; LINHART, Fung. hung. no. 142; OUDEMANS, Fung. neerl. no. 267; PETRAK, Fung. Eichl. no.

211; PETRAK, Fl. Bohem. no. 707; RABENHORST, Herb. myc. II. ed. no. 689; RABENHORST, Fung. eur. no. 3809; ROUMEGUÈRE, Fung. gall. no. 2054, 2639 & 3021; SCHNEIDER, Herb. no. 677, 678 & 679; SCHRÖTER, Pilze Schles. no. 648; SIEMASZKO, Fung. Bialowiezenses, no. 53; P. & H. SYDOW, Myc. germ. no. 880 & 1494; P. & H. SYDOW, Myc. march. no. 2188, 3127, 3238 & 4802; P. & H. SYDOW, Ured. no. 237, 536, 788, 789, 847, 1388, 1539, 1842, 2485, 2594 & 2595; THAXTER, Rel. FARL. no. 231; THÜMEN, Fung. austr. no. 363; THÜMEN, Myc. univ. no. 443; VESTERGREN, Micromyc. rar. sel. no. 1653; VILL, Fung. bavar. no. 917; VIZE, Fung. brit. no. 145; WESTENDORP, Herb. crypt. belg. no. 674.

Habitat in Japan

On *Abies firma* SIEB. et ZUCC. (*Momi*). *Honshû*:—Musashi (Tokyo). Suruga (Hakone-Miyanoshita). Shinano (Karuizawa). Inaba (Tottori, Inaba-mura). Hôki (Daisen-mura). Tajima (Yumura). Oki (Tôgo). *Shikoku*:—Tosa (Asakura-mura). *Kiushû*:—Hiuga (Mt. Kirishima).

On *Abies homolepis* SIEB. et ZUCC. (*A. brachyphylla* MAXIM.) (*Urajiro-momi*). *Honshû*:—Shimotsuke (Nikkô).

On *Abies Mariesii* MAST. (*Aomori-todomatsu*). *Honshû*:—Iwashi (Oze-numa). Shinano (Mt. Komagatake [Kiso]).

On *Abies Mayriana* MIYABE et KUDÔ (*Ao-todomatsu*). *Hokkaidô*:—Ishikari (Nopporo, Maruyama near Sapporo). Iburi (Lake side of Shikotsu-ko). Shiribeshi (Zenibako, Otaru-tôge).

On *Abies sachalinensis* Fr. SCHM. (*Aka-todomatsu*). *S. Saghalien*:—Motodomari (Noboripo). Ôdomari (Ôdomari). *Hokkaidô*:—Hidaka (Fuyushima). Kushiro (Lake side of Mashû-ko). *Kuriles*:—Etorofu (Naibo).

On *Abies Veitchii* LINDL. (*Shirabiso*). *Honshû*:—Shinano (Mt. Yatsugatake, Mt. Komagatake [Kiso], Mt. Ontake).

On *Cerastium alpinum* L. var. *beeringianum* RGL. (*Takane-miminagusa*). *Honshû*:—Shinano (Mt. Yatsugatake).

On *Cerastium schizopetalum* MAXIM. (*Miyama-miminagusa*). *Honshû*:—Shinano (Mt. Komagatake [Kiso], Mt. Yatsugatake).

On *Cerastium vulgatum* L. var. *glandulosum* RGL. (*Miminagusa*). *S. Saghalien*:—Ôdomari (Kaizuka, Ôdomari). Toyohara (Takinosawa). *Hokkaidô*:—Oshima (Mt. Komagatake, Ônuma). Ishikari (Sapporo, Maruyama near Sapporo, Sankakuyama near Sapporo, Mt.

Kuro-dake, Sôunkei). Iburi (Chitose). Kitami (Rishiri-Senpôji). Tokachi (Shikaribetsu-numa). *Kuriles*:—Kunashiri (Nikishiro). *Honshû*:—Musashi (Tokyo). Shinano (Agematsu). Tajima (Hamasaka). Inaba (Tottori). Hôki (Mt. Daisen). *Korea*:—Kôgen (Onseiri).

On *Stellaria florida* FISCH. var. *angustifolia* MAXIM. (*Iwatsumekusa*). *Honshû*:—Shinano (Mt. Komagatake [Kiso]).

On *Stellaria longifolia* MÜHLB. (*Nagaba-tsumekusa*). *S. Saghalien*:—Tomarioro (Kita-Nayoshi, Ambetsu). Shisuka (Higashi-Taraika).

On *Stellaria media* CYR. (*Hakobe*). *Hokkaidô*:—Oshima (Mt. Komagatake). Ishikari (Sapporo, Maruyama near Sapporo, Shiroishi-mura). Shiribeshi (Zenibako, Otaru). Tokachi (Obihiro). *Honshû*:—Musashi (Tokyo). Shinano (Matsumoto).

On *Stellaria radians* L. (*Yezo-yamahakobe*). *S. Saghalien*:—Toyohara (Aihama). Tomarioro (Ambetsu, Akashiki near Ambetsu). *Hokkaidô*:—Kushiro (Pontô [Kutcharo]).

On *Stellaria yezoensis* MAXIM. (*Yezo-fusuma*). *Hokkaidô*:—Ishikari (Sôunkei, Mt. Kuro-dake, Mt. Sapporo-dake). Kitami (Mt. Rishiri, Rebun-Uennai). Nemuro (Ochiishi, Nemuro). *Honshû*:—Rikuchû (Mt. Iwate).

The teleutospores of the present species are developed on leaves of the caryophyllaceous plants which live through the winter; they germinate about May to early June in middle and northern Japan and can infect species of *Abies*. The aecidial stage causes small erect witches' brooms on *Abies*, and the infected buds produce dense clusters of small leaves which are spirally arranged. Moreover they fall off in August. The mycelium is perennial in the buds and branches. The spermogonia and aecidia appear on the leaves in June to August and the aecidiospores infect the second host plant, various species of the Caryophyllaceae, and produce uredosori in 9 to 14 days after inoculation. The mycelium of the uredostage is also perennial on the leaves and shoots of the hosts as its aecidial stage.

The genetic connection of the present fungus was first established by FISCHER in 1900. He succeeded in infecting the aecidiospores from *Abies alba* on leaves of *Stellaria nemorum*. Then its heteroecism was amply confirmed by some European mycologists such as TUBEUF, KLEBAHN and BUBÁK. ARTHUR in 1911 carried out the first cultures with American material, proving that the aecidial stage on *Abies*

lasiocarpa is related to the teleutostage on *Cerastium oreophilum*. WEIR and HUBERT in 1917 made confirmatory cultures, infecting *Stellaria borealis* with the aecidiospores both from *Abies grandis* and *A. lasiocarpa*.

In North America, a witches' broom forming rust, *Peridermium coloradense* (DIET.) ARTH. et KERN on various species of *Picea* is widely distributed. Its mycelium is perennial as in the aecidial stage of this species on *Abies*. It not only attacks and stunts the growth of twigs and branches of young trees, but also brooms and dwarfs saplings and older trees. In 1917, WEIR and HUBERT successfully infected with the aecidiospores of *Peridermium coloradense* ARTH. et KERN from the leaves of *Picea Engelmanni*, on the leaves of *Stellaria borealis* and *S. longifolia*. A comparison of the uredo- and teleutospores resulting from inoculations with the aecidiospores of *Peridermium coloradense* taken from *Abies grandis* and *A. lasiocarpa*, lead WEIR and HUBERT to conclude that they belong to one and the same fungus, *Melampsorella Caryophyllacearum*.

In 1900, HENNINGS reported the aecidial stage of the present species on *Abies firma*, which was collected by M. SHIRAI in Tokyo, under the name of *Aecidium elatinum* ALB. et SCHW. It is the first record of this species in Japan. Within nearly thirty years after this first recording, YOSHINAGA, TOKUBUCHI, the SYDOWS, TOGASHI, KAWAI & ÔTANI, NAGAI & SHIMAMURA, NAITÔ & YAGI and the writer reported the present fungus from various districts of this country on the following plants: *Abies firma*, *A. homolepis*, *A. Mariesii*, *A. Mayriana*, *A. sachalinensis* and *A. Veitchii* as the aecidial hosts; *Cerastium alpinum* var. *beeringianum*, *C. schizopetalum*, *C. vulgatum* var. *glandulosum*, *Stellaria florida* var. *angustifolia*, *S. longifolia*, *S. media*, *S. radians* and *S. yezoensis* as the teleuto-hosts.

In this country, the aecidial connection of the present fungus was demonstrated by the writer by means of cultures. On July 28, 1927, he inoculated with the aecidiospores from leaves of *Abies Mayriana* which were collected at Nopporo in the province of Ishikari (Hokkaidô), on leaves of *Cerastium vulgatum* var. *glandulosum* and 9 days after sowing the spores, numerous uredosori appeared on the inoculated surface of the leaves of *Cerastium*. No return inoculation with the sporidia has been made by the writer.

This fungus differs from another species of the genus, *Melampsorella Symphyti* BUBÁK, in respect to the smaller uredosores as

well as the smaller aecidiospores without a smooth portion on their epispore. Moreover, the mycelium of the present fungus on the aecidial host is perennial and causes witches' broom, differing from the latter species.

This species is rather common and wide-spread throughout the northern hemisphere.

Pucciniastrum OTTH, 1861

Spermogonia amphigenous, subcuticular, minute.

Aecidia hypophyllous, rarely epiphyllous, minute, cylindrical, ruptured at the apex; peridia pale yellow or nearly colourless; peridial cells minute, irregularly polygonal; aecidiospores globose to ellipsoidal, contents orange-yellow in colour.

Uredosori hypophyllous, subepidermal; peridia hemispherical or conoidal, delicate, nearly colourless; peridial cells minute, irregularly polygonal; uredospores variable in shape, contents orange-yellow in colour.

Teleutosori amphigenous, mostly hypophyllous; teleutospores subepidermal, compacted laterally under the epidermis, or solitary within the mesophyll, globose, oblong or somewhat angular or flattened at sides, 2~5 cells (rarely one or more than 5), with vertical or oblique septa, epispore smooth, pale yellow to yellowish brown in colour.

TYPE SPECIES: *Pucciniastrum Epilobii* OTTH.

Key to species

Teleutospores known.

Ostiolar cells of peridia of uredosori coarsely or sparsely aculeate above.

On Pirolaceae (*Chimaphila* and *Pirola*).

Uredospores ellipsoidal, oblong to clavate-oblong, $23.4\sim 42.5 \times 10.8\sim 19 \mu$.
1. *Pucciniastrum Pyrolae* (p. 219)

On Rosaceae (*Rubus*).

Peridia of uredosori conical, extending above the epidermis.
Uredospores obovate, ellipsoidal or oblong-ellipsoidal, $15\sim 27 \times 9\sim 18 \mu$.
2. *Pucciniastrum americanum* (p. 225)

Peridia of uredosori hemispherical, covered by the epidermis.
Uredospores subglobose, obovate, ellipsoidal or oblong, $16\sim 26 \times 12\sim 16.5 \mu$.

3. *Pucciniastrum arcticum* (p. 228)

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Ostiolar cells of peridia of uredosori minutely echinulate, appearing nearly smooth when wet.

On Rosaceae.

Uredospores globose, subglobose, obovate or ellipsoidal, comparatively large, $15\sim 25.2 \times 12.5\sim 20 \mu$. On *Agrimonia*.

4. *Pucciniastrum Agrimoniae* (p. 231)

Uredospores globose, subglobose, obovate or ellipsoidal, comparatively small, $15\sim 21.6 \times 12.5\sim 18 \mu$. On *Potentilla*.

5. *Pucciniastrum Potentillae* (p. 237)

Ostiolar cells of peridia of uredosori smooth.

On Betulaceae (*Corylus*).

Uredospores obovate, ellipsoidal or oblong, $18\sim 27 \times 10\sim 16 \mu$.

6. *Pucciniastrum Coryli* (p. 240)

On Fagaceae (*Fagus*).

Uredospores ellipsoidal, obovate or oblong, $18\sim 24 \times 10\sim 15 \mu$.

7. *Pucciniastrum Fagi* (p. 242)

On Urticaceae (*Boehmeria*).

Uredospores subglobose, ovate or ellipsoidal, $18\sim 25 \times 13\sim 18 \mu$.

8. *Pucciniastrum Boehmeriae* (p. 242)

On Saxifragaceae (*Hydrangea*).

Uredospores ovate, ellipsoidal, oblong or clavate, $18\sim 33 \times 14\sim 21 \mu$.

9. *Pucciniastrum Hydrangeae-petioleae* (p. 245)

On Coriariaceae (*Coriaria*).

Uredospores ellipsoidal, ovate or oblong, $21.6\sim 26 \times 14.4\sim 19.8 \mu$.

10. *Pucciniastrum Coriariae* (p. 247)

On Tiliaceae (*Tilia*).

Uredospores subglobose, ellipsoidal, obovate or oblong, $18\sim 27 \times 12\sim 18 \mu$.

11. *Pucciniastrum Tiliae* (p. 248)

On Theaceae (*Stewartia*).

Uredospores ovate, ellipsoidal or oblong, $18\sim 27 \times 15\sim 19.5 \mu$.

12. *Pucciniastrum Yoshinogai* (p. 250)

On Oenotheraceae.

Uredospores subglobose, ovate or ellipsoidal, comparatively large, $16.2\sim 24.5 \times 12.6\sim 16.2 \mu$. On *Circaea*.

13. *Pucciniastrum Circaeae* (p. 251)

Uredospores subglobose, ovate or oblong, comparatively small, $14.4\sim 24 \times 10\sim 16.2 \mu$. On *Clarkia*, *Epilobium* and *Godetia*.

14. *Pucciniastrum Epilobii* (p. 255)

On Cornaceae (*Cornus*).

Uredospores ovate, pyriform or ellipsoidal, $18\sim 28.8 \times 12\sim 18 \mu$.

15. *Pucciniastrum Corni* (p. 266)

On Clethraceae (*Clethra*).

Uredospores subglobose, ovate or ellipsoidal, $18\sim 25.2 \times 14.4\sim 19.8 \mu$.

16. *Pucciniastrum Kusanoi* (p. 267)

On Styracaceae (*Pterostyrax* and *Styrax*).

Uredospores subglobose, ovate or ellipsoidal, $18\sim 26.5 \times 12.5\sim 17 \mu$.

17. *Pucciniastrum Styracinum* (p. 269)

- On Caprifoliaceae (*Viburnum*).
Uredospores ellipsoidal, ovate, pyriform or subglobose, 18~30 × 12.6~20 μ.
18. *Pucciniastrum Miyabeanum* (p. 271)
- Ostiolar cells of peridia of uredosori not well-developed.
- On Fagaceae (*Castanea* and *Castanopsis*).
Uredospores subglobose, ovate or ellipsoidal, 14~24 × 9~15 μ.
19. *Pucciniastrum Castaneae* (p. 273)
- On Tiliaceae (*Corchoropsis*).
Uredospores ellipsoidal or ovate, 16~23 × 11~17 μ.
20. *Pucciniastrum Corchoropidis* (p. 275)
- Teleutospores still unknown.
- Ostiolar cells or peridia of uredosori finely echinulate above.
- On Orchidaceae (*Goodyera*).
Uredospores ovate, oblong or oblong-clavate, 23.4~34.2 × 16.2~20.5 μ.
21. *Pucciniastrum Goodyerae* (p. 277)
- Ostiolar cells of peridia of uredosori smooth or not well-developed.
- On Urticaceae (*Pipturus*).
Uredospores subglobose, ellipsoidal or obovate, 24~40 × 20~23 μ.
22. *Pucciniastrum Pipturi* (p. 278)
- On Euphorbiaceae (*Mallotus*).
Uredospores subglobose, obovate, ellipsoidal or oblong, 20~36 × 16~24 μ.
23. *Pucciniastrum Malloti* (p. 278)
- On Celastraceae (*Celastrus*).
Uredospores subglobose or ellipsoidal, 20~25 × 16~22 μ.
24. *Pucciniastrum Celastri* (p. 279)
- On Actinidiaceae (*Actinidia*).
Uredospores obovate, ellipsoidal or oblong, 18~27 × 12~16 μ.
25. *Pucciniastrum Actinidiae* (p. 279)
- On Stachyuraceae (*Stachyurus*).
Uredospores obovate, ellipsoidal or oblong-clavate, 21~35 × 15~20 μ.
26. *Pucciniastrum Stachyuri* (p. 280)
- On Oenotheraceae (*Fuchsia* and *Lopezia*).
Uredospores subglobose, obovate or ellipsoidal, 14~24 × 13~16.5 μ.
27. *Pucciniastrum Fuchsiae* (p. 281)
- On Thymelaeaceae (*Wikstroemia*).
Uredospores oblong, obovate or subglobose, 18~27 × 14.5~18 μ.
28. *Pucciniastrum Wikstroemiae* (p. 282)
- On Gentianaceae.
On *Crawfordia*. Uredospores subglobose or ellipsoidal, 17.5~25 × 15~20 μ.
29. *Pucciniastrum Crawfordiae* (p. 282)
- On *Gentiana*. Uredospores subglobose or broadly ellipsoidal, 21~27 × 17~23 μ.
30. *Pucciniastrum Gentianae* (p. 283)
- On Rubiaceae (*Mussaenda*).
Uredospores subglobose, ellipsoidal, obovate or oblong, 18~30 × 14~18 μ.
31. *Pucciniastrum Mussaendae* (p. 283)

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- On Orchidaceae (*Goodyera*).
Uredospores ellipsoidal or obovate, 21~30 × 18~22.5 μ.
32. *Pucciniastrum ishikariense* (p. 284)

1. *Pucciniastrum Pyrolae* (KARST.) SCHRÖTER in Jahresber. Schles. Ges. f. vaterl. Kult. LVIII, p. 167, 1880; ARTHUR, Manual of the rusts in United States and Canada, p. 16; FRAGOSO, Fl. Ibér. Ured. II, p. 263; HIRATSUKA, f. in Jour. Facul. Agric. Hokkaidô Imp. Univ. XXI, p. 28 & 68, 1927; Bot. Mag. Tokyo, XLIV, p. 265, 1930; LIRO, Ured. Fenn. p. 513; P. & H. SYDOW, Monogr. Ured. III, p. 455.

Syn. *Aecidium Pyrolae* (ex errore *pynolae*) PERSOON in GMEL. Syst. Nat. II, p. 1473, 1791.

Uredo polymorpha STRAUSS var. *Pyrolae* STRAUSS in Ann. Wett. Ges. II, p. 87, 1810.

Uredo Pirolae MARTIUS, Fl. Mosq. p. 229, 1812.

Hypodermium (Uredo) Pyrolae LINK in Ges. Nat. Freunde Berlin Mag. VII, p. 28, 1815.

Caeoma Pyrolae SCHLECHTENDAL, Fl. Berol. p. 122, 1824.

Trichobasis Pyrolae BERKELEY, Outlin. Brit. Fung. p. 332, 1860, p.p.; COOKE, Handb. Brit. Fung. p. 529.

Physonema Pyrolae NIESSL in Verhandl. Naturf. Ges. Brünn, III, p. 104, 1864.

Uredo Pirolae WINTER in Pilze Deutschl. I, p. 254, 1881; FISCHER, Ured. Schw. p. 539; HARIOT, Ured. p. 306; KLEBAHN in Kryptogamenfl. Mark Brandenbr. Va, p. 845; MASSALONGO, Ured. Veron. p. 63.

Thekopsora (?) Pyrolae KARSTEN, Myc. Fenn. IV, p. 59, 1879; BUBÁK, Rostpilze Böhmens, p. 189; MIGULA, Krypt.-Fl. III, I, p. 470; OUDEMANS, Rév. Champ. I, p. 578; SACCARDO, Syll. Fung. VII, p. 866.

Melampsora Pirolae SCHRÖTER, Pilze Schles. I, p. 366, 1887; PLOWRIGHT, Monogr. Ured. & Ustil. p. 247.

Uredo Chimaphilae PECK in Ann. Rept. New York State Mus. XLVI, p. 33, 1893; SACCARDO, Syll. Fung. XI, p. 226.

Pucciniastrum Pirolae DIETEL in ENGLER-PRANTL, Natürl. Pflanzenfam. I, 1. Abt.**, p. 47, 1897; ARTHUR in N. Amer. Fl. VII, p. 108 & 678; GROVE, Brit. Rust Fungi, p. 367.

Pucciniastrum Pyrolae ARTHUR in Résult. Sci. Congr. Internat. Bot. Vienne (1905), p. 337, 1906.

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Pucciniastrum Pirolae TROTTER, Fl. Ital. Crypt. Ured. p. 383, 1914.

Icon. ARTHUR, Manual of the rusts in United States and Canada, fig. 25; FISCHER, l. c. fig. 337; FRAGOSO, l. c. fig. 130; GROVE, l. c. fig. 275; HIRATSUKA, f. in Jour. Facul. Agric. Hokkaidô Imp. Univ. pl. I, fig. 9, 1927; KLEBAHN, l. c. p. 842, fig. S, 5 (I & II); MOSS in Ann. Bot. XL, p. 835, fig. 19, pl. XXXIV, fig. 14, 15 & 40, 1926; TROTTER, l. c. fig. 9 (d, e); UNGER in Ann. Sci. Nat. Sér. 2, II, pl. VIII, fig. 9, 1834; Exantheme, pl. VI, fig. 30.

Uredosori amphigenous, mostly hypophyllous, sometimes on petioles, scattered or in small groups, causing reddish or reddish brown spots on the upper surface of the leaf, subepidermal, minute, round, 0.1~0.4 mm across, long covered by the epidermis, brownish yellow in colour; peridia hemispherical, firm; upper peridial cells small, isodiametrically to irregularly polygonal, 9~18 μ across, lateral ones somewhat radially elongate, walls of peridial cells thin, about 2 μ thick, gradually thickened below toward the orifice, smooth, colourless, somewhat overlapping; ostiolar cells large, 32~46 μ long, coarsely to sparsely aculeate above, greatly thickened below; uredospores ellipsoidal, oblong or clavate-oblong, 23.4~42.5 \times 10.8~19 μ ; epispore thin, 1.5~2.5 μ thick, with pointed warts, nearly colourless; contents orange-yellow in colour when fresh.

Teleutosori hypophyllous, subepidermal, inconspicuous, flat, an even layer of laterally united cells; teleutospores oblong or columnar, 24~28 \times 10~12 μ ; epispore uniformly thin, about 1 μ , colourless. (Plate IX, fig. 1)

Hosts and Distribution

FOR THE UREDO- AND TELEUTOSTAGE:

Chimaphila corymbosa PURSH. (*Ch. umbellata* Auct.) (ARTHUR 1907, p. 108; 1925, p. 678; 1934, p. 16; DAVIS 1914, p. 914; HIRATSUKA, f. 1927d, p. 69; P. & H. SYDOW 1915, p. 456)—Wisconsin.

Chimaphila maculata PURSH. (ARTHUR 1907, p. 108; 1927, p. 818; 1934, p. 16; HIRATSUKA, f. 1927d, p. 69; JACKSON 1918a, p. 320; KERN, THURSTON Jr., ORTON & ADAMS 1929, p. 8; SEYMOUR 1929, p. 545; P. & H. SYDOW 1915, p. 456)—Delaware, Oregon, Maryland, New Jersey, New York, Tennessee, Wisconsin, Pennsylvania.

Chimaphila occidentalis RYDB. (*Ch. umbellata* Auct.) (ARTHUR 1907, p. 108; 1925, p. 678; 1934, p. 16; HIRATSUKA, f. 1927d, p. 69;

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HOTSON 1925, p. 296; 1934, p. 65; JACKSON 1918b, p. 217; SEYMOUR 1929, p. 545)—Washington, Oregon, Montana.

Chimaphila taiwaniana MASAMUNE (HIRATSUKA, f. 1935e, p. 332; 1935g, p. 211; HIRATSUKA, f. & HASHIOKA 1935b, p. 523)—Japan.

Chimaphila umbellata NUTT. (*Pirola umbellata* L.) (HIRATSUKA, f. 1927a, p. 29; 1927c, p. 302; 1927d, p. 69 & 71; 1930b, p. 266; 1935g, p. 211)—Japan.

Pirola americana SW. (ARTHUR 1934, p. 16; DAVIS 1914, p. 914; KERN, THURSTON Jr., ORTON & ADAMS 1929, p. 8; SEYMOUR 1929, p. 545)—North Dakota, South Dakota, Pennsylvania, Wisconsin.

Pirola asarifolia MICHX. (*P. rotundifolia* var. *asarifolia* HOOK.) (ARTHUR 1925, p. 678; 1934, p. 16; GARRETT 1910, p. 300; HIRATSUKA, f. 1927d, p. 69; HOTSON 1934, p. 66; SEYMOUR 1929, p. 545)—Alaska; Alberta, Manitoba; Colorado, California, Montana, Washington.

Pirola chlorantha SW. (ARTHUR 1907, p. 108; 1934, p. 16; BUBÁK 1898, p. 18; 1908, p. 189; CONSTANTINEANU 1920, p. 443; FISCHER 1904, p. 540; FRAGOSO 1925, p. 264; GOBI & TRANZSCHEL 1891, p. 112; HIRATSUKA, f. 1927d, p. 70; HOTSON 1934, p. 66; JØRSTAD 1925, p. 115; KLEBAHN 1914, p. 846; LIRO 1908, p. 514; MAGNUS 1900, p. 20; PETRAK 1920, p. 134; PICBAUER 1927, p. 440; POEVERLEIN 1926, p. [41]; SCHRÖTER 1887, p. 366; SEYMOUR 1929, p. 545; P. & H. SYDOW 1915, p. 456; TRANZSCHEL 1900, p. 189; 1902, p. 54; TROTTER 1914, p. 384; WINTER 1881, p. 254)—Montana, Wyoming; Alberta, Manitoba; Germany, Switzerland, Italy, Rumania, Czechoslovakia, Norway, Finland, Russia.

Pirola elliptica NUTT. (ARTHUR 1907, p. 108; 1926, p. 234; 1927, p. 818; 1934, p. 16; CLINTON 1908b, p. 393; DAVIS 1914, p. 914; HIRATSUKA, f. 1927d, p. 70; KERN, THURSTON Jr., ORTON & ADAMS 1929, p. 8; MOSS 1926, p. 816; SEYMOUR 1929, p. 545; P. & H. SYDOW 1915, p. 456; TRELEASE 1884, p. 134)—New Hampshire, Delaware, Pennsylvania, Connecticut, Iowa, Wisconsin, New York; Ontario, Alberta, Nova Scotia, Saskatchewan.

Pirola grandiflora RADIUS (ARTHUR 1907, p. 108; HIRATSUKA, f. 1927d, p. 70; MAGNUS 1900, p. 20; PICBAUER 1932a, p. 5; 1933a, p. 6; P. & H. SYDOW 1915, p. 456)—Greenland; Germany, Czechoslovakia.

Pirola media SW. (GOBI & TRANZSCHEL 1891, p. 112; HIRATSUKA, f. 1927a, p. 29; 1927d, p. 70 & 71; 1928c, p. 566; 1929d, p. 103; 1930b,

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p. 266; 1935g, p. 211; JØRSTAD 1925, p. 115; 1934, p. 24; 1935, p. 67; LIND 1913, p. 295; LIRO 1908, p. 514; P. & H. SYDOW 1915, p. 456; TROTTER 1914, p. 384; WILSON 1934, p. 429; WINTER 1881, p. 254)—Norway, Finland, Russia, Denmark, Great Britain, Germany, Italy, France; Kamtchatka, Japan.

Pirola minor L. (*Erælebenia minor* RYDB.) (ARTHUR 1925, p. 678; 1934, p. 16; BECK 1889, p. 601; BUBÁK 1898, p. 18; FISCHER 1904, p. 540; FLAGEOLET 1891, p. [19]; FRAGOSO 1925, p. 264; GOBI & TRANZSCHEL 1891, p. 112; 1900, p. 189; GROVE 1913, p. 368; HIRATSUKA, f. 1927a, p. 29; 1927c, p. 302; 1927d, p. 70 & 71; 1928a, p. 30; 1928c, p. 566; 1929d, p. 103; 1930a, p. 81; 1930b, p. 266; 1935g, p. 211; HOTSON 1934, p. 66; JAAP 1904, p. 131; 1911, p. 334; JØRSTAD 1921, p. 15; 1925, p. 115; 1934, p. 24; 1935, p. 67; KLEBAHN 1914, p. 846; LARSEN 1932, p. 511; LIND 1913, p. 295; LIRO 1908, p. 514; MAGNUS 1894, p. 54; 1900, p. 20; MAYOR 1930a, p. 55; NIESSL 1864, p. 104; OUDEMANS 1892, p. 578; PICBAUER 1927, p. 440; PLOWRIGHT 1889, p. 247; POEVERLEIN 1926, p. [41]; SCHRÖTER 1887, p. 366; SEYMOUR 1929, p. 546; STANDLEY 1920, p. 147; P. & H. SYDOW 1915, p. 456; TRANZSCHEL 1900, p. 189; 1914, p. 555; TROTTER 1914, p. 384; WILSON 1934, p. 429; WINTER 1881, p. 254)—Great Britain, Denmark, Switzerland, Germany, Italy, Finland, Norway, Iceland, Sweden, Czechoslovakia, Russia; Colorado, Idaho, Washington, Montana; Alberta; Siberia, North Saghalien, Kamtchatka, Japan.

Pirola picta SM. (ARTHUR 1907, p. 108; 1934, p. 16; BLASDALE 1919, p. 139; HIRATSUKA, f. 1927d, p. 70; SCHRÖTER 1887, p. 366; SEYMOUR 1929, p. 546; P. & H. SYDOW 1915, p. 456)—California.

Pirola renifolia MAXIM. (HIRATSUKA, f. 1927a, p. 29; 1927c, p. 303; 1927d, p. 70 & 71; 1930b, p. 266; 1935g, p. 211)—Japan.

Pirola rotundifolia L. & var. (BUBÁK 1899, p. 20; 1908, p. 189; FISCHER 1904, p. 540; FRAGOSO 1925, p. 264; GOBI & TRANZSCHEL 1891, p. 112; GROVE 1913, p. 368; HIRATSUKA, f. 1927a, p. 29; 1927d, p. 70 & 71; 1928b, p. 504; 1930b, p. 266; 1935g, p. 144 & 211; JØRSTAD 1921, p. 15; 1925, p. 115; 1935, p. 67; KERN, THURSTON Jr., ORTON & ADAMS 1929, p. 8; KICKX 1867, p. 87; LAVROV 1926, p. 171; LEPIK 1928, p. 25; LIND 1913, p. 295; LIRO 1908, p. 513; MAGNUS 1890, p. 30; 1900, p. 20; NIESSL 1864, p. 104; OUDEMANS 1892, p. 578; PETRAK 1927, p. 346; PICBAUER 1927, p. 440; PLOWRIGHT 1889, p. 247; SCHRÖTER 1887, p. 366; P. & H. SYDOW 1915, p. 456; TRANZSCHEL 1900, p. 189; TROTTER 1914, p. 384; WINTER 1881, p. 254)—

Norway, Finland, Russia, Germany, Switzerland, Czechoslovakia, Denmark, Great Britain, France, Italy; Pennsylvania; Japan.

Pirola secunda L. & var. (*Ramischia secunda* GARKE) (ARTHUR 1907, p. 108; 1927, p. 818; 1934, p. 16; BLASDALE 1919, p. 139; CONSTANTINEANU 1920, p. 443; CRUCHET 1918, p. 6 & 9; DAVIS 1914, p. 914; FISCHER 1904, p. 540; GARRETT 1910, p. 300; GOBI & TRANZSCHEL 1891, p. 112; HEIM 1927, p. 93; HIRATSUKA, f. 1927a, p. 29; 1927b, p. 235; 1927c, p. 303; 1927d, p. 70 & 71; 1928a, p. 29; 1930a, p. 81; 1930b, p. 266; 1935g, p. 212; HOTSON 1925, p. 296; 1934, p. 66; JAAP 1907a, p. 264; 1908, p. 201; JACKSON 1918b, p. 217; JØRSTAD 1921, p. 15; 1925, p. 115; 1934, p. 24; 1935, p. 67; KLEBAHN 1914, p. 846; LARSEN 1932, p. 511; LAVROV 1926, p. 171; LEPIK 1928, p. 25; LIND 1913, p. 295; LIRO 1908, p. 514; MAGNUS 1890, p. 30; 1894, p. 30; 1913, p. 46; MAYOR 1919, p. 412; PICBAUER 1933b, p. 67; POEVERLEIN & BERTSCH 1927, p. 196; RAINIO 1926, p. 254; SCHRÖTER 1887, p. 366; SEYMOUR 1929, p. 546; STANDLEY 1920, p. 147; P. & H. SYDOW 1915, p. 456; TRANZSCHEL 1914, p. 555; TROTTER 1914, p. 384; VOSS 1889, p. 343; WINTER 1881, p. 254)—California, Montana, Colorado, Oregon, Washington, Wisconsin; Alberta, Ontario; Norway, Iceland, Switzerland, Denmark, Finland, Sweden, Germany, Italy, Russia, France, Yugoslavia, Rumania; Kamtchatka, Siberia, Japan.

Pirola secundiflora (BUBÁK 1898, p. 18; 1908, p. 189; PICBAUER 1927, p. 440)—Czechoslovakia.

Pirola uniflora L. (*Moneses uniflora* A. GREY) (ARTHUR 1925, p. 678; 1934, p. 16; BUBÁK 1898, p. 18; 1908, p. 189; CONSTANTINEANU 1920, p. 443; CRUCHET 1918, p. 5; ELIASSON 1897, p. 7; FISCHER 1904, p. 540; GOBI & TRANZSCHEL 1891, p. 112; HIRATSUKA, f. 1927d, p. 70; JAAP 1908, p. 201; JACKSON 1918a, p. 217; JØRSTAD 1921, p. 15; 1925, p. 115; KLEBAHN 1914, p. 846; LIND 1913, p. 295; LIRO 1908, p. 514; MAGNUS 1894, p. 54; 1900, p. 20; MASSALONGO 1883, p. 63; PICBAUER 1927, p. 440; SCHRÖTER 1887, p. 366; SEYMOUR 1929, p. 545; P. & H. SYDOW 1915, p. 456; TROTTER 1914, p. 384; VOSS 1889, p. 343; WETTSTEIN 1885, p. 547; 1888, p. 172; WINTER 1881, p. 254; WRÓBLEWSKI 1916, p. 102)—Alberta; Denmark, Sweden, Germany, France, Switzerland, Czechoslovakia, Finland, Rumania, Italy.

Pirola sp. (POEVERLEIN 1926, p. [41])—Germany.

Pirola sp. (TROTTER 1914, p. 384)—Italy.

Pirola sp. (TURCONI 1908, p. 120)—Italy.

Exsiccati. FOR THE UREDO- AND TELEUTOSTAGE: COOKE, Fung. brit. I, no. 438; FÜCKEL, Fung. rhen. no. 404; JACZEWSKI, KOMAROV & TRANZSCHEL, Fung. Ross. no. 25; ROUMEGUÈRE, Fung. gall. no. 1524; SCHNEIDER, Herb. no. 684, 685 & 686; SCHRÖTER, Pilze Schles. no. 520; P. & H. SYDOW, Myc. germ. no. 1218; P. & H. SYDOW, Myc. march. no. 1042 & 2650; P. & H. SYDOW, Ured. no. 138, 1000, 1235, 1341, 1791 & 1795; THÜMEN, Myc. univ. no. 1447; VILL, Fung. bavar. no. 724; Bad. Krypt. no. 404; Fl. exs. Austr.-Hung. no. 3548; Krypt. exs. Vindob. no. 935.

Habitat in Japan

On *Chimaphila taiwaniana* MASAMUNE (*Taiwan-umegasasô*). *Formosa*:—Taihoku (Mt. Nanko-taizan).

On *Chimaphila umbellata* NUTT. (*Ô-umegasasô*). *Hokkaidô*:—Oshima (Mt. Komagatake). Iburi (Numanohata).

On *Pirola media* SW. (*Maruba-no-ichiyakusô*). *Kuriles*:—Etorofu (Shana). *Honshû*:—Rikuchû (Mt. Iwate).

On *Pirola minor* L. var. *genuina* HERD. (*Yezo-ichiyakusô*). *S. Saghalien*:—Ôdomari (Ôdomari). Motodomari (Noboripo). Toyohara (Sakaehama). Tomarioro (Ambetsu). *Hokkaidô*:—Kitami (Mt. Rishiri). *Kuriles*:—Paramushir (Murakami-wan).

On *Pirola renifolia* MAXIM. (*Jinyô-ichiyakusô*). *Hokkaidô*:—Oshima (Ônuma). Shiribeshi (Okushiri). Iburi (Tomakomai, Numanohata). Ishikari (Jôzankei, Mt. Sapporo-dake, Mt. Kuro-dake). Hidaka (Mt. Apoi). Kushiro (Mt. Meakan-dake). Tokachi (Yamuwakka).

On *Pirola rotundifolia* L. var. *incarnata* DC. (*Benibana-ichiyakusô*). *Hokkaidô*:—Oshima (Mt. Komagatake). Ishikari (Maruyama near Sapporo). Iburi (Numanohata). *Honshû*:—Rikuchû (Mt. Iwate).

On *Pirola rotundifolia* L. var. *incarnata* DC. f. *subaphylla* MAK. (*Hitotsuba-ichiyakusô*). *Hokkaidô*:—Iburi (Mt. Eniwa-dake).

On *Pirola secunda* L. var. *vulgaris* HERD. (*Yama-ichiyakusô*). *S. Saghalien*:—Ôdomari (Ôdomari). Tomarioro (Ushoro). Motodomari (Kashipo). *Hokkaidô*:—Ishikari (Nopporo, Mt. Soranumadake, Mt. Teine, Jôzankei, Misumai). Tokachi (Mt. Memoro-dake). Kushiro (Mt. Meakan-dake). Shiribeshi (Zenibako-tôge). Iburi (Chitose).

Previous to the discovery of the teleutospores by ARTHUR, it was uncertain in what genus the present fungus should be placed. It had

been classified by some European mycologists as a species of *Thekopsora*.

The present species easily differs from other species of *Pucciniastrum* in having peculiar shaped peridia in the uredosori. The peridial cells are large with the walls gradually thickened below toward the opening and with the ostiolar cells large, greatly thickened below and coarsely echinulate above.

The genetic connection of this species has not been experimentally demonstrated. But TREBOUX (1914) and WEIR and HUBERT (1918) reported that it is apparent that this fungus overwinters on its evergreen host and propagates by means of the uredospores. The present writer also observed in the field the fact that the mycelium of its uredostage is perennial in the host-tissues, so that once the plant has become infected the fungus appears on it season after season.

This species on the Japanese species of *Chimaphila* and *Pirola* was first recorded by the writer in his paper, "Studies on the Melamporaceae of Japan" in 1927. Recently, the writer has received from Mr. HASHIOKA two collections of this fungus on *Chimaphila taiwaniana* from Formosa. *Pucciniastrum Pyrolae* (KARST.) SCHRÖT. is rather common in South Saghalien, Hokkaidô and the northern and middle parts of Honshû, and also in the Kuriles and the alpine region of Formosa. It is widely distributed throughout Europe, Siberia, North America and Greenland.

The writer has never examined any specimen of the teleutospores of the present species, and the description of the teleutostage above is compiled from North American Flora, VII, p. 108 by ARTHUR.

2. *Pucciniastrum americanum* (FARL.) ARTHUR in Bull. Torr. Bot. Club, XLVII, p. 468, 1920; N. Amer. Fl. VII, p. 677; Manual of the rusts in United States and Canada, p. 13; DODGE in Jour. Agric. Res. XXIV, p. 885, 1923; HIRATSUKA, f. in Jour. Facul. Agric. Hokkaidô Imp. Univ. XXI, p. 89, 1927.

Syn. *Pucciniastrum arcticum* TRANZSCHEL var. *americanum* FARLOW in Rhodora, X, p. 16, 1908; P. & H. SYDOW, Monogr. Ured. III, p. 450.

Aecidium ingenuum ARTHUR in Bull. Torr. Bot. Club, XLVI, p. 124, 1919, p.p.

Peridermium ingenuum ARTHUR in N. Amer. Fl. VII, p. 646,

1924, p.p.; SACCARDO, Syll. Fung. XXIII, p. 861, p.p.; P. & H. SYDOW, Monogr. Ured. IV, p. 3, p.p.

Icon. ARTHUR, Manual of the rusts in United States and Canada, fig. 20; CLINTON in Rept. Connecticut Agric. Exper. Stat. (1907~08), pl. XXXII, fig. 3; DAVIS in Transact. Wisconsin Acad. Sci., Arts & Lett., XXI, p. 255, fig. 1~3, 1924; DIETEL in Hedwigia, XLIV, p. 331, fig. 1 & 2 (as *Phragmidium gracile*), 1905; DODGE, l. c. pl. I ~ IV & V (A, B, C); MOSS in Ann. Bot. XL, p. 832, fig. 15; p. 833, fig. 16 & 17; pl. XXXIV, fig. 7, 11 & 12, 1926.

Spermogonia on needles of current season, hypophyllous, inconspicuous, subcuticular, 80~130 μ broad, 40~50 μ high; ostiolar filaments wanting.

Aecidia on needles of current season, hypophyllous, closely packed in rows, over a part or the whole leaf surface, often confluent; peridia nearly cylindrical to tongue-shaped, 0.5~0.8 mm high, very delicate and fragile; peridial cells in radial section narrowly oblong or linear, 32~42 \times 10~16 μ , somewhat overlapping, outer walls 1~2 μ thick, smooth, inner ones 3~5 μ thick, closely verrucose with slender tubercles; aecidiospores globose or broadly ellipsoidal, 16~23 \times 13~16 μ ; epispore colourless, 2~3 μ thick, half the thickness being due to the close, rather fine, and somewhat deciduous tubercles.

Uredosori hypophyllous, subepidermal, thickly scattered over large areas of the leaf surface, small, round or broadly ellipsoidal, 0.08~0.15 mm across, dehiscent from an apical pore, somewhat pulverulent, yellow to orange-yellow in colour; peridia conical, extending above the epidermis; peridial cells small, isodiametrically to irregularly polygonal, 5~18 μ across, walls smooth, thin, nearly colourless, somewhat overlapping; ostiolar cells numbering 5 to 7, globose, subglobose or ovate, 18~30 μ across, walls sparsely and prominently aculeate, somewhat contracted below into a smooth neck; uredospores obovate, ellipsoidal or oblong-ellipsoidal, 15~27 \times 9~18 μ ; epispore colourless, thin, 1~1.5 μ thick, echinulate with low points; contents orange-yellow in colour when fresh.

Teleutosori hypophyllous, subepidermal, small, causing brownish yellow discoloured areas of indefinite extent; teleutospores intercellular, solitary or gregarious, often compacted laterally under the epidermis, subglobose, ellipsoidal or somewhat polygonal, divided vertically into 2 to 5 cells (rarely one or more than 5), 15~24 μ

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high, 12~30 μ across; epispore uniformly thin, less than 1.2 μ thick, smooth, pale yellowish brown in colour.

Hosts and Distribution

FOR THE AECIDIAL STAGE:

Picea canadensis B. S. P. (*P. alba* LINK) (ARTHUR 1919, p. 124, p.p.; 1924c, p. 647, p.p.; 1934, p. 13; DARKER 1929, p. 162; RHOADS, HEDGCOCK, BETHAL & HARTLEY 1918, p. 336, p.p.)—Ontario.

FOR THE UREDO- AND TELEUTOSTAGE:

Rubus leucodermis DOUGL. et HOOK. (ARTHUR 1934, p. 13)—Maryland.

Rubus melanolasius FOCKE (*R. Idaeus* var. *melanolasius* FOCKE) (ARTHUR 1920, p. 469; 1925, p. 677; 1934, p. 13; HIRATSUKA, f. 1927d, p. 90; HOTSON 1934, p. 150; SEYMOUR 1929, p. 382)—Idaho, Montana; British Columbia.

Rubus neglectus PECK (*R. occidentalis* \times *strigosus* RYDB.) (ARTHUR 1925, p. 677; 1934, p. 13; DAVIS 1914, p. 914; FARLOW 1908, p. 10, as *Rubus occidentalis*; HIRATSUKA, f. 1927d, p. 90; SEYMOUR 1929, p. 382; P. & H. SYDOW 1915, p. 450)—Massachusetts.

Rubus strigosus MICHX. (*R. Idaeus* var. *aculeatissimus* ROB. et FERNALD, *R. Idaeus* var. *strigosus* MAXIM.) (ARTHUR 1920, p. 469; 1925, p. 677; 1926, p. 234; 1934, p. 13; BRECKLE 1918, p. 207; DARKER 1929, p. 159; DAVIS 1914, p. 914; HIRATSUKA, f. 1927d, p. 90; KERN, THURSTON Jr., ORTON & ADAMS 1929, p. 7; MOSS 1926, p. 816; SEYMOUR 1929, p. 381; STANDLEY 1920, p. 147; P. & H. SYDOW 1915, p. 450)—Connecticut, Iowa, Maine, Maryland, Massachusetts, Montana, New Hampshire, New Jersey, New York, North Dakota, Ohio, Vermont, West Virginia, Wisconsin, Pennsylvania; Nova Scotia, Ontario, Quebec.

Exsiccati. FOR THE UREDO- AND TELEUTOSTAGE: BARTHOLOMEW, Fung. Columb. no. 4067 & 4577; BARTHOLOMEW, N. Amer. Ured. no. 377, 482, 876, 1086, 1480, 1881 & 2280; BRECKLE, Fung. Dak. no. 293; ELLIS, N. Amer. Fung. no. 282; ELLIS & EVERHART, Fung. Columb. no. 1190; SEYMOUR & EARLE, Econ. Fung. no. 32.

In 1908, FARLOW treated this fungus on *Rubus neglectus* as a variety of the next species, *Pucciniastrum arcticum* TRANZSCH. var. *americanum* FARL. The chief point of difference between them was recognized in the form of the peridia in uredosori. The peridia of this fungus are more sharply conical in shape, and stand out from the leaf without being covered by the epidermis in maturity, while

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those of *Pucciniastrum arcticum* are hemispherical and are long covered by the epidermis. In 1920, ARTHUR raised this fungus to specific rank. However, DAVIS and DODGE decided that the differences in morphology between the above two species noted by FARLOW are due to host differences. DODGE (1923) concluded in his "Morphology and host relations of *Pucciniastrum americanum*." as follows:—"It has been shown that the form and size of sori vary greatly, depending upon what tissue they are found, indicating that *Pucciniastrum arcticum* and *P. americanum* are not distinct species. In the event that it can be shown that *Rubus triflorus* and *R. arcticus* can not be infected with spores from *Rubus strigosus* and related forms, distinct names for the strains or biologic forms might still be desirable."

In 1926, MOSS stated that this species has long conical shaped peridia with ostiolar cells constricted near the base and much thickened below, with recurved spines over the upper part, as marked characters differing from *Pucciniastrum arcticum*.

The genetic connection of this species was first experimentally demonstrated by DARKER in 1927 and 1928. He proved by successful infections in both directions that the present fungus on *Rubus Idaeus* var. *strigosus* (*R. strigosus*) has its aecidial stage on *Picea canadensis*. The above description of the aecidial stage is compiled from North American Flora, VII, p. 646 (*Peridermium ingenuum* ARTH.) by ARTHUR.

3. *Pucciniastrum arcticum* TRANZSCHEL in Script. Bot. Hort. Univ. Petropol. IV, p. 300, 1895; ARTHUR in N. Amer. Fl. VII, p. 107 & 677; Manual of the rusts in United States and Canada, p. 13; FRAGOSO, Fl. Ibér. Ured. II, p. 262; HIRATSUKA, f. in Jour. Facul. Agric. Hokkaidô Imp. Univ. XXI, p. 90, 1927; Transact. Sapporo Nat. Hist. Soc. X, p. 120, 1929; Bot. Mag. Tokyo, XLIV, p. 277, 1930; LIRO, Ured. Fenn. p. 507; SACCARDO, Syll. Fung. XXI, p. 733; P. & H. SYDOW, Monogr. Ured. III, p. 449.

Syn. *Uredo arcticus* LAGERHEIM in Hedwigia, XXVIII, p. 109, 1889; SACCARDO, Syll. Fung. IX, p. 331.

Aecidium ingenuum ARTHUR in Bull. Torr. Bot. Club, XLVI, p. 124, 1919, p.p.

Peridermium ingenuum ARTHUR in N. Amer. Fl. VII, p. 646,

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1924, p.p.; SACCARDO, Syll. Fung. XXIII, p. 861, p.p.; P. & H. SYDOW, Monogr. Ured. IV, p. 3, p.p.

Icon. ARTHUR, Manual of the rusts in United States and Canada, fig. 21; DAVIS in Transact. Wisconsin Acad. Sci., Arts & Lett., XXI, p. 255, fig. 4, 1924; MOSS in Ann. Bot. XL, p. 834, fig. 18; p. 840, fig. 21 (H); pl. XXXIV, fig. 8 & 13, 1926.

Spermogonia on needles of current season, hypophyllous, inconspicuous, subcuticular, 80~130 μ broad, 40~50 μ high; ostiolar filaments wanting.

Aecidia on needles of current season, hypophyllous, closely packed in rows, over a part or the whole leaf surface, often confluent; peridia nearly cylindrical to tongue-shaped, 0.5~0.8 mm high, very delicate and fragile; peridial cells in radial section narrowly oblong or linear, 32~42 \times 10~16 μ , somewhat overlapping, outer walls 1~2 μ thick, smooth, inner ones 3~5 μ thick, closely verrucose with slender tubercles; aecidiospores globose or broadly ellipsoidal, 16~23 \times 13~16 μ ; epispore colourless, 2~3 μ thick, half the thickness being due to the close, rather fine, and somewhat deciduous tubercles.

Uredosori hypophyllous, subepidermal, scattered or gregarious, often thickly scattered over the whole surface of the leaf, round, minute, 0.1~0.25 mm in diameter, yellow or pale yellow in colour; peridia hemispherical, covered by the epidermis, dehiscent at an apical pore; peridial cells minute, irregularly polygonal, 6~16 μ across, walls thin, colourless, smooth, somewhat overlapping; ostiolar cells large, 35~50 μ high, greatly thickened below, coarsely echinulate above; uredospores subglobose, obovate, ellipsoidal or oblong, 16~26 \times 12~16.5 μ ; epispore colourless, rather thin, 0.8~2 μ thick, finely echinulate; contents orange-yellow in colour when fresh.

Teleutosori hypophyllous, subepidermal, small, 0.1~0.3 mm across, in dense clusters limited by the nerves, brown in colour; teleutospores intercellular, solitary or gregarious, globose, subglobose, oblong or somewhat angular, divided into 2 to 5 cells by vertical or oblique septa, 18~30 μ across; epispore rather thin, about 1 μ thick, smooth, pale yellowish brown in colour. (Plate VIII, fig. 1)

Hosts and Distribution

FOR THE AECIDIAL STAGE:

Picea canadensis B. S. P. (*P. alba* LINK) (ARTHUR 1919, p. 124, p.p.; 1924, p. 647, p.p.; 1934, p. 13; DARKER 1929, p. 164; RHOADS,

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HEDGCOCK, BETHAL & HARTLEY 1918, p. 336, p.p.)—South Dakota, Vermont, Wisconsin; Alberta, Ontario.

FOR THE UREDO- AND TELEUTOSTAGE:

Rubus acaulis MICHX. (ARTHUR 1925, p. 677; 1934, p. 14; HIRATSUKA, f. 1927d, p. 91; SEYMOUR 1929, p. 379)—Alaska.

Rubus arcticus L. (GOBI & TRANZSCHEL 1891, p. 112; HIRATSUKA, f. 1927d, p. 91; 1929b, p. 120; 1929c, p. 61; 1930a, p. 83; 1930b, p. 277; JØRSTAD 1925, p. 115; 1934, p. 21; LAGERHEIM 1889, p. 110; LIRO 1908, p. 507 & 582; RAINIO 1926, p. 254; SEYMOUR 1929, p. 380; P. & H. SYDOW 1915, p. 449; TRANZSCHEL 1895, p. 299; 1914, p. 555)—Norway, Sweden, Finland, Russia; Japan, Kamtchatka.

Rubus Chamaemorus L. (ARTHUR 1925, p. 677; 1934, p. 14; HIRATSUKA, f. 1927d, p. 91; SEYMOUR 1929, p. 380)—Alaska.

Rubus saxatilis L. (FRAGOSO 1925, p. 263; GOBI & TRANZSCHEL 1891, p. 112; HIRATSUKA, f. 1927d, p. 91; LIRO 1908, p. 508; P. & H. SYDOW 1915, p. 449)—Finland, Russia.

Rubus stellatus SM. (ARTHUR 1907, p. 107; 1934, p. 14; HIRATSUKA, f. 1927d, p. 91; SEYMOUR 1929, p. 384; P. & H. SYDOW 1915, p. 449)—Alaska.

Rubus triflorus RICH. (*R. pubescens* RAF.) (ARTHUR 1925, p. 677; 1934, p. 14; BISBY 1924, p. 127; DARKER 1929, p. 164; DAVIS 1914, p. 914; HIRATSUKA, f. 1927d, p. 91; MOSS 1926, p. 816; SEYMOUR 1929, p. 384; P. & H. SYDOW 1915, p. 449)—Connecticut, Michigan, Minnesota, New Hampshire, Vermont, Wisconsin; Manitoba; New Brunswick, Ontario, Alberta.

Exsiccati. FOR THE UREDO- AND TELEUTOSTAGE: P. & H. SYDOW, Ured. no. 2738; VESTERGRENN, Micromyc. rar. sel. no. 857.

Habitat in Japan

On *Rubus arcticus* L. (*Chisima-ichigo*). *S. Saghalien*:—Shisuka (Shisuka).

The uredostage of this species was first described by LAGERHEIM in 1889 under the name of *Uredo arcticus* LAGERH. based upon a specimen on *Rubus arcticus* which was collected by him at Lulea in northern Sweden in June 1883. The teleutospores remained undescribed until 1895, when TRANZSCHEL recorded them on the same plant. He transferred the species to the genus *Pucciniastrum*.

In 1929, DARKER demonstrated the relation of the acidiospores on *Picea canadensis* to the teleutospores on *Rubus triflorus*, by transferring cultures in both directions. The description of the acedial

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stage above is compiled from North American Flora, VII, p. 646 (*Peridermium ingenuum* ARTH.).

In 1929, the writer recorded the collection by himself of this species on *Rubus arcticus* at Shisuka in South Saghalien. It is the first record of the present species from Japan. So far as the writer knows, this fungus is known from this country only from the above collection.

This species is widely distributed throughout the arctic region.

4. *Pucciniastrum Agrimoniae* (DIET.) TRANZSCHEL in Script. Bot. Hort. Univ. Petropol. IV, p. 301, 1895; ARTHUR in N. Amer. Fl. VII, p. 106; Manual of the rusts in United States and Canada, p. 14; DOIDGE in Bothalia, II, p. 161, 1926; FISCHER, Ured. Schw. p. 465; FRAGOSO, Fl. Ibér. Ured. II, p. 261; GROVE, Brit. Rust Fungi, p. 364; HARIOT, Ured. p. 251; HIRATSUKA, f. in Jour. Facul. Agric. Hokkaidô Imp. Univ. XXI, p. 86, 1927; Bot. Mag. Tokyo, XLIV, p. 273, 1930; KLEBAHN in Zeitschr. f. Pflanzenkr. XVII, p. 149, 1907; Kryptogamenfl. Mark Brandenbr. Va, p. 834; P. & H. SYDOW, Monogr. Ured. III, p. 446.

Syn. *Uredo Potentillarum* de CANDOLLE var. *Agrimoniae-Eupatoriae* de CANDOLLE in Fl. franç. VI, p. 81, 1815.

Caeoma (Uredo) Agrimoniae SCHWEINITZ in Transact. Amer. Phil. Soc. II, 4, p. 291, 1832; BURRILL in Bull. Illinois State Labor. Nat. Hist. II, p. 220, 1885.

Coleosporium ochraceum BONORDEN, Coniomyc. u. Crypt. p. 20, 1860.

Caeoma ochraceum NIESSL in Verhandl. Naturf. Ges. Brünn, III, p. 106, 1864.

Uredo Agrimoniae-Eupatoriae WINTER in Pilze Deutschl. I, p. 252, 1881; MASSALONGO, Ured. Veron. p. 63.

Uredo Agrimoniae SCHRÖTER, Pilze Schles. I, p. 374, 1887; SACCARDO, Syll. Fung. VII, p. 839; OUDEMANS, Rév. Champ. I, p. 586.

Uredo Agrimoniae de CANDOLLE in PLOWRIGHT, Monogr. Ured. & Ustil. p. 255, 1889.

Thekopsora Agrimoniae DIETEL in Hedwigia, XXIX, p. 153, 1890.

Pucciniastrum Agrimoniae-Eupatoriae LAGERHEIM in Tromsø Mus. Aarsh. XVII, p. 92, 1895; LIRO, Ured. Fenn. p. 508.

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Pucciniastrum Agrimoniae HIRATSUKA in Bot. Mag. Tokyo, XII, p. 30, 1898; Rev. Myc. XXI, p. 38, 1899.

Pucciniastrum Agrimoniae DIETEL in Hedwigia, XXXVI, p. 33, 1897; ENGLER-PRANTL, Natürl. Pflanzenfam. I, 1. Abt.**, p. 47, 1897.

Pucciniastrum Agrimoniae LAGERHEIM in BUBÁK, Rostpilze Böhmens, p. 186, 1908; MIGULA, Krypt.-Fl. III, 1, p. 468.

Pucciniastrum ochraceum LIND, Danish Fungi, p. 293, 1913.

Pucciniastrum Agrimoniae-Eupatoriae TRANZSCHEL in TROTTER, Fl. Ital. Crypt. Ured. p. 382, 1914.

Icon. ARTHUR, Manual of the rusts in United States and Canada, fig. 23; BONORDEN, l. c. pl. I, fig. 15; CLINTON in Rept. Connecticut Agric. Exper. Stat. (1907~1908), pl. XXXI, fig. C & pl. XXXII, fig. 4, 1908; DODGE in Jour. Agric. Res. XXIV, pl. V (D, E, F, G), 1923; FRAGOSO, l. c. fig. 129; GROVE, l. c. fig. 272; HIRATSUKA in Bot. Mag. Tokyo, XII, pl. II, fig. 1~6, 1898; KLEBAHN in Kryptogamenfl. Mark Brandenbr. Va, p. 842, fig. R, 4 (I-V); LUDWIG & REES in Amer. Jour. Bot. V, pl. VIII, fig. 1~4, 1918.

Uredosori hypophyllous, subepidermal, scattered or gregarious, sometimes thickly scattered over the whole surface of the leaf, irregularly rounded or oblong, minute, 0.12~0.4 mm across, dehiscent from a central pore, at last somewhat pulverulent, orange-yellow fading to pale yellow in colour; peridia hemispherical, delicate; peridial cells small, irregularly polygonal, 7~18 μ , walls thin (1.5~2 μ), thicker below toward the orifice, smooth; ostiolar cells subglobose to oblong, 20~25 μ high, walls rather thick, 2.5~5 μ , somewhat minutely echinulate or nearly smooth; uredospores globose, subglobose, obovate or ellipsoidal, 15~25.2 \times 12.5~20 μ ; epispore uniformly echinulate, rather thin, 1~1.5 μ thick, nearly colourless; contents orange-yellow in colour when fresh.

Teleutosori mostly hypophyllous, subepidermal, minute, pale brown to reddish brown in colour; teleutospores intercellular, solitary or grouped, often compacted laterally under the epidermis, globose, subglobose or oblong, sometimes somewhat angular or flattened at the sides, 2~4 celled (rarely one or more than 4), 18~30 μ high, 16~30 μ wide; epispore uniformly thickened, 1.5~2 μ , smooth, yellowish brown in colour. (Plate VIII, fig. 2)

Hosts and Distribution

FOR THE UREDO- AND TELEUTOSTAGE:

Agrimonia Eupatoria L. & var. (*A. glabrata* SPRENG., *A. Eupa-*

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toria var. *capensis*) (BAUDYŠ & PICBAUER 1925, p. 184; BUBÁK 1898, p. 18; 1899, p. 20; 1903b, p. 7; 1908, p. 186; 1915, p. [48]; BUTLER & BISBY 1931, p. 75; CONSTANTINEANU 1920, p. 443; DIETEL 1890a, p. 48; 1890b, p. 152; DOIDGE 1926, p. 161; FISCHER 1904, p. 466; FRAGOSO 1925, p. 262; GROVE 1913, p. 365; HARIOT 1908, p. 251; HIRATSUKA, f. 1927d, p. 87; JAAP 1907c, p. 4; 1914a, p. 19; JØRSTAD 1925, p. 115; KLEBAHN 1914, p. 835 & 903; KLIKA 1926, p. 34; LAGERHEIM 1895, p. 92; LAUBERT 1921, p. 241; LIND 1913, p. 293; LIRO 1908, p. 508; MAGNUS 1892a, p. 3; 1894, p. 56; 1900, p. 20; MASSALONGO 1883, p. 63; MAYOR 1930b, p. 174; 1934, p. 299; MIGULA 1910, p. 468; MOESZ 1923, p. 281; NISSL 1864, p. 106; OUDEMANS 1892, p. 586; PICBAUER 1927, p. 441; 1932b, p. 3; 1933a, p. 6; PLOWRIGHT 1889, p. 255; POEVERLEIN 1926, p. [40]; POEVERLEIN & BERTSCH 1927, p. 195; RANOJEVIĆ 1914, p. 399; SCHRÖTER 1887, p. 374; SIEMASZKO 1923b, p. 14; P. & H. SYDOW 1915, p. 448; P. & H. SYDOW & BUTLER 1912, p. 270; TROTTER 1914, p. 383; TURCONI 1908, p. 134; UNAMUNO 1934, p. 259; VOSS 1889, p. 342; WILSON 1934, p. 427; WINTER 1881, p. 253)—Norway, Sweden, Finland, Denmark, Germany, Austria, France, Spain, Italy, Great Britain, Czechoslovakia, Yugoslavia, Switzerland, Rumania, Bulgaria, Belgium, Poland, Russia; Siberia, India; Canary Islands, Natal, Cape Province, Transvaal.

Agrimonia gryposepala WALLR. (*A. hirsuta* BICKN., *A. Eupatoria* Auct.) (ADAMS 1919, p. 23; ARTHUR 1907, p. 106; 1926, p. 234; 1927, p. 818; 1934, p. 14; BRECKLE 1918, p. 207; BURRILL 1885, p. 220; DAVIS 1914, p. 914; DIETEL 1890b, p. 153; FARLOW 1878, p. 226; FRASER 1912, p. 191; FREEMAN 1901, p. 560; HIRATSUKA, f. 1927d, p. 87; JACKSON 1918a, p. 319; KERN, THURSTON Jr., ORTON & ADAMS 1929, p. 6; SEYMOUR 1929, p. 391; P. & H. SYDOW 1915, p. 448; TRELEASE 1884, p. 132)—Illinois, Iowa, Maryland, Minnesota, Nebraska, North Dakota, South Dakota, New York, Delaware, Vermont, Pennsylvania, West Virginia; Alberta, Manitoba, Nova Scotia.

Agrimonia hirsuta BONG. (JACKSON 1931a, p. 104)—Brazil.

Agrimonia incisa TORR. et GR. (ARTHUR 1907, p. 106; 1934, p. 14; HIRATSUKA, f. 1927d, p. 87; SEYMOUR 1929, p. 392; P. & H. SYDOW 1915, p. 448)—North Carolina.

Agrimonia leucantha KUNZE (FISCHER 1904, p. 466; HIRATSUKA, f. 1927d, p. 87; P. & H. SYDOW 1915, p. 448)—Switzerland.

Agrimonia microcarpa WALLR. (*A. pumila* MUHL.) (ARTHUR

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1907, p. 106; 1927, p. 818; 1934, p. 14; HIRATSUKA, f. 1927d, p. 87 & 88; SEYMOUR 1929, p. 392; P. & H. SYDOW 1915, p. 448)—Florida, Missouri, Kansas, Louisiana, Indiana, Michigan.

Agrimonia odorata MILL. (CONSTANTINEANU 1920, p. 443; FRAGGSO 1925, p. 262; HIRATSUKA, f. 1927d, p. 87; JAAP 1904, p. 131; KLEBAHN 1914, p. 835; LIND 1913, p. 293; POEVERLEIN & BERTSCH 1927, p. 196; SCHRÖTER 1887, p. 374; P. & H. SYDOW 1903b, p. 248; 1915, p. 448; TROTTER 1914, p. 383; WINTER 1881, p. 253)—Germany, Rumania, Italy, Denmark.

Agrimonia parviflora SOLAND (*A. polyphylla* TUB.) (ADAMS 1919, p. 23; ARTHUR 1907, p. 106; 1927, p. 818; 1934, p. 15; ARTHUR & BISBY 1918, p. 200 & 265; BURRILL 1885, p. 220; CIFERRI 1933, p. 159; DIETEL 1897a, p. 33; HIRATSUKA, f. 1927d, p. 87; KELLERMAN 1903, p. 22; KERN & CIFERRI 1930, p. 111; KERN, CIFFERI & THURSTON Jr., ORTON & ADAMS 1929, p. 6; KLEBAHN 1914, p. 835; LUDWIG & REES 1918, p. 56; PATTERSON 1902, p. 14; SEYMOUR 1929, p. 392; P. & H. SYDOW 1915, p. 448)—Alabama, Arkansas, Delaware, Kentucky, Michigan, Mississippi, Illinois, Indiana, New Jersey, New York, Ohio, North Carolina, Pennsylvania, Tennessee, Virginia, West Virginia; West Indies.

Agrimonia pilosa LEDEB. (*A. Eupatoria* Auct., *A. viscodula* BUNGE, *A. japonica* KOIDZ.) (BUTLER & BISBY 1931, p. 75; DIETEL 1890b, p. 152; 1899, p. 567; 1900b, p. 286; 1910, p. 313; HENNINGS 1902, p. 733; HIRATSUKA, f. 1927b, p. 235; 1927c, p. 305; 1927d, p. 88; 1928a, p. 30; 1928d, p. 691; 1930a, p. 82; 1930b, p. 274; 1930d, p. 329; 1932b, p. 40; 1933a, p. 148; 1935a, p. 150; 1935c, p. 41; 1935f, p. 280; HIRATSUKA, f. & HASHIOKA 1933, p. 162; HIRATSUKA, f. & YOSHINAGA 1935, p. 260; ITÔ & HIRATSUKA, f. 1927, p. 268; KLEBAHN 1914, p. 835; KUSANO 1902a, p. [198]; LIRO 1908, p. 508; MIURA 1928, p. 232; MURASHKINSKY & SIELING 1928, p. [9]; NAGAI & SHIMAMURA 1933, p. 84; NAITÔ & YAGI 1933, p. 16; SAWADA 1933, p. 51; P. & H. SYDOW 1913, p. 110; 1915, p. 448; TOGASHI 1924, p. 83; TOGASHI & HIRATSUKA, f. 1924, p. 76; TOGASHI & ÇNUMA 1934, p. 17; YOSHINAGA 1904b, p. [218]; YOSHINAGA & HIRATSUKA f. 1930, p. 654; YOSHINO 1905, p. [99]; WINTER 1881, p. 253)—India, Manchuria, Siberia, North Saghalien, Japan.

Agrimonia pubescens WALLR. (*A. mollis* BRITT.) (ARTHUR 1907, p. 106; 1926, p. 234; 1927, p. 818; 1934, p. 15; DAVIS 1914, p. 941; 1915b, p. 260; HIRATSUKA, f. 1927d, p. 87; KELLERMAN 1904, p. 60;

SEYMOUR 1929, p. 392; P. & H. SYDOW 1915, p. 448)—Arkansas, Indiana, Illinois, Iowa, Massachusetts, Michigan, Missouri, New York, Nebraska, New Mexico, Virginia, West Virginia, Wisconsin; Ontario.

Agrimonia rostellata WALLR. (ARTHUR 1925, p. 676; 1934, p. 15; HIRATSUKA, f. 1927d, p. 88; JACKSON 1921, p. 166; SEYMOUR 1929, p. 392)—Indiana, New York.

Agrimonia striata MICHX. (*A. Brittoniana* BICKN.) (ARTHUR 1907, p. 106; 1927, p. 818; 1934, p. 15; DAVIS 1914, p. 914; HIRATSUKA, f. 1927d, p. 87; KERN, THURSTON Jr., ORTON & ADAMS 1929, p. 6; SEYMOUR 1929, p. 392; STANDLEY 1916, p. 164; 1918, p. 41; P. & H. SYDOW 1915, p. 448; THURSTON Jr. & KERN 1931, p. 79)—Colorado, Maine, Nebraska, New York, New Mexico, South Dakota, North Dakota, Pennsylvania, Vermont, Virginia, West Virginia, Wisconsin; Alberta.

Agrimonia suaveolens HORT. (HIRATSUKA, f. 1927d, p. 88; P. & H. SYDOW 1915, p. 448)

Agrimonia zeylanica MOON (PETCH 1912, p. 240)—Ceylon.

Agrimonia sp. (ARTHUR 1907, p. 106)—New Mexico; Mexico.

Agrimonia sp. (BUTLER & BISBY 1931, p. 75)—India.

Exsiccati. FOR THE UREDO- AND TELEUTOSTAGE: ALLESCHER & SCHNABL, Fung. bavar. no. 122; BARTHOLOMEW, Fung. Columb. no. 2867 & 4169; BARTHOLOMEW, N. Amer. Ured. no. 75, 176, 281, 1277, 1580, 2083, 2278, 2279, 2377, 2686, 2874, 3177 & 3278; BRECKLE, Fung. Dakot. no. 85; CIFERRI, Mycofl. domingensis, no. 180; COOKE, Fung. brit. I, no. 635; II, no. 149; ELLIS, N. Amer. Fung. no. 274; ELLIS & EVERHART, Fung. Columb. no. 760; M. HOLWAY, Rel. HOLWAY. no. 238; JACZEWSKI, KOMAROV & TRANZSCHEL, Fung. Ross. no. 173; KELLERMAN, Ohio Fung. no. 116 & 177; RABENHORST, Fung. eur. no. 2189 & 4016; RABENHORST, Herb. myc. ed. II, no. 696; D. SACCARDO, Myc. ital. no. 1106; SCHNEIDER, Herb. no. 680, 681 & 682; SCHRÖTER, Pilze Schles. no. 240; SEYMOUR & EARLE, Econ. Fung. no. 276; SHEAR, New York Fung. no. 134; SIEMASZKO, Fung. Bialowienses, no. 54; P. & H. SYDOW, Myc. march. no. 1229; P. & H. SYDOW, Ured. no. 248, 1340, 1690 & 2698; THÜMEN, Fung. austr. no. 1124; THÜMEN, Myc. univ. no. 147, 749 & 2046; VIZE, Fung. brit. no. 57; VIZE, Micr. Fung. brit. no. 325.

Habitat in Japan

On *Agrimonia pilosa* LEDEB. (*Kin-midzuhiki*). *S. Saghalien*:—Ôdomori (Ôdomari, Kaidzuka). Toyohara (Sakaehama, Toyohara).

Tomarioro (Kushunnai). *Hokkaidô*:—Oshima (Hakodate, Esashi). Shiribeshi (Raiden-tôge, Zenibako, Ranshima, Otaru). Iburi (Hayakita, Mombetsu, Chitose). Ishikari (Sapporo, Maruyama near Sapporo, Sankakuyama near Sapporo, Tsukisappu, Bannosawa near Sapporo, Mt. Moiwa, Garugawa, Mt. Teine, Kotoni, Ikushunbetsu, Yuni-mura). Kitami (Mt. Rishiri, Rishiri-Senpôji, Oshidomari, Noshappu-saki near Wakkanai, Kitami-aioi). Tokachi (Shikaoimura, Ôtsu-mura, Obihiro). Hidaka (Urakawa, Saruru). Kushiro (Kutcharo, Nipushi [Lake side of Kutcharo], Bokke [Akan], Yûbetsu, Nanamagari [Akan], Harutori-ko). Nemuro (Nemuro, Shibetsu). *Kuriles*:—Kunashiri (Furukamappu). *Honshû*:—Mutsu (Hirosaki, Goshogawara, Moya-tôge, Ishie). Rikuchû (Morioka, Nanshōzan, Mt. Hayachine, Mt. Iwate, Tamayama-mura, Ôkama). Rikuzen (Sendai). Uzen (Mt. Gassan). Sado (Kingokuzan). Echigo (Tagai-mura, Ôshima-mura). Kaga (Yamanaka-machi, Kanazawa). Echizen (Higashiura-mura). Iwaki (Tôgatta). Musashi (Hachiôji, Tokyo, Takao-yama). Shimotsuke (Nikkô). Shinano (Mt. Komagatake [Kiso], Matsumoto). Idzu (Mt. Amagi, Kawana). Inaba (Tottori, Inaba-mura, Omokage-mura, Nakanogô-mura, Hôgi-mura, Mt. Okinosen). Hôki (Mt. Daisen, Kurayoshi). Tajima (Hamasaka). Idzumo (Matsue). *Shikoku*:—Tosa (Sakawa-machi, Kamihayama-mura). Iyo (Iradzu-yama). Awa (Koyadaira-mura). *Kiushû*:—Chikugo (Miike-machi). Higo (Mt. Aso, Tsumori-mura). Hiuga (Mt. Kirishima). Buzen (Mt. Hikosan). Satsuma (Toso near Kagoshima). Ôsumi (Yakushima). *Formosa*:—Taichû (Gojyô). Taihoku (Bokusaku, Wantan, Shinten). Shinchiku (Shinpajii). *Korea*:—Keiki (Seiryôri). Kôgen (Onseiri, Onseirei).

DIETEL found the teleutospores of this species on a specimen of *Agrimonia pilosa* collected in Siberia and also on those of *Agrimonia Eupatoria* (*A. gryposepala*) collected in Iowa, North America. He published an account of them in *Hedwigia* for 1890. According to him, the teleutospores are formed in the epidermal cells, and he gave it the name of *Thekopsora Agrimoniae* DIET. In 1895, TRANZSCHEL discovered that its teleutospores are produced under the epidermis or in the mesophyll, not in the epidermal cells as suggested by DIETEL, and transferred it to the genus *Pucciniastrum*, giving the name *Pucciniastrum Agrimoniae* TRANZSCH. At the same time, Naoharu HIRATSUKA also, independently of TRANZSCHEL, found that the teleutospores of this fungus occur under the epidermis of the leaves

of *Agrimonia*. In 1898, he described and illustrated the uredo- and teleutospores of the present species on *Agrimonia pilosa* based on specimens which were collected in the vicinity of Sapporo. It is the first record of this species in Japan. The uredostage is common in this country, but its teleutostage seldom occurs in southern Japan.

The aecidial stage of this species has not been reported. In 1907, KLEBAHN proved that this fungus could maintain itself by overwintered uredospores. In 1912, FRASER also reported that this fungus is probably either carried over the winter by the uredospores or is perennial in the rootstock or roots, as the young leaves of the conifers were not open at the time of his collection. As has been remarked by KLEBAHN, FRASER and others, the uredostage of this species hibernates also in this country.

This is the most widely distributed and by far the commonest species of the genus.

5. *Pucciniastrum Potentillae* KOMAROV in JACZEWSKI, KOMAROV & TRANZSCHEL, *Fungi Rossiae exsicc.* no. 327, 1899; *Hedwigia*, XXXIX, p. (128), 1900; ARTHUR in *N. Amer. Fl.* VII, p. 676; *Manual of the rusts in United States and Canada*, p. 14; HIRATSUKA, f. in *Jour. Facul. Agric. Hokkaidô Imp. Univ.* XXI, p. 91, 1927; *Bot. Mag. Tokyo*, XLIV, p. 275, 1930; *Jour. Soc. Agric. & Forestr. Sapporo*, XX, p. 695, 1928; SACCARDO, *Syll. Fung.* XVI, p. 319; P. & H. SYDOW, *Monogr. Ured.* III, p. 449.

Icon. ARTHUR, *Manual of the rusts in United States and Canada*, fig. 22; HIRATSUKA, f. in *Jour. Facul. Agric. Hokkaidô Imp. Univ.* XXI, pl. 1, fig. 10, 1927; MOSS in *Ann. Bot.* XL, pl. XXXIV, fig. 16, 1926.

Uredosori hypophyllous, scattered or frequently crowded in small groups, sometimes thickly scattered over the whole surface of the leaf, subepidermal, round or broadly ellipsoidal, minute, 0.1~0.4 mm across, orange-yellow in colour; peridia hemispherical, delicate, dehiscent from a central pore; peridial cells minute, irregularly polygonal, 7~18 μ across, walls thin, 1.5~2 μ thick, smooth, colourless; ostiolar cells 18~25 μ high, rounded at the apex, rather thick, 2~4 μ , somewhat minutely echinulate or appearing nearly smooth when wet; uredospores globose, subglobose, obovate or ellipsoidal, 15~21.6 \times 12.5~18 μ ; episporium finely echinulate, thin, 1~18 μ thick, colourless; contents orange-yellow in colour when fresh.

Teleutosori hypophyllous, subepidermal, small, limited by the

nerves, reddish brown in colour; teleutospores intercellular, solitary or irregularly grouped, globose, subglobose or ovate, or somewhat angular or flattened at the sides, divided into 2~4 cells (rarely more than 4) by vertical or oblique septa, 14~26.5 μ in diameter; epispore uniformly thin, about 1 μ thick, smooth, cinnamon brown in colour.

Hosts and Distribution

FOR THE UREDO- AND TELEUTOSTAGE:

Potentilla centigrana MAXIM. (HIRATSUKA, f. 1927c, p. 306; 1927d, p. 92; 1930b, p. 276)—Japan.

Potentilla cryptotaeniae MAXIM. (HIRATSUKA, f. 1927c, p. 306; 1927d, p. 92; 1930b, p. 276)—Japan.

Potentilla fragarioides L. & var. (*P. stolonifera* LEHM.) (DIETEL 1905b, p. 105; 1908, p. 227; HENNINGS 1902, p. 732; HIRATSUKA, f. 1927c, p. 306; 1927d, p. 92; 1928a, p. 30; 1928d, p. 695; 1930a, p. 83; 1930b, p. 276; 1930d, p. 330; 1933a, p. 150; 1935a, p. 150; HIRATSUKA, f. & YOSHINAGA 1935, p. 260; JØRSTAD 1934, p. 22; KASAI 1910, p. 48; KOMAROV 1900, p. [128]; MIURA 1928, p. 233; P. & H. SYDOW 1915, p. 449; TAI 1932, p. 539; TERUI 1930, p. 159; TOGASHI & Ônuma 1934, p. 17; TRANZSCHEL 1914, p. 555; YOSHINAGA & HIRATSUKA, f. 1930, p. 654)—Manchuria, Kamtchatka, Japan.

Potentilla Freyniana BORUM. (HIRATSUKA, f. 1927c, p. 306; 1927d, p. 92 & 93; 1930b, p. 276; HIRATSUKA, f. & YOSHINAGA 1935, p. 260; TOGASHI & ÔNUMA 1934, p. 17; YOSHINAGA & HIRATSUKA, f. 1930, p. 654)—Japan.

Potentilla tridentata SOLAND (*Sibbaldiopsis tridentata* RYDB.) (ARTHUR 1925, p. 677; 1934, p. 14; DAVIS 1914, p. 914; HIRATSUKA, f. 1927d, p. 92; MOSS 1926, p. 815; POVAH 1935, p. 137; SEYMOUR 1929, p. 390; P. & H. SYDOW 1915, p. 449)—Maine, Minnesota, Michigan, New Hampshire, New York, Wisconsin; New Brunswick, Ontario, Manitoba.

Potentilla sp. (HIRATSUKA, f. 1935d, p. 707)—Japan.

Exsiccati. FOR THE UREDO- AND TELEUTOSTAGE: BARTHOLOMEW, Fung. Columb. no. 2367; JACZEWSKI, KOMAROV & TRANZSCHEL, Fung. Ross. no. 327; THAXTER, Rel. FARL. no. 279.

Habitat in Japan

On *Potentilla centigrana* MAXIM. (*Hime-hebiichigo*). *Hokkaidô*:—Oshima (Nakayama-tôge). Shiribeshi (Otaru). Ishikari (Maruyama near Sapporo, Nopporo, Mt. Moiwa).

On *Potentilla cryptotaeniae* MAXIM. (*Mitsumotosô*). *Hokkaidô*:

—Oshima (Hakodate). Ihuri (Chitose). Ishikari (Sapporo, Jôzan-kei, Maruyama near Sapporo).

On *Potentilla fragarioides* L. (*Kijimushiro*). *S. Saghalien*:—Motodomari (Noboripo). Shisuka (Shisuka). *Hokkaidô*:—Ihuri (Hayakita). Ishikari (Sapporo, Makomanai, Tsukisappu, Kamikawa-mura, Sunagawa, Kuriyama). Tokachi (Shikaribetsu-numa, Kuttari, Pankenikoro [Kuttari]). Kushiro (Yûbetsu). Kitami (Rebun-Momoiwa). *Honshû*:—Rikuchû (Mt. Hayachine). Shimotsuke (Nikkô-Akanumagahara). Musashi (Tokyo). Inaba (Tottori, Enoki-tôge). Hôki (Neu-machi). *Shikoku*:—Tosa (Sakawa-machi, Kôchi-shi, Mikadzuki-mura). *Korea*:—Kôgen (Onseiri).

On *Potentilla Freyniana* BORUM. (*Mitsuba-tsuehiguri*). *Hokkaidô*:—Oshima (Ônuma). Ishikari (Atsubetsu, Nopporo, Mt. Kurodake). *Honshû*:—Rikuchû (Mt. Hayachine). Echigo (Shibata, Ôshima-mura). Shinano (Mt. Komagatake [Kiso]). *Shikoku*:—Tosa (Aki-machi).

On *Potentilla* sp. *Kiushû*:—Chikugo (Miike-machi).

This species was newly created by KOMAROV taking a specimen on *Potentilla fragarioides* which was published in JACZEWSKI, KOMAROV & TRANZSCHEL, Fungi Rossiae exsiccati, no. 327 (1899). This original collection was made by himself at Taimagou, province of Kirin, Manchuria in June 1896.

The first reference to this species from Japan was made in 1902 under the name *Phragmidium fragarioides* (DC.) SCHRÖT. by HENNINGS who reported two specimens of uredostage on *Potentilla fragarioides* which were collected by S. HORI at Nikkô in the province of Shimotsuke and by T. YOSHINAGA at Sakawa-machi in the province of Tosa. After three years, DIETEL reported the same fungus from the same specimen as *Pucciniastrum Potentillae* KOM. Since then, DIETEL, YOSHINAGA, TERUI and the writer have recorded it on *Potentilla centigrana*, *P. cryptotaeniae*, *P. fragarioides* and *P. Freyniana* from various places in South Saghalien, Hokkaidô, Honshû, Shikoku, Kiushû and Korea.

Pucciniastrum Potentillae is widely distributed in Manchuria, Kamtchatka and Japan, and has also been reported from North America.

The aecidial connection of this species has not been demonstrated by cultures. In northern Japan, the uredosori are very common, but the teleutosori appear to be rare, as only a few sori have been found

on some of the materials collected in the late autumn. Plants of *Potentilla cryptotaeniae* bearing the uredosori of this fungus which were collected by the writer at Maruyama near Sapporo in November 1926, were potted and kept for three years in the hope of securing the teleutostage, but it failed to develop though fresh uredosori were formed in each successive year. The fungus, therefore, is capable of overwintering in the uredostage.

This species is chiefly distinguished from *Pucciniastrum Agri- moniae* (DIET.) TRANZSCH. which it closely resembles in general appearance, by the somewhat smaller uredospores, $15\sim 21.6 \times 12.5\sim 18 \mu$, instead of $16.2\sim 25.2 \times 12.5\sim 20 \mu$.

6. *Pucciniastrum Coryli* KOMAROV in JACZEWSKI, KOMAROV & TRANZSCHEL, Fungi Rossiae exsicc. no. 275, 1899; Hedwigia, XXXIX, p. [125], 1900; HIRATSUKA, f. in Jour. Facul. Agric. Hokkaidô Imp. Univ. XXI, p. 97, 1927; Jour. Soc. Agric. & Forestr. Sapporo, XX, p. 695, 1928; Bot. Mag. Tokyo, XLIV, p. 281, 1930; SACCARDO, Syll. Fung. XVI, p. 320; P. & H. SYDOW, Monogr. Ured. III, p. 454.

Icon. HIRATSUKA, f. in Jour. Facul. Agric. Hokkaidô Imp. Univ. XXI, pl. I, fig. 13, 1927; P. & H. SYDOW, l. c. pl. XIX, fig. 161.

Uredosori hypophyllous, subepidermal, scattered or rarely grouped, often thickly scattered over the whole surface of the leaf, round, minute, $0.1\sim 0.2$ mm in diameter, pale yellow in colour, at last somewhat pulverulent; peridia hemispherical, delicate, rupturing at the apex; upper peridial cells small, isodiametrically to irregularly polygonal, $8\sim 22 \mu$ across; lateral ones radially elongate; walls of peridial cells thin, $1\sim 2 \mu$ thick, smooth, nearly colourless; ostiolar cells globose or ellipsoidal, walls rather thick, $2\sim 4 \mu$, smooth, colourless; uredospores obovate, ellipsoidal or oblong, $18\sim 27 \times 10\sim 16 \mu$; epispore thin, $1.2\sim 1.5 \mu$ thick, uniformly echinulate, nearly colourless; contents orange-yellow in colour.

Teleutosori hypophyllous, subepidermal, minute, in dense clusters limited by the veins, yellow to brownish yellow in colour; teleutospores intercellular, solitary or grouped, often compacted laterally under the epidermis, oblong or polygonal, divided longitudinally into 2 to 8 cells (occasionally more than 8), $18\sim 30 \mu$ high, $12\sim 24 \mu$ wide; epispore thin, smooth, pale brownish coloured.

Hosts and Distribution

FOR THE UREDO- AND TELEUTOSTAGE:

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Corylus Avellana L. (SIEMASZKO 1923a, p. 23)—Caucasus.

Corylus heterophylla FISCH. (KOMAROV 1899, p. [126]; HIRATSUKA, f. 1927d, p. 97; 1928d, p. 692; 1935a, p. 150; MIURA 1928, p. 230; P. & H. SYDOW 1915, p. 454; TAI 1932, p. 539)—Manchuria, Japan.

Corylus rostrata AIT. var. (*C. mandshurica* MAXIM.) (DIETEL 1903a, p. 628; HIRATSUKA, f. 1927c, p. 307; 1927d, p. 98; 1930b, p. 281; 1930d, p. 331; 1932b, p. 41; 1933a, p. 149; 1935a, p. 150; P. & H. SYDOW 1915, p. 454)—Japan.

Exsiccati. FOR THE UREDO- AND TELEUTOSTAGE: JACZEWSKI, KOMAROV & TRANZSCHEL, Fung. Ross. no. 275.

Habitat in Japan

On *Corylus heterophylla* FISCH. var. *japonica* KOIDZ. (*Hashibami*). Honshû:—Inaba (Tottori). Korea:—Keiki (Seiryôri). Kôgen (Banbutsusô [Soto-Kongô]).

On *Corylus rostrata* AIT. var. *mandshurica* RGL. (*Ô-tsunohashibami*). Hokkaidô:—Ishikari (Sapporo). Honshû:—Rikuchû (Goshomura). Korea:—Kôgen (Onseiri).

On *Corylus rostrata* AIT. var. *Sieboldiana* MAXIM. (*Tsunohashibami*). Honshû:—Rikuchû (Shiwa, Morioka, Tamayama-mura). Rikuzen (Sendai). Shimotsuke (Nikkô). Musashi (Tokyo). Inaba (Tottori, Mt. Naginosen, Mt. Okinosen). Hôki (Mt. Daisen). Idzumo (Kijima-mura).

In 1899, KOMAROV originally described the present species on *Corylus heterophylla* in Fungi Rossiae exsicc. no. 275, based upon a specimen which was collected by himself at Omoso in the province of Kirin, Manchuria in 1896. This original specimen bears both uredo- and teleutospores.

The first record of the species from this country was made by DIETEL in 1903, from a specimen on *Corylus rostrata* var. *Sieboldiana* which was collected by S. KUSANO at Nikkô in the province of Shimotsuke. Recently, the writer also reported this fungus from various places of Hokkaidô, Honshû and Korea.

The aecidial connection of this species has not been demonstrated by cultures. The writer made inoculations with the uredospores of this fungus from *Corylus rostrata* var. *Sieboldiana* on *Corylus heterophylla* var. *japonica*, *C. rostrata* var. *mandshurica* and *C. rostrata* var. *Sieboldiana*. He secured positive results on all plants.

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7. *Pucciniastrum Fagi* YAMADA in HIRATSUKA, f. in Bot. Mag. Tokyo, XLIV, p. 280, 1930.

Uredosori hypophyllous, scattered or grouped on yellowish brown discoloured areas, subepidermal, round, very minute, 0.05~0.15 mm in diameter, yellow to pale yellowish brown in colour; peridia hemispherical, delicate, firm, colourless; peridial cells small, irregularly polygonal, 6~15 μ across, walls thin, smooth, nearly colourless; ostiolar cells rounded, smooth, rather thick at the apex; uredospores ellipsoidal, obovate or oblong, 18~24 \times 10~15 μ ; episporium thin, 1 μ or less, minutely echinulate, colourless; contents orange-yellow in colour when fresh; rudimentary paraphyses intermixed.

Teleutosori amphigenous, mostly hypophyllous, minute, often confluent, subepidermal, orange-yellow to yellowish brown in colour; teleutospores intercellular, scattered or loosely aggregated beneath the epidermis or at times solitary within the mesophyll, globose, subglobose or ovate, or angular or flattened at the sides, 12~27 μ high, 12~25 μ broad, divided into 2 to 5 cells (rarely one or more than 5) by vertical septa; episporium uniformly thin, 1~1.5 μ thick, smooth, pale yellowish brown in colour.

Hosts and Distribution

FOR THE UREDO- AND TELEUTOSTAGE:

Fagus crenata BL. (*F. Sieboldi* ENDL.) (HIRATSUKA, f. 1930b, p. 280; 1934c, p. 131; 1935c, p. 41; 1935f, p. 281)—Japan.

Habitat in Japan

On *Fagus crenata* BL. (*Buna*). *Honshû*:—Rikuchû (Nanshōzan, Takizawa near Morioka, Hakomine, Mt. Iwate). *Idzu* (Mt. Amagi). *Kiushû*:—Buzen (Mt. Hikosan).

This species is closely related to *Pucciniastrum Castaneae* DIET. from which it is distinguishable by its much smaller uredosori, absence of the well-developed paraphyses in its uredosori and the shape and size of uredo- and teleutospores.

It is one of species endemic to Japan.

8. *Pucciniastrum Boehmeriae* P. et H. SYDOW in Ann. Myc. I, p. 19, 1903; Monogr. Ured. III, p. 450; HIRATSUKA, f. in Jour. Facul. Agric. Hokkaidō Imp. Univ. XXI, p. 94, 1927; Bot. Mag. Tokyo, XLIV, p. 278, 1930; SACCARDO, Syll. Fung. XVII, p. 401.

Syn. *Uredo* (*Pucciniastrum*?) *Boehmeriae* DIETEL in ENGL. Bot. Jahrb. XXVIII, p. 290, 1900.

Icon. HIRATSUKA, f. in Jour. Facul. Agric. Hokkaidō Imp. Univ. XXI, pl. I, fig. 11, 1927.

Uredosori hypophyllous, scattered or grouped, often thickly covering the whole surface of the leaf, subepidermal, round, minute, 0.08~0.15 mm in diameter, at last somewhat pulverulent, yellow to light yellow in colour; peridia hemispherical, delicate, firm, rupturing at the apex; peridial cells small, isodiametrically or irregularly polygonal, 7~16 μ across, walls rather thin, 1~2 μ thick, smooth, nearly colourless; ostiolar cells rounded, smooth; uredospores subglobose, ovate, broadly ellipsoidal or ellipsoidal, 18~25 \times 13~18 μ ; episporium thin, 1~1.5 μ thick, colourless, finely echinulate; contents orange-yellow in colour when fresh.

Teleutosori hypophyllous, subepidermal, minute, limited by the nerves; teleutospores intercellular, solitary or gregarious, globose, subglobose, ovate or polygonal, 1~4 celled (occasionally more than 4), 18~30 μ high, 14.4~25 μ wide; episporium yellowish brown in colour, uniformly thin, about 1 μ , smooth. (Plate IX, fig. 3)

Hosts and Distribution

FOR THE UREDO- AND TELEUTOSTAGE:

Boehmeria holosericea BL. (HIRATSUKA, f. 1930b, p. 278; HIRATSUKA, f. & YOSHINAGA 1935, p. 260; NAITÔ & YAGI 1933, p. 16; YOSHINAGA & HIRATSUKA, f. 1930, p. 654)—Japan.

Boehmeria japonica MIQ. & var. (DIETEL 1903a, p. 629, as *Boehmeria longifolia* STEUD.; 1905b, p. 105; HIRATSUKA, f. 1927d, p. 95; 1930b, p. 278; 1930d, p. 330; 1935f, p. 280; NAITÔ & YAGI 1933, p. 16; NAMBU 1904, p. [1]; P. & H. SYDOW 1903, p. 19; 1915, p. 450)—Japan.

Boehmeria Sieboldiana BL. (DIETEL 1905b, p. 105; HIRATSUKA, f. 1927d, p. 95; 1930b, p. 279; HIRATSUKA, f. & YOSHINAGA 1935, p. 260; YOSHINAGA & HIRATSUKA, f. 1930, p. 654)—Japan.

Boehmeria spicata THUNB. (*B. longispica* STEUD.) (DIETEL 1903a, p. 629; HENNINGS 1905a, p. 597; HIRATSUKA, f. 1927d, p. 95; 1930b, p. 279; 1930d, p. 330; 1932b, p. 41; 1933, p. 148; 1935f, p. 280; 1936b, p. 270; HIRATSUKA, f. & YOSHINAGA 1935, p. 260; NAITÔ & YAGI 1933, p. 16; NAMBU 1904, p. [1]; P. & H. SYDOW 1903a, p. 19; 1915, p. 450; YOSHINAGA & HIRATSUKA, f. 1930, p. 654)—Japan.

Boehmeria Splitsgerbera KOIDZ. (*B. biloba* WEDD.) (DIETEL 1900b, p. 290; HIRATSUKA, f. 1927d, p. 95; 1930b, p. 278; 1935f, p. 281; KUSANO 1902a, p. [199]; P. & H. SYDOW 1903a, p. 19; 1915, p. 450; YOSHINAGA 1904, p. [218])—Japan.

Boehmeria tricuspis MAK. (*B. platanifolia* FRANCH. et SAV. var. *tricuspis* MATSUM., *B. japonica* MIQ. var. *tricuspis* HCE.) (DIETEL 1903a, p. 629; HIRATSUKA, f. 1927d, p. 95; 1930b, p. 279; 1933a, p. 148; HIRATSUKA, f. & YOSHINAGA 1935, p. 260; YOSHINAGA & HIRATSUKA, f. 1930, p. 654)—Japan.

Boehmeria sp. (P. & H. SYDOW 1917, p. 175)—Philippines.

Habitat in Japan

On *Boehmeria holosericea* BL. (*Oni-yabumao*). *Shikoku*:—Tosa (Higashikawa-mura). *Kiushû*:—Satsuma (Tagami near Kagoshima).

On *Boehmeria japonica* MIQ. (*Yabumao*). *Honshû*:—Musashi (Tokyo). Sagami (Hakoneyama, Kamakura). Idzu (Mt. Amagi). Inaba (Shiomi-mura). *Kiushû*:—Hiuga (Miyazaki). Higo (Yamaga). Bungo (Mie). Ôsumi (Tarumidzu-mura).

On *Boehmeria japonica* MIQ. var. *platanifolia* MAXIM. (*Me-yabumao*). *Kiushû*:—Ôsumi (Takakuma-mura).

On *Boehmeria Sieboldiana* BL. (*Nagaba-yabumao*). *Shikoku*:—Tosa (Mt. Yanaze, Kitagawa-mura).

On *Boehmeria spicata* THUNB. (*Ko-akaso*). *Honshû*:—Kaga (Yamanaka-machi). Echizen (Awano-mura, Higashiura-mura). Tango (Yoshidzu-mura). Musashi (Takaoyama). Idzu (Mt. Amagi). Inaba (Manisan near Tottori, Tottori, Mt. Okinosen, Mt. Ôginosen, Mt. Naginosen, Shiomi-mura). Hôki (Mt. Daisen). *Shikoku*:—Tosa (Sakawa-machi, Ioki-mura). Awa (Hinotani-mura). Iyo (Iradzu-yama). *Kiushû*:—Bungo (Tsukumi-tôge). Satsuma (Toso near Kagoshima).

On *Boehmeria SPLITZGERBERA* KOIDZ. (*Raseitasô*). *Honshû*:—Mutsu (Hirosaki). Rikuchû (Kamaishi). Awa. Sagami (Yokosuka, Kamakura). Idzu (Itô, Kawana). Kii (Shionomisaki-mura).

On *Boehmeria tricuspis* MAK. (*Akaso*). *Honshû*:—Rikuzen (Sendai). Iwaki (Sôma). Uzen (Atami). Shimotsuke (Nikkô). *Shikoku*:—Tosa (Amatsubo-mura). Iyo (Mikame-machi, Iradzu-yama).

The uredostage of the present species on *Boehmeria biloba* (*B. SPLITZGERBERA*) was collected by S. KUSANO in the province of Awa in December 1897. He sent his specimen to DIETEL who published and described it under the name of *Uredo* (*Pucciniastrum?*) *Boehmeriae* in his "Uredineae japonicae, II" in 1900. Three years later, the SYDOWS transferred it to the genus *Pucciniastrum*. Since then,

DIETEL, HENNINGS, NAMBU, YOSHINAGA, NAITÔ & YAGI and the writer have recorded the occurrence of this fungus on *Boehmeria holosericea*, *B. japonica*, *B. japonica* var. *platanifolia*, *B. Sieboldiana*, *B. spicata*, *B. SPLITZGERBERA* and *B. tricuspis* from this country. This species is widely distributed throughout southern Japan, from such parts as Honshû, Shikoku and Kiushû, but has not as yet been found in Hokkaidô and South Saghalien.

In 1917, this fungus was also recorded by the SYDOWS from the Philippine Islands.

9. *Pucciniastrum Hydrangeae-petiolearidis* HIRATSUKA, f. in Jour. Facul. Agric. Hokkaidô Imp. Univ. XXI, p. 27 & 93, 1927; Bot. Mag. Tokyo, XLIV, p. 277, 1930.

Icon. HIRATSUKA, f. in Jour. Facul. Agric. Hokkaidô Imp. Univ. XXI, pl. I, fig. 4, 1927.

Uredosori hypophyllous, on yellowish or pale brownish coloured areas, scattered or in small groups, often uniformly scattered over the whole surface of the leaf, subepidermal, round, minute, 0.15 ~ 0.34 mm in diameter, yellowish brown in colour; peridia hemispherical, delicate, firm, dehiscent from a central pore; upper peridial cells small, irregularly polygonal, 8~18 μ across, lateral ones radially elongate; walls of peridial cells thin, 1.2~2 μ thick, smooth, nearly colourless; ostiolar cells rounded, slightly thicker at apex, smooth; uredospores ovate, ellipsoidal, oblong or clavate, 18~33 \times 14~21 μ ; epispore thin, 1~1.8 μ thick, finely echinulate.

Teleutosori amphigenous, mostly hypophyllous, subepidermal, in dense clusters limited by the nerves, yellowish brown in colour; teleutospores intercellular, solitary or gregarious, often compacted laterally under the epidermis, globose, subglobose, ovate or prismatic, composed of 2~4 cells (rarely more than 4), 19.8~32.4 μ long, 18~27 μ wide; epispore uniformly thin, about 1 μ thick, smooth, pale yellowish brown in colour.

Hosts and Distribution

FOR THE UREDO- AND TELEUTOSTAGE:

Hydrangea anomala DON. (HIRATSUKA, f. 1934b, p. 5; HIRATSUKA, f. & HASHIOKA 1934, p. 237)—Japan.

Hydrangea Kawakamii HAYATA—Japan.

Hydrangea petiolaris SIEB. et ZUCC. (*H. scandens* MAXIM.) (HIRATSUKA, f. 1927a, p. 28; 1927c, p. 306; 1927d, p. 94; 1929b, p.

120; 1930a, p. 83; 1930b, p. 277; 1930d, p. 330; 1932b, p. 40; 1933a, p. 150; 1934b, p. 5; 1935f, p. 281; HIRATSUKA, f. & YOSHINAGA 1935, p. 261; ITÔ & HIRATSUKA, f. 1927, p. 269)—Japan.

Habitat in Japan

On *Hydrangea anomala* DON. (*Taiwan-tsuruajisai*). *Formosa*:—Tainan (Mt. Arisan).

On *Hydrangea Kawakamii* HAYATA (*Taiwan-gotôdzuru*). *Formosa*:—Shinchiku: Nemoto (Y. HASHIOKA).

On *Hydrangea petiolaris* SIEB. et ZUCC. (*Tsuru-ajisai*). *S. Saghalien*:—Motodomari (Shiritori). *Hokkaidô*:—Oshima (Ônuma, Mt. Komagatake). Iburi (Lake side of Shikotsu-ko, Rebunge-tôge). Shiribeshi (Raiden-tôge, Akaiwa near Otaru, Zenibako). Ishikari (Sapporo, Maruyama near Sapporo, Mt. Moiwa, Ishiyama, Jôzankei, Mt. Soranuma-dake, Mt. Teine, Nopporo, Mt. Kuro-dake, Sôunkei). Tokachi (Obihiro). Kitami (Mombetsu, Okedo-mura). Kushiro (Akan-Kutcharo-sandô). *Honshû*:—Mutsu (Sukayu in Mt. Hak-kôda). Shimotsuke (Mt. Shirane, Nikkô). Shinano (Mt. Komagatake [Kiso], Mt. Yatsugatake, Mt. Tsubakuro-dake). Idzu (Mt. Amagi). Inaba (Mt. Okinosen, Mt. Hyônosen). Hôki (Mt. Daisen). *Shikoku*:—Tosa (Mt. Inamura). *Kiushû*:—Chikuzen (Yamaguchimura).

The writer created the present species in 1927 based upon a specimen on *Hydrangea petiolaris* which was collected by himself at Maruyama near Sapporo (Hokkaidô) and in addition he recorded that this fungus is widely distributed in Hokkaidô. Since then, the present fungus on *Hydrangea petiolaris* was recorded by ITÔ, YOSHINAGA and the writer from various places in South Saghalien, Hokkaidô, Honshû, Shikoku and Kiushû, and the same fungus on *Hydrangea anomala* was reported by the writer and HASHIOKA from Formosa. Recently, the writer also received from Mr. HASHIOKA a specimen of this fungus on *Hydrangea Kawakamii* which had been collected by him in Shinchiku Province, Formosa. This species has not been previously recorded on *Hydrangea Kawakamii*.

This fungus differs distinctly from the American species, *Thekopsora Hydrangeae* (FARL.) MAGN. They can be distinguished from each other by the following characters. The teleutospores of *Thekopsora Hydrangeae* are mostly epiphyllous, while those of this species are usually hypophyllous or occasionally epiphyllous. The teleutospores of the former are intracellular, but those of the present

fungus are intercellular. Our fungus is also distinguishable from the American fungus by the larger size of its uredospores.

The genetic connection of this fungus has not been demonstrated by cultures. Judging from field observations, however, it is to be expected that the aecidial stage occurs on *Abies* sp.

10. *Pucciniastrum Coriariae* DIETEL in ENGL. Bot. Jahrb. XXVIII, p. 286, 1900; HIRATSUKA, f. in Jour. Facul. Agric. Hokkaidô Imp. Univ. XXI, p. 84, 1927; Bot. Mag. Tokyo, XLIV, p. 272, 1930; SACCARDO, Syll. Fung. XVI, p. 320; P. & H. SYDOW, Monogr. Ured. III, p. 452.

Icon. HIRATSUKA, f. in Jour. Facul. Agric. Hokkaidô Imp. Univ. XXI, pl. I, fig. 3, 1927.

Uredosori hypophyllous, subepidermal, in small groups, on yellowish or yellowish brown areas, round, minute, 0.08~0.15 mm in diameter, yellowish brown in colour; peridia hemispherical, delicate, firm, dehiscent from a central pore; peridial cells small, irregularly polygonal, 8~18 μ across, walls rather thin, 1~2 μ thick, smooth, nearly colourless; ostiolar cells subglobose or globose, 14.4~18 \times 10.8~14.4 μ , walls rather thin, smooth, hyaline to subhyaline; uredospores ellipsoidal, ovate or oblong, 21.6~26 \times 14.4~19.8 μ ; episporium thin, 1.2~1.5 μ thick, colourless, finely echinulate.

Teleutospores hypophyllous, subepidermal, causing pale yellowish brown discoloured areas of indefinite extent; teleutospores intercellular, cylindrical-ovate or prismatic, divided vertically into 2 to 4 cells (rarely more than 4), 21.6~32.4 μ long, 12~30.6 μ wide; episporium uniformly thin, smooth, subhyaline or pale yellow in colour.

Hosts and Distribution

FOR THE UREDO- AND TELEUTOSTAGE:

Coriaria intermedia MATSUM. (HIRATSUKA, f. 1927d, p. 85; 1930b, p. 272; HIRATSUKA, f. & HASHIOKA 1933, p. 162; SAWADA 1931, p. 50; H. SYDOW & PETRAK 1931, p. 171)—Japan, Philippines.

Coriaria japonica A. GRAY (DIETEL 1900b, p. 286; HIRATSUKA, f. 1927d, p. 85; 1930b, p. 272; P. & H. SYDOW 1915, p. 452)—Japan.

Coriaria nepalensis WALL. (BUTLER & BISBY 1931, p. 76; HIRATSUKA, f. 1927d, p. 85; P. & H. SYDOW 1915, p. 452; P. & H. SYDOW & BUTLER 1907, p. 503)—Himalaya.

Habitat in Japan

On *Coriaria intermedia* MATSUM. (*Taiwan-dokuutsugi*). *Formosa*:—Taitô (Taitô). Taichû (Uchô).

On *Coriaria japonica* A. GRAY (*Doku-utsugi*). *Honshû*:—Musashi (Tokyo). Sagami (Hakone). Suruga (Mt. Fuji).

The type specimen of the present species is a collection by S. KUSANO made on November 7, 1898 at the Botanical Garden of Tokyo Imperial University. Its type host plant is *Coriaria japonica*. The writer found the present fungus also on *Coriaria intermedia* which was collected by T. KAWAKAMI in Formosa on specimens preserved in the Herbarium of Faculty of Agriculture, Hokkaidô Imperial University. He reported it in 1927.

In 1907, the SYDOWS and BUTLER recorded the occurrence of this fungus parasitic on *Coriaria nepalensis* in Himalaya. Recently, H. SYDOW and PETRAK (1931) also recorded it on *Coriaria intermedia* from the Philippine Islands.

11. *Pucciniastrum Tiliae* MIYABE in HIRATSUKA in Bot. Mag. Tokyo, XI, p. 47, 1897; Rev. Myc. XXI, p. 37, 1899; HIRATSUKA, f. in Jour. Facul. Agric. Hokkaidô Imp. Univ. XXI, p. 83, 1927; Bot. Mag. Tokyo, XLIV, p. 271, 1930; SACCARDO, Syll. Fung. XVI, p. 363.

Syn. *Pucciniastrum Tiliae* HIRATSUKA in P. & H. SYDOW, Monogr. Ured. III, p. 453, 1915.

Icon. HIRATSUKA in Bot. Mag. Tokyo, XI, pl. IV, fig. 12~20, 1897.

Spermogonia on needles of current season, amphigenous, abundant, aggregated, often confluent, subcuticular, minute, conoidal, lenticular to flattened hemispherical, 130~210 μ across, 20~70 μ high; spermatophores unbranched, straight, obclavate; spermatia oblong, 4~8.5 \times 1.5~2.5 μ , colourless, smooth.

Aecidia on needles of current season, hypophyllous, rarely epiphyllous, arranged in two rows, one on each side of the midrib, deeply immersed, cylindrical, up to 3.5 mm long, about 0.2 mm across, orange-yellow in colour; peridia colourless, ruptured at the apex; peridial cells ovate to ellipsoidal, 48~74 \times 15~22 μ , slightly overlapping; inner walls thin, minutely verrucose, outer ones thin, smooth; aecidiospores globose to ellipsoidal, 19~33.5 \times 12~22 μ ; epispore thin, about 1 μ thick, minutely verrucose except a small part where it is almost smooth; contents orange-yellow in colour.

Uredosori hypophyllous, scattered or gregarious, subepidermal, small, round, 0.06~0.18 mm across, covered by the epidermis which ruptures at a centrally placed stomatic pore, often somewhat pul-

verulent; peridia hemispherical, delicate, firm, rupturing at the apex; peridial cells small, irregularly polygonal, 7.5~15 μ across; walls smooth, thin, 1.2~2 μ thick; ostiolar cells rounded, walls smooth, rather thick, 2.5~4 μ thick, nearly colourless; uredospores subglobose, ellipsoidal, obovate or oblong, 18~27 \times 12~18 μ ; epispore finely echinulate, thin, 1~1.5 μ thick; contents orange-yellow in colour.

Teleutosori hypophyllous, subepidermal, scattered or in small groups, forming in crusts, limited by the nerves, small, angular in shape, at first orange-yellow, then brown to reddish brown in colour; teleutospores forming under the epidermis, generally compacted laterally, subglobose, oblong or somewhat angular, divided into 2~6 cells by vertical or oblique septa, 20~45 μ long, 15~30 μ wide; epispore uniformly thin (0.8~1.2 μ), smooth, pale yellowish brown to light brown in colour.

Hosts and Distribution

FOR THE AECIDIAL STAGE:

Abies Mayriana MIYABE et KUDÔ (KAMEI 1932b, p. 165)—Japan (*cultures*).

FOR THE UREDO- AND TELEUTOSTAGE:

Tilia amurensis KOM. (HIRATSUKA, f. 1927d, p. 83; MIURA 1928, p. 233)—Manchuria.

Tilia japonica SIMK. (*T. cordata* MILL. var. *japonica* MIQ.) (HIRATSUKA 1897, p. 48; HIRATSUKA, f. 1927b, p. 235; 1927c, p. 304; 1927d, p. 83 & 84; 1930b, p. 271; P. & H. SYDOW 1913, p. 110; 1915, p. 453; TOKUBUCHI 1911, p. [307])—Japan.

Tilia manshurica RUPR. et MAXIM. (*T. cordata* MILL. var. *mandshurica* MAXIM.) (HIRATSUKA, f. 1927d, p. 83; 1928d, p. 691)—Manchuria.

Tilia Maximowicziana SHIRASAWA (*T. Miqueliana* MAXIM., *T. Miyabei* JACK) (HIRATSUKA 1897, p. 48; HIRATSUKA, f. 1927c, p. 304; 1927d, p. 83 & 84; 1930b, p. 272; P. & H. SYDOW 1913, p. 110; 1915, p. 453)—Japan.

Exsiccati. FOR THE UREDO-AND TELEUTOSTAGE: JACZEWSKI, KOMAROV & TRANZSCHEL, Fung. Ross. no. 226 (a, b).

Habitat in Japan

On *Tilia japonica* SIMK. (*Shinanoki*). *Hokkaidô*:—Oshima (Kita-mura, Mt. Komagatake, Ônuma). Shiribeshi (Raiden-tôge, Zenibako, Otaru-tôge). Ishikari (Sapporo, Kotoni-Bannosawa, Mt. Moiwa, Shiroishi-mura, Maruyama near Sapporo, Mt. Sapporo-dake,

Jōzankei, Garugawa, Mt. Teine, Nopporo, Iwamizawa). Hidaka (Samani-sandō, Urakawa). Tokachi (Obihiro). Kushiro (Akan-Bokke, Mt. Oakan-dake, Mt. Meakan-dake, Kutcharo). *Honshū*:—Rikuchū (Himekami-yama). Shinano (Mt. Komagatake [Kiso]). Inaba (Mt. Hyōnosen, Mt. Naginosen). Oki (Naka-mura).

On *Tilia Maximowicziana* SHIRASAWA (*Ōba-bodaiju*). *Hokkaidō*:—Ishikari (Sapporo, Maruyama near Sapporo, Mt. Moiwa, Mt. Teine, Nopporo, Jōzankei, Misumai).

In 1897, this species was created by MIYABE and it was published in Naoharu HIRATSUKA's paper, entitled, "Notes on some Melampsorae of Japan, I". The type of this species is a collection on *Tilia cordata* var. *japonica* (*T. japonica*) by Naoharu HIRATSUKA at Sapporo (Hokkaidō) on September 22, 1896. He also reported that this species is found on *Tilia Miqueliana* (*T. Maximowicziana*) in the vicinity of Sapporo. Then, it was recorded by TOKUBUCHI, the SYDOWS and the writer from various districts of Hokkaidō and Honshū in Japan.

In 1899, this fungus on *Tilia cordata* var. *mandshurica* (*T. manshurica*) which was collected by W. KOMAROV at Dschai-gauanzai-lin, the province of Kirin, Manchuria, was published in JACZEWSKI, KOMAROV & TRANZSCHEL, *Fungi Rossiae exsiccati*, no. 226. In 1927, the writer reported a collection of this species on *Tilia amurensis* by H. MISUMI at Heichikō, Manchuria.

The heteroecism of this fungus was first established by KAMEI, who sowed sporidia of the teleutospores from *Tilia japonica* and *T. Maximowicziana* on needles of *Abies Mayriana*, and obtained positive results. The description of the aecidial stage as given above is obtained from KAMEI's manuscript through his generous courtesy.

12. *Pucciniastrum Yoshinagai* HIRATSUKA, f. in *Transact. Tottori Soc. Agric. Sci.* II, p. 247, 1931.

Icon. HIRATSUKA, f. l. c. p. 247, fig. 1.

Uredosori hypophyllous, scattered or grouped, subepidermal, minute, round, 0.07~0.15 mm across, pale yellow in colour; peridia hemispherical, delicate, firm, opening from a central pore; peridial cells small, irregularly polygonal, upper peridial cells 10~18 μ across, walls thin, smooth, nearly colourless; ostiolar cells rounded, walls 2.5~3.2 μ thick, smooth, nearly colourless; uredospores ovate, ellip-

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soidal or oblong, 18~27 \times 15~19.5 μ ; epispore finely echinulate, thin, 1~1.5 μ thick, nearly colourless.

Teleutosori mostly hypophyllous, subepidermal, minute, limited by the nerves, yellow in colour; teleutospores intercellular, solitary or irregularly grouped, globose or subglobose, sometimes truncate at the apex, 1~5 celled, with vertical or oblique septa, 18~27 μ in diameter; epispore rather thin, about 1 μ thick, smooth, pale yellowish brown in colour.

Hosts and Distribution

FOR THE UREDO- AND TELEUTOSTAGE:

Stewartia pseudo-Camellia MAXIM. (HIRATSUKA, f. 1931, p. 248; HIRATSUKA, f. & YOSHINAGA 1935, p. 262)—Japan.

Habitat in Japan

On *Stewartia pseudo-Camellia* MAXIM. (*Natsutsubaki*). *Shikoku*:—Iyo (Higashisanbō-ga-mori [Nibukawa-mura]). Tosa (Mt. Inamura).

The present species is known only from the above two collections made in Shikoku, Japan by T. YOSHINAGA. It seems to have a narrow range of distribution.

13. *Pucciniastrum Circaeae* (THÜM.) SPEGAZZINI in *Dec. Myc. Ital.* no. 65, 1879; BUBÁK, *Rostpilze Böhmens*, p. 186; FRAGOSO, *Fl. Ibér. Ured.* II, p. 259; GROVE, *Brit. Rust Fungi*, p. 365; HIRATSUKA, f. in *Jour. Facul. Agric. Hokkaidō Imp. Univ.* XXI, p. 25 & 74, 1927; *Bot. Mag. Tokyo*, XLIV, p. 268, 1930; KLEBAHN in *Zeitschr. f. Pflanzenkr.* XV, p. 96, 1905; XVII, p. 150, 1907; *Kryptogamenfl. Mark Brandenbr. Va.*, p. 833; LIRO, *Ured. Fenn.* p. 511; MIGULA, *Krypt.-Fl.* III, 1, p. 468; OUDEMANS, *Rév. Champ.* I, p. 576; SACCARDO, *Syll. Fung.* VII, p. 763; P. & H. SYDOW, *Monogr. Ured.* III, p. 445; TROTTER, *Fl. Ital. Crypt. Ured.* p. 382.

Syn. *Uredo Circaeae* SCHUMACHER, *Enum. Pl. Saell.* II, p. 228, 1803.

Uredo Circaeae ALBERTINI et SCHWEINITZ, *Consp. Fung. Nisk.* p. 124, 1805.

Caeoma Onagrarum LINK, *Sp. Pl.* II, p. 29, 1825, p.p.

Melampsora Circaeae THÜMEN, *Myc. univ.* no. 447, 1876.

Phragmopsora Circaeae WINTER in *Hedwigia*, XVIII, p. 172, 1879.

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Melampsora Circaeae WINTER in Pilze Deutschl. I, p. 243, 1881; PLOWRIGHT, Monogr. Ured. & Ustil. p. 245; SCHRÖTER, Pilze Schles. I, p. 364.

Pucciniastrum Circaeae SCHRÖTER; FISCHER, Ured. Schw. p. 461, 1904; HARIOT, Uréd. p. 250.

Icon. FISCHER, l. c. fig. 302; FRAGOSO, l. c. fig. 128; GROVE, l. c. fig. 273; HIRATSUKA, f. in Jour. Facul. Agric. Hokkaidô Imp. Univ. XXI, pl. I, fig. 6, 1927; KLEBAHN in Zeitschr. f. Pflanzenkr. XV, p. 98, fig. 3, 1905; Kryptogamenfl. Mark Brandenbr. Va, p. 828, fig. R, 3 (I-V); MIGULA, l. c. pl. X, C, fig. 1 & 2; P. & H. SYDOW, l. c. pl. XIX, fig. 160; TROTTER, l. c. fig. 31.

Spermogonia and aecidia demonstrated by FISCHER in 1916. Description not yet available.

Uredosori mostly hypophyllous, subepidermal, scattered or gregarious, often covering the whole surface of the leaf, small, round, 0.08~0.24 mm across, sometimes confluent, orange-yellow to pale yellow in colour; peridia hemispherical, delicate, dehiscent from a central pore; peridial cells small, irregularly polygonal, 8~18 μ across, walls rather thin, 1.5~2 μ thick, colourless, smooth; ostiolar cells more or less larger, walls 1.8~3 μ thick, smooth; uredospores subglobose, ovate or ellipsoidal, 16.2~24.5 \times 12.6~16.2 μ ; epispore rather thin, 1~1.5 μ thick, minutely echinulate; contents orange-yellow in colour when fresh.

Teleutosori mostly hypophyllous, subepidermal, in dense clusters, limited by the veins, often spread over the whole surface of the leaf, pale yellow in colour; teleutospores solitary or gregarious, often compacted laterally under the epidermis, globose, subglobose to ovate, somewhat angular or flattened at the sides, divided longitudinally into 2~4 cells (rarely more than 4), 18~30 μ high, 16~30 μ wide; epispore uniformly thin, 1.5~2 μ thick, smooth, pale yellow in colour. (Plate VIII, fig. 4)

Hosts and Distribution

FOR THE AECIDIAL STAGE:

Abies alba MILL. (*A. pectinata* DC.) (FISCHER 1916b, p. 334; HIRATSUKA, f. 1927d, p. 75)—Switzerland (*cultures*).

FOR THE UREDO- AND TELEUTOSTAGE:

Circaea alpina L. (BUBÁK 1908, p. 187; CONSTANTINEANU 1920, p. 443; FRAGOSO 1925, p. 260; GOBI & TRANZSCHEL 1891, p. 105; HIRATSUKA, f. 1927a, p. 26; 1927b, p. 235; 1927c, p. 303; 1927d, p.

75; 1928a, p. 29; 1928c, p. 566; 1929d, p. 104; 1930a, p. 81; 1930b, p. 268; 1930d, p. 329; 1932b, p. 40; 1933a, p. 149; JAAP 1908, p. 201; 1909b, p. 304; 1914, p. 432; JØRSTAD 1923b, p. 18; 1925, p. 114; 1935, p. 65; KAWAI & ÔTANI 1931, p. 240; KLEBAHN 1914, p. 834; LAUBERT 1927, p. 47; LIND 1913, p. 294; LIRO 1908, p. 512; MAYOR 1919, p. 412; NISSL 1864, p. 105; PETRAK 1920, p. 134; PICBAUER 1927, p. 441; POEVERLEIN & BERTSCH 1927, p. 195; SCHRÖTER 1887, p. 364; P. & H. SYDOW 1915, p. 446; TRANZSCHEL 1900, p. 189; TROTTER 1914, p. 382; VOSS 1889, p. 338; WINTER 1881, p. 243)—Finland, Norway, Denmark, Russia, Germany, Austria, Switzerland, France, Italy, Rumania, Czechoslovakia; Siberia, Japan.

Circaea cardiophylla MAK. (HIRATSUKA, f. 1927a, p. 26; 1927c, p. 303; 1927d, p. 75; 1930b, p. 269)—Japan.

Circaea erubescens FRANCH. et SAV. (HIRATSUKA, f. 1927a, p. 26; 1927c, p. 303; 1927d, p. 75; 1930b, p. 269; HIRATSUKA, f. & YOSHINAGA 1935, p. 261; YOSHINAGA & HIRATSUKA, f. 1930, p. 654)—Japan.

Circaea intermedia EHRH. (BUBÁK 1897, p. 4; 1898, p. 18; 1899, p. 20; 1908, p. 187; CONSTANTINEANU 1920, p. 443; FISCHER 1904, p. 463; FRAGOSO 1925, p. 260; GROVE 1913, p. 366; HIRATSUKA, f. 1927d, p. 75; JAAP 1904a, p. 131; JØRSTAD 1923b, p. 18; 1925, p. 115; KLEBAHN 1914, p. 834; LIND 1913, p. 294; MAGNUS 1891, p. 253; NISSL 1864, p. 105; PETRAK 1927, p. 346; PICBAUER 1927, p. 441; PLOWRIGHT 1889, p. 245; POEVERLEIN & BERTSCH 1927, p. 195; SCHRÖTER 1887, p. 364; P. & H. SYDOW 1915, p. 446; TROTTER 1914, p. 382; VOSS 1889, p. 338; WILSON 1934, p. 427; WINTER 1881, p. 243)—Norway, Denmark, Germany, Great Britain, France, Switzerland, Italy, Czechoslovakia, Rumania.

Circaea lutetiana L. (BAUDYŠ & PICBAUER 1925, p. 184; BÄUMLER 1902, p. 18; CONSTANTINEANU 1920, p. 443; DIETEL 1890, p. 48; FISCHER 1904, p. 463; FRAGOSO 1925, p. 260; GROVE 1913, p. 366; HIRATSUKA, f. 1927d, p. 75; JAAP 1904a, p. 131; 1907b, p. 172; 1909b, p. 304; 1914b, p. 432; KLEBAHN 1914, p. 834; LAUBERT 1927, p. 47; LIND 1913, p. 294; MAGNUS 1891, p. 253; 1895, p. 5; OUDEMANS 1892, p. 577; PICBAUER 1927, p. 441; 1933, p. 7; PLOWRIGHT 1889, p. 245; POEVERLEIN 1926, p. [40]; POEVERLEIN & BERTSCH 1927, p. 195; RANOJEVIĆ 1914, p. 399; SCHRÖTER 1887, p. 364; P. & H. SYDOW 1915, p. 446; TROTTER 1914, p. 382; VOSS 1889, p. 338; WILSON 1934, p. 427; WINTER 1881, p. 243)—Great Britain, Rumania, Germany, Switzerland, Czechoslovakia, Italy.

Circaea Pricei HAYATA (HIRATSUKA, f. 1936a, p. 161; HIRATSUKA, f. & HASHIOKA 1935c, p. 237)—Japan.

Circaea quadrisulcata FRANCH. et SAV. (HIRATSUKA, f. & YOSHINAGA 1935, p. 261)—Japan.

Exsiccati. FOR THE UREDO- AND TELEUTOSTAGE: ALLESCHER & SCHNABL, Fung. bavar. no. 317; BERKELEY, Fung. brit. no. 342; COOKE, Fung. brit. I, no. 62; II, no. 74; FÜCKEL, Fung. rhen. no. 1548; JAAP, Fung. sel. no. 528; JACZEWSKI, KOMAROV & TRANZSCHEL, Fung. Ross. no. 227; KRIEGER, Fung. saxon. no. 114, 518 & 1110; KUNZE, Fung. sel. no. 548; PETRAK, Fung. Eichl. no. 179; PETRAK, Fl. Bohem. no. 346; RABENHORST, Fung. eur. no. 498 & 3807; ROUMEGUÉRE, Fung. gall. no. 3312; D. SACCARDO, Myc. ital. no. 262; SCHNEIDER, Herb. no. 712; SCHRÖTER, Pilze Schles. no. 308 & 413; SPEGAZZINI, Dec. Myc. ital. no. 65; P. & H. SYDOW, Myc. germ. no. 308, 364 & 1496; P. & H. SYDOW, Myc. march. no. 127 & 2127; P. & H. SYDOW, Ured. no. 137, 447, 448, 2699 & 2770; THÜMEN, Myc. univ. no. 447 & 1731; Fl. exs. Austr.-Hung. no. 355; Krypt. exs. Vindob. no. 705.

Habitat in Japan

On *Circaea alpina* L. (*Miyama-tanitate*). *S. Saghalien*:—Moto-domari (Makunkotan, Mt. Tosso, Noboripo, Mt. Shiritori, Mt. Kashi-po). Tomarioro (Akashiki near Ambetsu). *Hokkaidô*:—Ishikari (Sôunkei, Mt. Kuro-dake, Mt. Hakuun-dake, Mt. Sapporo-dake). Kushiro (Mt. Meakan-dake). *Kuriles*:—Shikotan (Shakotan). *Honshû*:—Shimotsuke (Nikkô-Yumoto). Shinano (Mt. Tsubakuro-dake, Mt. Yatsugatake). Hôki (Mt. Daisen).

On *Circaea cardiophylla* MAK. (*Ushitakisô*). *Hokkaidô*:—Ishikari (Yuni-mura).

On *Circaea erubescens* FRANCH. et SAV. (*Tanitate*). *Hokkaidô*:—Iburi (Rebunge-tôge). *Honshû*:—Inaba (Mt. Hyônosen). *Shikoku*:—Tosa (Mt. Yanaze, Mt. Tsuetate).

On *Circaea Pricei* HAYATA (*Tatsutaka-tanitate*). *Formosa*:—Shinchiku (Shakarô).

On *Circaea quadrisulcata* FRANCH. et SAV. (*Midzutamasô*). *Shikoku*:—Tosa (Tosayama-mura).

The heteroecism of the present fungus was first established by FISCHER in 1916. He sowed sporidia of the teleutospores from *Circaea lutetiana* on *Abies pectinata* (*A. alba*), *Picea excelsa* and

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Larix europaea, and obtained spermogonia and aecidia on the needles of *Abies*, while no sign of the fungus appeared on *Picea* and *Larix*. But the description of the aecidial stage has never been published in any form, so far as the writer is aware. KLEBAHN gives some evidence for his suggestion that perhaps an overwintering of this fungus occurs in the rhizomes of the host plant.

This species was first recorded by the writer from this country in 1927 in his paper, "Studies on the Melampsoraceae of Japan." He stated that this fungus occurs on *Circaea alpina*, *C. cardiophylla* and *C. erubescens* in Hokkaidô and South Saghalien.

No culture work of this species has been conducted in Japan. But, from field observations made by the writer, it has been assumed that the aecidial stage occurs on *Abies* sp.

14. *Pucciniastrum Epilobii* OTTH in Mitteil. Naturforsch. Ges. Bern, LXXI, p. 72, 1861; BUBÁK, Rostpilze Böhmens, p. 185; CUNNINGHAM, Rust Fungi of New Zealand, p. 114; FISCHER, Ured. Schw. p. 459; FRAGOSO, Fl. Ibér. Ured. II, p. 258; HARIOT, Ured. p. 251; HIRATSUKA, f. in Jour. Facul. Agric. Hokkaidô Imp. Univ. XXI, p. 76, 1927; KARSTEN, Myc. Fenn. IV, p. 56; KLEBAHN in Zeitschr. f. Pflanzenkr. IX, p. 23, 1899; XV, p. 94, 1905; XXII, p. 341, 1912; PRINGSH. Jahrb. f. Wiss. Bot. XXXIV, p. 386, 1900; XXXV, p. 694, 1901; Kryptogamenfl. Mark Brandenbr. Va, p. 831; LIRO, Ured. Fenn. p. 509; MIGULA, Krypt.-Fl. III, 1, p. 468; OUDEMANS, Rév. Champ. I, p. 576; SACCARDO, Syll. Fung. VII, p. 762; P. & H. SYDOW, Monogr. Ured. III, p. 444; TROTTER, Fl. Ital. Crypt. Ured. p. 381; WILSON in Transact. Bot. Soc. Edinb. XIV, p. 428, 1934.

Syn. *Uredo pustulata* PERSOON, Syn. Fung. p. 219, 1801; COOKE, Handb. Brit. Fung. p. 526, 1871.

Uredo pustulata PERSOON var. *Epilobii* PERSOON, Syn. Fung. p. 219, 1801.

Caeoma Onagrarum LINK, Sp. Pl. II, p. 29, 1825, p.p.

Erysibe pustulata WALLROTH var. *Epilobiorum* WALLROTH, Fl. Crypt. Germ. II, p. 198, 1833.

Melampsora Epilobii FÜCKEL, Symb. Myc. p. 44, 1870; BURRILL in Bull. Illinois State Labor. Nat. Hist. II, p. 212, 1885; LAMBOTTE, Fl. Myc. Belg. II, p. 66, 1880; WINTER in Pilze Deutschl. I, p. 243; WÜNSCHE, Pilze, p. 30, 1877.

Phragmopsora Epilobii MAGNUS in Hedwigia, XIV, p. 123, 1875.

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Melampsora Chamaenerii ROSTRUP in Medd. f. d. Bot. For. Kjöbenhavn, I, p. 77, 1884.

Melampsora pustulata SCHRÖTER, Pilze Schles. I, p. 364, 1887; PLOWRIGHT, Monogr. Ured. & Ustil. p. 244.

Pucciniastrum pustulatum DIETEL in ENGLER-PRANTL, Natürl. Pflanzenfam. I, 1. Abt.**, p. 47 (1897) & p. 551 (1900); ARTHUR in N. Amer. Fl. VII, p. 107 & 677; Manual of the rusts in United States and Canada, p. 15; CUNNINGHAM in Transact. New Zealand Inst. LV, p. 30, 1924; GROVE, Brit. Rust Fungi, p. 366; HIRATSUKA, f. in Bot. Mag. Tokyo, XLIV, p. 269, 1930.

Pucciniastrum Abieti-Chamaenerii KLEBAHN in PRINGSH. Jahrb. f. Wiss. Bot. XXXIV, p. 387, 1900; Kryptogamenfl. Mark Brandenbr. Va, p. 829; FRAGOSO, Fl. Ibér. Ured. II, p. 257; SACCARDO, Syll. Fung. XVII, p. 469; P. & H. SYDOW, Monogr. Ured. III, p. 442.

Pucciniastrum Chamaenerii ROSTRUP, Plantepat. p. 304, 1902; Bot. Tidsskr. XXV, p. 292, 1903; BUBÁK, Rostpilze Böhmens, p. 184; MIGULA, Krypt.-Fl. III, 1, p. 467.

Pucciniastrum pustulatum LIND, Danish Fungi, p. 294, 1913.

Icon. ARTHUR, Manual of the rusts in United States and Canada, fig. 24; BELL in Bot. Gaz. LXXVII, pl. IV, fig. 31 & 32; pl. V, fig. 40 & 41, 1924; BUBÁK, l. c. fig. 44; CUNNINGHAM in Transact. New Zealand Inst. LV, fig. 98, 1924; Rust Fungi of New Zealand, fig. 21 (2, b) & fig. 23; DIETEL in ENGLER-PRANTL, Natürl. Pflanzenfam. I, 1. Abt.**, fig. 29 (D); II. Aufl. VI, fig. 28 (D); FRAGOSO, l. c. fig. 127; GROVE, l. c. fig. 274; HIRATSUKA, f. in Jour. Facul. Agric. Hokkaidô Imp. Univ. XXI, pl. I, fig. 8, 1927; HUNTER in Bot. Gaz. LXXXIII, pl. II, fig. 6, 1927; KLEBAHN in Zeitschr. f. Pflanzenkr. IX, p. 25, text-fig. 2, 1899; XV, p. 95, text-fig. 2, 1905; Kryptogamenfl. Mark Brandenbr. Va, p. 828, fig. R, 1 (I-IX) & 2 (I-VII); MIGULA, l. c. pl. X, C, fig. 5-7; MOSS in Ann. Bot. XL, p. 840, fig. 21 (I) & pl. XXXIV, fig. 17, 1926; ROSTRUP, Plantepat. fig. 120, 1902.

Spermogonia on needles of current season, hypophyllous, subcuticular, minute, 60-140 μ broad, 16-32 μ high; spermatia oval, 1.6-3.2 μ across.

Aecidia on needles of current season, hypophyllous, in two irregular rows on yellowish spots occupying a part or all of the leaf, small, cylindrical, 0.18-0.3 mm in diameter, up to 1.2 mm high, orange-yellow in colour; peridia colourless, delicate, rupturing at the apex; peridial cells irregularly polygonal, elongated vertically,

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slightly overlapping, 24-42 \times 10-20 μ , outer walls smooth, rather thin; inner ones finely verrucose, rather thick; aecidiospores subglobose, ovate or ellipsoidal, 13-23 \times 10-18 μ ; epispore colourless, finely verrucose with a smooth spot on one side, rather thin, 1-1.8 μ thick; contents yellow when fresh.

Uredosori hypophyllous, scattered or in groups, on discoloured areas of indefinite extent, subepidermal, minute, round, 0.1-0.3 mm across, covered by the epidermis, at times somewhat pulverulent, yellowish brown to yellow in colour; peridia hemispherical, delicate, dehiscent from an apical pore; peridial cells small, irregularly polygonal, 6-18 μ across, walls thin, 1-2 μ thick, smooth, colourless; ostiolar cells rounded, with smooth, rather thick walls (2-2.5 μ); uredospores subglobose, ovate or oblong, 14.4-24 \times 10-16.2 μ ; epispore thin, 1-1.5 μ , finely echinulate, colourless; contents orange-yellow when fresh.

Teleutosori hypophyllous, rarely epiphyllous or caulicolous, subepidermal or sunk within the mesophyll, minute, reddish brown to blackish brown in colour; teleutospores intercellular, solitary or gregarious, often compacted laterally under the epidermis, subglobose, oblong or short cylindrical, sometimes somewhat angular or flattened at the sides, divided longitudinally into 2 to 4 cells (occasionally one or more than 4), 17-35 μ high, 7-30 μ broad; epispore thin, 1-1.5 μ thick, somewhat thickened at apex (1.5-3 μ), smooth, yellowish brown in colour. (Plate VIII, fig. 6)

Hosts and Distribution

FOR THE AECIDIAL STAGE:

Abies alba MILL. (*A. pectinata* DC.) (ARTHUR 1907, p. 107; BUBÁK 1906, p. 155; 1908, p. 185; CONSTANTINEANU 1920, p. 442; FISCHER 1904, p. 461; FRAGOSO 1925, p. 258; GROVE 1913, p. 367; HIRATSUKA, f. 1927d, p. 78; JAAP 1907b, p. 172; KLEBAHN 1914, p. 831; LIND 1913, p. 294; P. & H. SYDOW 1915, p. 443; TROTTER 1914, p. 381; WRÓBLEWSKI 1916, p. 99)—Germany, Switzerland, France, Denmark, Rumania, Czechoslovakia.

Abies amabilis FORBES (ARTHUR 1925, p. 677; 1934, p. 15; HIRATSUKA, f. 1927d, p. 78; HOTSON 1925, p. 294; 1934, p. 115; SEYMOUR 1929, p. 62)—Washington; British Columbia.

Abies arizonica MERRIAM (ARTHUR 1925, p. 677; 1934, p. 15; HIRATSUKA, f. 1927d, p. 78; SEYMOUR 1929, p. 62)—Colorado.

Abies balsamea MILL. (ARTHUR 1925, p. 677; 1934, p. 15; BISBY

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1916, p. 536; DAVIS 1914, p. 914; FRASER 1912, p. 176 & 192; HIRATSUKA, f. 1927d, p. 78; RHOADS, HEDGCOCK, BETHAL & HARTLEY 1918, p. 329; SEYMOUR 1929, p. 63; P. & H. SYDOW 1915, p. 443)—Michigan, Vermont, New York, Wisconsin; Nova Scotia.

Abies cephalonica LOUD.—Switzerland.

Abies concolor LINDL. et GORD. (ARTHUR 1925, p. 677; 1934, p. 15; BISBY 1916, p. 536; HIRATSUKA, f. 1927d, p. 78; RHOADS, HEDGCOCK, BETHAL & HARTLEY 1918, p. 329; SEYMOUR 1929, p. 65)—Colorado.

Abies grandis Lindl. (ARTHUR 1925, p. 677; 1934, p. 15; BISBY 1916, p. 536; HIRATSUKA, f. 1927d, p. 78; HOTSON 1925, p. 294; 1934, p. 115; JACKSON 1918b, p. 214; RHOADS, HEDGCOCK, BETHAL & HARTLEY 1918, p. 329; SEYMOUR 1929, p. 65)—Oregon, Idaho, Montana, Washington.

Abies lasiocarpa NUTT. (ARTHUR 1925, p. 677; 1934, p. 15; BISBY 1916, p. 536; HIRATSUKA, f. 1927d, p. 78; HOTSON 1925, p. 295; 1934, p. 116; JACKSON 1918b, p. 214; RHOADS, HEDGCOCK, BETHAL & HARTLEY 1918, p. 329; SEYMOUR 1929, p. 66; WEIR & HUBERT 1916, p. 373; 1917b, p. 109)—Alaska; Colorado, Idaho, Montana, Oregon, Washington; British Columbia.

Abies Mayriana MIYABE et KUDÔ (HIRATSUKA, f. 1926, p. 84; 1927d, p. 78 & 80; 1932a, p. 24; KAMEI 1932b, p. 165)—Japan.

Abies nobilis LINDL. (ARTHUR 1925, p. 677; 1934, p. 15; HIRATSUKA, f. 1927d, p. 78; SEYMOUR 1929, p. 67)—Oregon.

Abies pinsapo BOISS.—Switzerland.

FOR THE UREDO- AND TELEUTOSTAGE:

Clarkia elegans DOUGL. (*Phaeostoma elegans* NELSON) (ARTHUR 1925, p. 677; 1934, p. 15; HIRATSUKA, f. 1927d, p. 78)—Alaska.

Epilobium adenocaulon HAUSSK. & var. (ARTHUR 1907, p. 107; 1927, p. 818; 1934, p. 15; BISBY 1916, p. 536; BLASDALE 1919, p. 139; BRECKLE 1918, p. 207; DAVIS 1914, p. 914; GARRETT 1910, p. 299; HIRATSUKA, f. 1927d, p. 78; HOTSON 1925, p. 295; 1934, p. 112; JACKSON 1918b, p. 216; KERN, THURSTON Jr., ORTON & ADAMS 1929, p. 7; MOSS 1926, p. 816; POVAH 1935, p. 136; SEYMOUR 1929, p. 528; STANDLEY 1920, p. 147; P. & H. SYDOW 1915, p. 445)—Alaska; Manitoba, Saskatchewan, British Columbia, Ontario; California, Colorado, Wisconsin, Pennsylvania, Maine, Michigan, Wyoming, Montana, Idaho, Iowa, North Dakota, New York, Oregon, South Dakota, Utah, Virginia, West Virginia, Washington, Nebraska.

Epilobium affine BONG. (BISBY 1916, p. 536; SEYMOUR 1929, p. 528)—Alaska.

Epilobium alpinum L. (ARTHUR 1907, p. 107; 1927, p. 818; 1934, p. 15; FRAGOSO 1925, p. 259; HIRATSUKA, f. 1927d, p. 78; HOTSON 1934, p. 112; LARSEN 1932, p. 512; SEYMOUR 1929, p. 528; P. & H. SYDOW 1915, p. 445; WEIR 1918, p. 13; WILSON 1924, p. 140; 1934, p. 428)—Alaska; Colorado, Montana, Utah; Great Britain, Iceland.

Epilobium alsinefolium VILL. (*E. origanifolium* LAM.) (BUBÁK 1908, p. 186; FRAGOSO 1925, p. 259; HIRATSUKA, f. 1927d, p. 78; JØRSTAD 1925, p. 114; PICBAUER 1927, p. 441; P. & H. SYDOW 1915, p. 445; TROTTER 1914, p. 381)—Czechoslovakia, Switzerland, Italy, Norway.

Epilobium americanum HAUSSK. (GARRETT 1925, p. 205; SEYMOUR 1929, p. 528)—Utah.

Epilobium anagallidifolium LAM. (ARTHUR 1907, p. 107; 1927, p. 818; BISBY 1916, p. 536; GARRETT 1910, p. 300; HIRATSUKA, f. 1927d, p. 79; HOTSON 1934, p. 112; JØRSTAD 1925, p. 114; SEYMOUR 1929, p. 528; P. & H. SYDOW 1915, p. 445)—Montana, Utah.

Epilobium angustifolium L. (*Chamaenerion angustifolium* SCOP, *Ch. spicatum* S. F. GRAY, *Epilobium spicatum* LAM.) (ARTHUR 1907, p. 107; 1927, p. 818; 1934, p. 15; BISBY 1916, p. 536; 1924, p. 127; BRECKLE 1918, p. 207; BUBÁK 1897, p. 5; 1898, p. 18; 1906, p. 155; 1908, p. 185; CONSTANTINEANU 1920, p. 442; DAVIS 1914, p. 914; DIETEL 1900b, p. 286; FISCHER 1904, p. 461; FRAGOSO 1925, p. 258; FRASER 1912, p. 176 & 192; FÜCKEL 1870, p. 44; GOBI & TRANZSCHEL 1891, p. 105; GROVE 1913, p. 367; HIRATSUKA, f. 1927b, p. 235; 1927c, p. 304; 1927d, p. 79 & 80; 1928a, p. 29; 1929c, p. 61; 1930a, p. 82; 1930b, p. 270; 1932a, p. 23; 1933a, p. 149; HOTSON 1925, p. 295; 1934, p. 112; JAAP 1900, p. 264; 1906, p. 123; 1907a, p. 263; 1907b, p. 172; 1911, p. 334; 1914a, p. 19; JACKSON 1918b, p. 214; JØRSTAD 1925, p. 114; KARSTEN 1879, p. 56; KAWAI & ÔTANI 1931, p. 240; KLEBAHN 1914, p. 831; KLIKA 1926, p. 34; LAMBOTTE 1880, p. 66; LIND 1913, p. 294; LIRO 1908, p. 510; MAGNUS 1892a, p. 3; 1900, p. 20; MAYOR 1919, p. 411; MIGULA 1910, p. 468; MURASHKINSKY & SIELING 1928, p. [10]; OUDEMANS 1892, p. 576; PETRAK 1927, p. 346; PICBAUER 1927, p. 440; PLOWRIGHT 1889, p. 245; POEVERLEIN & BERTSCH 1927, p. 195; POVAH 1935, p. 137; RAINIO 1926, p. 254; SCHRÖTER 1887, p. 364; SEYMOUR 1929, p. 529; SIEMASZKO 1923a, p. 23; STANDLEY 1916, p. 164; 1920, p. 147; P. & H. SYDOW 1913, p.

110; 1915, p. 443; THÜMEN 1881, p. 114; TOGASHI 1924, p. 83; TRANZSCHEL 1900, p. 189; TROTTER 1914, p. 381; VOSS 1878, p. 90; 1889, p. 338; WEIR & HUBERT 1916, p. 373; 1917b, p. 109; WETTSTEIN 1885, p. 551; WILSON 1934, p. 427; WRÓBLEWSKI 1916, p. 99; WÜNSCHE 1877, p. 30)—Great Britain, Belgium, France, Italy, Germany, Denmark, Norway, Finland, Switzerland, Czechoslovakia, Austria, Rumania, Poland, Bulgaria, Russia, Caucasus; North Saghalien, Japan; Colorado, Idaho, Maine, Michigan, Montana, New Hampshire, New Jersey, New York, South Dakota, North Dakota, Oregon, Vermont, Washington, Wisconsin, California, New Mexico, West Virginia; Ontario, Alberta, British Columbia, Manitoba, New Brunswick, Newfoundland, Saskatchewan, Nova Scotia, North West Territory; Alaska.

Epilobium brevistylum BARBEY (ARTHUR 1925, p. 677; 1934, p. 15; BISBY 1916, p. 536; GARRETT 1910, p. 300; HIRATSUKA, f. 1927d, p. 79; HOTSON 1934, p. 112; JACKSON 1918b, p. 217)—Oregon, California, Utah.

Epilobium californicum HAUSSK. (ARTHUR 1925, p. 677; 1934, p. 15; BISBY 1916, p. 536; BLASDALE 1919, p. 139; HIRATSUKA, f. 1927d, p. 79; SEYMOUR 1929, p. 529)—California.

Epilobium cephalostigma HAUSSK. (TOGASHI & ÔNUMA 1934, p. 17)—Japan.

Epilobium clavatum TREL. (HIRATSUKA, f. 1927d, p. 79; HOTSON 1925, p. 295; 1934, p. 112; SEYMOUR 1929, p. 529)—Washington.

Epilobium collinum GMEL. (FRAGOSO 1925, p. 259; HIRATSUKA, f. 1927d, p. 79; P. & H. SYDOW 1915, p. 445)

Epilobium coloratum MUHL. (ARTHUR 1907, p. 107; 1926, p. 234; 1927, p. 818; 1934, p. 15; BLASDALE 1919, p. 139; BURRILL 1885, p. 212; DAVIS 1914, p. 914; FREEMAN 1901, p. 539; HIRATSUKA, f. 1927d, p. 79; JACKSON 1918a, p. 321; KERN, THURSTON JR., ORTON & ADAMS 1929, p. 7; PATERSON 1902, p. 14; SEYMOUR 1929, p. 529; P. & H. SYDOW 1915, p. 445)—Pennsylvania, California, Delaware, Iowa, Nebraska, Montana, Minnesota, Tennessee, New York; Ontario.

Epilobium davuricum FISCH. (JØRSTAD 1921, p. 15; 1925, p. 114; 1935, p. 67)—Norway.

Epilobium Dodonaei VILL. (FRAGOSO 1925, p. 259; HIRATSUKA, f. 1927d, p. 79; SIEMASZKO 1923a, p. 23; P. & H. SYDOW 1915, p. 443; VOSS 1889, p. 338)—Caucasus.

Epilobium Drummondii HAUSSK. (GARRETT 1910, p. 300; HIRATSUKA, f. 1927d, p. 79; SEYMOUR 1929, p. 529)—Utah.

Epilobium exaltatum (RYDB.) (*Chamaenerion exaltatum* RYDB.) (ARTHUR 1925, p. 677; 1934, p. 15)—Alaska.

Epilobium franciscanum BARBEY (ARTHUR 1925, p. 677; 1934, p. 15; BLASDALE 1919, p. 139; HIRATSUKA, f. 1927d, p. 79; SEYMOUR 1929, p. 529)—California.

Epilobium glandulosum LEHM. (ARTHUR 1925, p. 677; 1934, p. 15; HIRATSUKA, f. 1927d, p. 79)—Alaska.

Epilobium Hectorsi HAUSSK. (HIRATSUKA, f. 1927d, p. 79)—Germany.

Epilobium hirsutum L. (ARTHUR 1907, p. 107; 1934, p. 15; BÄUMLER 1902, p. 19; BUBÁK 1898, p. 4; 1908, p. 186; FRAGOSO 1925, p. 259; HIRATSUKA, f. 1927d, p. 79; KLEBAHN 1914, p. 832; POEVERLEIN 1926, p. [40]; POEVERLEIN & BERTSCH 1927, p. 195; SEYMOUR 1929, p. 529; P. & H. SYDOW 1915, p. 445; TROTTER 1914, p. 381)—Massachusetts, New York; Ontario; Germany, Italy, Czechoslovakia.

Epilobium holosericeum TREL. (ARTHUR 1907, p. 107; 1934, p. 16; BLASDALE 1919, p. 139; HIRATSUKA, f. 1927d, p. 79; SEYMOUR 1929, p. 529; P. & H. SYDOW 1915, p. 445)—California.

Epilobium Hornemanni REICH. (JØRSTAD 1925, p. 114; SEYMOUR 1929, p. 529)—Norway.

Epilobium indicum HAUSSK. (HIRATSUKA, f. 1927d, p. 79; KLEBAHN 1914, p. 833)—Germany.

Epilobium inodorum HAUSSK. (HIRATSUKA, f. 1927d, p. 79; KLEBAHN 1914, p. 833)—Germany.

Epilobium latifolium L. (*Chamaenerion latifolium* Sw.) (ARTHUR 1934, p. 15; HIRATSUKA, f. 1927d, p. 79; JØRSTAD 1925, p. 114; LIND 1913, p. 294; P. & H. SYDOW 1915, p. 443; TROTTER 1914, p. 381)—Italy, Denmark, Norway; Alaska.

Epilobium lineare MUHL. (*E. densum* RAF., *E. palustre* var. *lineare* A. GRAY) (ARTHUR 1907, p. 107; 1934, p. 16; DAVIS 1931, p. 260; FREEMAN 1901, p. 539; HIRATSUKA, f. 1927d, p. 79; SEYMOUR 1929, p. 529 & 530; P. & H. SYDOW 1915, p. 445)—Minnesota, New York, Wisconsin.

Epilobium linnaeoides HOOK. f. (CUNNINGHAM 1931, p. 114)—New Zealand.

Epilobium montanum L. (BÄUMLER 1902, p. 19; DIETEL 1890, p. 47; FRAGOSO 1925, p. 259; HIRATSUKA, f. 1927d, p. 79; KLEBAHN 1914, p. 832; MAGNUS 1892a, p. 3; POEVERLEIN 1926, p. [40]; P. & H. SYDOW 1915, p. 445; TROTTER 1914, p. 381; VOSS 1889, p. 338; WETTSTEIN 1885, p. 551)—Italy, Germany.

Epilobium novomexicanum HAUSSK. (ARTHUR 1925, p. 677; 1934, p. 16; BISBY 1916, p. 536; HIRATSUKA, f. 1927d, p. 80; SEYMOUR 1929, p. 529; STANDLEY 1916, p. 164; 1918, p. 41)—New Mexico.

Epilobium occidentale RYDB. (*E. adenocaulon* var. *occidentale* TREL.) (ARTHUR 1907, p. 107; 1934, p. 16; HIRATSUKA, f. 1927d, p. 80; SEYMOUR 1929, p. 528; P. & H. SYDOW 1915, p. 445)—California, Wyoming.

Epilobium palustre L. (ARTHUR 1925, p. 677; 1934, p. 16; BUBÁK 1903b, p. 7; 1915, p. [45]; COOKE 1871, p. 526; FRAGOSO 1925, p. 258; GOBI & TRANZSCHEL 1891, p. 105; GROVE 1913, p. 367; HIRATSUKA, f. 1927d, p. 80; JAAP 1900, p. 264; 1904a, p. 131; 1909a, p. 24; 1909b, p. 304; JØRSTAD 1923b, p. 18; 1925, p. 114; 1935, p. 67; KLEBAHN 1914, p. 833; LARSEN 1932, p. 512; LIND 1913, p. 294; LIRO 1908, p. 510; MAYOR 1933, p. 26; PLOWRIGHT 1889, p. 245; RAINIO 1926, p. 254; RANOJEVIĆ 1914, p. 399; SCHRÖTER 1887, p. 364; P. & H. SYDOW 1915, p. 445; TRANZSCHEL 1900, p. 189; VOSS 1889, p. 338; WILSON 1934, p. 428)—Norway, Iceland, Germany, Switzerland, Yugoslavia, Poland, Denmark, Finland, Great Britain; Japan; Alaska.

Epilobium paniculatum NUTT. (ARTHUR 1907, p. 108; 1934, p. 16; HIRATSUKA, f. 1927d, p. 80; HOTSON 1925, p. 295; 1934, p. 112; P. & H. SYDOW 1915, p. 445)—Montana, Washington.

Epilobium parviflorum RETZ. (HIRATSUKA, f. 1927d, p. 80; KLEBAHN 1914, p. 832)—Germany, Switzerland.

Epilobium Parieshii TREL. (SEYMOUR 1929, p. 530)

Epilobium platyphyllum RYDB. (ARTHUR 1925, p. 677; 1934, p. 16; HIRATSUKA, f. 1927d, p. 80; HOTSON 1934, p. 112; SEYMOUR 1929, p. 530; STANDLEY 1920, p. 147)—Montana.

Epilobium pubens A. RICH. (CUNNINGHAM 1924, p. 30; 1931, p. 114)—New Zealand.

Epilobium roseum RETZ. (BUBÁK 1897, p. 5; 1898, p. 18; 1899, p. 20; 1908, p. 186; BUBÁK & KABÁT 1906, p. [5]; FISCHER 1904, p. 461; FRAGOSO 1925, p. 259; HIRATSUKA, f. 1927d, p. 80; JAAP 1900, p. 264; 1904a, p. 131; 1907a, p. 263; 1907b, p. 172; 1910, p. 146; 1911, p. 334; 1914a, p. 19; 1917, p. 115; JØRSTAD 1925, p. 114; KLEBAHN 1914, p. 832; KLIKA 1926, p. 34; LAUBERT 1927, p. 47; LIND 1913, p. 294; NIESSL 1864, p. 105; MAGNUS 1900, p. 20; MAYOR 1919, p. 411; PETRAK 1927, p. 346; POEVERLEIN 1926, p. [40]; POEVERLEIN & BERTSCH 1927, p. 195; RANOJEVIĆ 1910, p. 366; SCHRÖTER 1887, p. 364; P. & H. SYDOW 1915, p. 445; TRANZSCHEL 1900, p. 189; TROTTER

1914, p. 381; VOSS 1889, p. 338)—Norway, Denmark, Germany, Bulgaria, Czechoslovakia, Switzerland, Italy, France.

Epilobium stramineum RYDB. (GARRETT 1919, p. 208; HIRATSUKA, f. 1927d, p. 80; SEYMOUR 1929, p. 530)—Utah.

Epilobium tetragonum L. (*E. virgatum* KOCH) (FISCHER 1904, p. 461; FRAGOSO 1925, p. 259; HIRATSUKA, f. 1927d, p. 80; KLEBAHN 1914, p. 833; SCHRÖTER 1887, p. 364; P. & H. SYDOW 1915, p. 445)—Germany, Switzerland.

Epilobium sp. (FISCHER 1904, p. 461)—Switzerland.

Epilobium sp. (HOTSON 1925, p. 295)—Washington.

Epilobium sp. (ARTHUR 1907, p. 108)—Alaska.

Epilobium sp. (CLINTON 1908b, p. 393)—Connecticut.

Epilobium sp. (POEVERLEIN & BERTSCH 1927, p. 195)—Germany.

Godetia grandiflora LINDL. (*Clarkia superba* NELS. et MACBR.) (ARTHUR 1925, p. 677; 1934, p. 15; HIRATSUKA, f. 1927d, p. 80)—Alaska.

Godetia sp.—Switzerland.

Exsiccati. FOR THE UREDO- AND TELEUTOSTAGE: ALLESCHER & SCHNABL, Fung. bavar. no. 622; BARTHOLOMEW, Fung. Columb. no. 2575, 2782, 3180, 3773, 4334, 4335, 4470 & 4471; BARTHOLOMEW, N. Amer. Ured. no. 77, 877, 978, 979, 1087, 1279, 1379, 1482, 1680, 2084, 2575, 2576, 2876 & 2977; BRECKLE, Fung. Dakot. no. 371 & 420; ELLIS, N. Amer. Fung. no. 1076; ELLIS & EVERHART, Fung. Columb. no. 267; GARRETT, Fung. Utah. no. 95 & 111; GRIFFITHS, West Amer. Fung. no. 242; JAAP, Fung. sel. no. 267; KRIEGER, Fung. saxon. no. 219 (a, b) & 1412; KUNZE, Fung. sel. no. 309; PETRAK, Fung. Eichl. no. 177; ROUMEGUÉRE, Fung. gall. no. 744 & 1506; D. SACCARDO, Myc. ital. no. 261 & 459; SCHMIDT & KUNZE, no. 213; SCHRÖTER, Pilze Schles. no. 307, 419 & 558; SPEGAZZINI, Dec. Myc. ital. no. 62; P. & H. SYDOW, Myc. march. no. 340, 1048 & 1320; P. & H. SYDOW, Myc. germ. no. 1074 & 1330; P. & H. SYDOW, Ured. no. 197, 344, 896, 1043, 1296, 1297, 1445, 1632, 1633, 1839, 1840, 2134, 2135, 2244 & 2697; THÜMEN, Fung. austr. no. 355, 727 & 851; THÜMEN, Myc. univ. no. 1246; VESTERGREN, Micromyc. rar. sel. no. 754 & 858; VILL, Fung. bavar. no. 918 & 919; WESTENDORP, Herb. Crypt. Belg. no. 674 & 1060; Fl. exs. Austr.-Hung. no. 771.

Habitat in Japan

On *Epilobium angustifolium* L. (*Yanagiran*). *S. Saghalien*:—Ôdomari (Ôdomari, Kaidzuka). Toyohara (Toyohara, Konuma). Moto-

domari (Mt. Kashipo, Manui, Mt. Tosso, Noboripo, Shiritori). Shisuka (Shisuka). Tomarioro (Ambetsu, Kita-Nayoshi). *Hokkaidô*:—Oshima (Mt. Komagatake, Ônuma). Iburi (Noboribetsu, Mt. Makkari-nupuri). Shiribeshi (Otaru, Kutchan, Raiden-tôge). Ishikari (Sapporo, Maruyama near Sapporo, Mt. Moiwa, Nopporo, Garugawa, Mt. Teine, Shinotsu, Mt. Sapporo-dake, Jôzankei, Hiroshima-mura). Kitami (Rishiri-Oshidomari, Kitami-aioi). Kushiro (Akan-Shirikomabetsu, Akan-Nanamagari, Mt. Oakan-dake). Nemuro (Nemuro). *Honshû*:—Mutsu (Mt. Iwaki). Shimotsuke (Nikkô-Yumoto). Shinano (Suwa, Mt. Yatsugatake).

On *Epilobium cephalostigma* HAUSSK. (*Iwa-akabana*). *Honshû*:—Rikuchû (Mt. Hayachine). Shinano (Mt. Komagatake [Kiso], Mt. Yatsugatake).

The uredostage of this fungus was first described by PERSOON in 1801 under the name of *Uredo pustulata* PERS. taking its type specimen on *Epilobium montanum* from Europe. OTTH in 1861 established the new genus *Pucciniastrum* taking both uredo- and teleutospores on *Epilobium roseum* as its type, and named it *Pucciniastrum Epilobii* OTTH. Some authorities have been using the name *Pucciniastrum pustulatum* (PERS.) DIET. (1897) accepting also the name *Uredo pustulata* PERS. for this species. But the usage of this name is bad; the name *Pucciniastrum Epilobii* must be used in accordance with the International Rules.

In 1900, KLEBAHN divided this species into the two distinct species: *Pucciniastrum Epilobii* OTTH on *Epilobium palustre* and its allied plants and *Pucciniastrum Abieti-Chamaenerii* KLEB. on *Epilobium angustifolium* and its allies, depending chiefly upon the biologic characters. However, *Pucciniastrum Abieti-Chamaenerii* is practically identical with *Pucciniastrum Epilobii* in morphological characters, so that the writer can see no valid reason for maintaining it in any other status than as a biological form of the latter species.

The genetic connection of this species was first demonstrated by KLEBAHN in 1898. He made inoculations with sporidia of the teleutospores from *Epilobium angustifolium* on young needles of *Abies pectinata* (*A. alba*), *Larix decidua* (*L. europaea*), *Pinus silvestris* and *Picea excelsa*, and got successful infection with a marked development of spermogonia and aecidia on the needles of *Abies alba* only, while on *Larix*, *Picea* and *Pinus* the inoculations were unsuccessful. He also determined the return infection with the aecidiospores on *Epilo-*

bium angustifolium, on which numerous uredosori developed. Moreover, he tried to inoculate with the uredospores from *Epilobium angustifolium* and with the aecidiospores on *Epilobium montanum*, *E. roseum*, *E. hirsutum* and *Oenothera biennis* and with the aecidiospores on *Epilobium parviflorum*, *E. montanum*, *E. palustre* and *E. tetragonum*, and got negative results on all plants. Further, its heteroecism has been amply confirmed by some other European mycologists, such as, FISCHER, TUBEUF and BUBÁK.

In 1911, FRASER was the first to report successful inoculations in North America between the aecidial stage of this species on *Abies balsamea* and the teleutostage on *Epilobium angustifolium*. In 1916, WEIR and HUBERT also reported successful inoculations on *Abies lasiocarpa* with teleutospores on *Epilobium angustifolium*. They also stated that repeated attempts to secure infections on *Epilobium angustifolium* with uredospores developed on *Epilobium adenocaulon* had resulted negatively. In 1915, the SYDOWS reported that this fungus on *Epilobium adenocaulon* and several other species of *Epilobium* winters over in the evergreen portion of the plants in the uredostage.

In Japan, in 1926 the writer showed by culture experiments that the aecidia of the present species occur on the leaves of *Abies Mayriana*. The sporidia from teleutospores of this species on *Epilobium angustifolium* which had been collected at the foot of Mt. Teine, province of Ishikari on November 24, 1925, were suspended above the young needles of *Abies Mayriana*, *Larix Kaempferi* and *Picea jezoensis* on May 21 of the next year. Positive results were secured on *Abies Mayriana* while on the remaining plants inoculations did not result.

In 1900, DIETEL first recorded this species on *Epilobium angustifolium* from this country. It was collected by M. MIYOSHI at Nikkô in the province of Shimotsuke in August of 1899. Later, the present species on *Epilobium angustifolium* was also reported by the SYDOWS, TOGASHI and the writer from different places of South Saghalien, Hokkaidô and Honshû. Recently, TOGASHI and ÔNUMA reported this fungus on *Epilobium cephalostigma* from Mt. Hayachine, Rikuchû Province.

This fungus is very widely distributed throughout the northern hemisphere, and has also been reported from New Zealand.

15. *Pucciniastrum Corni* DIETEL in ENGL. Bot. Jahrb. XXXIV, p. 587, 1905; HIRATSUKA, f. in Jour. Facul. Agric. Hokkaidô Imp. Univ. XXI, p. 72, 1927; Bot. Mag. Tokyo, XLIV, p. 267, 1930; SACCARDO, Syll. Fung. XXI, p. 733; P. & H. SYDOW, Monogr. Ured. III, p. 451.

Syn. *Pucciniastrum Corni* HIRATSUKA in sched.

Icon. HIRATSUKA, f. in Jour. Facul. Agric. Hokkaidô Imp. Univ. XXI, pl. I, fig. 2, 1927.

Uredosori hypophyllous, subepidermal, scattered or grouped, minute, round, 0.1~0.18 mm across, pale brownish yellow in colour; peridia hemispherical, delicate, firm, dehiscent from an apical pore; peridial cells small, irregularly polygonal, 7~16 μ across, walls smooth, thin, 1~1.5 μ thick, slightly overlapping; ostiolar cells ellipsoidal or ovate, walls thick, 2.5~5 μ thick, colourless, smooth; uredospores ovate, pyriform or ellipsoidal, 18~28.8 \times 12~18 μ ; epispore rather thin, echinulate, pale yellow in colour; often rudimentary paraphyses intermixed.

Teleutosori amphigenous, mostly hypophyllous, subepidermal, in dense clusters limited by the veins, pale yellow in colour; teleutospores intercellular, solitary or grouped, often in a single layer beneath the epidermis, globose, ovate or ellipsoidal, divided vertically into 2~5 cells (rarely more than 5), 14.4~27 μ in diameter; epispore smooth, uniformly thin, about 1 μ thick, light yellowish brown in colour.

Hosts and Distribution

FOR THE UREDO- AND TELEUTOSTAGE:

Cornus Kousa BUERG. (*Benthamia japonica* SIEB. et ZUCC.) (DIETEL 1907, p. 76; HIRATSUKA, f. 1927d, p. 73; 1930b, p. 268; 1932b, p. 40; 1935f, p. 281; HIRATSUKA, f. & YOSHINAGA 1935, p. 261; P. & H. SYDOW 1915, p. 451; YOSHINAGA & HIRATSUKA, f. 1930, p. 653)—Japan.

Cornus officinalis SIEB. et ZUCC. (DIETEL 1905a, p. 587; HIRATSUKA, f. 1927d, p. 73; 1930b, p. 268; NAMBU 1906, p. [252]; P. & H. SYDOW 1915, p. 451)—Japan.

Habitat in Japan

On *Cornus Kousa* BUERG. (*Yamabôshi*). Honshû:—Rikuchû (Yumoto-mura, Tamayama-mura, Takizawa-yama). Musashi (Tokyo). Idzu (Atami). Echizen (Higashiura-mura, Awano-mura).

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Tajima (Hamasaka). Shikoku:—Tosa (Mt. Kunimi). Iyo (Iradzu-yama).

On *Cornus officinalis* SIEB. et ZUCC. (*Sanshyu*) (*cultivated*). Honshû:—Musashi (Tokyo).

This species was originally described in 1905 by DIETEL founded on a collection on *Cornus officinalis* made by N. NAMBU at Meguro, Tokyo, in November 1903. Two years later, DIETEL also recorded that the same fungus occurs on *Cornus Kousa* based upon a specimen which was collected by NAMBU in Tokyo. These specimens have never been seen by the writer. Since then, the writer and YOSHINAGA reported the occurrence of the present species on *Cornus Kousa* in Honshû and Shikoku. It is rather common in Honshû (Japan).

It is probable that this species has an aecidial stage on *Abies*, but nothing has yet been discovered to confirm the suspicion.

16. *Pucciniastrum Kusanoi* DIETEL in ENGL. Bot. Jahrb. XXXII, p. 629, 1903; HIRATSUKA, f. in Jour. Facul. Agric. Hokkaidô Imp. Univ. XXI, p. 72, 1927; Bot. Mag. Tokyo, XLIV, p. 267, 1930; XLVII, p. 713, 1933; SACCARDO, Syll. Fung. XVII, p. 401; P. & H. SYDOW, Monogr. Ured. III, p. 450.

Icon. HIRATSUKA, f. in Jour. Facul. Agric. Hokkaidô Imp. Univ. XXI, pl. I, fig. 7, 1927.

Spermogonia on needles of current season, amphigenous, subcuticular, lenticular to flattened hemispherical, 90~150 μ across, 45~60 μ high, honey-yellow in colour; spermatia oblong, 3.5~5.5 \times 1.2~2 μ , colourless, smooth.

Aecidia on needles of current season, hypophyllous, in two rows, one on each side of the midrib, cylindrical, 0.24~0.33 mm across, 0.5~2 mm long, orange-yellow in colour; peridia colourless, firm, rupturing at the apex; peridial cells rhomboidal or hexagonal, elongated vertically, 50~69 \times 12~18 μ , overlapping, with inner walls thick, verrucose, with outer walls thin, smooth; aecidiospores globose, subglobose or ellipsoidal, 18~25 \times 13.5~18 μ ; epispore 1.5~2 μ thick, colourless, closely verrucose; contents yellow in colour.

Uredosori hypophyllous, scattered or grouped, sometimes thickly covering the whole surface of the leaf, subepidermal, minute, round, 0.08~0.2 mm across, often somewhat powdery, orange-yellow in colour; peridia hemispherical, delicate, firm; peridial cells small, irregularly polygonal, 7~18 μ across, walls thin, 1.5~2 μ thick,

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smooth, nearly colourless; ostiolar cells rounded, rather thick, $2.5 \sim 4 \mu$ thick, smooth; uredospores subglobose, ovate or ellipsoidal, $18 \sim 25.2 \times 14.4 \sim 19.8 \mu$; epispore thin, $1 \sim 1.8 \mu$ thick, minutely echinulate, colourless; contents orange-yellow in colour when fresh.

Teleutosori hypophyllous, subepidermal, minute, limited by nerves, causing yellowish brown to reddish brown discoloration; teleutospores mostly loosely aggregated, often compacted laterally under the epidermis, divided longitudinally into 2 to 4 cells (occasionally one or more than 4), subglobose or oblong, or somewhat angular or flattened at the sides, $18 \sim 27 \mu$ in diameter; epispore uniformly thin, less than 1.5μ thick, smooth, light yellow in colour.

Hosts and Distribution

FOR THE AECIDIAL STAGE:

Abies Mayriana MIYABE et KUDÔ (HIRATSUKA, f. 1933c, p. 713)—Japan (*cultures*).

FOR THE UREDO- AND TELEUTOSTAGE.

Clethra barbinervis SIEB. et ZUCC. (DIETEL 1903a, p. 629; HIRATSUKA, f. 1927d, p. 72; 1930b, p. 267; 1930d, p. 329; 1932b, p. 40; 1933a, p. 150; 1933c, p. 713; 1935f, p. 281; HIRATSUKA, f. & YOSHINAGA 1935, p. 261; P. & H. SYDOW 1915, p. 450; YOSHINAGA & HIRATSUKA, f. 1930, p. 653)—Japan.

Habitat in Japan

On *Clethra barbinervis* SIEB. et ZUCC. (*Ryôbu*). *Honshû*:—Iwaki (Sôma). Shimotsuke (Nikkô-Yumoto). Musashi (Tokyo). Idzu (Mt. Amagi). Suruga (Mt. Fuji). Noto (Hashi-mura, Tadzuru-hama-mura). Tango (Yoshidzu-mura). Inaba (Tottori, Enoki-tôge, Manisan near Tottori, Mt. Naginosen). Hôki (Misasa, Mt. Daisen). Idzumo (Kijima-mura). *Shikoku*:—Tosa (Mt. Kunimi). Iyo (Iradzu-yama). Awa (Furumiya-mura).

The present species was created in 1903 by DIETEL taking as its type a specimen collected by S. KUSANO at Sôma, province of Iwaki in northern Honshû (Japan). Later, the writer and YOSHINAGA reported that this species occurs in southern Honshû and Shikoku. This is one of the species endemic to this country; it is rather widely distributed throughout Honshû and Shikoku.

The genetic relationship of the present species was first experimentally proved by the writer in 1933. Inoculations with the sporidia from teleutospores of this fungus were made on young needles of *Abies Mayriana*, *Larix Kaempferi* and *Picea jezoensis*, and positive results were obtained on *Abies Mayriana* only, while no

sign of infection on *Larix Kaempferi* and *Picea jezoensis* appeared. Then the return infection with the aecidiospores was also determined on leaves of *Clethra barbinervis*, upon which numerous uredosori developed.

17. *Pucciniastrum Styracinum* HIRATSUKA in Bot. Mag. Tokyo, XII, p. 32, 1898; Rev. Myc. XXI, p. 38, 1899; HIRATSUKA, f. in Jour. Facul. Agric. Hokkaidô Imp. Univ. XXI, p. 67, 1927; Bot. Mag. Tokyo, XLIV, p. 264, 1930; SACCARDO, Syll. Fung. XVI, p. 319; P. & H. SYDOW, Monogr. Ured. III, p. 451.

Icon. HIRATSUKA in Bot. Mag. Tokyo, XII, pl. II, fig. 7~13; Rev. Myc. XXI, pl. CLXXXVIII, fig. 22~26.

Spermogonia on needles of current season, amphigenous, mostly hypophyllous, abundant, closely aggregated, subcuticular, minute, subconoidal to lenticular, $115 \sim 155.5 \times 48 \sim 66.5 \mu$; spermatia oblong, $4.8 \sim 5.1 \times 1.6 \sim 2 \mu$, colourless, smooth.

Aecidia on needles of current season, hypophyllous, in two rows, one on each side of the midrib, cylindrical, solitary or confluent, $0.2 \sim 0.3$ mm across, $0.5 \sim 2.5$ mm long, orange-yellow in colour; peridia colourless, rupturing at the apex; peridial cells ovate to ellipsoidal, mostly elongated vertically, abutting, fragile and easily separated, $41 \sim 48 \times 13 \sim 17 \mu$; inner walls finely verrucose, thin, outer ones smooth, thin; aecidiospores globose to ellipsoidal, $15 \sim 23.5 \times 12 \sim 22 \mu$; epispore minutely verrucose; contents orange-yellow in colour.

Uredosori hypophyllous, scattered or gregarious, often thickly scattered over the whole surface of the leaf, subepidermal, minute, round, $0.1 \sim 0.25$ mm across, often somewhat pulverulent, yellow in colour; peridia hemispherical, firm, dehiscent from an apical pore; peridial cells minute, irregularly polygonal, $8 \sim 18 \mu$ across, walls thin, $1.2 \sim 2 \mu$ thick, smooth, nearly colourless; ostiolar cells rounded, rather thick, $2 \sim 4 \mu$ thick, smooth; uredospores subglobose, ovate or ellipsoidal, $18 \sim 26.5 \times 12.5 \sim 17 \mu$; epispore echinulate, thin, $1 \sim 1.5 \mu$ thick, colourless; contents orange-yellow in colour when fresh; rudimentary paraphyses intermixed.

Teleutosori mostly hypophyllous, subepidermal, minute, limited by the nerves, yellowish brown to reddish brown in colour; teleutospores intercellular, rounded or somewhat angular, divided into 2~4 cells (occasionally more than 4) by vertical or oblique septa, $18 \sim$

30 μ high, 10~24 μ across; epispore uniformly thin, smooth, pale brownish yellow in colour. (Plate IX, fig. 2)

Hosts and Distribution

FOR THE AECIDIAL STAGE:

Abies Mayriana MIYABE et KUDÔ (KAMEI 1932b, p. 165)—Japan (cultures).

FOR THE UREDO- AND TELEUTOSTAGE:

Pterostyrax micranthum SIEB. et ZUCC. (HIRATSUKA, f. 1934d, p. 470; HIRATSUKA, f. & YOSHINAGA 1935, p. 262)—Japan.

Styrax formosanum MATSUM. (HIRATSUKA, f. & HASHIOKA 1933, p. 162; SAWADA 1933, p. 52)—Japan.

Styrax japonicum SIEB. et ZUCC. (HIRATSUKA 1898, p. 33; 1899, p. 38; HIRATSUKA, f. 1927d, p. 67; 1930b, p. 264; 1932b, p. 40; 1936b, p. 270; NAITÔ & YAGI 1933, p. 17; P. & H. SYDOW 1915, p. 452)—Japan.

Styrax Obassia SIEB. et ZUCC. (HIRATSUKA 1898, p. 33; 1899, p. 38; HIRATSUKA, f. 1927c, p. 302; 1927d, p. 67; 1930b, p. 265; P. & H. SYDOW 1915, p. 452)—Japan.

Exsiccati. FOR THE UREDO- AND TELEUTOSTAGE: P. & H. SYDOW, Fung. exot. no. 225 & 226; P. & H. SYDOW, Ured. no. 1446.

Habitat in Japan

On *Pterostyrax micranthum* SIEB. et ZUCC. (*Ôba-asagara*). *Shikoku*:—Tosa (Mt. Shiraga, Hongawa-mura).

On *Styrax formosanum* MATSUM. (*Taiwan-egonoki*). *Formosa*:—Taichû (Gojyô).

On *Styrax japonicum* SIEB. et ZUCC. (*Egonoki*). *Honshû*:—Rikuchû (Morioka, Hanamaki). Ugo (Akita). Echigo (Kamo, Fukuto-mura). Noto (Hashi-mura, Kasashiho-mura, Tadzuruhama-mura). Kaga (Yamanaka-machi). Echizen (Higashiura-mura). Tango (Yoshidzu-mura). Musashi (Tokyo). Mino (Kawauye-mura). Inaba (Omokage-mura, Tottori, Inaba-mura). *Kiushû*:—Higo (Kumamoto). Satsuma (Mureoka near Kagoshima). Ôsumi (Yakushima).

On *Styrax Obassia* SIEB. et ZUCC. (*Hakuunboku*). *Hokkaidô*:—Ishikari (Sapporo, Mt. Moiwa, Maruyama near Sapporo, Ishiyama, Nopporo, Jôzankei, Mt. Teine). *Honshû*:—Rikuchû (Takizawayama).

This species was first described and illustrated by Naoharu HIRATSUKA (1898) based upon a specimen on *Styrax Obassia* collected

by himself at Sapporo, Hokkaidô. He also recorded that the same fungus occurs on *Styrax japonicum* in Honshû. Then, the SYDOWS published the present species on *Styrax japonicum* collected by K. HARA at Kawauye-mura in the province of Mino and by G. YAMADA at Morioka in the province of Rikuchû in their "Fungi Exotici exsiccati", nos. 225 and 226, respectively. On the label of the former specimen, the host plant is misprinted as *Styrax Obassia*, but it is really *Styrax japonicum*, not *S. Obassia*. Then, the writer reported that this species on both species of *Styrax* is distributed in various districts of Hokkaidô, Honshû and Kiushû in his monograph of *Pucciniastrum* and other papers. Moreover, the writer and HASHIOKA (1933) recorded this species on *Styrax formosanum* from Formosa, Japan. Recently, the writer received from Mr. YOSHINAGA two specimens of this fungus on *Pterostyrax micranthum* which had been collected by him in the province of Tosa, Shikoku.

It is restricted to this country, as far as the writer knows.

Kamei worked out the genetic connection of this fungus between aecidia on *Abies Mayriana* and uredo- and teleutosori on *Styrax Obassia*. The writer has never examined any specimen of the aecidial stage, but, through the kindness of Mr. KAMEI the description of spermogonia and aecidia given above is obtained from his manuscript.

18. *Pucciniastrum Miyabeanum* HIRATSUKA in Bot. Mag. Tokyo, XII, p. 33, 1898; Rev. Myc. XXI, p. 39, 1899; HIRATSUKA, f. in Jour. Facul. Agric. Hokkaidô Imp. Univ. XXI, p. 65, 1927; Bot. Mag. Tokyo, XLIV, p. 264, 1930; Jap. Jour. Bot. VI, p. 22 & 23, 1932; SACCARDO, Syll. Fung. XVI, p. 320; P. & H. SYDOW, Monogr. Ured. III, p. 451.

Icon. HIRATSUKA, f. in Jour. Facul. Agric. Hokkaidô Imp. Univ. XXI, pl. I, fig. 1.

Spermogonia on needles of current season, mostly epiphyllous, subcuticular, hemispherical, flattened, minute, 112~156 μ across, 42~66 μ high, honey-yellow in colour; spermatia globose, ellipsoidal to oblong, 2.8~6 \times 1.2~2.5 μ , colourless.

Aecidia on needles of current season, hypophyllous, in two irregular rows on yellowish discoloured areas occupying a part or all of the leaf, cylindrical, 0.8~1.6 mm high, 0.25~0.35 mm across; peridia colourless, delicate, rupturing at the apex; peridial cells

rhomboidal or elongated hexagonal, overlapping, $42\sim 63 \times 15.5\sim 21 \mu$, with outer walls smooth, thin, $1\sim 1.2 \mu$ thick, inner ones rather thick, verrucose; aecidiospores globose, subglobose, ellipsoidal or ovate, $18\sim 27 \times 15\sim 18 \mu$; epispore about 2μ thick, finely echinulate, nearly colourless; contents orange-yellow in colour.

Uredosori hypophyllous, scattered or gregarious, on pale yellowish discoloured spots, subepidermal, round, minute, $0.08\sim 0.25$ mm across, yellow in colour; peridia hemispherical, firm, dehiscent from an apical pore; upper peridial cells small, irregularly polygonal, $8\sim 18 \mu$ across, lateral ones somewhat radially elongate; walls of the peridial cells smooth, thin, $1\sim 2 \mu$ thick, colourless; uredospores ellipsoidal, ovate, pyriform or globose, $18\sim 30 \times 12.6\sim 20 \mu$; epispore rather thin, $1.2\sim 1.5 \mu$ thick, finely echinulate, colourless; contents orange-yellow when fresh.

Teleutosori hypophyllous, subepidermal, generally in dense clusters, limited by the nerves, pale yellow to yellowish brown in colour; teleutospores intercellular, mostly in small groups, globose, subglobose or ovate, sometimes somewhat angular or flattened at the sides, divided into $2\sim 6$ cells by vertical or oblique septa, $15\sim 25 \mu$ long, $15\sim 27 \mu$ wide; epispore uniformly thin, less than 1μ , smooth, pale yellow in colour. (Plate VIII, fig. 3)

Hosts and Distribution

FOR THE AECIDIAL STAGE:

Abies Mayriana MIYABE et KUDÔ (HIRATSUKA, f. 1932a, p. 22)
—Japan (cultures).

FOR THE UREDO- AND TELEUTOSTAGE:

Viburnum furcatum BL. (HIRATSUKA 1898, p. 34; 1899, p. 39; HIRATSUKA, f. 1927c, p. 302; 1927d, p. 66; 1928a, p. 29; 1930a, p. 81; 1930b, p. 264; 1930d, p. 329; 1932a, p. 22; 1932b, p. 40; P. & H. SYDOW 1915, p. 451)—Japan.

Habitat in Japan

On *Viburnum furcatum* BL. (*Mushikari*). *S. Saghalien*:—Toyohara (Tonnaicha-sandô). *Hokkaidô*:—Oshima (Ônuma, Mt. Komagatake). Iburi (Chitose, Lake side of Shikotsu-ko, Mt. Makari-nupuri, Tokushunbetsu). Shiribeshi (Raiden-tôge). Ishikari (Sapporo, Mt. Moiwa, Garugawa, Mt. Teine, Jôzankei, Nopporo, Maruyama near Sapporo, Mt. Kuro-dake). Teshio (Kami-Otoi-neppu). *Honshû*:—Mutsu (Mt. Iwaki, Hirosaki). Shinano (Mt. Komagatake [Kiso]). Inaba (Mt. Okinosen, Mt. Naginosen, Mt. Hyônosen, Mt. Ôginosen). Hôki (Mt. Daisen).

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This species was first created by Naoharu HIRATSUKA in 1898 based upon specimens which were collected in the vicinity of Sapporo. The writer has also recorded the occurrence of this species in Honshû, Hokkaidô and South Saghalien. The host plant is indigenous to Japan and the fungus is very widely distributed, extending from South Saghalien to southern Honshû.

The writer also showed for the first time by cultural experiments that the aecidia of this species occur on *Abies Mayriana*. In April 1931, sporidia from the teleutospores of this fungus were sown on needles of *Abies Mayriana*, *Larix Kaempferi*, *Picea jezoensis* and *Pinus densiflora* and on leaves of *Chelidonium majus*. Positive results were readily secured on the needles of *Abies*, while on the remaining plants inoculations were unsuccessful. In May of the same year, the aecidiospores which had been produced on the needles of *Abies Mayriana* were sown on leaves of *Clethra barbinervis*, *Styrax japonicum* and *Viburnum furcatum*. Successful results were obtained on the last species only.

19. *Pucciniastrum Castaneae* DIETEL in Hedwigia, XLI, p. [178], 1902; HIRATSUKA, f. in Jour. Facul. Agric. Hokkaidô Imp. Univ. XXI, p. 96, 1927; Bot. Mag. Tokyo, XLIV, p. 279, 1930; SACCARDO, Syll. Fung. XVII, p. 401; P. & H. SYDOW, Monogr. Ured. III, p. 453.

Syn. *Uredo Castaneae* HENNINGS in Philippine Jour. Sci. III, p. 43, 1908; Hedwigia, XLVII, p. 252, 1908; SACCARDO, Syll. Fung. XXI, p. 802.

Melampsoridium Castaneae DIETEL in sched.

Icon. HIRATSUKA, f. in Jour. Facul. Agric. Hokkaidô Imp. Univ. XXI, pl. I, fig. 5, 1927.

Uredosori hypophyllous, subepidermal, scattered or crowded in small groups, often thickly scattered over the whole surface of the leaf, round, minute, $0.1\sim 0.25$ mm in diameter, somewhat pulverulent, orange-yellow in colour; peridia hemispherical, delicate, firm, dehiscent from an apical pore; peridial cells small, irregularly polygonal, walls thin, $1.2\sim 3 \mu$, smooth; paraphyses numerous, clavate or capitate, $27\sim 37.8 \mu$ long, walls colourless, smooth; uredospores subglobose, ovate or ellipsoidal, $14\sim 24 \times 9\sim 15 \mu$; epispore thin, $0.8\sim 1.5 \mu$ thick, echinulate, colourless; contents orange-yellow when fresh.

Teleutosori mostly hypophyllous, subepidermal, scattered or

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grouped, limited by the nerves, yellow to yellowish brown in colour; teleutospores intercellular, solitary or grouped, generally compacted laterally under the epidermis, ovate or oblong, somewhat angular, divided vertically into 2 to 6 cells (rarely one or more than 6), $19.8 \sim 35 \times 14 \sim 30 \mu$; epispore uniformly thin, $0.8 \sim 1.2 \mu$ thick, pale yellow in colour, smooth.

Hosts and Distribution

FOR THE UREDO- AND TELEUTOSTAGE:

Castanea crenata SIEB. et ZUCC. (*C. sativa* MILL. var. *pubinervis* MAK., *C. vulgaris* LAM. var. *japonica* A. DC., *C. pubinervis* C. K. SCHN.) (DIETEL 1902a, p. [178]; 1905b, p. 105; HENNINGS 1905a, p. 597; HIRATSUKA, f. 1927d, p. 96 & 97; 1930b, p. 279; 1930d, p. 330; 1933a, p. 148; 1935a, p. 150; 1935f, p. 281; 1936b, p. 270; HIRATSUKA, f. & HASHIOKA 1933, p. 163; HIRATSUKA, f. & YOSHINAGA 1935, p. 261; NAMBU 1904, p. [1]; NAITÔ & YAGI 1933, p. 16; NISHIDA 1902, p. [273]; SAWADA 1933, p. 52; P. & H. SYDOW 1913, p. 110; 1915, p. 454; YOSHINAGA 1904a, p. [34]; YOSHINAGA & HIRATSUKA, f. 1930, p. 654)—Japan.

Castanea vulgaris LAM. (HENNINGS 1908a, p. 43; 1908b, p. 252; HIRATSUKA, f. 1927d, p. 96; P. & H. SYDOW 1915, p. 454)—Philippines.

Castanopsis javanica (BUTLER & BISBY 1931, p. 76; P. & H. SYDOW & BUTLER 1912, p. 270)—India.

Habitat in Japan

On *Castanea crenata* SIEB. et ZUCC. (*Kuri*). *Honshû*:—Mutsu (Ishie). Rikuchû (Takizawa-mura, Yanagawa-mura). Shimotsuke (Nikkô). Musashi (Tokyo, Ômiya). Idzu (Mt. Amagi). Echigo (Kamo). Noto (Hashi-mura). Kaga (Yamanaka-machi). Echizen (Higashiura-mura, Awano-mura). Inaba (Tottori, Manisan near Tottori, Inabayama, Mt. Okinosen). Hôki (Daisen-mura). Idzumo (Kijima-mura). Tango (Naka-Maizuru). *Shikoku*:—Iyo (Shinritsumura). Tosa (Hatayama-mura, Ônomi-mura, Aki-machi). *Kiushû*:—Chikugo (Miike-machi). Hizen (Mt. Unzen). Higo (Idzumi-mura, Nanayaki-mura, Konoha-mura). Ôsumi (Kanoya, Takakuma-mura). Satsuma (Toso near Kagoshima, Taniyama-mura, Kagoshima). *Korea*:—Keiki (Keijô). *Formosa*:—Taichû (Rengechi).

This fungus is an interesting species differing from ordinary species of *Pucciniastrum* in some characters. It is differentiated by the possession of well-developed peripheral paraphyses in the uredosorus and the absence of a distinct peridium although sometimes a rudimentary one is seen.

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The type specimen of this species was collected by T. NISHIDA at Nikkô in the province of Shimotsuke (Japan) in October 1900. In 1908, HENNINGS described a rust fungus on *Castanea vulgaris* (*C. crenata*?) from the Philippine Islands, under the name of *Uredo Castaneae* HENNINGS, with the following diagnosis; "*Uredo Castaneae* P. HENN. sp. nov. Maculis rotundatis vel effusis, fuscidulis; soris hypophyllis gregariis minutis, farinosis, epidermide fissa velatis; uredosporis ovoideis vel ellipsoideis flavido-hyalinis, echinatis, $12 \sim 20 \times 8 \sim 12 \mu$. Luzon, Distr. Lepanto, Balili, in foliis *Castaneae vulgaris*, cult., MERRILL 4874, Nov., 1905."

In their monograph, the SYDOWS (1915) treated this Philippine species as a synonym of *Pucciniastrum Castaneae* DIET. Unfortunately, the writer has not been able to see the type specimen of *Uredo Castaneae*, but he treated that species as the uredostage of the present species judging from its original description, following also the SYDOWS' opinion.

In 1914, FUJIKURO reported a rust fungus on *Quercus serrata* var. *chinensis* (*Q. suber*) found in Formosa as *Uredo Castaneae* P. HENN. Although the writer has not been able to examine the Formosan specimen, it seems to be the uredostage of *Cronartium Quercuum* MIYABE. Afterwards, YOSHINAGA and the writer reported the occurrence of this fungus in Honshû, Shikoku, Kiushû and Formosa. It is rather common in Japan in southern Honshû, Shikoku and Kiushû.

20. *Pucciniastrum Corchoropsidis* DIETEL in P. & H. SYDOW, Monogr. Ured. III, p. 452, 1915; HIRATSUKA, f. in Jour. Facul. Agric. Hokkaidô Imp. Univ. XXI, p. 82, 1927; Bot. Mag. Tokyo, XLIV, p. 271, 1930.

Syn. *Uredinopsis Corchoropsidis* DIETEL in ENGL. Bot. Jahrb. XXXII, p. 628, 1903; SACCARDO, Syll. Fung. XVII, p. 270.

Uredosori hypophyllous, subepidermal, scattered, small, $50 \sim 80 \mu$ in diameter; peridia hemispherical, upper peridial cells small, cubical, lateral ones radially elongate, walls smooth; uredospores ellipsoidal or ovate, $16 \sim 23 \times 11 \sim 17 \mu$; epispore echinulate, thin, $1 \sim 1.5 \mu$ thick, hyaline.

Teleutosori hypophyllous, minute; teleutospores intercellular, forming within the mesophyll, subglobose, ellipsoidal or oblong, $2 \sim 5$ celled, $12 \sim 24 \mu$ across; epispore smooth, $1 \sim 1.5 \mu$ thick.

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Hosts and Distribution

FOR THE UREDO- AND TELEUTOSTAGE:

Corchoropsis tomentosa MAK. (*C. crenata* SIEB. et ZUCC.) (DIETEL 1903a, p. 628; HIRATSUKA, f. 1927d, p. 82 & 83; 1930b, p. 271; 1935f, p. 281; NAMBU 1904, p. [2]; P. & H. SYDOW 1915, p. 453)—Japan.

Habitat in Japan

On *Corchoropsis tomentosa* MAK. (*Karasunogoma*). Honshû:—Idzu (Mt. Amagi).

The present species was first described by DIETEL (1903), based upon a specimen which was collected by N. NAMBU on Mt. Amagi, as *Uredinopsis Corchoropsidis* DIET. with the following remarks:—"Wir haben es hier mit einem eben so interessanten wie unscheinbaren Pilze zu thun, der durch sein Vorkommen auf einer Tiliacee den Zusammenhang zwischen den Gattungen *Pucciniastrum* und *Uredinopsis* vermittelt, von deren letzterer bisher nur Vertreter auf Farnkräutern bekannt geworden waren, während auf *Tilia* ein *Pucciniastrum* aus Japan bereits bekannt ist. Aber da bei unserem Pilze die Teleutosporen einzeln dem Parenchym der Nährpflanze eingebettet sind, kann die Zugehörigkeit zu *Uredinopsis* nicht zweifelhaft sein. Man findet sie in Menge auf meist viereckigen, durch die Nervatur des Blattes scharft begrenzten Flecken, die an den herbstlich halbentfärbten Blättern des vorliegenden Materiales durch dunklere Färbung der Blattoberseite sich abheben. Mehrere solcher Flecken, deren Seitenlänge 1~2 mm beträgt, fließen bisweilen zusammen. Aber selbst da, wo diese Sporen in Menge gehäuft vorhanden sind, kommt es nicht zur Bildung geschlossener subepidermaler Krusten, sondern nur zur Entstehung unregelmässiger Nester. Während die Stellen, an denen die Teleutosporen zu finden sind, sich durch die Färbung der Blattes kenntlich machen, waren die spärlich vorhandenen Uredolager, da ihre Breite weniger als 0.1 mm beträgt, nur mit Hilfe der Lupe zu entdecken. Vielleicht sind sie im frischen Zustande auch mit blossem Auge sichtbar, wenn sie in grösserer Menge beisammenstehen und wenn die Sporen aus dem Pseudoperidium hervortreten. Letzteres besteht aus zarten, mit einander verwachsenen Schläuchen, die an der Spitze durch Querwände in einige kurze Zellen geteilt sind."

Later, DIETEL transferred the species to the genus *Pucciniastrum*. The type specimen has not seen by the present writer nor is there

any specimen in his herbarium. The description of the present species as above, is compiled from the original description.

21. *Pucciniastrum Goodyerae* ARTHUR in N. Amer. Fl. VII, p. 105, 1907; Manual of the rusts in United States and Canada, p. 12; HIRATSUKA, f. in Jour. Facul. Agric. Hokkaidô Imp. Univ. XXI, p. 100, 1927.

Syn. *Uredo Goodyerae* TRANZSCHEL in Trudi St. Petersburg. Obshch. Est. Otd. Bot. XXIII, p. 28, 1893; Hedwigia, XXXII, p. 240, 1893; SACCARDO, Syll. Fung. XI, p. 227.

Pucciniastrum (?) *Goodyerae* LIRO, Ured. Fenn. p. 501, 1908.

Pucciniastrum Goodyerae TRANZSCHEL in P. & H. SYDOW, Monogr. Ured. III, p. 456, 1915.

Icon. ARTHUR, Manual of the rusts in United States and Canada, fig. 19.

Uredosori amphigenous, scattered or crowded in small groups, subepidermal, minute, round, 0.12~0.35 mm across, orange-yellow, then pale yellow in colour, long covered by the epidermis; peridia hemispherical, delicate, firm, dehiscent from an apical pore; peridial cells small, isodiametrically to irregularly polygonal, 7.5~15 μ across, lateral ones radially elongate; walls of peridial cells thin, smooth, colourless or subhyaline; ostiolar cells rather large, 32.4~42 μ high, finely echinulate above; uredospores ovate, oblong or oblong-clavate, 23.4~34.2 \times 16.2~20.5 μ ; epispore finely echinulate, uniformly thin, 1.5~2 μ thick, colourless; contents pale yellow in colour. Teleutospores unknown. (Plate IX, fig. 4)

Hosts and Distribution

FOR THE UREDO- AND TELEUTOSTAGE:

Goodyera decipiens HUBBARD (*G. Menziesii* LINDL., *Epipactis decipiens* AMES, *Peramium decipiens* PIPER, *P. Menziesii* MORONG.) (ARTHUR 1907, p. 105; 1927, p. 818; 1934, p. 12; BLASDALE 1919, p. 139; HIRATSUKA, f. 1927d, p. 100; HOTSON 1925, p. 294; 1934, p. 114; JACKSON 1918b, p. 216; SEYMOUR 1929, p. 185; P. & H. SYDOW 1915, p. 456)—Washington, California, Colorado, Oregon, New Mexico.

Goodyera repens R. BR. (HIRATSUKA, f. 1927d, p. 100; LIRO 1908, p. 502; MAYOR 1924, p. 387; P. & H. SYDOW 1915, p. 456; WILSON 1934, p. 429)—Russia, Finland, Great Britain, Switzerland.

Exsiccati. FOR THE UREDO- AND TELEUTOSTAGE: P. & H. SYDOW, Ured. no. 1798.

In 1893, TRANZSCHEL described *Uredo Goodyerae* TRANZSCH. on *Goodyera repens* which was collected at Levasho near St. Petersburg, Russia. In 1907, ARTHUR transferred this species to the genus *Pucciniastrum* because of the characters of its uredostage. Its teleutostage is not yet known.

In the SYDOWS' monograph (1915), the author's name of this species is erroneously recorded as TRANZSCHEL instead of ARTHUR.

22. *Pucciniastrum Pipturi* H. SYDOW in H. SYDOW & PETRAK in Ann. Myc. XXIX, p. 171, 1931.

Uredosori hypophyllous, subepidermal, scattered or in small groups, round, small, 0.1~0.24 mm across, at first covered by the epidermis, then naked and somewhat pulverulent, orange-yellow in colour; peridia delicate, firm; upper peridial cells small, irregularly polygonal, 8~20 μ across, lateral ones somewhat radially elongate, walls of the peridial cells smooth, thin, nearly colourless or pale yellowish coloured; uredospores subglobose, ellipsoidal or obovate, 24~40 \times 20~28 μ ; epispore at first nearly colourless, then more or less intensely brown, 1.2~2.5 μ thick, often thicker at the apex, with dense and short aculeate papillae; germ pores inconspicuous. Teleutospores still unknown.

Hosts and Distribution

FOR THE UREDO- AND TELEUTOSTAGE:

Pipturus arborescens C. B. ROB. (H. SYDOW & PETRAK 1931, p. 171)—Philippines.

Through the courtesy of Dr. SYDOW, the writer was able to examine a part of the original specimen of the present species and three specimens from its co-type ones. Its host plant, *Pipturus* is closely related to *Boehmeria* on which occurs *Pucciniastrum Boehmeriae* P. et H. SYD. in southern Japan and the Philippine Islands. Both genera belong to Boehmerieae of the family Urticaceae. But, the present fungus differs distinctly from *Pucciniastrum Boehmeriae* by the possession of larger uredospores.

This species is only known from the Philippine Islands as far as the writer knows.

23. *Pucciniastrum Malloti* HIRATSUKA, f. in HIRATSUKA, f. & HASHIOKA in Bot. Mag. Tokyo, XLIX, p. 23, 1935.

Uredosori hypophyllous, scattered or loosely grouped, subepider-

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mal, minute, round, 0.14~0.4 mm across, yellowish brown in colour; peridia hemispherical or flattened hemispherical, delicate, firm, dehiscent from an apical pore; peridial cells small, irregularly polygonal, 7~15 μ across, walls smooth, thin, nearly colourless; uredospores subglobose, obovate, ellipsoidal or oblong, 20~36 \times 16~24 μ ; epispore thin, 1~1.5 μ thick, minutely echinulate; contents pale yellow in colour. Teleutospores still unknown.

Hosts and Distribution

FOR THE UREDO- AND TELEUTOSTAGE:

Mallotus japonicus MÜLL.-ARG. (HIRATSUKA, f. & HASHIOKA 1935a, p. 23)—Japan.

Habitat in Japan

On *Mallotus japonicus* MÜLL.-ARG. (*Akame-gashiwa*). *Formosa*:—Taihoku: Mt. Kan-non (Y. HASHIOKA, *type!*)

24. *Pucciniastrum Celastris* P. et H. SYDOW in P. & H. SYDOW & BUTLER in Ann. Myc. V, p. 503, 1907; Monogr. Ured. III, p. 454; HIRATSUKA, f. in Jour. Facul. Agric. Hokkaidô Imp. Univ. XXI, p. 99, 1927; SACCARDO, Syll. Fung. XXI, p. 732.

Uredosori hypophyllous, scattered or in small groups, subepidermal, round, minute, 0.1~0.2 mm across; peridia present; uredospores subglobose or ellipsoidal, 20~25 \times 16~22 μ ; epispore echinulate-verruculose, about 2 μ thick, colourless. Teleutospores unknown.

Hosts and Distribution

FOR THE UREDO- AND TELEUTOSTAGE:

Celastrus paniculatus WILLD. (BUTLER & BISBY 1931, p. 76; HIRATSUKA, f. 1927d, p. 100; P. & H. SYDOW 1915, p. 455; P. & H. SYDOW & BUTLER 1907, p. 503)—Himalaya.

This species is known only from Kumaon, Himalaya in India, where it was collected on *Celastrus paniculatus* by INAYAT. No material of this species has been examined, and the description is taken from the original.

25. *Pucciniastrum Actinidiae* HIRATSUKA, f. nov. spec.

Soris uredosoriferis hypophyllis, maculis flavidis vel flavo-brunneis insidentibus, sparsis vel aggregatis, minutis, rotundatis, 0.08~0.18 mm diam., diu epidermide tectis, tandem poro centrali apertis, pallide flavo-brunneis; peridiis hemisphaericis, delicatis, subhyalinis; cellulis peridiis minutis, cubicis, 7~14 μ diam., parietibus levibus; cellulis ostiolaribus ellipsoideis vel oblongis, 12~16 \times 7~12 μ ,

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parietibus levibus, hyalinis vel subhyalinis; uredosporis obovatis, ellipsoideis vel oblongis, $18\sim 27 \times 12\sim 16 \mu$; episporio subhyalino, minutissime echinulato, $1.5\sim 2.2 \mu$ crasso. Teleutosporis ignotis.

Hab. in foliis *Actinidiae formosanae* in Formosa, Japonia.

Uredosori hypophyllous, subepidermal, scattered or grouped on yellow or yellowish brown discoloured areas of indefinite extent, round, minute, $0.08\sim 0.18$ mm across, covered by the epidermis, then dehiscent by a central pore, pale yellowish brown in colour; peridia hemispherical, delicate, subhyaline; peridial cells minute, cubical, $7\sim 14 \mu$ across, walls smooth; ostiolar cells ellipsoidal or oblong, $12\sim 16 \times 7\sim 12 \mu$, walls smooth, colourless or subhyaline; uredospores obovate, ellipsoidal or oblong, $18\sim 27 \times 12\sim 16 \mu$; episporium $1.5\sim 2.2 \mu$ thick, minutely echinulate, subhyaline. Teleutospores still unknown.

Hosts and Distribution

FOR THE UREDO- AND TELEUTOSTAGE:

Actinidia formosana HAYATA—Japan.

Habitat in Japan

On *Actinidia formosana* HAYATA (*Taiwan-sarunashi*). Formosa: —Taichû: Mt. Hassen (Kahôdai) (Oct. 30, 1931, T. SUZUKI, type!).

The present fungus is referred to genus *Pucciniastrum* with considerable confidence in spite of the absence of teleutospores, on account of the structure of the uredosori and the essential characters of the uredospores.

26. *Pucciniastrum Stachyuri* HIRATSUKA, f. in HIRATSUKA, f. & YOSHINAGA in Mem. Tottori Agric. Coll. III, p. 262, 1935.

Syn. *Uredo Stachyuri* DIETEL in ENGL. Bot. Jahrb. XXXVII, p. 108, 1905; SACCARDO, Syll. Fung. XXI, p. 789; P. & H. SYDOW, Monogr. Ured. IV, p. 447.

Uredosori hypophyllous, scattered or in small groups, on yellowish discoloured spots, subepidermal, minute, round, $0.09\sim 0.22$ mm across, yellowish brown in colour; peridia hemispherical or applanate-conoidal, delicate, firm; upper peridial cells small, irregularly polygonal, $7\sim 14 \mu$ across, lateral ones radially elongate, walls thin, smooth, nearly colourless; uredospores obovate, ellipsoidal or oblong-clavate, $21\sim 35 \times 15\sim 20 \mu$; episporium $1.2\sim 1.8 \mu$ thick, uniformly aculeate, nearly colourless, germ pores indistinct. Teleutospores still unknown.

Hosts and Distribution

FOR THE UREDO- AND TELEUTOSTAGE:

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Stachyurus Matsuzakii NAKAI (HIRATSUKA, f. 1934e, p. 622; 1935f, p. 284)—Japan.

Stachyurus praecox SIEB. et ZUCC. (DIETEL 1905b, p. 108; HIRATSUKA, f. 1934e, p. 622; HIRATSUKA, f. & YOSHINAGA 1935, p. 262; P. & H. SYDOW 1924, p. 447; YOSHINAGA & HIRATSUKA, f. 1930, p. 665)—Japan.

Habitat in Japan

On *Stachyurus Matsuzakii* NAKAI (*Hachijô-kibushi*). Honshû: —Idzu (Hachijô-shima).

On *Stachyurus praecox* SIEB. et ZUCC. (*Kibushi*). Shikoku: —Tosa (Mt. Yanaze).

27. *Pucciniastrum Fuchsiae* HIRATSUKA, f. in Jour. Facul. Agric. Hokkaidô Imp. Univ. XXI, p. 98, 1927.

Syn. *Uredo Fuchsiae* ARTHUR et HOLWAY in ARTHUR in Amer. Jour. Bot. VI, p. 538, 1918; N. Amer. Fl. VII, p. 614; SACCARDO, Syll. Fung. XXIII, p. 943; P. & H. SYDOW, Monogr. Ured. IV, p. 442.

Uredosori hypophyllous, in small irregular groups, minute, round, $0.1\sim 0.2$ mm across, long covered by the epidermis, then naked, somewhat pulverulent, pale yellow in colour; peridia hemispherical, delicate, dehiscent from an apical pore; peridial cells small, irregularly polygonal, $7\sim 12 \mu$ across, walls rather thin, colourless, smooth, not thickened or sculptured at the ostiole; uredospores subglobose, obovate or ellipsoidal, $14\sim 24 \times 13\sim 16.5 \mu$; episporium rather thin, $1\sim 1.8 \mu$ thick, minutely echinulate, nearly colourless; germ pore obscure. Teleutospores still unknown. (Plate VIII, fig. 5)

Hosts and Distribution

FOR THE UREDO- AND TELEUTOSTAGE:

Fuchsia splendens ZUCC. (ARTHUR 1918, p. 538; 1924, p. 614; HIRATSUKA, f. 1927d, p. 98; SEYMOUR 1929, p. 533; P. & H. SYDOW 1924, p. 442)—Guatemala.

Fuchsia sp. (SMITH & REES 1932, p. 308)—Great Britain.

Lopezia hirsuta JACZ. (ARTHUR 1918, p. 538; 1924, p. 614; HIRATSUKA, f. 1927d, p. 99; SEYMOUR 1929, p. 533; P. & H. SYDOW 1924, p. 442)—Guatemala; Costa Rica.

By the kindness of Dr. ARTHUR the writer was enabled to examine a specimen of this species on *Lopezia hirsuta* which was collected by E. W. D. HOLWAY from Guatemala (no. 649). This is the only specimen which the writer has examined.

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28. *Pucciniastrum Wikstroemiae* ARTHUR in STEVENS in B. P. BISHOP Mus. Bull. XIX, p. 115, 1925; HIRATSUKA, f. in Jour. Facul. Agric. Hokkaidô Imp. Univ. XXI, p. 99, 1927.

Uredosori hypophyllous, subepidermal, solitary or in small groups of 2 to 6, causing little or no discoloration, bullate, minute, round or oblong, 0.08~0.4 mm across, epidermis rupturing irregularly and remaining overarched; peridia delicate, colourless; peridial cells small, irregularly polygonal, slightly overlapping, walls thin, about 1 μ thick, smooth, nearly colourless; uredospores oblong, obovate or subglobose, 18~27 \times 14.5~18 μ ; epispore rather thick, 1.8~3 μ , sparsely echinulate, nearly colourless. Teleutospores still unknown.

Hosts and Distribution

FOR THE UREDO- AND TELEUTOSTAGE:

Wikstroemia uva-ursi A. GRAY (HIRATSUKA, f. 1927d, p. 99; STEVENS 1925, p. 115)—Hawaii.

Through the generous courtesy of Dr. ARTHUR, the writer has been enabled to examine the original material of this species.

29. *Pucciniastrum Crawfordiae* H. SYDOW in H. SYDOW & PETRAK in Ann. Myc. XXIX, p. 170, 1931.

Uredosori hypophyllous, subepidermal, mostly scattered over the whole surface of the leaf, minute, round, 0.1~0.24 mm across, covered by yellowish brown coloured epidermis; peridia hemispherical, delicate, firm, dehiscent from an apical pore; peridial cells small, irregularly polygonal, 10~17.5 μ across, walls thin, smooth, nearly colourless; ostiolar cells rounded, walls smooth, thin; uredospores subglobose or ellipsoidal, rarely oblong, 17.5~25 \times 15~20 μ ; epispore thin, 1~1.5 μ thick, colourless, densely and minutely echinulate, nearly colourless; contents coloured. Teleutospores unknown.

Hosts and Distribution

FOR THE UREDO- AND TELEUTOSTAGE:

Crawfordia luzoniensis VID. (H. SYDOW & PETRAK 1931, p. 170)—Philippines.

The only known locality for this species is Baguio, Benguet Province, Luzon in the Philippine Islands where it was collected on *Crawfordia luzoniensis* by M. S. CLEMENS in December 1925. A part of the type specimen was furnished through the courtesy of Dr. SYDOW for the writer's examination.

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30. *Pucciniastrum Gentianae* HIRATSUKA, f. et HASHIOKA in Transact. Tottori Soc. Agric. Sci. V, p. 237, 1935.

Uredosori hypophyllous, scattered or densely scattered on the whole surface of the leaf, subepidermal, minute, round, 0.15~0.36 mm across, covered by the epidermis, yellow in colour; peridia hemispherical, delicate; peridial cells minute, irregularly polygonal, 8~16 μ across, smooth, pale yellow; ostiolar cells rounded, smooth; uredospores subglobose or broadly ellipsoidal, 21~27 \times 17~23 μ ; epispore 2~3 μ thick, echinulate-verruculose. Teleutospores still unknown.

Hosts and Distribution

FOR THE UREDO- AND TELEUTOSTAGE:

Gentiana formosana HAYATA (HIRATSUKA, f. & HASHIOKA 1935c, p. 237)—Japan.

Habitat in Japan

On *Gentiana formosana* HAYATA (*Hôrai-rindô*). *Formosa*:—Tainan: Mt. Niitaka (Tâtaka) (Y. HASHIOKA, type!).

This species differs from *Pucciniastrum Crawfordiae* H. SYDOW on *Crawfordia luzoniensis* (Gentianaceae) in having thick-walled and larger uredospores.

31. *Pucciniastrum Mussaendae* H. SYDOW in H. SYDOW & PETRAK in Ann. Myc. XXIX, p. 171, 1931.

Uredosori hypophyllous, subepidermal, scattered or grouped, round, very minute, 0.08~0.18 mm across, long covered by the epidermis, yellow in colour; peridia hemispherical, delicate, dehiscent by a central pore; peridial cells small, ovate-oblong or irregularly polygonal, 7~15 μ across, walls thin, smooth, nearly colourless; uredospores subglobose, ellipsoidal, obovate or oblong, 18~30 \times 14~18 μ ; epispore thin, 1.5~2 μ thick, colourless, sparsely echinulate; germ pores inconspicuous. Teleutospores unknown.

Hosts and Distribution

FOR THE UREDO- AND TELEUTOSTAGE:

Mussaenda benguetensis ELM. (H. SYDOW & PETRAK 1931, p. 171)—Philippines.

The writer was fortunate enough to examine a part of the type specimen of this species by the kindness of Dr. SYDOW, and that is the only specimen the writer has examined. The original collection was made by M. S. CLEMENS at Mt. Pulog, Luzon, Philippine Islands in February 1925.

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32. *Pucciniastrum ishikariense* HIRATSUKA, f. nov. spec.

Syn. *Pucciniastrum Goodyerae* (not ARTHUR) HIRATSUKA, f. in Jour. Facul. Agric. Hokkaidô Imp. Univ. XXI, p. 26, 1927; Bot. Mag. Tokyo, XLIV, p. 281, 1930.

Icon. HIRATSUKA, f. in Jour. Facul. Hokkaidô Imp. Univ. XXI, pl. I, fig. 12.

Soris uredosporiferis plerumque epiphyllis, subepidermalibus, sparsis vel laxe aggregatis, minutis, rotundatis, 0.12~0.35 mm diam., peridiis hemisphaericis, delicatis; cellulis peridiis minutis, irregulariter polygonalibus; uredosporis ellipsoideis vel obovatis, 21~30 × 18~22.5 μ; episporio remote echinulato vel crasse aculeato, 2~3 μ crasso. Teleutosporis ignotis.

Hab. in foliis *Goodyera Maximowiczianae* et *nankoense* in Japonia.

Uredosori mostly epiphyllous, subepidermal, scattered or loosely aggregate, small, round, 0.12~0.35 mm across, covered by the epidermis, at last more or less powdery, orange-yellow in colour; peridia hemispherical, firm, delicate, rupturing at the apex; peridial cells small, irregularly polygonal; uredospores ellipsoidal or obovate, 21~30 × 18~22.5 μ; episporium 2~3 μ thick, with scattered, short spines or spiny warts; contents orange-yellow in colour. Teleutosporis unknown.

Hosts and Distribution

FOR THE UREDO- AND TELEUTOSTAGE:

Goodyera Maximowicziana MAK. (HIRATSUKA, f. 1927a, p. 27; 1927c, p. 307; 1927d, p. 100; 1930b, p. 281)—Japan.

Goodyera nankoensis FUKUYAMA—Japan.

Habitat in Japan

On *Goodyera Maximowicziana* MAK. (*Akebono-shusuran*). Hokkaidô:—Ishikari: Sôunkei (Aug. 4, 1925 [type !] & Aug. 18, 1933, HIRATSUKA, f.); Mt. Kuro-dake (Aug. 18, 1925, K. MIYABE & HIRATSUKA, f.).

On *Goodyera nankoensis* FUKUYAMA (*Nanko-futabaran*). Formosa:—Taihoku: Takejin (Mt. Nanko) (July 29, 1934, Y. HASHIOKA).

This species differs from *Pucciniastrum Goodyerae* ARTH., with which it has been united, especially in respect to the shape of uredospores and the thickness of their episporium.

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The uredospores of this fungus are ellipsoidal or obovate, measuring 21~30 × 18~22.5 μ and their episporium 2~3 μ thick, while those of *Pucciniastrum Goodyerae* are ovate, oblong or oblong-clavate, measuring 23.4~34.2 × 16.2~20.5 μ and their episporium 1.5~2 μ thick.

***Thekopsora* MAGNUS, 1875**

Spermogonia epiphyllous or hypophyllous, subcuticular, minute.

Aecidia hypophyllous, subepidermal, minute, cylindrical; peridia delicate, nearly colourless or pale yellowish coloured; peridial cells small, irregularly polygonal; aecidiospores globose, subglobose to broadly ellipsoidal, contents orange to orange-red in colour.

Uredosori hypophyllous, subepidermal, minute; peridia appanate-hemispherical, hemispherical to conoidal, nearly colourless, delicate; peridial cells small, irregularly polygonal; uredospores variable in shape, contents orange-yellow in colour.

Teleutosori amphigenous; teleutosporis intracellular, forming in the epidermal cells, globose, subglobose, oblong or somewhat angular, 2~6 celled (mostly 4), with vertical or oblique septa; episporium smooth, pale yellow to yellowish brown in colour.

TYPE SPECIES: *Thekopsora areolata* MAGNUS.

Key to species

Teleutosporis known.

Ostiolar cells of peridia of uredosori coarsely to finely echinulate at the apex. On Ericaceae.

Uredospores ellipsoidal, oblong or clavate-oblong, 28.8~50.4 × 13.5~22.5 μ. On *Arbutus*, *Arctostaphylos* and *Arctous*.

1. *Thekopsora sparsa* (p. 286)

Uredospores subglobose, ellipsoidal or oblong, 18~34.2 × 12.5~17.5 μ. On *Tripetaleia*.

2. *Thekopsora Tripetaleiae* (p. 290)

Uredospores ovate, ellipsoidal or oblong, 16~28.8 × 9~14.4 μ. On *Menziesia*.

3. *Thekopsora Menziesiae* (p. 292)

Ostiolar cells of peridia of uredosori smooth.

On Saxifragaceae (*Hydrangea*).

Uredospores broadly ellipsoidal or obovate, 16~25 × 12~20 μ.

4. *Thekopsora Hydrangeae* (p. 293)

On Amygdalaceae (*Prunus*).

Uredospores ovate, ellipsoidal or oblong, comparatively large, 19.8~30.6 × 12.6~18 μ.

5. *Thekopsora pseudo-Cerasi* (p. 296)

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Uredospores globose, subglobose, ellipsoidal or ovate, comparatively small, $14.4\text{--}25.2 \times 10\text{--}18 \mu$.

6. *Thekopsora areolata* (p. 297)

On Ericaceae.

Ostiolar cells of peridia of uredosori ovate, oblong or clavate, comparatively large, $32\text{--}44 \times 10\text{--}18 \mu$. On *Leucothoe*.

7. *Thekopsora hakkodensis* (p. 305)

Ostiolar cells of peridia of uredosori ellipsoidal, ovate or oblong, comparatively small, $20\text{--}35 \times 7.2\text{--}15 \mu$. On *Azalea*, *Gaylussacia*, *Menziesia*, *Polycodium*, *Rhodora*, *Vaccinium* and *Xolisma*.

8. *Thekopsora Myrtillina* (p. 306)

On Borraginaceae (*Anchusa*, *Brachybotrys*, *Myosotis* and *Trigonotis*).

Uredospores subglobose, ovate or ellipsoidal, $17\text{--}22.5 \times 13\text{--}20 \mu$.

9. *Thekopsora Brachybotrydis* (p. 316)

On Rubiaceae.

Uredospores subglobose, ovate or ellipsoidal, comparatively large, $18\text{--}27 \times 12\text{--}18 \mu$. On *Rubia*.

10. *Thekopsora Rubiae* (p. 317)

Uredospores subglobose, ovate or ellipsoidal, comparatively small, $13.5\text{--}24 \times 10\text{--}17.5 \mu$. On *Asperula*, *Galium* and *Sherardia*.

11. *Thekopsora guttata* (p. 320)

Teleutospores still unknown.

Ostiolar cells of peridia of uredosori echinulate-verrucose at the apex. On Ericaceae (*Gaultheria*).

Uredospores subglobose, ellipsoidal, ovate or oblong, $18\text{--}32 \times 12\text{--}18 \mu$.

12. *Thekopsora Gaultheriae* (p. 324)

Ostiolar cells of peridia of uredosori smooth.

On Ericaceae.

Uredospores subglobose, ellipsoidal or broadly obovate, comparatively large, $18\text{--}28.8 \times 14.4\text{--}19.8 \mu$. On *Vaccinium*.

13. *Thekopsora Vacciniorum* (p. 325)

Uredospores ovate or globose, comparatively small, $15\text{--}25 \times 12\text{--}17 \mu$. On *Calluna* and *Erica*.

14. *Thekopsora Fischeri* (p. 327)

On Compositae (*Aster* and *Heteropappo*).

Uredospores globose, ellipsoidal or obovate, $17.5\text{--}25 \times 15\text{--}20 \mu$.

15. *Thekopsora Asteridis* (p. 328)

1. *Thekopsora sparsa* (WINT.) MAGNUS in DALLA TORRE & SARNTH., Fl. Tirol, III, p. 118, 1905; HIRATSUKA, f. in Jour. Facul. Agric. Hokkaidô Imp. Univ. XXI, p. 24, 1927; Bot. Mag. Tokyo, XLIII, p. 19, 1929; MIGULA, Krypt.-Fl. III, 1, p. 470; P. & H. SYDOW, Monogr. Ured. III, p. 464.

Syn. *Melampsora sparsa* WINTER in Pilze Deutschl. I, p. 245, 1881; SACCARDO, Syll. Fung. VII, p. 593.

Uredo Arbuti DIETEL et HOLWAY in DIETEL in Bot. Gaz. XVIII, p. 256, 1893; SACCARDO, Syll. Fung. XI, p. 225.

Pucciniastrum Arbuti DIETEL et HOLWAY in DIETEL in ENGLER-PRANTL, Natürl. Pflanzenfam. I, 1. Abt.**, p. 47, 1897.

Pucciniastrum sparsum FISCHER, Ured. Schw. p. 469, 1904; ARTHUR in N. Amer. Fl. VII, p. 108 & 678; Manual of the rusts in United States and Canada, p. 17; HARIOT, Ured. p. 249; LIRO, Ured. Fenn. p. 520.

Uredo Copelandi P. et H. SYDOW in Ann. Myc. II, p. 31, 1904; SACCARDO, Syll. Fung. XVII, p. 443.

Pucciniastrum sparsum MAGNUS in TROTTER, Fl. Ital. Crypt. Ured. p. 385, 1914.

Thekopsora sparsa FISCHER in KLEBAHN in Kryptogamenfl. Mark Brandenbr. Va, p. 844, 1914; FRAGOSO, Fl. Ibér. Ured. II, p. 269.

Icon. ARTHUR, Manual of the rusts in United States and Canada, fig. 27; FISCHER, Ured. Schw. fig. 306; Mitteil. Naturforsch. Ges. Bern, (1916), p. 132, fig. 1, 1916; FRAGOSO, l. c. fig. 133; GREBELSKY in Centralbl. f. Bakt. II. Abt. XLIII, p. 649, text-fig., 1915; MIGULA, l. c. pl. X, D, fig. 1~3; P. & H. SYDOW, Monogr. Ured. III, pl. XX, fig. 162.

Spermogonia on needles of current season, amphigenous, somewhat conical or applanate, inconspicuous, small, $0.07\text{--}0.1$ mm in diameter, about 35μ high.

Aecidia on needles of current season, hypophyllous, on slightly discoloured spots, cylindrical, apically dehiscent in somewhat lid-like manner; peridia delicate, colourless; peridial cells in face view irregularly polygonal, in side view rhomboidal, slightly overlapping, outer walls very thin, smooth, inner ones rather thick, $4\text{--}6.5 \mu$ thick, finely verrucose; aecidiospores globose or broadly ellipsoidal, $21\text{--}32 \times 18\text{--}25 \mu$; epispore colourless, thin, about 1μ thick, finely verrucose except a small spot on one side.

Uredosori amphigenous, subepidermal, scattered or grouped, minute, round, $0.2\text{--}0.5$ mm in diameter, long covered by the epidermis, yellow to yellowish brown in colour; peridia hemispherical, firm; peridial cells rather large, elongated vertically, gradually thickened below toward the orifice, smooth; ostiolar cells larger, 32.4

~ 51 μ high, coarsely to finely echinulate at the apex, greatly thickened below; uredospores ellipsoidal, oblong or clavate-oblong, 28.8~50.4 \times 13.5~22.5 μ ; epispore thin, 1.2~2 μ thick, sparsely echinulate, colourless; contents orange-yellow in colour when fresh.

Teleutosori amphigenous, mostly epiphyllous, limited by nerves, brownish black to black in colour; teleutospores within the epidermal cells, singly or loosely grouped, globose, subglobose, ellipsoidal or oblong-prismatic, divided vertically into 2~5 cells (generally 4), 24~36 μ high, 18~38 μ wide; epispore thin, 1.2~2 μ thick, cinnamon-brown, darker and much thicker at the apex (up to 7 μ), smooth. (Plate X, fig. 1, 2 & 5)

Hosts and Distribution

FOR THE AECIDIAL STAGE:

Picea excelsa LINK (ARTHUR 1925, p. 678; 1934, p. 17; FISCHER 1916a, p. 132)—Switzerland (*cultures*).

FOR THE UREDO- AND TELEUTOSTAGE:

Arbutus densiflora H. B. K. (ARTHUR 1907, p. 108; SEYMOUR 1929, p. 552; P. & H. SYDOW 1915, p. 465)—Oaxaca.

Arbutus macrophylla MART. (ARTHUR 1907, p. 108; P. & H. SYDOW 1915, p. 465)—Morelos.

Arbutus Menziesii PURSH (ARTHUR 1907, p. 108; 1927, p. 818; 1934, p. 18; BLASDALE 1919, p. 139; HOTSON 1925, p. 296; 1934, p. 64; JACKSON 1918b, p. 217; SEYMOUR 1929, p. 552; P. & H. SYDOW 1915, p. 465)—Oregon, Washington, California.

Arbutus sp. (ARTHUR 1918, p. 334)—Guatemala.

Arctostaphylos columbiana PIPER (HOTSON 1925, p. 296; SEYMOUR 1929, p. 552)—Washington.

Arctostaphylos Hookeri G. DON (ARTHUR 1925, p. 678; 1934, p. 18; SEYMOUR 1929, p. 552)—California.

Arctostaphylos Manzanita PARRY (ARTHUR 1907, p. 109; HOTSON 1934, p. 64; JACKSON 1918b, p. 217; SEYMOUR 1929, p. 552; P. & H. SYDOW 1915, p. 465)—Oregon.

Arctostaphylos nevadensis A. GRAY (ARTHUR 1907, p. 109; 1927, p. 818; 1934, p. 18; HOTSON 1934, p. 64; JACKSON 1918b, p. 217; SEYMOUR 1929, p. 553; P. & H. SYDOW 1904, p. 31; 1915, p. 465)—California, Oregon.

Arctostaphylos patula GREENE (ARTHUR 1907, p. 109; 1934, p. 18; BLASDALE 1919, p. 139; SEYMOUR 1929, p. 553; P. & H. SYDOW 1904, p. 31; 1915, p. 465)—California, Oregon.

Arctostaphylos uva-ursi SPRENG. (*A. officinalis* W. et GRAB.) (FISCHER 1912, p. 97; FRAGOSO 1925, p. 271; KLEBAHN 1914, p. 844; LIRO 1908, p. 521; P. & H. SYDOW 1915, p. 465; TROTTER 1914, p. 465)—Finland, Denmark, Germany, France, Italy, Norway.

Arctous alpina NIEDENZU (*Arbutus alpina* L., *Arctostaphylos alpina* SPRENG., *Mairania alpina* DESV.) (ARTHUR 1907, p. 109; 1927, p. 818; 1934, p. 18; BUBÁK & KABÁT 1915, p. 108; CRUCHET 1918, p. 5; FISCHER 1904, p. 469; FRAGOSO 1925, p. 271; GREBELSKY 1915, p. 646; HARIOT 1908, p. 249; JØRSTAD 1925, p. 87; 1935, p. 67; KLEBAHN 1914, p. 844; LIND 1934, p. 107; MAYOR 1919, p. 412; MIGULA 1910, p. 471; RAINIO 1926, p. 254; SEYMOUR 1929, p. 552; P. & H. SYDOW 1915, p. 465; TROTTER 1914, p. 385; WINTER 1881, p. 245)—Norway, Sweden, Finland, Italy, France, Switzerland; British Columbia, Quebec; Alaska.

Arctous japonicus NAKAI (*Arctous alpina* var. *japonica* TAKEDA, *Arctostaphylos alpina* var. *japonicus* HULT.) (HIRATSUKA, f. 1927a, p. 24; 1927c, p. 308; 1928a, p. 30; 1928c, p. 566; 1929a, p. 19; 1929d, p. 104; 1930a, p. 84; 1930c, p. 62; 1935g, p. 136, 161 & 213; TOGASHI & ÔNUMA 1934, p. 17)—Japan.

Exsiccati. FOR THE UREDO- AND TELEUTOSTAGE: BARTHOLOMEW, Fung. Columb. no. 3181; BARTHOLOMEW, N. Amer. Ured. no. 779 & 3279; RABENHORST, Fung. eur. no. 4042; P. & H. SYDOW, Ured. no. 998, 1796, 1797, 1894 & 1895; VESTERGREN, Micromyc. rar. sel. no. 859.

Habitat in Japan

On *Arctous japonicus* NAKAI (*Kuma-kokemomo*). *S. Saghalien*:—Motodomari (Mt. Tosso, Mt. Nupuripo). Tomarioro (Mt. Ushoro). *Hokkaidô*:—Ishikari (Mt. Kuro-dake). *Kuriles*:—Urap (Tokotan). Matsuwa (Miharashi-dai). *Honshû*:—Rikuchû (Mt. Hayachine). Shinano (Mt. Komagatake [Kiso]).

This species is one of the arctic and alpine species.

It was first described by WINTER in 1881, based upon a specimen on *Arctostaphylos alpina* (*Arctous alpina*) which was collected at Leistkamm (St. Gallen) in Switzerland, as a new species, under the name *Melampsora sparsa* WINT. It was transferred by MAGNUS in 1905 to the genus *Thekopsora*. In 1895, the uredostage on *Arbutus Menziesii* from California, North America was newly described by DIETEL and HOLWAY as a new species, *Uredo Arbuti* DIET. et HOLW. Nine years later, the uredostage on *Arctostaphylos patula* from

California was described by the SYDOWS as a new species, *Uredo Copelandi* P. et H. SYD. Later, *Uredo Arbuti* DIET. et HOLW. (*Pucciniastrum Arbuti* DIET. et HOLW.) and *Uredo Copelandi* P. et H. SYD. have been treated by the SYDOWS, ARTHUR and others as synonyms of *Thekopsora sparsa* MAGN. (*Pucciniastrum sparsum* FISCH.).

FISCHER was the first to show in 1916 that the aecidial stage of this species occurred on *Picea excelsa*. He used germinating teleutospores on *Arctostaphylos alpina* (*Arctous alpina*) and sowed on leaves of *Abies pectinata* (*A. alba*), *Larix decidua* and *Picea excelsa*, obtaining the development of spermogonia and peridermia on the last plant only.

The present species may be distinguished from other species of *Thekopsora*, by the peculiar shape of peridia in uredosori and the larger uredospores. The cells of the peridia in the uredosori are large and elongated vertically with the walls gradually thickened below toward the opening, and the ostiolar cells are larger (32.4~51 μ high), also greatly thickened below and coarsely echinulate above. In these characteristics of peridia in the uredosori, this fungus closely resembles *Pucciniastrum Pyrolae* (KARST.) SCHRÖT., but it differs from the latter in the position of teleutospores and the size of uredospores.

In this country, the present species was first recorded by the writer based upon a specimen on *Arctous japonicus* collected in the alpine region of Mt. Kuro-dake in the province of Ishikari in 1927. In the next year, the occurrence of this fungus was also reported by him in South Saghalien and the Kuriles. But these specimens bear only the uredospores. In 1930, the writer reported that its teleutospores on the same plant had been collected by G. YAMADA in 1907 at the top of Mt. Hayachine in the province of Rikuchū.

There are no species of *Picea*, however, in the vicinity where this fungus appears to be perennial on the teleuto-host, and field observations would also suggest that it may overwinter by means of uredogeneration. No culture work has been conducted in this country. The writer has not seen the aecidial stage and can only quote the description given by ARTHUR and FISCHER.

2. *Thekopsora Tripetaleiae* HIRATSUKA, f. in Jour. Facul. Agric. Hokkaidō Imp. Univ. XXI, p. 23, 1927; Bot. Mag. Tokyo, XLIII, p. 18, 1929.

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Syn. *Uredo Tripetaleiae* DIETEL in Ann. Myc. XII, p. 85, 1914; SACCARDO, Syll. Fung. XXIII, p. 926; P. & H. SYDOW, Monogr. Ured. IV, p. 440.

Uredosori hypophyllous, subepidermal, scattered or gregarious, often thickly scattered over the whole surface of the leaf, minute, round, 0.1~0.24 mm in diameter, yellow or yellowish brown in colour; peridia hemispherical, firm, dehiscent by an apical pore; upper peridial cells small, irregularly polygonal, 6~14 μ across, lateral ones radially elongated; walls of peridial cells thin, smooth, nearly colourless; ostiolar cells comparatively large, 18~30 μ high, coarsely and finely echinulate at the apex, thickened below; uredospores subglobose, ellipsoidal or oblong, 18~34.2 \times 12.5~17.5 μ ; epispore thin, 1~1.5 μ thick, densely echinulate, hyaline; contents orange-yellow when fresh.

Teleutosori mostly epiphyllous, rarely hypophyllous, minute, limited by nerves, yellowish brown to brownish black in colour; teleutospores intracellular, forming in the epidermal cells, globose, subglobose or oblong, divided vertically into 2~5 cells (generally 4), 12.5~20 μ broad, 16.2~20 μ high; epispore uniformly thin, 1~1.5 μ thick, yellow to pale yellowish brown in colour, smooth.

Hosts and Distribution

FOR THE UREDO- AND TELEUTOSTAGE:

Tripetaleia bracteata MAXIM. (DIETEL 1914, p. 85; HIRATSUKA, f. 1927a, p. 23; 1927c, p. 308; 1929a, p. 18; 1933a, p. 151; 1935g, p. 136, 144, 161 & 213; ITÔ & HIRATSUKA, f. 1927, p. 269; P. & H. SYDOW 1924, p. 440; TOGASHI & ÔNUMA 1934, p. 18)—Japan.

Tripetaleia paniculata SIEB. et ZUCC. (HIRATSUKA, f. 1927a, p. 23; 1927c, p. 308; 1929a, p. 18; 1930d, p. 331; 1932b, p. 41; 1935g, p. 144 & 213; TOGASHI & ÔNUMA 1934, p. 18)—Japan.

Habitat in Japan

On *Tripetaleia bracteata* MAXIM. (*Miyama-hotsutsuji*). Hokkaidô:—Oshima (Ônuma, Mt. Komagatake). Ishikari (Mt. Kuro-dake). Honshû:—Mutsu (Mt. Hakkôda, Mt. Iwaki). Rikuchū (Mt. Yakeishi-dake, Mt. Hayachine, Mt. Iwate, Mt. Sukawa-dake). Ugo (Mt. Komagatake). Shimotsuke (Mt. Shirane). Suruga (Mt. Fuji). Shinano (Mt. Komagatake [Kiso]).

On *Tripetaleia paniculata* SIEB. et ZUCC. (*Hotsutsuji*). Hokkaidô:—Hidaka (Samani-sandô). Honshû:—Rikuchū (Mt. Iwate, Mt. Hayachine, Mt. Yakeishi-dake, Nanshōzan). Kaga (Yamanaka-

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machi). Tango (Yoshidzu-mura). Inaba (Mt. Hyōnosen). Hōki (Mt. Daisen).

The first reference to the present fungus was made by DIETEL in 1914, under the name *Uredo Tripetaleiae* DIET. based upon uredo-material on *Tripetaleia bracteata* collected by K. TAMURA in Mt. Fuji, Suruga Province, Japan. Later, in 1927, the writer found its uredo- and teleutostages on a specimen of *Tripetaleia bracteata* which was collected by himself at Ōnuma in the province of Oshima, and he transferred it to the genus *Thekopsora* naming it *Thekopsora Tripetaleiae* HIRATS. f.

The geographical distribution of the present species, so far as available specimens show, is peculiarly limited to Hokkaidō and Honshū in Japan.

It is very rare to find the teleutospores of this fungus, most of the specimens the writer has examined being in the uredostage. From field observations made by the writer, it is evident that this species overwinters in the uredostage in the middle part of Japan. No culture work of the present species has been conducted.

3. *Thekopsora Menziesiae* HIRATSUKA, f. in Jour. Facul. Agric. Hokkaidō Imp. Univ. XXI, p. 22, 1927; Bot. Mag. Tokyo, XLIII, p. 18, 1929.

Uredosori hypophyllous, subepidermal, scattered or loosely grouped, sometimes thickly scattered over the whole surface of the leaf, minute, round, 0.1~0.15 mm across, brownish yellow in colour; peridia conical, firm; upper peridial cells small, irregularly polygonal, 8~15 μ across, lateral ones radially elongate, with smooth, thin, colourless walls, somewhat overlapping; ostiolar cells comparatively large, 18~30 μ high, finely echinulate above, greatly thickened below; uredospores ovate, ellipsoidal or oblong, 16~28.8 \times 9~14.4 μ ; epispore rather thin, 1~1.5 μ thick, minutely echinulate, colourless.

Teleutosori amphigenous, mostly epiphyllous, minute, limited by nerves, reddish brown in colour; teleutospores within the epidermal cells, solitary or irregularly grouped, globose, subglobose or oblong-prismatic, divided into 4~6 cells (generally 4) by longitudinal or oblique septa, 12.6~21.6 μ wide, 18~21.6 μ high; epispore thin, 1~1.5 μ , slightly thicker at the apex, smooth, yellow to pale brownish yellow in colour; germ pores conspicuous. (Plate X, fig. 4)

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Hosts and Distribution

FOR THE UREDO- AND TELEUTOSTAGE:

Menziesia cilicalyx MAXIM. var.—Japan.

Menziesia pentandra MAXIM. (HIRATSUKA, f. 1927a, p. 22; 1927b, p. 236; 1927c, p. 308; 1929a, p. 18; 1933a, p. 151; ITÔ & HIRATSUKA, f. 1927, p. 269; TOGASHI & ŌNUMA 1934, p. 17)—Japan.

Habitat in Japan

On *Menziesia cilicalyx* MAXIM. var. *multiflora* MAK. (*Urajiro-yōraku*). Honshū:—Shinano: Mt. Tsubakuro-dake (HIRATSUKA, f.).

On *Menziesia pentandra* MAXIM. (*Ko-yōraku*). Hokkaidō:—Shiribeshi (Inaho-tōge, Raiden-tōge). Ishikari (Mt. Teine, Jōzankei, Mt. Sapporo-dake, Mt. Kuro-dake). Kushiro (Mt. Oakan-dake, Mt. Meakan-dake). Honshū:—Mutsu (Mt. Hakkōda). Rikuchū (Mt. Iwate, Mt. Hayachine). Shimotsuke (Nikkō-Yumoto). Shinano (Mt. Tsubakuro-dake, Mt. Komagatake [Kiso], Mt. Yatsugatake).

This species was first described by the writer in 1927 from a specimen on *Menziesia pentandra* collected by himself in Mt. Meakan-dake, province of Kushiro as its type specimen. He also recorded that it was found in other places of Hokkaidō and northern Honshū.

The present fungus is closely allied to *Thekopsora Tripetaleiae* HIRATS. f., and can be easily distinguished from it by the shape and size of the uredospores as well as the characters of the teleutospores. The uredospores of this species are smaller, measuring 16~28.8 \times 9~14.4 μ in size, while those of *Thekopsora Tripetaleiae* measure 18~34.2 \times 12.5~17.5 μ . Moreover, the teleutospores of the former species are somewhat larger, 4~6 celled (mostly 4), and their epispore is somewhat thickened at the apex, while those of the latter species are smaller, 2~4 celled, and their epispore is uniformly thin.

This species has not previously been recorded on *Menziesia cilicalyx* MAXIM. var. *multiflora* MAK. so far as the writer is aware. The aecidial connection of this species has not been demonstrated by cultures.

4. *Thekopsora Hydrangeae* (FARL.) MAGNUS in VESTERGREN, Micromyc. rar. sel. no. 571, 1902; P. & H. SYDOW, Monogr. Ured. III, p. 468.

Syn. *Uredo Hydrangeae* BERKELEY et CURTIS in Bot. Gaz. IX, p. 191, 1884; SACCARDO, Syll. Fung. VII, p. 850.

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Melampsora Hydrangeae FARLOW in Host Index N. Amer. Fung. p. 200, 1891.

Coleosporium Hydrangeae SNYDER in Proc. Indiana Acad. Sci. (1896), p. 218, 1897.

Pucciniastrum Hydrangeae ARTHUR in Résult. Sci. Congr. Internat. Bot. Vienne (1905), p. 337, 1906; N. Amer. Fl. VII, p. 106 & 676; Manual of the rusts in United States and Canada, p. 17.

Peridermium Hydrangeae ADAMS in Mycologia, XII, p. 34, 1920; P. & H. SYDOW, Monogr. Ured. IV, p. 20.

Icon. ADAMS in Bull. Pennsylvania Exper. Stat. no. 160, fig. 9 (c), 1919; ARTHUR, Manual of the rusts in United States and Canada, fig. 26; DODGE in Jour. Agric. Res. XXIV, pl. V, fig. H, I, J & K, 1923.

Spermogonia on needles of current season, chiefly hypophyllous, inconspicuous, flattened-hemispherical, 75~140 μ across, 20~32 μ high.

Aecidia on needles of current season, hypophyllous, in two rows, cylindrical, 0.16~0.22 mm in diameter, 1~1.5 mm high; peridia colourless, fragile, the margin erose; peridial cells in face view angularly oblong, in side view linear-oblong, 38~48 \times 15~20 μ , slightly overlapping, outer walls very thin, smooth or finely verrucose, inner ones thicker, about 2 μ , evenly and prominently verrucose; aecidiospores broadly ellipsoidal or ovate, 18~26 \times 14~20 μ ; epispore colourless, finely verrucose, except an elongate smooth spot on one side, thin, about 1 μ thick on smooth side, slightly thicker on opposite side.

Uredosori hypophyllous, subepidermal, scattered or in irregular groups on discoloured areas, round, small, 0.1~0.21 mm across, dark-yellow fading to pale yellow in colour, ruptured epidermis inconspicuous; peridia hemispherical, delicate, firm, dehiscent from a central pore; peridial cells small, irregularly polygonal, 7~16 μ across, walls uniformly thin, 1~1.8 μ thick; ostiolar cells slightly or not elongated, 10~18 μ across, walls thin, smooth, nearly colourless; uredospores broadly ellipsoidal or obovate, 16~25 \times 12~20 μ ; epispore nearly colourless, thin, 1~1.5 μ thick, sparsely and strongly echinulate.

Teleutosori amphigenous or chiefly epiphyllous, effused or confluent into small angular groups, 0.2~0.8 mm across, not raised, reddish brown to brownish black in colour; teleutospores intracellular, within the epidermal cells, globose, subglobose or ellipsoidal, occa-

sionally somewhat polygonal, 2~4 celled (generally 4), with vertical septa, 21~28 μ across; epispore thin, 1.2~2 μ thick, slightly thicker at the apex, smooth, dark cinnamon-brown in colour. (Plate X, fig. 3)

Hosts and Distribution

FOR THE AECIDIAL STAGE:

Tsuga canadensis CARR. (ADAMS 1919, p. 20; 1920, p. 35; ARTHUR 1925, p. 676; 1934, p. 17; KERN, THURSTON Jr., ORTON & ADAMS 1929, p. 7; SEYMOUR 1929, p. 7; P. & H. SYDOW 1923, p. 20)—Pennsylvania, Indiana, Tennessee, West Virginia.

Tsuga caroliniana ENGELM. (ARTHUR 1934, p. 17)—North Carolina.

FOR THE UREDO- AND TELEUTOSTAGE:

Hydrangea arborescens L. & var. (ADAMS 1919, p. 19; 1920, p. 33; ARTHUR 1907, p. 106; 1927, p. 818; 1934, p. 17; KERN, THURSTON Jr., ORTON & ADAMS 1929, p. 7; PATTERSON 1902, p. 9; SEYMOUR 1929, p. 347; P. & H. SYDOW 1915, p. 468)—Arkansas, District of Columbia, Illinois, Indiana, Kentucky, Maryland, Ohio, Tennessee, North Carolina, Virginia, West Virginia, Pennsylvania.

Hydrangea paniculata SIEB. (KERN, THURSTON Jr., ORTON & ADAMS 1929, p. 7)—Pennsylvania.

Exsiccati. FOR THE UREDO- AND TELEUTOSTAGE: BARTHOLOMEW, Fung. Columb. no. 2868; BARTHOLOMEW, N. Amer. Ured. no. 76, 2378 & 2875; ELLIS & EVERHART, N. Amer. Fung. no. 1884; RABENHORST, Fung. eur. no. 3631; SEYMOUR & EARLE, Econ. Fung. no. 206; VESTERGRÉN, Micromyc. rar. sel. no. 571.

The uredostage of the present fungus was first described by BERKELEY and CURTIS in 1884 as *Uredo Hydrangeae* BERK. et CURT. taking the type specimen on *Hydrangea arborescens* which was collected at Cobden, Illinois in North America. It was transferred by FARLOW in 1891 to the genus *Melampsora*, and eleven years later, it was first treated by MAGNUS as a species of *Thekopsora*.

This species is widely distributed in the United States of America, but it has not been recorded from other countries, so far as the writer is aware.

The genetic connection of this fungus was first established by ADAMS (1919), who succeeded in obtaining uredosori on *Hydrangea arborescens* var. *grandiflora* inoculating with the aecidiospores on *Tsuga canadensis*. The writer has not seen the aecidial stage and can only quote the description given by ADAMS and ARTHUR.

ARTHUR stated that the teleutospores of this fungus are sometimes formed between the epidermis and mesophyll, in North American Flora, VII, p. 106, 1907, but, such an occurrence seems very rare. It has not been observed by the writer, although a careful examination of some American materials was made.

5. *Thekopsora pseudo-Cerasi* HIRATSUKA, f. in Jour. Facul. Agric. Hokkaidô Imp. Univ. XXI, p. 16, 1927; Bot. Mag. Tokyo, XLIII, p. 20, 1929.

Uredosori hypophyllous, scattered or in small groups on yellowish brown coloured spots, minute, round, oblong or irregular-shaped, 0.1~0.4 mm across, covered by the epidermis, then open from a central pore, yellowish brown in colour; peridia hemispherical, firm; peridial cells minute, isodiametrically to irregularly polygonal, 6~16 μ across, walls rather thin, smooth, nearly colourless; ostiolar cells comparatively large, rounded, with thicker, smooth walls; uredospores ovate, ellipsoidal or oblong, 19.8~30.6 \times 12.6~18 μ ; epispore thin, 1.2~1.5 μ thick, finely echinulate, colourless.

Teleutosori amphigenous, mostly epiphyllous, minute, limited by the nerves, formed in crusts, purplish brown to chestnut brown in colour; teleutospores within the epidermal cells, globose, ovate to oblong, divided into 2~4 cells (generally 4), 23.4~28.8 μ high, 16.2~27 μ wide; epispore thin, 1~1.5 μ thick, yellow or pale yellowish brown in colour, smooth.

Hosts and Distribution

FOR THE UREDO- AND TELEUTOSTAGE:

Prunus Cerasus L. (HIRATSUKA, f. 1927a, p. 16; 1927c, p. 310; 1929a, p. 20)—Japan, Maritime Province of Siberia.

Prunus serrulata LINDL. var. (HIRATSUKA, f. 1927a, p. 16; 1927c, p. 310; 1929a, p. 21)—Japan.

Habitat in Japan

On *Prunus Cerasus* L. (*Seiyô-mizakura*) (cultivated). Hokkaidô:—Ishikari (Sapporo, Maruyama near Sapporo, Kotoni, Jôzan-kei, Shiroishi-mura).

On *Prunus serrulata* LINDL. var. *sachalinensis* MAK. (*Yezoyamazakura*). Hokkaidô:—Ishikari (Sapporo).

About forty years ago, Naoharu HIRATSUKA regarded this species as a new one, distinguishing it from *Thekopsora areolata* (FR.) MAGN. by the larger uredo- and teleutospores. He described it in

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his graduation thesis of Sapporo Agricultural College (1896), but this description had not been reported in any form until the writer published it as *Thekopsora pseudo-Cerasi* HIRATS. f. in 1927.

Through the kindness of Dr. TRANZSCHEL of Leningrad, the writer received a specimen of this fungus on *Prunus Cerasus* which was collected by TRANZSCHEL at Okeanskaja near Vladivostok, Maritime Province of Siberia in September 1929.

No culture work of the present fungus has been conducted.

6. *Thekopsora areolata* (FR.) MAGNUS in Sitzungsber. d. Ges. Nat. Freunde zu Berlin (1875), p. 58, 1875; Hedwigia, XIV, p. 123, 1875; Bot. Zeitg. (1875), p. 504, 1875; DIETEL in ENGLER-PRANTL, Natürl. Pflanzenfam. II. Aufl. VI, p. 39, 1928; FRAGOSO, Fl. Ibér. Ured. II, p. 265; HIRATSUKA, f. in Jour. Facul. Agric. Hokkaidô Imp. Univ. XXI, p. 14, 1927; Bot. Mag. Tokyo, XLIII, p. 19, 1929; KARSTEN, Myc. Fenn. IV, p. 58; KLEBAHN in Kryptogamenfl. Mark Brandenbr. Va, p. 836; OUDEMANS, Rév. Champ. I, p. 577; SACCARDO, Syll. Fung. VII, p. 764; P. & H. SYDOW, Monogr. Ured. III, p. 459.

Syn. *Licea strobilina* ALBERTINI et SCHWEINITZ, Consp. Fung. Nisk. p. 109, 1805; de CANDOLLE in Fl. franç. VI, p. 100; WALLROTH, Fl. Crypt. Germ. II, p. 343.

Perichaena strobilina FRIES, Symb. Gasteromyc. p. 11, 1817; Syst. Myc. III, p. 190.

Uredo Padi KUNZE et SCHMIDT, Crypt. exsicc. no. 187, 1817; COOKE, Handb. Brit. Fung. p. 527, 1871.

Sclerotium areolatum FRIES, Syst. Myc. II, p. 263, 1822.

Phelonites strobilina FRIES, Sum. veg. Scand. II, p. 459, 1849.

Melampsora areolatum FRIES, Sum. veg. Scand. II, p. 482, 1849.

Pomatomyces strobilina OERSTED in Vid. Medd. f. Naturh. For. Kjobenhavn (1863), p. 249, 1863.

Pucciniastrum areolatum OTTH in WARTMANN & SCHENK, Schw. Krypt. no. 521, 1863; TROTTER, Fl. Ital. Crypt. Ured. p. 386.

Aecidium strobilinum REESS in Abhandl. Naturf. Ges. Halle, XI, p. 105, 1869; KARSTEN, Myc. Fenn. IV, p. 45; OUDEMANS, Rév. Champ. I, p. 582; PLOWRIGHT, Monogr. Ured. & Ustil. p. 266; SACCARDO, Syll. Fung. VII, p. 824; SCHRÖTER, Pilze Schles. I, p. 381; WINTER in Pilze Deutschl. I, p. 260.

Pleosporopsis strobilina OERSTED, Syst. d. Pilze, p. 55, 1873; SACCARDO, Syll. Fung. III, p. 693.

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Melampsora Padi WINTER in Pilze Deutschl. I, p. 244, 1881; SCHRÖTER, Pilze Schles. I, p. 365.

Melampsora Padi PLOWRIGHT, Monogr. Ured. & Ustil. p. 246, 1889.

Pucciniastrum Padi DIETEL in ENGLER-PRANTL, Natürl. Pflanzenfam. I, 1. Abt.**, p. 47, 1897; FISCHER, Ured. Schw. p. 463; HARIOT, Ured. p. 252; LIRO, Ured. Fenn. p. 503.

Thekopsora Padi KLEBAHN in PRINGSH. Jahrb. Wiss. Bot. XXXIV, p. 378, 1900; XXXV, p. 696, 1901.

Pucciniastrum strobilinum LIRO, Ured. Fenn. p. 503, 1908.

Thekopsora Padi BUBÁK, Rostpilze Böhmens, p. 187, 1908; MIGULA, Krypt.-Fl. III, 1. p. 469.

Thekopsora Padi GROVE, Brit. Rust Fungi, p. 368, 1913.

Thekopsora strobilina JØRSTAD in Medd. f. norske Skogforsøksvesen, VI, p. 82, 1925.

Icon. ALBERTINI & SCHWEINITZ, l. c. pl. VI, fig. 3; BRIOSI & CAVARA, Fung. parass. no. 409; BUBÁK, l. c. fig. 45; COOKE, Handb. Brit. fung. fig. 141; CORDA, Icon. fung. V, pl. III, fig. 30; DIETEL in ENGLER-PRANTL, Natürl. Pflanzenfam. I, 1. Abt.**, fig. 53 (C, D); II. Aufl. VI, fig. 29 (D, E); FISCHER, l. c. fig. 303; FRAGOSO, l. c. fig. 131; GROVE, l. c. fig. 276; HARTIG, Lehrb. Pflanzenkr. fig. 143 & 144, 1900; KLEBAHN in PRINGSH. Jahrb. Wiss. Bot. XXXV, p. 696, fig. V; p. 697, fig. VI; p. 698, fig. VII, 1901; Zeitschr. f. Pflanzenkr. XVII, p. 151, fig. 4; p. 152, fig. 5, 1907; Kryptogamenfl. Mark Brandenbr. Va, p. 842, fig. S, 1 (I~XIII); LINHART, Fung. hung. no. 8; LIRO, l. c. fig. 12; MIGULA, l. c. pl. XC, fig. 3 & 4; NEES, Syst., pl. VIII, fig. 101; NEGER, Krankh. Waldb. fig. 181 & 182, 1919; REESS, l. c. pl. II, fig. 7~10; ROSTRUP, Plantepat. fig. 121~123, 1902; SAPPIN-TROUFFY in Le Botaniste, V, p. 174, fig. 58; p. 175, fig. 59, 1896; TROTTER, l. c. fig. 96; TUBEUF in Arb. d. Biol. Abt. f. Land- u. Forstw. d. K. Gesundh. II, p. 164~166, text-figs. 1~4, 1901.

Spermogonia gregarious, subcuticular, flattened.

Aecidia crowded, covering the upper side of the lower part of the scales of fallen cones, rarely on the under side of the scales, subepidermal, hemispherical or polygonal, 0.8~1.2 mm across, 0.8~1 mm high, reddish brown to dark brown in colour; peridia firm; peridial cells small, irregularly polygonal, 25~38 × 18~27 μ, yellowish brown in colour; outer walls greatly thickened, 10~22 μ thick, smooth, inner ones rather thin, 2~3 μ thick, verrucose; aecidiospores

globose, ovate or ellipsoidal, somewhat angular, 20~30 × 15~22 μ; epispore rather thick (up to 6 μ), verrucose, with a narrow, thin, smooth stripe.

Uredosori hypophyllous, subepidermal, scattered or gregarious, on violet or reddish brown coloured angular spots, minute, round or oblong, 0.08~0.4 mm across, often somewhat pulverulent, orange-yellow in colour; peridia hemispherical, delicate; peridial cells small, isodiametrically to irregularly polygonal, 7~15 μ across, walls thin, smooth, colourless, inner walls gradually thickened toward the ostiole; ostiolar cells comparatively large, oblong, up to 21 μ high, smooth, nearly colourless; uredospores globose, subglobose, ellipsoidal or ovate, 14.4~25.2 × 10~18 μ; epispore colourless, finely echinulate, thin, 1~1.8 μ thick.

Teleutosori amphigenous, mostly epiphyllous, intracellular, limited by the nerves, at last forming dark brown to blackish brown discoloration on the surface of the leaf; teleutospores formed in the epidermal cells, globose, subglobose or ovate, somewhat polygonal, divided into 2~5 cells (generally 4) by longitudinal or oblique septa, 16.2~23.4 μ high, 13.5~27 μ across; epispore thin, 0.8~1.2 μ thick, smooth, yellowish brown, darker and generally slightly thicker at the apex (2~3 μ). (Plate XI, fig. 1)

Hosts and Distribution

FOR THE AECIDIAL STAGE:

Picea excelsa LINK (*Abies excelsa* POIR.) (BUBÁK 1908, p. 188; CONSTANTINEANU 1920, p. 443; CRUCHET 1918, p. 6; DIETEL 1928, p. 39; FISCHER 1904, p. 465; FRAGOSO 1925, p. 267; GOBI & TRANZSCHEL 1891, p. 115; GROVE 1913, p. 369; JAAP 1906, p. 123; 1908, p. 201; 1914a, p. 19; JØRSTAD 1921, p. 16; 1923b, p. 19; 1925, p. 83; 1935, p. 66; KARSTEN 1879, p. 46; KLEBAHN 1914, p. 839; LAUBERT 1927, p. 48; LIND 1913, p. 294; LIRO 1908, p. 505; MAYOR 1927, p. 68; 1930b, p. 179; MIGULA 1910, p. 469; NIESSL 1864, p. 109; PICBAUER 1927, p. 439; PLOWRIGHT 1889, p. 246; POEVERLEIN 1926, p. [41]; POEVERLEIN & BERTSCH 1927, p. 196; SCHRÖTER 1887, p. 381; SIEMASZKO 1923b, p. 15; P. & H. SYDOW 1915, p. 461; TRANZSCHEL 1900, p. 190; TROTTER 1914, p. 387; WILSON 1934, p. 429)—Norway, Finland, Denmark, Germany, Great Britain, Switzerland, Austria, Rumania, France, Poland, Russia.

Picea jezoensis CARR. (*P. ajanensis* FISCH.) (JØRSTAD 1934, p. 23; TRANZSCHEL 1914, p. 554)—Kamtchatka.

Picea obovata LEDEB. (FRAGOSO 1925, p. 267; LIRO 1908, p. 505; MURASHKINSKY & SIELING 1928, p. [10]; P. & H. SYDOW 1915, p. 461)—Finland, Siberia.

FOR THE UREDO- AND TELEUTOSTAGE:

Prunus avium L. (JØRSTAD 1925, p. 85; 1935, p. 66; MAYOR 1924, p. 387)—Norway, Switzerland.

Prunus Cerasus L. (JØRSTAD 1925, p. 85)—Norway.

Prunus domestica L. (JØRSTAD 1925, p. 85; 1935, p. 66)—Norway.

Prunus Padus L. & var. (*Padus racemosa* LAM.) (BUBÁK 1898, p. 18; 1899, p. 20; 1908, p. 188; BUBÁK & KABÁT 1906, p. [5]; COOKE 1871, p. 527; DIETEL 1890, p. 48; 1928, p. 39; ELIASSON 1897, p. 6; FISCHER 1904, p. 465; FRAGOSO 1925, p. 267; GOBI & TRANZSCHEL 1891, p. 105; GROVE 1913, p. 369; HARIOT 1908, p. 252; HIRATSUKA, f. 1927a, p. 15; 1927c, p. 15; 1927c, p. 309; 1929a, p. 20; JAAP 1900, p. 265; 1906, p. 123; 1907a, p. 263; 1908, p. 201; JØRSTAD 1921, p. 16; 1923b, p. 19; 1925, p. 84; 1934, p. 23; 1935, p. 66; KARSTEN 1879, p. 58; KLEBAHN 1914, p. 839; LAUBERT 1921, p. 241; 1927, p. 49; LIND 1913, p. 294; LIRO 1908, p. 505; MAGNUS 1890, p. 30; 1892a, p. 3; 1894, p. 54; MAYOR 1919, p. 412; MIGULA 1910, p. 469; NISSL 1864, p. 105; OUDEMANS 1892, p. 577; PETRAK 1927, p. 346; PICBAUER 1927, p. 439; 1931, p. 11; 1933a, p. 6; PLOWRIGHT 1889, p. 246; POEVERLEIN 1926, p. [41]; POTEBNIA 1910, p. 43; SCHRÖTER 1887, p. 365; SIEMASZKO 1923a, p. 23; 1923b, p. 15; P. & H. SYDOW 1913, p. 110; 1915, p. 461 THÜMEN 1878, p. 226; 1880a, p. 87; TRANZSCHEL 1890, p. 133; 1900, p. 189; TROTTER 1914, p. 387; VOSS 1876, p. 112; 1889, p. 339; WILSON 1934, p. 429; WINTER 1881, p. 245)—Norway, Sweden, Denmark, Finland, Germany, Switzerland, Italy, Holland, France, Belgium, Great Britain, Czechoslovakia, Poland, Caucasus; Japan, North Saghalien, Kamtchatka.

Prunus serotina EHRH. (DIETEL 1928, p. 39; P. & H. SYDOW 1915, p. 461)—Germany.

Prunus Ssiori Fr. SCHM. (HIRATSUKA, f. 1927a, p. 15; 1927b, p. 235; 1927c, p. 309; 1928a, p. 31; 1929a, p. 20; 1930a, p. 85)—Japan.

Prunus virginiana L. (*Padus virginiana* ROEM.) (DIETEL 1928, p. 39; FISCHER 1904, p. 465; JØRSTAD 1925, p. 85; LIRO 1908, p. 506; MIGULA 1910, p. 469; P. & H. SYDOW 1915, p. 461; WINTER 1881, p. 245)—Finland, Germany, Switzerland.

Prunus sp. (FISCHER 1904, p. 465)—Switzerland.

Prunus sp. (KERN, CIFERRI & THURSTON Jr., 1933, p. 23)—West Indies.

Exsiccati. FOR THE AECIDIAL STAGE: BERKELEY, Fung. brit. no. 292; COOKE, Fung. brit. I, no. 522; FÜCKEL, Fung. rhen. no. 1469; LINHART, Fung. hung. no. 45; MAIRE, Exs. Hypod. no. 40; MOUGEOT & NESTLER, Stirp. vog. no. 579; OUDEMANS, Fung. neerl. no. 263; PETRAK, Fl. Bohem. no. 347 (a); RABENHORST, Fung. eur. no. 1883; RABENHORST, Herb. myc. no. 245 & 646; SIEMASZKO, Fung. Bialowienses, no. 55 (a); P. & H. SYDOW, Myc. march. no. 2500; P. & H. SYDOW, Myc. germ. no. 1863 & 2288; P. & H. SYDOW, Ured. no. 246 & 2641; THÜMEN, Fung. austr. no. 956; THÜMEN, Myc. univ. no. 940; Krypt. exs. Vindob. no. 934 (a); Schweiz. Crypt. no. 717. FOR THE UREDO- AND TELEUTOSTAGE: BRIOSI & CAVARA, Fung. parass. no. 409; COOKE, Fung. brit. I, no. 536; JACZEWSKI, KOMAROV & TRANZSCHEL, Fung. Ross. no. 172; KARSTEN, Fung. fenn. no. 100; KRIEGER, Fung. saxon. no. 267; PETRAK, Fl. Bohem. no. 347 (b); RABENHORST, Fung. eur. no. 786 & 2621; D. SACCARDO, Myc. ital. no. 925; SCHMIDT & KUNZE, Crypt., no. 187; SCHNEIDER, Herb. no. 723 & 724; SCHRÖTER, Pilze Schles. no. 557; SIEMASZKO, Fung. Bialowienses, no. 55 (b); P. & H. SYDOW, Myc. germ. no. 160, 1992 & 2092; P. & H. SYDOW, Myc. march. no. 129; P. & H. SYDOW, Ured. no. 238, 1045, 1992, 2293, 2828 & 2829; THÜMEN, Fung. austr. no. 105, 226 & 657; THÜMEN, Myc. univ. no. 1536; VIZE, Fung. brit. no. 146; Krypt. exs. Vindob. no. 934 (b); Schweiz. Crypt. no. 521.

Habitat in Japan

On *Prunus Padus* L. (*Yezo-no-uwamidzuzakura*). Hokkaidô:—Ishikari (Sapporo, Maruyama near Sapporo, Jōzankei). Kushiro (Lake-side of Kutcharo-ko).

On *Prunus Ssiori* Fr. SCHM. (*Shūri-zakura*). S. Saghalien:—Ōdomari (Kaidzuka). Motodomari (Noboripo). Toyohara (Toyohara). Hokkaidô:—Iburi (Chitose). Shiribeshi (Inaho-tōge). Ishikari (Sapporo, Maruyama near Sapporo, Mt. Moiwa, Jōzankei, Mt. Kuro-dake, Sōunkei). Tokachi (Shikaribetsu-numa). Kushiro (Mt. Meakan-dake, Nipushi, Kutcharo). Honshū:—Shinano (Mt. Tsubakuro-dake).

ALBERTINI and SCHWEINITZ were the first to describe the aecidial stage of this species on the cone-scales of *Picea excelsa*. They gave it the name *Licea strobilina* ALB. et SCHW. The uredostage of this

fungus was first published in 1817 under the name *Uredo Padi* KZE. et SCHM. in SCHMIDT and KUNZE, Crypt. exsicc. no. 187.

It was FRIES who first described the teleutostage of this species. In 1822, he described it on *Prunus Padus* as *Sclerotium areolatum* FR. For this fungus, therefore, the scientific name *Thekopsora areolata* (FR.) MAGN. must be used accepting the name of *Sclerotium areolatum* FR., the oldest name for the teleutostage of this fungus.

In 1927, the writer published his comparative study of *Thekopsora* on the Japanese species of *Prunus* based upon a large number of specimens which were collected in Hokkaidô. He came to the conclusion that the *Thekopsora* found on the four Japanese species of *Prunus*, *Prunus Padus*, *P. Ssiori*, *P. serrulata* var. *sachalinensis* and *P. Cerasus*, are evidently to be divided into two distinct species. That is, the fungus on the former two species, *Prunus Padus* and *P. Ssiori* belonging to the subgenus *Padus* differs from the one on the latter two species belonging to the subgenus *Cerasus*, and the former is identical with the present species, while the latter is a new species, *Thekopsora pseudo-Cerasi* HIRATS. f.

The present species is distinguished morphologically from the latter by the much smaller uredospores as well as by the size and shape of the teleutospores, although there could not be found any remarkable difference between them either in the position of uredo- and teleutosori and the essential characters of the peridia in uredosori nor in the ostiolar cells. In Table 12, the results of measurements of the uredospores of both species on different plants are shown.

TABLE 12. Measurements of uredospores of *Thekopsora areolata* (Fr.) MAGN. and *Th. pseudo-Cerasi* HIRATS. f. on different plants

Species	Hosts	Materials	Length (in μ)	Width (in μ)
<i>Thekopsora areolata</i>	<i>Prunus avium</i>	Ås, Norway, Aug., 1925, leg. I. JØRSTAD	15~22.5	10.5~15
	<i>P. Cerasus</i>	Asker, Norway, Sept., 1924, leg. I. JØRSTAD	12.5~22.5	11.25~16.25
	<i>P. Padus</i>	Maruyama near Sapporo, Ishikari, Japan, Nov., 1895, leg. Y. TOKUBUCHI	14.4~25.2	10.8~18
	<i>P. Padus</i>	Leipzig, Sachsen, Germany, Sept., 1894, leg. P. DIETEL	15~22.5	12.5~15

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TABLE 12 (Continued)

Species	Hosts	Materials	Length (in μ)	Width (in μ)
<i>Thekopsora areolata</i>	<i>P. Padus</i>	Kufstein, Tirol, Germany, Aug., 1929, leg. P. DIETEL	15~22.5	11.25~16.25
	<i>P. Padus</i>	Winterbach, Westfalen, Germany, Oct., 1923, leg. A. LUDWIG ⁽¹⁾	13.75~23.75	11.25~16.25
	<i>P. Ssiori</i>	Mt. Kuro-dake, Ishikari, Japan, Sept., 1926, leg. HIRATSUKA, f.	14.4~23.4	10.8~18
	<i>P. virginiana</i>	Tamsel, Küstrin, Germany, Sept., 1905, leg. P. VOGEL ⁽²⁾	13.75~22.5	11.25~15
<i>Thekopsora pseudo-Cerasi</i>	<i>P. Cerasus</i>	Okeanoskaja near Vladivostok, USSR, Sept., 1929, leg. W. TRANZSCHEL	20~30	13.75~18
	<i>P. Cerasus</i>	Sapporo, Ishikari, Japan, Sept., 1922, leg. HIRATSUKA, f.	19.8~30.2	12.6~18
	<i>P. serrulata</i> var. <i>sachalinensis</i>	Sapporo, Ishikari, Japan, Sept., 1896, leg. HIRATSUKA	19.8~30.6	12.6~18

(1) SYDOW, Mycotheca germanica, no. 2092. (2) SYDOW, Uredineen, no. 1992.

From Table 12, it will be seen that the uredospores of *Thekopsora areolata* on various species of *Prunus* are usually smaller than those on *Thekopsora pseudo-Cerasi*. Moreover, as seen in the table, the uredospores on *Prunus Cerasus* from Norway are smaller than those of *Thekopsora pseudo-Cerasi* on the same plant, and agree with those of *Thekopsora areolata*, while those on the same host from Vladivostok, Maritime Province of Siberia are indistinguishable in size from *Thekopsora pseudo-Cerasi*.

As to the teleutospores, measurements were also made of spores of both species as shown in Table 13.

TABLE 13. Measurements of teleutospores of *Thekopsora areolata* (Fr.) MAGN. and *Th. pseudo-Cerasi* HIRATS. f. on different plants

Species	Hosts	Materials	Height (in μ)	Diameter (in μ)
<i>Thekopsora areolata</i>	<i>Prunus padus</i>	Maruyama near Sapporo, Ishikari, Japan, Nov., 1895, leg. Y. TOKUBUCHI	16.2~24.2	14.4~25.2
	<i>P. Ssiori</i>	Mt. Kuro-dake, Ishikari, Japan, Sept., 1926, leg. HIRATSUKA, f.	16.2~23.4	13.5~27
<i>Thekopsora pseudo-Cerasi</i>	<i>P. serrulata</i> var. <i>sachalinensis</i>	Sapporo, Ishikari, Japan, Sept., 1896, leg. HIRATSUKA	23.4~28.8	16.2~27
	<i>P. Cerasus</i>	Sapporo, Ishikari, Japan, Sept., 1922, leg. HIRATSUKA, f.	25.2~28.8	16.2~27

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From this table, it will be found that the teleutospores of *Thekopsora pseudo-Cerasi* are longer than those of the present species. The writer noticed furthermore, that there is a remarkable difference between them, in the shape and the epispore of the teleutospores, viz., the teleutospores of the former are oblong to ovate, forming in the spacious epidermal cell without pressing one another, so they do not assume a polygonal shape, and their epispore is uniformly thin, while the teleutospores of the latter are globose or subglobose, generally polygonal with pressing one another, and their epispore darker and slightly thickened at the apex.

The heteroecism of this species has been experimentally demonstrated by KLEBAHN, TUBEUF and FISCHER in Europe. In 1899, KLEBAHN tried to inoculate with sporidia from *Prunus Padus* on *Abies*, *Larix* and *Pinus*, and got a positive result on the young shoots of *Picea excelsa*, on which the mycelia developed well, but, aecidia were not produced. From this fact, he stated that the aecidial stage seems to be probably either *Aecidium strobilinum* REESS or *Ae. conorum-Piceae* REESS producing on the cone-scales of *Picea*. At last, TUBEUF demonstrated in 1900 by experiments that *Aecidium strobilinum* is really the aecidial stage of this species. He collected fresh materials of *Aecidium strobilinum* on the cone-scales of *Picea excelsa* in the autumn of 1899 and the materials were overwintered out of doors. In the following May, he inoculated with the aecidiospores from the matured aecidia on the cones on leaves of *Prunus Padus*, and got uredosori on the inoculated leaves. He also stated that a few aecidia were produced on the young shoots of *Picea excelsa* by inoculating with sporidia of this species. Afterwards, FISCHER also confirmed these facts shown by KLEBAHN and TUBEUF. In Japan, old specimens of the fallen cones of *Picea Glehni* and *P. jezoensis* have been collected in different places of Hokkaidô, but as they are all completely devoid of the aecidiospores and peridial cells, it is appropriate here simply to mention the existence of a Peridermium on the cones of *Picea Glehni* and *P. jezoensis*, and to leave the ascertainment of their relation for a future study.

From Japan, this species was first recorded by the SYDOWS in 1913 under the name *Thekopsora areolata* MAGN., based upon a specimen on *Prunus Padus* collected by M. MIURA at Jôzankei near Sapporo, Ishikari province.

7. *Thekopsora hakkodensis* ITÔ et HIRATSUKA, f. in HIRATSUKA, f. in Jour. Facul. Agric. Hokkaidô Imp. Univ. XXI, p. 22, 1927; Bot. Mag. Tokyo, XLIII, p. 15, 1929.

Uredosori hypophyllous, scattered or in small groups, often thickly scattered over the whole leaf surface, subepidermal, minute, round, 0.1~0.45 mm across, yellowish brown in colour; peridia hemispherical, firm; upper peridial cells small, irregularly polygonal, 8~20 μ across, lateral ones radially elongated; walls of peridial cells thin, 1~2.5 μ thick, smooth, nearly colourless; ostiolar cells ovate, oblong or clavate, 32~44 \times 10~18 μ , walls smooth, colourless; uredospores subglobose, ovate or ellipsoidal, 16.2~27 \times 14.4~19.8 μ ; epispore echinulate, rather thin, 1~2 μ thick, colourless; sometimes rudimentary paraphyses intermixed in uredosori.

Teleutosori amphigenous, mostly epiphyllous, effused, limited by the nerves, not raised, reddish brown to purplish brown in colour; teleutospores intracellular, forming within the epidermal cells, globose, subglobose or oblong, sometimes somewhat angular by pressure, divided into 2~5 cells by vertical or oblique septa (rarely one celled), 20~30 μ broad, 15~25 μ high; epispore smooth, yellowish brown, uniformly thin, 1~1.5 μ thick. (Plate IX, fig. 5)

Hosts and Distribution

FOR THE UREDO- AND TELEUTOSTAGE:

Leucothoe Grayana MAXIM. (HIRATSUKA, f. 1927a, p. 22; 1929a, p. 15; 1932c, p. 111; ITÔ & HIRATSUKA, f. 1927, p. 269; TOGASHI & ÔNUMA 1934, p. 17)—Japan.

Habitat in Japan

On *Leucothoe Grayana* MAXIM. (*Hanahirinoki*). Hokkaidô:—Ishikari (Jôzankei). Honshû:—Mutsu (Mt. Hakkôda). Rikuchû (Mt. Iwate, Mt. Hayachine).

The present species was originally described by ITÔ and the writer in 1927, based upon a specimen of the uredostage on *Leucothoe Grayana* which was collected by them in the neighbourhood of Sukayu hot-spring in the Hakkôda Mountains, province of Mutsu, Japan in September 1926.

Later, through the courtesy of Dr. YAMADA, the writer was enabled to examine a specimen of the uredo- and teleutostage of this fungus on the same plant which was collected by him at Jôzankei near Sapporo, thirty years ago. This species, which appears to distribute widely in northern Japan, is known at present from the above

four localities, on its one known host, *Leucothoe Grayana*, so far as the writer is aware.

The present fungus is closely related to *Thekopsora Myrtilina* KARST. and *Th. Vacciniorum* KARST., but can be distinguished from them by its larger ostiolar cells of peridia in uredosori as well as by its host relation.

8. *Thekopsora Myrtilina* KARSTEN, Myc. Fenn. IV, p. 59, 1879; HIRATSUKA, f. in Jour. Facul. Agric. Hokkaidô Imp. Univ. XXI, p. 19, 1927; Bot. Mag. Tokyo, XLIII, p. 16, 1929; KLEBAHN in Kryptogamenfl. Mark Brandenbr. Va, p. 843.

Syn. *Aecidium* ? *Myrtili* SCHUMACHER, Enum. Pl. Saell. II, p. 227, 1803.

Uredo pustulata PERSOON var. *Vaccinii* ALBERTINI et SCHWEINITZ, Consp. Fung. Nisk. p. 126, 1805, p.p.

Uredo Vacciniorum de CANDOLLE in Fl. franç. VI, p. 85, 1815, p.p.; COOKE, Handb. Brit. Fung. p. 527, 1871, p.p.

Uredo minima SCHWEINITZ in Schr. Nat. Ges. Leipzig, I, p. 70, 1822.

Caeoma Vacciniorum LINK, Sp. Pl. II, p. 15, 1825, p.p.

Caeoma (Uredo) Azaleae SCHWEINITZ in Transact. Amer. Phil. Soc. (II), IV, p. 291, 1832.

Melampsora Vaccinii WINTER in Pilze Deutschl. I, p. 244, 1881, p.p.; MASSALONGO, Ured. Veron. p. 70.

Thekopsora Vacciniorum de TONI (not KARSTEN) in SACCARDO, Syll. Fung. VII, p. 705, p.p.; BUBÁK, Rostpilze Böhmens, p. 188, p.p.; FRAGOSO, Fl. Ibér. Ured. II, p. 268, p.p.; GROVE, Brit. Rust Fungi, p. 371, p.p.; KLEBAHN in Kryptogamenfl. Mark Brandenbr. Va, p. 840, p.p.; MIGULA, Krypt.-Fl. III, I, p. 470, p.p.; OUDEMANS, Rév. Champ. I, p. 578; P. & H. SYDOW, Monogr. Ured. III, p. 462, p.p.

Melampsora Vacciniorum SCHRÖTER, Pilze Schles. I, p. 365, 1887, p.p.; PLOWRIGHT, Monogr. Ured. & Ustil. p. 246.

Pucciniastrum Vacciniorum LAGERHEIM in Tromsø Mus. Aarsh. XVII, p. 93, 1895; LIRO, Ured. Fenn. p. 515, p.p.

Pucciniastrum Vacciniorum DIETEL in ENGLER-PRANTL, Natürl. Pflanzenfam. I, 1. Abt.**, p. 47, 1897, p.p.; FISCHER, Ured. Schw. p. 467, p.p.; HARIOT, Ured. p. 252, p.p.; TROTTER, Fl. Ital. Crypt. Ured. p. 384, p.p.

Peridermium Peckii THÜMEN in Mitteil. Forstl. Vers. Oest. II,

p. 320, 1880; ADAMS in Pennsylvania State Coll. Agric. Exper. Stat. Bull. no. 160, p. 52, 1919; ARTHUR & KERN in Bull. Torr. Bot. Club, XXXIII, p. 433, 1906.

Aecidium Peckii DIETEL in ENGLER-PRANTL, Natürl. Pflanzenfam. I, 1. Abt.**, p. 78, 1897.

Pucciniastrum Myrtili ARTHUR in Résult. Sci. Congr. Internat. Bot. Vienne (1905), p. 337, 1906; N. Amer. Fl. VII, p. 109 & 678; Manual of the rusts in United States and Canada, p. 18.

Pucciniastrum minimum ARTHUR in Résult. Sci. Congr. Internat. Bot. Vienne (1905), p. 337, 1906; N. Amer. Fl. VII, p. 109.

Thekopsora minima P. et H. SYDOW, Monogr. Ured. III, p. 465, 1915.

Icon. ADAMS, l. c. text-fig. 5 & 6; pl. I, fig. 2; ARTHUR, Manual of the rusts in United States and Canada, fig. 28; FISCHER, l. c. fig. 305; FRAGOSO, l. c. fig. 132; GROVE, l. c. fig. 277; KLEBAHN, l. c. p. 842, fig. S, 3a (I, II); 3b (I, II); MOSS in Ann. Bot. XL, p. 836, text-fig. 20 & pl. XXXIV, fig. 6, 1926.

Spermogonia on needles of current season, hypophyllous, numerous, scattered, inconspicuous, extending considerably into the walls of the epidermal cells, low and applanate, small, 65~125 μ broad, 20~26 μ high.

Aecidia on needles of current season, hypophyllous, in two rows on yellowish spots occupying a part or usually all the leaf, cylindrical, small, 0.2~0.3 mm across, 0.5~1 mm high; peridial cells delicate, readily falling apart, slightly overlapping; outer walls very thin, smooth, inner ones 4~5 μ thick, moderately verrucose; aecidiospores globose or broadly ellipsoidal, 18~27 \times 15~21 μ ; epispore colourless, thin, 1~1.5 μ , finely and evenly verrucose.

Uredosori hypophyllous, scattered or somewhat gregarious, sub-epidermal, small, round, 0.08~0.2 mm across, bullate, dehiscent from a small central pore, yellowish red fading to pale yellow in colour, long covered by overarching epidermis; peridia hemispherical, firm; peridial cells small, isodiametrically to irregularly polygonal, 6~18 μ across, somewhat overlapping, walls uniformly thin, 1~2 μ , smooth, nearly colourless; ostiolar cells ovate or oblong, 20~35 \times 7.2~15 μ , walls smooth, nearly colourless, rather thick, 2.5~6 μ thick, often nearly obliterating the lumen; uredospores subglobose, broadly ob-ovate or ellipsoidal, 16~31.25 \times 13~21.25 μ ; epispore colourless, thin, 1~2 μ thick, minutely echinulate; contents orange-yellow when fresh; often rudimentary paraphyses intermixed in uredosori.

Teleutosori mostly hypophyllous, intracellular, minute, mostly limited by the nerves, not raised, yellowish brown to chestnut-brown in colour; teleutospores within the epidermal cells, globose, ovate, oblong or columnar, $15\sim 27 \times 8\sim 21 \mu$, 2~5 celled (rarely one celled), with vertical or oblique septa; epispore smooth, uniformly thin, $0.8\sim 1.2 \mu$ thick, often slightly thickened at the apex, pale brown or nearly colourless. (Plate IX, fig. 6)

Hosts and Distribution

FOR THE AECIDIAL STAGE:

Tsuga canadensis CARR. (*Abies canadensis* MICHX.) (ADAMS 1919, p. 18; ARTHUR 1925, p. 678; 1934, p. 18; ARTHUR & KERN 1906, p. 434; FRASER 1912, p. 185; 1913, p. 237 & 239; 1914, p. 27 & 28; JACKSON 1921, p. 174; KERN, THURSTON Jr., ORTON & ADAMS 1929, p. 7; RHOADS, HEDGCOCK, BETHAL & HARTLEY 1918, p. 329; SEYMOUR 1929, p. 57; P. & H. SYDOW 1915, p. 466)—Alabama, Connecticut, Massachusetts, Maine, Michigan, New Hampshire, New York, North Carolina, South Carolina, Virginia, West Virginia, Pennsylvania, Wisconsin; Nova Scotia.

Tsuga caroliniana ENGELM. (RHOADS, HEDGCOCK, BETHAL & HARTLEY 1918, p. 329; SEYMOUR 1929, p. 59)

FOR THE UREDO- AND TELEUTOSTAGE:

Azalea canescens MICHX. (ARTHUR 1934, p. 18)—Vermont.

Azalea nudiflora L. (*Rhododendron nudiflorum* T. & G.) (ARTHUR 1907, p. 109; 1927, p. 818; 1934, p. 18; ARTHUR & BISBY 1918, p. 202 & 265; KERN, THURSTON Jr., ORTON & ADAMS 1929, p. 7; SEYMOUR 1929, p. 547; P. & H. SYDOW 1915, p. 466)—Alabama, Georgia, Connecticut, New York, North Carolina, Pennsylvania, South Carolina.

Azalea viscosa L. (*Rhododendron viscosum* TORR.) (ARTHUR 1907, p. 109; 1934, p. 18; JACKSON 1918a, p. 319; SEYMOUR 1929, p. 547; P. & H. SYDOW 1915, p. 466)—New York, New Jersey, Alabama, Massachusetts, Delaware.

Azalea sp. (ARTHUR 1927, p. 818)—Delaware, Georgia.

Azalea sp. (CLINTON 1908b, p. 392)—Connecticut.

Gaylussacia baccata KOCH (*G. resinosa* T. et G.) (ARTHUR 1907, p. 109; 1927, p. 818; 1934, p. 18; DAVIS 1924, p. 279; FRASER 1914, p. 27 & 28; KERN, THURSTON Jr., ORTON & ADAMS 1929, p. 7; SEYMOUR 1929, p. 553; P. & H. SYDOW 1915, p. 464)—New York, Maine, Michigan, Vermont, Wisconsin, Massachusetts, Pennsylvania, Connecticut; Quebec.

Gaylussacia frondosa T. et G. (KERN, THURSTON Jr., ORTON & ADAMS 1929, p. 7)—Pennsylvania.

Menziesia pilosa PERS. (ARTHUR 1907, p. 109; 1934, p. 18; SEYMOUR 1929, p. 549; P. & H. SYDOW 1915, p. 466)—West Virginia.

Polycodium stramineum GREENE (KERN, THURSTON Jr., ORTON & ADAMS 1929, p. 7)—Pennsylvania.

Rhodora canadensis L. (*Rhododendron canadense* B. S. P.) (ARTHUR 1907, p. 109; 1927, p. 818; 1934, p. 18; FRASER 1912, p. 184 & 193; SEYMOUR 1929, p. 546; P. & H. SYDOW 1915, p. 466)—New Hampshire, Maine; Nova Scotia.

Vaccinium alaskense HOWELL (ARTHUR 1925, p. 679; 1934, p. 18; SEYMOUR 1929, p. 553)—Alaska.

Vaccinium atrococcum HELLER (SEYMOUR 1929, p. 553; P. & H. SYDOW 1915, p. 464)

Vaccinium axillare NAKAI (HIRATSUKA, f. 1927a, p. 20; 1929a, p. 17; 1935g, p. 136, 144, 150, 161 & 212; ITÔ & HIRATSUKA, f. 1927, p. 270)—Japan.

Vaccinium caespitosum MICHX. (*V. caespitosum* var. *cuneifolium* NUTT.) (ARTHUR 1907, p. 109; 1927, p. 818; 1934, p. 18; GARRETT 1910, p. 300; HOTSON 1925, p. 294; 1934, p. 67; JACKSON 1918b, p. 216; SEYMOUR 1929, p. 553; STANDLEY 1920, p. 147; P. & H. SYDOW 1915, p. 464)—Montana, Utah, Washington, Oregon; Alaska.

Vaccinium canadense RICH. (ARTHUR 1907, p. 109; 1934, p. 18; DAVIS 1914, p. 914; FRASER 1913, p. 237 & 239; MOSS 1926, p. 816; SEYMOUR 1929, p. 554; P. & H. SYDOW 1915, p. 464)—Wisconsin; Ontario.

Vaccinium Chamissonis BONG. (HIRATSUKA, f. 1927a, p. 20; 1927b, p. 236; 1927c, p. 309; 1929a, p. 17; 1935g, p. 136 & 212)—Japan.

Vaccinium Chandleri HEPSON (P. & H. SYDOW 1915, p. 464)

Vaccinium corymbosum L. (ARTHUR 1907, p. 109; 1927, p. 818; 1934, p. 18; KERN, THURSTON Jr., ORTON & ADAMS 1929, p. 7; SEYMOUR 1929, p. 554; P. & H. SYDOW 1915, p. 464)—Pennsylvania, Alabama, Delaware, Maine, New York; Ontario.

Vaccinium cylindraceum SM. (P. & H. SYDOW 1915, p. 464)

Vaccinium erythrocarpon MICHX. (ARTHUR 1934, p. 18)—West Virginia.

Vaccinium globulare RYDB. (ARTHUR 1907, p. 109; 1927, p. 818; 1934, p. 18; GARRETT 1919, p. 207; HOTSON 1934, p. 67; SEYMOUR 1929, p. 554; P. & H. SYDOW 1915, p. 464)—Idaho, Montana.

Vaccinium hirtum THUNB. (HENNINGS 1905a, p. 597; HIRATSUKA, f. 1927a, p. 20; 1929a, p. 17; 1935g, p. 212; HIRATSUKA, f. & YOSHINAGA 1935, p. 262; P. & H. SYDOW 1915, p. 464; YOSHINAGA & HIRATSUKA, f. 1930, p. 655)—Japan.

Vaccinium intermedium RUTH. (P. & H. SYDOW 1915, p. 464)

Vaccinium macrocarpon AIT. (*Oxycoccus macrocarpus* PURSH) (ARTHUR 1925, p. 679; 1934, p. 18; HOTSON 1934, p. 67; JACKSON 1918b, p. 216; SEYMOUR 1929, p. 555)—Oregon (*cultivated*).

Vaccinium macrophyllum PIPER (ARTHUR 1925, p. 679; 1934, p. 18; HOTSON 1934, p. 67; JACKSON 1918b, p. 216; SEYMOUR 1929, p. 555)—Montana, Idaho, Oregon.

Vaccinium membranaceum DOUGL. (*V. myrtilloides* HOOK.) (ARTHUR 1907, p. 109; 1927, p. 818; 1934, p. 18; HOTSON 1925, p. 294; 1934, p. 67; SEYMOUR 1929, p. 555; STANDLEY 1920, p. 147; P. & H. SYDOW 1915, p. 464)—Idaho, Montana, Washington, Oregon, Wyoming.

Vaccinium microphyllum RYDB. (WEIR 1918, p. 13)

Vaccinium Myrsinites LAM. (ARTHUR 1907, p. 109; 1934, p. 19; SEYMOUR 1929, p. 555; P. & H. SYDOW 1915, p. 464)—Florida.

Vaccinium Myrtilus L. (BUBÁK 1897, p. 5; 1898, p. 4 & 18; 1899, p. 20; 1908, p. 189; 1916, p. 145; CONSTANTINEANU 1920, p. 444; COOKE 1871, p. 527; DIETEL 1890a, p. 48; FISCHER 1904, p. 468; FRAGOSO 1925, p. 269; GOBI & TRANZSCHEL 1891, p. 106; GROVE 1913, p. 371; HEIM 1927, p. 93; HENNINGS 1905b, p. 212; JAAP 1904a, p. 131; 1905, p. 396; 1906, p. 123; 1907b, p. 172; 1908, p. 201; 1910, p. 146; 1911, p. 334; JØRSTAD 1921, p. 16; 1923b, p. 19; 1925, p. 87; 1935, p. 66; KLEBAHN 1914, p. 841; LAMBOTTE 1880, p. 75; LARSEN 1932, p. 551; LIND 1913, p. 295; 1934, p. 106; LIRO 1908, p. 516; MAGNUS 1890, p. 30; 1894, p. 54; 1900, p. 20; MASSALONGO 1883, p. 70; MAYOR 1919, p. 412; 1930b, p. 174; MIGULA 1910, p. 470; MURASHKINSKY & SIELING 1928, p. [10]; OUDEMANS 1892, p. 578; PETRAK 1927, p. 346; PICBAUER 1927, p. 439; PLOWRIGHT 1889, p. 247; POEVERLEIN & BERTSCH 1927, p. 196; SCHRÖTER 1887, p. 365; SEYMOUR 1929, p. 555; SIEMASZKO 1923b, p. 15; STANDLEY 1920, p. 147; P. & H. SYDOW 1915, p. 464; THÜMEN 1880b, p. 213; TRANZSCHEL 1900, p. 189; TROTTER 1914, p. 384; TURCONI 1908, p. 120; VOSS 1878, p. 92; 1899, p. 339; WETTSTEIN 1885, p. 550; 1888, p. 173; WILSON 1924, p. 141; 1934, p. 430; WINTER 1881, p. 244)—Norway, Iceland, Finland, Denmark, Sweden, Italy, Germany, Switzerland, France,

Great Britain, Bulgaria, Belgium, Spain, Czechoslovakia, Austria, Rumania, Russia, Poland; Siberia.

Vaccinium oreophilum RYDB. (ARTHUR 1907, p. 109; 1927, p. 818; 1934, p. 19; HOTSON 1934, p. 67; SEYMOUR 1929, p. 555; STANDLEY 1916, p. 164; P. & H. SYDOW 1915, p. 464)—Montana, New Mexico, Colorado.

Vaccinium ovalifolium SM. (ARTHUR 1925, p. 679; 1934, p. 19; HOTSON 1934, p. 67; JACKSON 1918b, p. 216; SEYMOUR 1929, p. 555)—Alaska; Oregon, Washington.

Vaccinium Oxycoccus L. (*Oxycoccus vulgaris* HILL., *O. palustris* L.) (JAAP 1909a, p. 24; KLEBAHN 1914, p. 843; LIND 1913, p. 295; POEVERLEIN & BERTSCH 1927, p. 196; P. & H. SYDOW 1915, p. 464; WINTER 1881, p. 244)—Germany, Denmark.

Vaccinium parvifolium SM. (ARTHUR 1925, p. 679; 1934, p. 19; HOTSON 1925, p. 294; 1934, p. 67; SEYMOUR 1929, p. 556)—Washington, California.

Vaccinium pennsylvanicum LAM. (*V. angustifolium* AIT.) (ARTHUR 1925, p. 679; 1934, p. 19; DAVIS 1914, p. 914; KERN, THURSTON Jr., ORTON & ADAMS 1929, p. 7; MOSS 1926, p. 816; SEYMOUR 1929, p. 556; P. & H. SYDOW 1915, p. 464)—Connecticut, Maine, Michigan, Wisconsin, Pennsylvania, New Hampshire; Ontario, Nova Scotia.

Vaccinium reticulatum SM. (STEVENS 1925, p. 115)—Hawaii.

Vaccinium scoparium LEIB. (*Vaccinium erythrocoecum* RYDB., *V. Myrtilus* var. *microphyllum* HOOK.) (ARTHUR 1925, p. 679; 1934, p. 19; HOTSON 1934, p. 67; SEYMOUR 1929, p. 554 & 556; P. & H. SYDOW 1915, p. 464)—Colorado, Wyoming, Idaho; Alberta.

Vaccinium Smallii A. GRAY (HIRATSUKA, f. 1935g, p. 136 & 212; KAWAI & ÔTANI 1931, p. 240)—Japan.

Vaccinium uliginosum L. (ARTHUR 1907, p. 109; 1934, p. 19; BUBÁK 1898, p. 4 & 18; 1908, p. 189; ELIASSON 1897, p. 7; FISCHER 1904, p. 469; FRAGOSO 1925, p. 269; GOBI & TRANZSCHEL 1891, p. 106; HIRATSUKA, f. 1927a, p. 20; 1927c, p. 309; 1928a, p. 30; 1928c, p. 566; 1929a, p. 17; 1929c, p. 62; 1929d, p. 104; 1930a, p. 84; 1933a, p. 151; 1935g, p. 136, 161 & 212; JAAP 1904a, p. 131; 1907b, p. 172; 1909a, p. 24; 1911, p. 334; JØRSTAD 1921, p. 16; 1923b, p. 19; 1925, p. 87; 1934, p. 25; 1935, p. 66; KARSTEN 1879, p. 59; KLEBAHN 1914, p. 843; LARSEN 1932, p. 511; LAUBERT 1921, p. 241; 1927, p. 50; LIND 1913, p. 295; LIRO 1908, p. 516; MIGULA 1910, p. 470; PETRAK 1920, p. 134; PICBAUER 1927, p. 439; 1929, p. 11; 1933a, p. 7; POEVER-

LEIN 1926, p. [41]; POEVERLEIN & BERTSCH 1927, p. 196; RAINIO 1926, p. 254; SCHRÖTER 1887, p. 366; SEYMOUR 1929, p. 556; P. & H. SYDOW 1915, p. 464; TRANZSCHEL 1900, p. 189; TROTTER 1914, p. 384; TURCONI 1908, p. 120; WILSON 1924, p. 141; 1934, p. 430; WINTER 1881, p. 244)—Denmark, Finland, Sweden, Norway, Iceland, Germany, Great Britain, Italy, Czechoslovakia, Switzerland, Poland; New Hampshire; Siberia, Kamtchatka, North Saghalien, Japan.

Vaccinium Usunoki NAKAI (*V. Buergeri* MIQ.) (HIRATSUKA, f. 1927a, p. 20; 1929a, p. 17; 1935g, p. 213; ITÔ & HIRATSUKA, f. 1927, p. 270)—Japan.

Vaccinium vacillans KALM. (ARTHUR 1925, p. 679; 1934, p. 19; JACKSON 1918a, p. 320; KERN, THURSTON Jr., ORTON & ADAMS 1929, p. 7; SEYMOUR 1929, p. 556)—Arkansas, Connecticut, Delaware, Pennsylvania, North Carolina.

Vaccinium virgatum AIT. (ARTHUR 1925, p. 679; 1934, p. 19; SEYMOUR 1929, p. 556)—Virginia.

Vaccinium sp. (JACKSON 1918b, p. 216)—Oregon.

Vaccinium sp. (GARRETT 1919, p. 207)—Utah.

Xolisma elliptica NAKAI (*Pieris elliptica* NAKAI) (HIRATSUKA, f. 1930d, p. 331; 1935g, p. 213)—Japan.

Exsiccati. FOR THE AECIDIAL STAGE: ELLIS, N. Amer. Fung. no. 1023; SEYMOUR & EARLE, Econ. Fung. no. 225. FOR THE UREDO- AND TELEUTOSTAGE: BARTHOLOMEW, Fung. Columb. no. 2384, 2869, 4333, 4680 & 5083; BARTHOLOMEW, N. Amer. Ured. no. 378, 676, 1182, 1278, 1481, 2281, 2282, 2379, 2479, 2574, 2687 & 3084; CAVARA, Fung. Longob. no. 11; COOKE, Fung. brit. I, no. 119; CLEMENTS, Crypt. Form. Colo. no. 588; ELLIS, N. Amer. Fung. no. 1023 & 1081; ELLIS & EVERHART, N. Amer. Fung. no. 2717; FÜCKEL, Fung. rhen. no. 405; JAAP, Fung. sel. no. 529; KRIEGER, Fung. saxon. no. 218; KUNZE, Fung. sel. no. 549; PETRAK, Fl. Bohem. no. 420; RACIBORSKI, Fung. polon. no. 47; RAVENEL, Fung. amer. no. 486 & 731; RABENHORST, Fung. eur. no. 1787 & 2815; ROUMEGUÈRE, Fung. gall. no. 1522; D. SACCARDO, Myc. ven. no. 1417; D. SACCARDO, Myc. ital. no. 1259; SCHMIDT & KUNZE, no. 89; SCHRÖTER, Pilze Schles. no. 147 & 460; SCHNEIDER, Herb. no. 676 & 727; SEYMOUR & EARLE, Econ. Fung. no. 44, 225 (a, b) & 486; SIEMASZKO, Fung. Baialowienses, no. 56; SPEGAZZINI, Dec. Myc. ital. no. 66; P. & H. SYDOW, Myc. germ. no. 309; P. & H. SYDOW, Myc. march. no. 647, 1047, 4228 & 4322; P. & H. SYDOW, Ured. no. 136, 236, 289, 1046,

1188 & 1896; THAXTER, Rel. FARL. no. 278 (a, b) & 280 (a, b); THÜMEN, Fung. austr. no. 357 & 358; THÜMEN, Myc. univ. no. 1247; VESTERGRENN, Micromyc. rar. sel. no. 986 (a, b); VIZE, Fung. brit. no. 59; VIZE, Micr. Fung. brit. no. 226; Krypt. exs. Vindob. no. 1418.

Habitat in Japan

On *Vaccinium axillare* NAKAI (*Kuro-usugo*). *Hokkaidô*:—Ishikari (Mt. Kuro-dake). *Honshû*:—Mutsu (Mt. Hakkôda). Rikuchû (Mt. Iwate). Suruga (Mt. Akaishi). Shinano (Mt. Yatsugatake, Mt. Komagatake [Kiso], Mt. Ontake).

On *Vaccinium Chamissonis* BONG. (*Yezo-kurousugo*). *Hokkaidô*:—Ishikari (Mt. Kuro-dake). Kushiro (Mt. Meakan-dake, Mt. Oakan-dake).

On *Vaccinium hirtum* THUNB. (*Kakumino-sunoki*). *Shikoku*:—Tosa (Kamoda-mura, Mt. Eboshi-washio, Asakura-mura).

On *Vaccinium Smallii* A. GRAY (*Ôba-sunoki*). *S. Saghalien*:—Tomarioro (Ambetsu). *Hokkaidô*:—Ishikari (Mt. Kuro-dake). *Honshû*:—Rikuchû (Mt. Iwate).

On *Vaccinium uliginosum* L. (*Kuromamenoki*). *S. Saghalien*:—Shisuka (Shisuka). Motodomari (Mt. Tosso, Noboripo, Mt. Kashipo). Tomarioro (Kushunnai). *Hokkaidô*:—Ishikari (Mt. Kuro-dake, Kumonotaira [Daisetsu-zan], Mt. Hokkai-dake, Mt. Hakuun-dake, Mt. Nisekaushipe). *Kuriles*:—Shikotan (Shakotan). Urup (Tokotan). Shimushir (Yamagoshi-saki). *Honshû*:—Shinano (Mt. Komagatake [Kiso]).

On *Vaccinium Usunoki* NAKAI (*Usunoki*). *Honshû*:—Mutsu (Mt. Hakkôda).

On *Xolisma elliptica* NAKAI (*Kashioshimi*). *Honshû*:—Kaga (Yamanaka-machi). Wakasa (Obama). Tango (Yoshidzu-mura). Inaba (Enoki-tôge, Omokage-mura, Tottori).

This species is a collective one which is parasitic on various ericaceous plants, especially various species of *Vaccinium*. It is rather common and wide-spread in the northern hemisphere.

The uredostage of this species was first described by SCHUMACHER in 1803, based upon a specimen on *Vaccinium Myrtilus* from the Island of Zealand in Denmark, as a new species, *Aecidium ? Myrtilli* SCHUM. It was KARSTEN who treated this fungus for the first time as a species of *Thekopsora* in 1879. He named it *Thekopsora Myrtilina* KARST. taking a collection of the uredostage on *Myrtilus uliginosa* (*Vaccinium uliginosum*) made at Forssa in Fin-

land. In the same paper, he created a new species, *Thekopsora* (?) *Vacciniorum* KARST. based upon a specimen of the uredostage on *Vaccinium Vitis-Idaea*.

In 1881, WINTER regarded the two species of KARSTEN, *Thekopsora Myrtillina* and *Th. Vacciniorum*, as the same species, and treated it as a species of *Melampsora*, naming it *Melampsora Vaccinii* WINT. He described the uredo- and teleutostage of his species and gave the three species of *Vaccinium*; *V. Myrtillus*, *V. uliginosum* and *V. Vitis-Idaea* as its host plants. In 1887, SCHRÖTER used the specific name *Melampsora Vacciniorum* SCHRÖT. instead of *Melampsora Vaccinii* WINT. In 1895, LAGERHEIM transferred it to the genus *Pucciniastrum* in the broad sense and named it *Pucciniastrum Vacciniorum* LAGERH. Two years later, DIETEL also gave it the name *Pucciniastrum Vacciniorum* DIET., independently of LAGERHEIM.

In 1906, ARTHUR used the name *Pucciniastrum Myrtilli* (SCHUM.) ARTH. taking from the earliest name of this fungus, *Aecidium* (?) *Myrtilli* SCHUM. In their monograph, the SYDOWS (1915) used the name *Thekopsora Vacciniorum* KARST. and regarded *Thekopsora Myrtillina* KARST., *Pucciniastrum Vacciniorum* LAGERH., *P. Myrtilli* ARTH. and others as synonyms of it.

As mentioned above, *Thekopsora Myrtillina* KARST. has been treated by some authorities as a synonym of *Thekopsora Vacciniorum* KARST. These species closely resemble each other especially in the character of the ostiolar cells of peridia in uredosori and the shape of uredospores as well as in the host relation. But, it can be distinguished from the latter species on *Vaccinium Vitis-Idaea* by the much smaller and pale yellowish uredosori. Moreover, a tendency seems to exist for the uredospores of *Thekopsora Vacciniorum* to be more or less larger than those of *Thekopsora Myrtillina*.

FRASER in 1910 was the first to conduct culture experiments with this species. He obtained successful infections, resulting in spermogonia and aecidia on leaves and cones of *Tsuga canadensis* by inoculating with sporidia of teleutospores from *Rhodora canadensis* (*Rhododendron canadense*). Two years after, he also obtained the development of the aecidia on the leaves of *Tsuga canadensis* following sowing from the teleutospores on *Vaccinium canadense*. The same author in the next year obtained the aecidia on *Tsuga canadensis*, following sowing of the teleutospores from *Gaylussacia resinosa* (*G. baccata*). In 1911, CLINTON successfully infected *Gaylussacia*

baccata by sowing the aecidiospores from *Tsuga*, resulting in the development of the uredosori of this species. In 1919, ADAMS reported that the aecidiospores from *Tsuga canadensis* were sown on *Azalea nudiflora*, *Vaccinium angustifolium* (*V. pennsylvanicum*) and *Gaylussacia* spp., and positive results were secured on these plants. He also said that field evidence supported by cultures indicated the relationship between *Pucciniastrum Myrtilli* and *P. minimum*, and that they may be identical.

In this country, inoculation experiments with this species have not yet been made. The writer is not aware that the aecidial stage of this species has been recorded in Japan; but it will doubtless be found when searched for.

In 1905, HENNINGS identified the uredostage of this fungus on *Vaccinium hirtum* with *Thekopsora Vacciniorum* KARST. based upon a specimen collected by T. YOSHINAGA on Mt. Eboshi-washio in the province of Tosa. It is the first record of this species in this country. Since then, the present fungus on *Vaccinium axillare*, *V. Buergeri*, *V. Chamissonis*, *V. Smallii*, *V. uliginosum* and *Xolisma elliptica* has been recorded by KAWAI & ÔTANI, TOGASHI & ÔNUMA and the writer from South Saghalien, the Kuriles, Hokkaidô and Honshû.

Uredo Andromedae COOKE was treated by ARTHUR as a synonym of *Pucciniastrum Myrtilli* (SCHUM.) ARTH. in 1925. But JACKSON reported in 1931 that there seems to be some reasonable basis for doubt that it belongs with the latter species. The writer has never examined any specimens of *Uredo Andromedae* COOKE, but he provisionally treated this species as distinct from *Thekopsora Myrtillina*, following JACKSON's opinion. The original description and the host plants of this species are shown in the following.

Uredo Andromedae COOKE in RAVENEL, Fungi Americani exsiccati, no. 747; SACCARDO, Syll. Fung. VII, p. 853; P. & H. SYDOW, Monogr. Ured. IV, p. 439.

"Sorid hypophyllis, maculae rotundatae, brunneolae insidentibus, gregariis; brunneo-cinnamomeis, pulvinatis; uredosporis e globoso angulatis, 14-18 μ diam., sublevibus, episporio hyalino, siccis chlorinis."

Hosts and Distribution

Pieris mariana BENTH. et HOOK. (*Andromeda mariana* L., *Neopieris mariana* BRITT.) (ARTHUR 1907, p. 119; 1925, p. 679; 1934, p.

18; JACKSON 1918a, p. 374; SEYMOUR 1929, p. 551; P. & H. SYDOW 1924, p. 439)—Delaware.

Pieris nitida BENTH. et HOOK. (*Andromeda nitida* BARTR., *Neopieris nitida* BRITT.) (ARTHUR 1907, p. 119; 1925, p. 679; 1934, p. 18; SEYMOUR 1929, p. 551; P. & H. SYDOW 1924, p. 439)—Georgia.

Pernettya Pentlandii DC. (JACKSON 1931c, p. 490)—Bolivia.

Xolisma ligustrina BRITT. (*Andromeda ligustrina* MUHL.) (ARTHUR 1907, p. 119; 1925, p. 679; 1934, p. 18; JACKSON 1918a, p. 374; SEYMOUR 1929, p. 551; P. & H. SYDOW 1924, p. 439)—Arkansas, Alabama, Delaware.

9. *Thekopsora Brachybotrydis* TRANZSCHEL in Ann. Myc. V, p. 551, 1907; SACCARDO, Syll. Fung. XXI, p. 734; P. & H. SYDOW, Monogr. Ured. III, p. 469.

Syn. *Thekopsora Trigonotidis* TRANZSCHEL in sched.

Uredosori hypophyllous, subepidermal, scattered or loosely grouped on brownish to dark brown areas of indefinite extent, sometimes involving almost the entire leaf, minute, round, 0.1~0.5 mm across, covered by brownish epidermis which ruptures at a centrally placed stomatic pore; peridia hemispherical, firm; upper peridial cells small, irregularly polygonal, 8~20 μ across, lateral ones radially elongated, walls of the peridial cells thin, 1~2 μ thick, pale yellowish brown, smooth; ostiolar cells rounded, smooth; rudimentary paraphyses intermixed; uredospores subglobose, obovate or ellipsoidal, 17~22.5 \times 13~20 μ ; epispore colourless, thin, 0.8~1.2 μ thick, shortly echinulate.

Teleutosori hypophyllous, occasionally also epiphyllous, on indefinite brown areas, intracellular; teleutospores within the epidermal cells, globose, ovate or oblong, or sometimes angular by pressure, divided into 2~6 cells (rarely one celled), 15~24 μ high, 18~36 μ broad; epispore uniformly thin, 1~1.5 μ thick, yellowish brown, smooth.

Hosts and Distribution

FOR THE UREDO- AND TELEUTOSTAGE:

Anchusa myosotidiflora LEHM. var. *gradiflora* DC.—Altai (W. Siberia).

Brachybotrys paridiformis MAXIM. (MIURA 1928, p. 235; P. & H. SYDOW 1915, p. 469; TRANZSCHEL 1907, p. 551)—Manchuria, Maritime Province of Siberia.

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Myosotis palustris LAM. (HIRATSUKA, f. 1935e, p. 331)—Japan.

Trigonotis brevipes MAXIM. (HIRATSUKA, f. 1935d, p. 707; 1935e, p. 331)—Japan.

Trigonotis radicans MAXIM.—Maritime Province of Siberia.

Habitat in Japan

On *Myosotis palustris* LAM. (*Wasurenagusa*) (cultivated). Hokkaidô:—Ishikari (Sapporo).

On *Trigonotis brevipes* MAXIM. (*Midzu-tabirako*). Kiushû:—Buzen (Mt. Hikosan).

This species was described by TRANZSCHEL (1907) based upon a collection on *Brachybotrys paridiformis* made by P. SIUZEV in Manchuria in September 1905. Through the courtesy of Dr. TRANZSCHEL, the writer was able to study a part of this original specimen and also a specimen of this fungus on the same plant which was collected by W. KOMAROV at Kondratenkovo in the Maritime Province of Siberia in August 1913. Moreover, the writer obtained from Dr. TRANZSCHEL, the two specimens of the uredostage of rust fungi on Borraginaceae; one of them is parasitic on *Anchusa myosotidiflora* var. *grandiflora* which was collected by B. SCHISCHKEN and P. KRYLOR from Altai, W. Siberia in July 1911, and the other is parasitic on *Trigonotis radicans* which was collected by himself in Distr. Vladivostok, Maritime Province, in August 1927. After the writer's examination of these specimens, he found that these fungi are morphologically indistinguishable from the uredostage of *Thekopsora Brachybotrydis*. Therefore, he identified the fungi on *Anchusa myosotidiflora* var. *grandiflora* and *Trigonotis radicans* with this species, although the teleutospores have never been seen.

In 1935, the writer first recorded the present fungus from this country, based upon two specimens; one of them is parasitic on *Myosotis palustris* which was collected by Naoharu HIRATSUKA at Sapporo, Ishikari Province, and the other is parasitic on *Trigonotis brevipes* which was collected by E. TOBINAGA in Mt. Hikosan, Buzen Province. These specimens bear both uredo- and teleutospores.

The present species is widely distributed in Manchuria, Maritime Province of Siberia, Altai and Japan.

10. *Thekopsora Rubiae* KOMAROV in JACZEWSKI, KOMAROV & TRANZSCHEL, Fungi Rossiae exsicc. no. 328, 1899; Hedwigia, XXXIX, p. (128), 1900; HIRATSUKA, f. in Jour. Soc. Agric. & Forestr. Sapporo,

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XX, p. 18, 1928; Bot. Mag. Tokyo, XLIII, p. 14, 1929; SACCARDO, Syll. Fung. XVI, p. 321; P. & H. SYDOW, Monogr. Ured. III, p. 468.

Syn. *Uredo Rubiae* DIETEL in ENGL. Bot. Jahrb. XXVIII, p. 290, 1900.

Uredosori hypophyllous, subepidermal, scattered or sometimes in small groups, often thickly scattered over the whole surface, small, round, 0.1~0.3 mm across, brownish yellow in colour; peridia appanate-hemispherical, firm; peridial cells small, irregularly polygonal, 6~15 μ across, walls thin, 1.2~2 μ thick, slightly coloured, smooth; ostiolar cells comparatively thick, 2~4 μ thick, smooth; uredospores subglobose, ovate or ellipsoidal, 18~27 \times 12~18 μ ; epispore finely echinulate, rather thin, 1~1.5 μ thick, colourless.

Teleutosori hypophyllous, scattered or gregarious, often covering the whole surface of the leaf, minute, 0.2~0.3 mm across, brownish black or almost black in colour; teleutospores intracellular, forming in the epidermal cells, globose, ellipsoidal or oblong, somewhat angular, divided vertically into 2~5 cells, 25~35 \times 18~25 μ ; epispore rather thick, 2~3 μ , pale yellowish brown to pale brown in colour, smooth. (Plate X, fig. 6; Plate XI, fig. 6)

Hosts and Distribution

FOR THE UREDO- AND TELEUTOSTAGE:

Rubia chinensis RGL. (HIRATSUKA, f. 1935b, p. 235)—Japan.

Rubia cordifolia L. & var. (DIETEL 1900b, p. 290; 1902b, p. 52; 1903a, p. 629; 1910, p. 313; HIRATSUKA, f. 1927c, p. 308; 1928d, p. 696; 1929a, p. 14; 1932b, p. 41; 1935a, p. 151; 1935f, p. 281; HIRATSUKA, f. & YOSHINAGA 1935, p. 262; KOMAROV 1900, p. [128]; MIURA 1928, p. 234; MIYAKE 1914, p. 43; NAITÔ & YAGI 1933, p. 15; P. & H. SYDOW 1909, p. 169; 1913, p. 110; 1915, p. 469; TAI 1932, p. 539; YOSHINAGA & HIRATSUKA, f. 1930, p. 655)—China, Maritime Province of Siberia, Manchuria, Japan.

Exsiccati. FOR THE UREDO- AND TELEUTOSTAGE: JACZEWSKI, KOMAROV & TRANZSCHEL, Fung. Ross. no. 328 (a, b).

Habitat in Japan

On *Rubia chinensis* RGL. (*Ô-akane*). Korea:—Kôgen (Onseirei, Bansôkei [Soto-Kongô]).

On *Rubia cordifolia* L. var. *lanceifolia* RGL. (*Kurumaba-akane*). Shikoku:—Sanuki (Kusakabe-machi).

On *Rubia cordifolia* L. var. *Mungista* MIQ. (*Akane*). Hokkaidô:

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—Oshima (Esashi). Honshû:—Mutsu (Chibiki, Asamushi, Hiro-saki). Rikuchû (Morioka). Ugo (Yokote). Iwaki (Sôma). Musashi (Tokyo). Sagami (Kamakura). Awa (Tomisaki-mura). Idzu (Shû-zenji, Atami). Suruga (Shizuoka). Shinano (Karuisawa). Yamashiro (Mt. Atago near Kyoto). Inaba (Mt. Hyônosen). Shikoku:—Tosa (Agekura-mura). Kiushû:—Hiuga (Mt. Kirishima).

On *Rubia cordifolia* L. var. *pratensis* MAXIM. (*Ô-kurumaakane*). Korea:—Keiki (Keijô, Seiryôri).

The present species on *Rubia cordifolia* (*R. cordifolia* var. *pratensis*) was established by KOMAROV based upon two specimens which were issued in Fungi Rossiae exsiccati, no. 382, a & b in 1899. Specimen no. 382—a which was collected by KOMAROV in the province of Kirin, Manchuria in July 1896, bears only the uredosori, while the latter specimen which was collected by him at Posiet in the Maritime Province of Siberia in October 1896, bears both uredo- and teleutospores.

In 1900, DIETEL treated the uredostage of the present fungus on *Rubia cordifolia* var. *Mungista* which was collected by S. KUSANO at Sôma, province of Iwaki in Japan, as a new species under the name of *Uredo Rubiae* DIET. This is the first record of the present species in this country. Two years later, he identified the same fungus on the same plant collected by S. KUSANO in Tokyo, with *Thekopsora Rubiae* KOM. Since then, the SYDOWS, DIETEL, NAMBU, YOSHINAGA, NAITÔ & YAGI and the writer have reported the occurrence of this fungus in various places of Hokkaidô, Honshû, Shikoku, Kiushû and Korea. Moreover, MIYAKE in 1914 recorded that the present fungus on *Rubia cordifolia* (*R. cordifolia* var. *Mungista*) was obtained from North China, and MIURA in 1928 also reported that this species on *Rubia cordifolia* var. *pratensis* had been collected by him in South Manchuria. Recently, through the courtesy of Dr. TRANZSCHEL, the writer obtained two specimens of the present fungus from Russia. One of them is parasitic on *Rubia cordifolia* var. *silvatica* was collected by TRANZSCHEL at Charitonowka, Maritime Province, and the other is on *Rubia cordifolia* var. *pratensis* which was collected by him at Okeanskaja near Vladivostok. On the latter specimen, a large number of teleutospores has been seen.

This species is one of those which are widely distributed throughout the Far East.

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11. *Thekopsora guttata* (SCHRÖT.) P. et H. SYDOW, Monogr. Ured. III, p. 467, 1915; HIRATSUKA, f. in Transact. Sapporo Nat. Hist. Soc. IX, p. 235, 1927; Bot. Mag. Tokyo, XLIII, p. 14, 1929.

Syn. *Caeoma Galii* LINK, Sp. Pl. II, p. 21, 1825.

Melampsora guttata SCHRÖTER in Abhandl. Schles. Ges. f. Vaterl. Cult. Abt. f. Naturw. 1869/72, p. 26, 1872.

Uredo Sherardiae ROSTRUP in THÜMEN, Myc. univ. no. 1348, 1879.

Melampsora Galii WINTER in Pilze Deutschl. I, p. 244, 1881; SCHRÖTER, Pilze Schles. I, p. 365.

Thekopsora Galii de TONI in SACCARDO, Syll. Fung. VII, p. 765, 1888; BUBÁK, Rostpilze Böhmens, p. 188; FRAGOSO, Fl. Ibér. Ured. II, p. 272; GROVE, Brit. Rust Fungi, p. 370; KLEBAHN in Kryptogamenfl. Mark Brandenbr. Va, p. 839; MIGULA, Krypt.-Fl. III, 1, p. 469.

Caeoma Asperulae ROSTRUP in LAGERHEIM in Tromsø Mus. Aarsh. XVII, p. 105, 1895.

Pucciniastrum Galii FISCHER, Ured. Schw. p. 471, 1904; ARTHUR in N. Amer. Fl. VII, p. 679; Manual of the rusts in United States and Canada, p. 19; HARIOT, Ured. p. 251; LIRO, Ured. Fenn. p. 521.

Pucciniastrum Galii de TONI in TROTTER, Fl. Crypt. Ured. p. 385, 1914.

Icon. ARTHUR, Manual of the rusts in United States and Canada, fig. 29; FISCHER, l. c. fig. 307; FRAGOSO, l. c. fig. 135; KLEBAHN, l. c. p. 842, fig. S, 2 (I, II); MAGNUS in Ber. Deutsch. Bot. Ges. XIV, pl. IX, fig. 8 & 9, 1896; MIGULA, l. c. pl. X, D, fig. 4 & 5.

Uredosori hypophyllous, occasionally on petioles or stems, scattered or gregarious, at times thickly scattered over the whole surface of the leaf, subepidermal, minute, round, 0.1~0.25 mm in diameter, pulvinate, yellowish orange in colour; peridia hemispherical, firm, delicate; upper peridial cells small, irregularly polygonal, 8~15 μ across, lateral ones radially elongated, walls of peridial cells smooth, thin, less than 1.5 μ thick, colourless; ostiolar cells rounded, 10~17 μ high, walls 1.5~2.5 μ thick, smooth, nearly colourless; uredospores subglobose, ovate or ellipsoidal, 13.5~24 \times 10~17.5 μ ; epispore minutely echinulate, rather thin, 1~1.5 μ thick, colourless; contents orange-yellow in colour when fresh.

Teleutosori amphigenous, inconspicuous, dark brown discoloured areas of indefinite extent, at times involving entire leaves; teleuto-

spores intracellular, within the epidermal cells, globose, subglobose or somewhat angular, 20~30 μ across, divided vertically into 2~4 cells (generally 4); epispore thin, 1.2~2 μ thick, slightly thicker at the apex, smooth, yellowish brown in colour.

Hosts and Distribution

FOR THE UREDO- AND TELEUTOSTAGE:

Asperula galioides BIEB. (FRAGOSO 1925, p. 273; P. & H. SYDOW 1915, p. 468)—Spain.

Asperula odorata L. (FISCHER 1904, p. 472; FRAGOSO 1925, p. 273; HIRATSUKA, f. 1928b, p. 504; 1929a, p. 15; JØRSTAD 1925 p. 87; LIND 1913, p. 295; SIEMASZKO 1925a, p. 9; P. & H. SYDOW 1915, p. 468; WILSON 1934, p. 430)—Denmark, Norway, Switzerland, Great Britain, France, Poland; Siberia, Japan.

Galium Aparine L. (JØRSTAD 1925, p. 87)—Norway.

Galium aristatum L. (*G. Schultesii* VEST.) (SCHRÖTER 1887, p. 365; P. & H. SYDOW 1915, p. 468)—Germany.

Galium Cruciana SCOP. (PICBAUER 1933a, p. 6)—Germany, Czechoslovakia.

Galium davuricum TURCZ.—Maritime Province of Siberia (Nikolsk ~ Ussurijsky, Sept. 5, 1927, leg. W. TRANZSCHEL).

Galium divaricatum LAM. (FRAGOSO 1925, p. 273)—Spain.

Galium gracile BUNGE—Japan.

Galium Mollugo L. (BAUDYŠ & PICBAUER 1925, p. 184; BUBÁK 1897, p. 5; 1898, p. 18; 1899, p. 20; 1908, p. 188; FISCHER 1904, p. 471; FRAGOSO 1925, p. 273; GOBI & TRANZSCHEL 1891, p. 105; JAAP 1900, p. 265; 1911, p. 334; 1914a, p. 19; KLEBAHN 1914, p. 840; LIND 1913, p. 295; LIRO 1908, p. 522; MAYOR 1919, p. 412; PETRAK 1922a, p. 3; PICBAUER 1927, p. 440; 1931, p. 11; 1933a, p. 6; POEVERLEIN 1926, p. [41]; POEVERLEIN & BERTSCH 1927, p. 196; SCHRÖTER 1887, p. 365; P. & H. SYDOW 1915, p. 468; TROTTER 1914, p. 386; VOSS 1878, p. 91; 1889, p. 339; WINTER 1881, p. 244)—Germany, Italy, Norway, Finland, Czechoslovakia, Switzerland, Russia.

Galium palustre L. (KLEBAHN 1914, p. 840)—Germany.

Galium paradosum MAXIM.—Maritime Province of Siberia (Mons Londoko, along the Kirma river, Amur, Aug. 22, 1895, leg. W. KOMAROV).

Galium rotundifolium L. (FRAGOSO 1925, p. 273; POEVERLEIN & BERTSCH 1927, p. 196; P. & H. SYDOW 1915, p. 468)—Switzerland, Germany.

Galium saxatile L. (*G. hercynicum* WEIGEL) (BUBÁK 1899, p. 20; 1908, p. 188; FRAGOSO 1925, p. 273; JØRSTAD 1925, p. 87; P. & H. SYDOW 1915, p. 468; WILSON 1934, p. 430)—Denmark, Norway, Czechoslovakia, Germany, Great Britain.

Galium silvaticum L. (BÄUMLER 1902, p. 19; BUBÁK 1899, p. 20; 1908, p. 188; FRAGOSO 1925, p. 273; KLEBAHN 1914, p. 840; PICBAUER 1927, p. 440; 1931, p. 11; SCHRÖTER 1887, p. 365; P. & H. SYDOW 1915, p. 468; WINTER 1881, p. 244)—Germany, Czechoslovakia.

Galium silvestre POLLICH. (BUBÁK 1898, p. 18; 1908, p. 188; FISCHER 1904, p. 472; FRAGOSO 1925, p. 273; JØRSTAD 1925, p. 87; P. & H. SYDOW 1915, p. 468; TROTTER 1914, p. 386)—Germany, Switzerland, Italy, Czechoslovakia.

Galium spurium L. var. (FRAGOSO 1925, p. 273)—Spain.

Galium sudeticum TAUCH. (CONSTANTINEANU 1916, p. 382; 1920, p. 444)—Rumania.

Galium trifloriforme KOM. (HIRATSUKA, f. 1927b, p. 235; 1927c, p. 307; 1929a, p. 15; 1929b, p. 121; 1930a, p. 83)—Japan.

Galium triflorum MICHX. (ARTHUR 1925, p. 679; 1934, p. 19; DAVIS 1931, p. 261; HOTSON 1934, p. 154; JACKSON 1918b, p. 215)—California, Colorado, Idaho, New York, Oregon, Pennsylvania, Utah, Wisconsin; British Columbia; Russia.

Galium uliginosum L. (FRAGOSO 1925, p. 273; JAAP 1900, p. 265; JØRSTAD 1925, p. 87; KLEBAHN 1914, p. 840; P. & H. SYDOW 1915, p. 468; WINTER 1881, p. 244)—Norway, Germany.

Galium verum L. (BUBÁK 1898, p. 18; 1899, p. 20; 1908, p. 188; FRAGOSO 1925, p. 273; GROVE 1913, p. 370; HIRATSUKA, f. 1928a, p. 30; 1928b, p. 504; 1929a, p. 15; 1930a, p. 83; 1935a, p. 150; JAAP 1911, p. 334; JØRSTAD 1925, p. 87; KLEBAHN 1914, p. 840; LIRO 1908, p. 522; MAYOR & CRUCHET 1927, p. 148; PICBAUER 1927, p. 440; POEVERLEIN & BERTSCH 1927, p. 196; SCHRÖTER 1887, p. 365; P. & H. SYDOW 1915, p. 468; TROTTER 1914, p. 386; VOSS 1889, p. 339; WILSON 1934, p. 430; WINTER 1881, p. 244)—Norway, Finland, Italy, Germany, Czechoslovakia, Great Britain, France; Japan.

Sherardia arvensis L. (JAAP 1900, p. 265; KLEBAHN 1914, p. 840; LIND 1913, p. 295; P. & H. SYDOW 1915, p. 468)—Germany, Denmark.

Exsiccati. FOR THE UREDO- AND TELEUTOSTAGE: ALLESCHER & SCHNABL, Fung. bavar. no 423; BARTHOLOMEW, N. Amer. Ured. no.

1679 & 2478; PETRAK, Fl. Bohem. no. 906; D. SACCARDO, Myc. ital. no. 52; SCHNEIDER, Herb. no. 672, 713 & 881; SCHRÖTER, Pilze Schles. no. 306 & 440; SIEMASZKO, Fung. Bialowienses, no. 146; P. & H. SYDOW, Myc. germ. no. 768, 974 & 2093; P. & H. SYDOW, Myc. march. no. 1132; P. & H. SYDOW, Ured. no. 943, 992, 1186, 1494, 2193, 2294, 2295, 2489, 2543, 2593, 2830 & 2831; THÜMEN, Fung. austr. no. 354; THÜMEN Myc. univ. no. 42 & 1348.

Habitat in Japan

On *Asperula odorata* L. (*Kurumabasô*). Hokkaidô:—Iburi (Chitose). Ishikari (Sapporo).

On *Galium gracile* BUNGE (*Yotsuba-mugura*). Honshû:—Inaba: Tottori (HIRATSUKA, f.); Ubeno-mura (HIRATSUKA, f.).

On *Galium trifloriforme* KOM. (*Kuruma-mugura*). S. Saghalien:—Motodomari (Mt. Shiritori). Hokkaidô:—Ishikari (Mt. Kurodake, Nopporo). Tokachi (Panke-nikoro [Kuttari-mura]). Kushiro (Akan-Bokke). Kitami (Okedo-mura).

On *Galium verum* L. (*Kawara-matsuba*). S. Saghalien:—Motodomari (Noboripo). Hokkaidô:—Shiribeshi (Zenibako). Ishikari (Sapporo, Jōzankei). Tokachi (Obihiro). Honshû:—Mutsu (Yokouchi-mura). Shinano (Ariake-mura). Korea:—Kōgen (Onseiri).

This species is widely distributed throughout the northern hemisphere on various species of *Asperula*, *Galium* and *Sherardia* belonging to the family Rubiaceae.

The uredostage of the present fungus was first described by LINK in 1825, under the name of *Caeoma Galii* LINK. In 1872, SCHRÖTER treated this fungus as a new species of *Melampsora*, naming it *Melampsora guttata* SCHRÖT. It is the first recorded classification of this fungus as a species of a perfect genus. The scientific name long used for this fungus is *Thekopsora Galii*, but it should be changed, as is above used, to *Thekopsora guttata* accepting the name *Melampsora guttata* of SCHRÖTER (1872) in compliance with the International Rules.

In 1927, the writer recorded for the first time the discovery of this species in Japan, based upon a specimen on *Galium trifloriforme* collected by him at Bokke, the lake side of Akan-ko in the province of Kushiro. In the next year, he also recorded that this species occurs on *Galium verum* in South Saghalien and on *Asperula odorata* and *Galium verum* in some localities of Hokkaidô. In 1929, the writer also reported in his paper, "*Thekopsora of Japan*" that this

species had been found previously in this country on *Asperula odorata*, *Galium trifloriforme* and *G. verum*. Moreover, the writer recorded this fungus on *Galium verum* from the province of Kôgen, Korea in 1935. Recently, he also found it on *Galium gracile* in the vicinity of Tottori. The latter is a new host plant for the present species.

Through the kindness of Dr. TRANZSCHEL, the writer examined two specimens of the present species on species of *Galium*; one of them is parasitic on *Galium davuricum* which was collected by Dr. TRANZSCHEL at Nikolsk-Ussurijsky, Maritime Province of Siberia in September 1927, and the other is parasitic on *Galium paradosum* which was collected by W. KOMAROV at Mons Londoko, along the Kirma river, Amur, in August 1895. *Galium davuricum* and *G. paradosum* are also new host plants for this species.

12. *Thekopsora Gaultheriae* P. et H. SYDOW, Monogr. Ured. III, p. 466, 1915.

Syn. *Pucciniastrum Gaultheriae* P. et H. SYDOW in P. & H. SYDOW & BUTLER in Ann. Myc. V, p. 503, 1907; SACCARDO, Syll. Fung. XXI, p. 733.

Uredosori hypophyllous, maculi irregular-shaped, subepidermal, scattered or aggregate, minute, round or irregular in shape, 0.15~0.35 mm in diameter, covered by the epidermis, opening at a central pore; peridia hemispherical, firm; peridial cells comparatively large, elongated, thin-walled (about 1.5 μ thick), smooth, thickened toward the orifice; ostiolar cells echinulate-verrucose at the apex; uredospores subglobose, ellipsoidal, ovate or oblong, rarely oblong-clavate, 18~32 \times 12~18 μ ; epispore about 2 μ thick, hyaline, loosely aculeate. Teleutospores still unknown.

Hosts and Distribution

FOR THE UREDO- AND TELEUTOSTAGE:

Gaultheria nummularioides D. DON (BUTLER & BISBY 1931, p. 76; P. & H. SYDOW 1915, p. 467; P. & H. SYDOW & BUTLER 1907, p. 503)—Himalaya.

The only known locality for this species is Kumaon, Himalaya in India where it was collected on *Gaultheria nummularioides* by INAYAT. No material of this species has been examined. The description of the present species given above, is taken from its original

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description. It is said by the SYDOWS, who originally described this species, to resemble *Thekopsora sparsa* (WINT.) MAGN. in general appearance, but it differs in the size and shape of the uredospores.

13. *Thekopsora Vacciniorum* KARSTEN, Myc. Fenn. IV, p. 58, 1879; BUBÁK, Rostpilze Böhmens, p. 188, p.p.; FRAGOSO, Fl. Ibér. Ured. II, p. 268, p.p.; GROVE, Brit. Rust Fungi, p. 371, p.p.; HIRATSUKA, f. in Jour. Facul. Agric. Hokkaidô Imp. Univ. XXI, p. 20, 1927; Bot. Mag. Tokyo, XLIII, p. 15, 1929; KLEBAHN in Kryptogamenfl. Mark Brandenbr. Va, p. 840, p.p.; MIGULA, Krypt.-Fl. III, 1, p. 470, p.p.; SACCARDO, Syll. Fung. VII, p. 765, p.p.; P. & H. SYDOW, Monogr. Ured. III, p. 462, p.p.

Syn. *Uredo pustulata* PERSOON var. *Vaccinii* ALBERTINI et SCHWEINITZ, Consp. Fung. Nisk. p. 126, 1905, p.p.

Uredo Vacciniorum de CANDOLLE in Fl. franç. VI, p. 85, 1815, p.p.; COOKE, Handb. Brit. Fung. p. 527, p.p.

Caeoma Vacciniorum LINK, Sp. Pl. II, p. 15, 1825, p.p.

Melampsora Vaccinii WINTER in Pilze Deutschl. I, p. 224, 1881, p.p.

Melampsora Vacciniorum SCHRÖTER, Pilze Schles. I, p. 365, 1887, p.p.

Pucciniastrum Vacciniorum DIETEL in ENGLER-PRANTL, Natürl. Pflanzenfam. I, 1. Abt.**, p. 47, 1897, p.p.; FISCHER, Ured. Schw. p. 467, p.p.; HARIOT, Ured. p. 252, p.p.; TROTTER, Fl. Ital. Crypt. Ured. p. 384, p.p.

Uredosori hypophyllous, solitary or in small groups, subepidermal, round, minute, 0.21~0.55 mm across, long covered by the epidermis, brown to dark brown in colour; peridia hemispherical, firm, dehiscent by a central pore; peridial cells rather small, irregularly polygonal, 8~18 μ across, walls smooth, nearly colourless, rather thin; ostiolar cells comparatively large, oblong to clavate, 21.6~30.6 \times 7.2~14.4 μ , walls smooth, colourless; uredospores subglobose, ellipsoidal to broadly obovate, 18~28.8 \times 14.4~19.8 μ ; epispore thin, 1~2 μ thick, echinulate; contents orange-yellow in colour. Teleutospores still unknown.

Hosts and Distribution

FOR THE UREDO- AND TELEUTOSTAGE:

Vaccinium Vitis-Idaea L. (ARTHUR 1934, p. 19; BUBÁK 1908, p. 189; CONSTANTINEANU 1920, p. 444; COOKE 1871, p. 527; FAULL

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1930, p. 57; FISCHER 1904, p. 468; FRAGOSO 1925, p. 269; GOBI & TRANZSCHEL 1891, p. 106; GROVE 1913, p. 371; HIRATSUKA, f. 1927a, p. 21; 1927b, p. 236; 1927c, p. 309; 1928a, p. 30; 1928c, p. 566; 1929a, p. 16; 1929d, p. 104; 1933a, p. 151; 1935g, p. 137, 145, 150, 156, 162 & 214; ITÔ & HIRATSUKA, f. 1927, p. 270; JAAP 1907a, p. 263; 1911, p. 334; 1914b, p. 432; JØRSTAD 1921, p. 16; 1923b, p. 19; 1925, p. 87; 1934, p. 25; 1935, p. 66; KARSTEN 1879, p. 59; KAWAI & ÔTANI 1931, p. 240; KLEBAHN 1914, p. 841; LAMBOTTE 1880, p. 75; LAUBERT 1921, p. 241; LIND 1913, p. 295; LIRO 1908, p. 517; MAGNUS 1890, p. 30; MAYOR 1919, p. 412; MAYOR & CRUCHET 1925, p. 3; MIGULA 1910, p. 470; PICBAUER 1929, p. 11; POEVERLEIN 1926, p. [41]; RAINIO 1926, p. 254; SCHRÖTER 1887, p. 366; P. & H. SYDOW 1915, p. 464; TOGASHI 1924, p. 83; TRANZSCHEL 1914, p. 554; TROTTER 1914, p. 384; VOSS 1878, p. 92; 1889, p. 339; WILSON 1934, p. 430)—Ontario, Nova Scotia; Norway, Sweden, Finland, Denmark, Belgium, Germany, Switzerland, Russia, Czechoslovakia, Austria, Rumania, Italy, Great Britain; Siberia, Kamtchatka, Japan.

Habitat in Japan

On *Vaccinium Vitis-Idaea* L. (*Kokemomo*). *S. Saghalien*:—Motodomari (Mt. Tosso). Toyohara (Aihama, Sakaehama). Ôdomari (Ôdomari). Shisuka (Shisuka). *Hokkaidô*:—Iburi (Noboribetsu). Ishikari (Mt. Sapporo-dake, Mt. Soranuma-dake, Mt. Hakuun-dake, Mt. Kuro-dake, Mt. Ushiro-asahi-dake). Kitami (Mt. Rishiri, Rebun-Momoiwa). Tokachi (Mt. Saoro-dake). Kushiro (Mt. Oakan-dake, Mt. Meakan-dake). *Kuriles*:—Urup (Kobune-minato). *Honshû*:—Mutsu (Mt. Iwaki, Mt. Hakkôda). Rikuchû (Mt. Yakeishi-dake, Mt. Hayachine, Mt. Iwate). Shinano (Mt. Komagatake [Kiso], Mt. Tsubakuro-dake, Mt. Yatsugatake). Shimotsuke (Mt. Shirane). Suruga (Mt. Fuji). Echigo (Mt. Myôkô).

In this country, the present fungus was first recorded in 1924 by TOGASHI based upon a specimen collected at Momoiwa, Rebun Isl., province of Kitami, Hokkaidô. In 1927, the writer reported that this species is widely distributed in the mountains of Hokkaidô and of the middle and northern parts of Honshû. Then, it was also recorded by the writer from South Saghalien and the Kuriles, and by KAWAI and ÔTANI from South Saghalien. These Japanese specimens bear the uredostage only. As far as can be ascertained by the writer, the teleutostage of this fungus has not been found in any country.

From field observations made by the writer, it is evident that in northern Japan this species overwinters in the uredostage.

The present species is easily distinguished from its nearest relative, *Thekopsora Myrtillina* KARST. by the much larger uredosori.

14. *Thekopsora Fischeri* CRUCHET in Bull. Soc. Vaud. d. Sci. Nat. II, p. 77, 1916; FRAGOSO, Fl. Ibér. Ured. II, p. 271; SACCARDO, Syll. Fung. XXIII, p. 845.

Syn. *Uredo Ericae* NAUMANN in Jahresb. Vereinig. angew. Bot. IX, p. 207, 1912; P. & H. SYDOW, Monogr. Ured. IV, p. 439.

Pucciniastrum Ericae CUMMINS in Mycologia, XXVII, p. 613, 1935.

Icon. CRUCHET, l. c. p. 78, fig. 3; p. 79, fig. 4; FRAGOSO, l. c. fig. 134; NAUMANN, l. c. p. 208, fig. 4.

Uredosori hypophyllous, subepidermal, hardly visible, round, small, 0.08~0.2 mm across, slightly yellow in colour; peridia hemispherical, firm, delicate; peridial cells small, irregularly polygonal, walls smooth, thin, nearly colourless; ostiolar cells globose or subglobose, 15~22 μ in diameter, with smooth, colourless walls; uredospores irregularly ovate, obovate or subglobose, 15~25 \times 12~17 μ ; epispore thin, less than 1 μ thick, minutely echinulate, subhyaline; contents orange-yellow in colour. Teleutospores unknown.

Hosts and Distribution

FOR THE UREDO- AND TELEUTOSTAGE:

Calluna vulgaris HULL. (CRUCHET 1916, p. 78; FRAGOSO 1925, p. 272)—Spain, Switzerland.

Erica ciliaris (FRAGOSO 1925, p. 272)—France.

Erica cinerea L.—France.

Erica gracilis SALISB. (NAUMANN 1912, p. 207; P. & H. SYDOW 1924, p. 439)—Germany.

Erica hyemalis NICHOLS (DIEHL 1934, p. 613; NAUMANN 1912, p. 207; P. & H. SYDOW 1924, p. 439)—California; Germany.

This species was first described by P. CRUCHET based upon a specimen on *Calluna vulgaris* which was collected by him at Grange des Bois near Payerne (Vaud), Switzerland on October 21, 1915. Though the writer has not seen the original specimen of this species, he was, through the kindness of Dr. CRUCHET, so fortunate as to be able to examine a specimen on the same plant which was collected by CRUCHET at Les Halleryo pres Payerne (Vaud) in July 1916. More-

over, the writer also examined the following two collections, through the courtesy of Dr. MAYOR.

On *Calluna vulgaris* HULL. Bois au-dessus de Cerf seu Bevaix, coute de Neuchâtel, Switzerland, Sept. 15, 1917, leg. E. MAYOR.

On *Erica cinerea* L. Emrious de Espérausses, Tarn, France, August, 1932, leg. E. MAYOR. *Erica cinerea* has not been previously recorded as a host plant of this species, so far as the writer knows.

15. *Thekopsora Asteridis* TRANZSCHEL, nov. spec.

Soris uredosporiferis hypophyllis, rarius epiphyllis vel petioliculis, subepidermalibus, sparsis vel aggregatis, minutis, rotundatis, 0.2~0.4 mm diam.; peridiis hemisphaericis; cellulis peridiis minutis, irregulariter polygonalibus, 7~18 μ diam., parietibus levibus, tenuibus; uredosporis globosis, ellipsoideis vel obovatis, rarius angularis, 17.5~25 \times 15~20 μ ; episporio tenui, circa 1.5 μ crasso, densiuscule echinulato. Teleutosporis ignotis.

Hab. in foliis *Asteridis alpini*, *incisi*, *Maackii*, *trinervis* et *Heteropappo piopido* in Sibiria.

Uredosori hypophyllous, occasionally epiphyllous or petiolicolous, subepidermal, scattered or grouped on greenish to brownish areas of idenfinite extent, small, round, 0.2~0.4 mm across, covered by yellow to yellowish brown epidermis which ruptures at a centrally placed pore; peridia hemispherical, firm; upper peridial cells small, irregularly polygonal, 7~18 μ across, lateral ones vertically elongated, walls of peridial cells smooth, nearly colourless, somewhat overlapping; uredospores globose, ellipsoidal or obovate, sometimes somewhat angular, 17.5~25 \times 15~20 μ ; episporium thin, about 1.5 μ thick, very closely echinulate, nearly colourless. Teleutospores not seen.

Hosts and Distribution

FOR THE UREDO- AND TELEUTOSTAGE:

Aster alpinus L.—Siberia (Troitzkasavsk, Transbaikalia, Siberia, Russia, Aug., 1916, leg. P. MICHUO).

Aster incisus FISCH.—Maritime Province of Siberia (Okeanskaja near Vladivostok, Sept., 1929, leg. W. TRANZSCHEL, *type*!).

Aster Maackii RUPR.—Maritime Province of Siberia (Okeanskaja near Vladivostok, leg. W. TRANZSCHEL).

Aster trinervis ROXL.—Maritime Province of Siberia (Okeanskaja near Vladivostok, leg. W. TRANZSCHEL).

Heteropappo piopido LESS.—Maritime Province of Siberia (Okeanskaja near Vladivostok, leg. W. TRANZSCHEL).

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***Calyptospora* KÜHN, 1869**

Spermogonia epiphyllous, minute, subcuticular.

Aecidia hypophyllous, subepidermal, minute, cylindrical; peridia colourless, firm; peridial cells minute, irregularly polygonal; aecidiospores globose, subglobose to broadly ellipsoidal, contents orange-red in colour.

Teleutosori caulicolous, forming a continuous layer around the abnormally elongated and thickened stems; teleutospores intracellular, formed in the epidermal cells, subglobose, ellipsoidal, oblong or prismatic, 3~5 celled (mostly 4), with vertical septa; episporium smooth, golden-brown in colour.

TYPE SPECIES: *Calyptospora Goeppertiana* KÜHN.

1. *Calyptospora Goeppertiana* KÜHN in Hedwigia, VIII, p. 81, 1869; BUBÁK, Rostpilze Böhmens, p. 189; DIETEL in ENGLER-PRANTL, Natürl. Pflanzenfam. I, 1. Abt.***, p. 47, 1897; II. Aufl. VI, p. 39, 1928; FRAGOSO, Fl. Ibér. Ured. II, p. 274; GROVE, Brit. Rust Fungi, p. 372; KLEBAHN in Kryptogamenfl. Mark Brandenbr. Va, p. 846; MIGULA, Krypt.-Fl. III, 1, p. 471; OUDEMANS, Rév. Champ. I, p. 579; SACCARDO, Syll. Fung. VII, p. 766; SCHRÖTER, Pilze Schles. I, p. 367; P. & H. SYDOW, Monogr. Ured. III, p. 470.

Syn. *Aecidium columnare* ALBERTINI et SCHWEINITZ, Consp. Fung. Nisk. p. 121, 1805; RABENHORST, Krypt.-Fl. I, p. 20; WALLROTH, Fl. Crypt. Germ. II, p. 257.

Peridermium columnare KUNZE et SCHMIDT, Deutsch. Schwämme, no. 10, 1815; ARTHUR & KERN in Bull. Torr. Bot. Club, XXXIII, p. 432, 1906; COOKE, Handb. Brit. Fungi, p. 535.

Caeoma columnneum LINK, Sp. Pl. II, p. 66, 1825.

Uredo columnaris SPRENGEL in Syst. Veg. IV, p. 570, 1827.

Melampsora Goeppertiana WINTER in Pilze Deutschl. I, p. 245, 1881.

Melampsora columnaris WETTSTEIN in Verhandl. Zool.-Bot. Ges. Wien, XXXV, p. 551, 1885.

Calyptospora columnare KÜHN in RABENHORST, Fung. eur. no. 3521, 1886; Hedwigia, XXVI, p. 28, 1887; ARTHUR in N. Amer. Fl. VII, p. 114.

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Peridermium Holwayi P. et H., SYDOW in Ann. Myc. I, p. 19, 1903; ARTHUR & KERN in Bull. Torr. Bot. Club, XXXIII, p. 431, 1906; SACCARDO, Syll. Fung. XVII, p. 408.

Pucciniastrum Goeppertianum KLEBAHN, Wirtswechs. Rostpilze, p. 391, 1904; ARTHUR, Manual of the rusts in United States and Canada, p. 19; FISCHER, Ured. Schw. p. 466; HARIOT, Ured. p. 253; LIRO, Ured. Fenn. p. 518; TROTTER, Fl. Ital. Crypt. Ured. p. 387.

Peridermium ornamentale ARTHUR in Bull. Torr. Bot. Club, XXVIII, p. 665, 1901; N. Amer. Fl. VII, p. 646; ARTHUR & KERN in Bull. Torr. Bot. Club, XXXIII, p. 433, 1906; SACCARDO, Syll. Fung. XVII, p. 409; P. & H. SYDOW, Monogr. Ured. IV, p. 13.

Aecidium ornamentale FARLOW, Bibl. Index, I, p. 71, 1905.

Thekopsora Goeppertiana HIRATSUKA, f. in Jour. Soc. Agric. & Forestr. Sapporo, XIX, p. 167, 1927.

Icon. ADAMS in Pennsylvania State Coll. Bull. no. 160, fig. 9 (A), 1919; ALBERTINI & SCHWEINITZ, l. c. pl. V, fig. 4; ARTHUR, Manual of the rusts in United States and Canada, fig. 30; BUBÁK, l. c. fig. 46; DELACROIX & MAUBLANC, Malad. pl. cult. malad. parasit. pl. XXXI, fig. 4~7, 1909; DIETEL in ENGLER-PRANTL, Natürl. Pflanzenfam. I, 1. Abt.**., fig. 29 (A, B, C); II. Aufl. VI, fig. 28 (A, B, C); FISCHER, l. c. fig. 304; FRANK, Krankh. Pfl. fig. 85, 1880; GROVE, l. c. fig. 278; HARIOT, l. c. fig. 30; HARTIG, Lehrb. Pflanzenkr. fig. 121~125, 1900; HIRATSUKA, f. in Jour. Jap. Bot. IX, p. 276, fig. 1 & 2; p. 277, fig. 3 & 4, 1933; HUNTER in Bot. Gaz. LXXXIII, pl. II, fig. 7, 1927; KLEBAHN in Kryptogamenfl. Mark Brandenbr. Va, p. 856, fig. T, 1 (I~III); LINHART, Fung. hung. no. 44; MIGULA, l. c. pl. X, E, fig. 1 & 2; NEGER, Krankh. Waldb. fig. 180, 1919; SORAUER, Handb. Pflanzenkr. III. Aufl. II, p. 358, fig. 12; P. & H. SYDOW, Monogr. Ured. III, pl. XX, fig. 163; TROTTER, l. c. fig. 8, 10, 34 & 97; TUBEUF, Pflanzenkr. fig. 179~182, 1895; WEIR in Mycologia, XVIII, pl. XXXIV, fig. 1~6 & pl. XXXV, fig. 1~3, 1926.

Spermogonia on needles of current season, epiphyllous, inconspicuous, subcuticular, minute, 42~140 μ broad, 12~30 μ high, brownish or black in colour; spermatia oval, colourless.

Aecidia on needles of current season, hypophyllous, not changing form of leaf, in two irregular rows, on yellowish discoloured portions of effected needles, cylindrical, 0.5~1.5 mm high, 0.08~0.18 mm in diameter, orange-yellow in colour; peridia colourless, rupturing at the apex, margin irregularly lacerate; peridial cells irregularly

polygonal, 35~60 \times 16~24 μ , overlapping, both outer and inner walls rather thin, 1.5~3 μ thick, finely and rather closely verrucose on inner face; aecidiospores globose, subglobose or broadly ellipsoidal, 18~24 \times 13~18 μ ; epispore colourless, thin, 1~1.5 μ thick, finely and rather closely verrucose; contents orange-red fading to pale yellow in colour.

Teleutosori caulicolous, from a perennial mycelium, forming a continuous layer around the abnormally elongated and thickened stems, surface even, polish reddish brown, becoming dull; teleutospores within the epidermal cells, subglobose, ellipsoidal, oblong or prismatic, closely pressed, usually 3~5 celled (mostly 4), with vertical septa, 18~36 \times 12~24 μ ; epispore thin, less than 1 μ thick, slightly thicker at apex, 1~3 μ , smooth, golden-brown in colour, a single germ pore at the apex of each cell. (Plate XI, fig. 2~5)

Hosts and Distribution

FOR THE AECIDIAL STAGE:

Abies alba MILL. (*A. pectinata* DC.) (ARTHUR 1907, p. 114; BUBÁK 1898, p. 19; 1906, p. 154; 1908, p. 190; BUBÁK & KABÁT 1906, p. [5]; CONSTANTINEANU 1920, p. 444; FISCHER 1904, p. 467; FRAGOSO 1925, p. 275; GROVE 1913, p. 373; KLEBAHN 1914, p. 846; MAGNUS 1894, p. 54; MIGULA 1910, p. 471; OUDEMANS 1919, p. 349; PICBAUER 1927, p. 439; SCHRÖTER 1887, p. 367; P. & H. SYDOW 1915, p. 472; TROTTER 1914, p. 388; WILSON 1934, p. 430; WINTER 1881, p. 245)—Germany, Switzerland, Czechoslovakia, Italy, Rumania, Great Britain.

Abies amabilis FORBES (ARTHUR 1925, p. 682; 1934, p. 19; HOTSON 1925, p. 282; 1934, p. 117; SEYMOUR 1929, p. 62)—Washington.

Abies balsamea MILL. (ADAMS 1919, p. 21; ARTHUR 1925, p. 682; 1934, p. 19; FRAGOSO 1925, p. 275; FRASER 1912, p. 177 & 192; 1914, p. 27 & 28; KERN, THURSTON Jr., ORTON & ADAMS 1929, p. 6; RHOADS, HEDGCOCK, BETHAL & HARTLEY 1918, p. 332; SEYMOUR 1929, p. 63; P. & H. SYDOW 1915, p. 472)—Pennsylvania, Wisconsin; Nova Scotia, Quebec, Saskatchewan.

Abies concolor LINDL. et GORD. (ARTHUR 1924c, p. 646; 1934, p. 19; BLASDALE 1919, p. 107; HOTSON 1934, p. 117; RHOADS, HEDGCOCK, BETHAL & HARTLEY 1918, p. 332; SEYMOUR 1929, p. 64)—California, Oregon.

Abies Fraseri LINDL. (ARTHUR 1910, p. 231 & 240; FRAGOSO

1925, p. 275; RHOADS, HEDGCOCK, BETHAL & HARTLEY 1918, p. 332; SEYMOUR 1929, p. 65; P. & H. SYDOW 1915, p. 472)

Abies grandis LINDL. (HOTSON 1934, p. 117; JACKSON 1918b, p. 205; RHOADS, HEDGCOCK, BETHAL & HARTLEY 1918, p. 332, & 336; SEYMOUR 1929, p. 65)—Oregon, Washington.

Abies lasiocarpa NUTT. (*A. subalpina* ENGELM.) (ARTHUR 1901, p. 665; 1924c, p. 646; 1925, p. 682; 1934, p. 19; ARTHUR & KERN 1906, p. 432; HOSTON 1925, p. 282; 1934, p. 117; RHOADS, HEDGCOCK, BETHAL & HARTLEY 1918, p. 332 & 336; SEYMOUR 1929, p. 66; WEIR 1926, p. 274)—Colorado, Idaho, Montana, Oregon, Washington, Wyoming; Alberta, British Columbia.

Abies magnifica MURR. (ARTHUR 1925, p. 682; 1934, p. 19; BLASDALE 1919, p. 107; HOTSON 1934, p. 117; JACKSON 1918b, p. 205; RHOADS, HEDGCOCK, BETHAL & HARTLEY 1918, p. 332; SEYMOUR 1929, p. 67)—California, Oregon.

Abies nobilis LINDL. (RHOADS, HEDGCOCK, BETHAL & HARTLEY 1918, p. 332; SEYMOUR 1929, p. 67)

Abies Nordmanniana SPACH (GROVE 1913, p. 373; WILSON 1934, p. 430)—Great Britain.

Abies sachalinensis Fr. SCHM. (HENNING 1900b, p. 147; HIRATSUKA, f. 1929b, p. 121; 1930a, p. 85; 1935g, p. 216; KAWAI & ÔTANI 1931, p. 238)—Japan.

Abies sibirica LEDEB.—Siberia (Distr. Tara, Siberia, July, 1921, leg. K. E. MURASHKINSKY).

FOR THE TELEUTOSTAGE:

Vaccinium caespitosum MICHX. (ARTHUR 1925, p. 682; 1934, p. 20; HOTSON 1934, p. 66; SEYMOUR 1929, p. 553)—Montana, California, Utah, Oregon.

Vaccinium canadense RICH. (ARTHUR 1907, p. 114; 1934, p. 20; DAVIS 1931, p. 260; SEYMOUR 1929, p. 553; P. & H. SYDOW 1915, p. 472)—Massachusetts, Wisconsin, Maine.

Vaccinium Chandleri JEPS. (ARTHUR 1907, p. 114; 1934, p. 20; BLASDALE 1919, p. 107; SEYMOUR 1929, p. 554; P. & H. SYDOW 1915, p. 472)—California.

Vaccinium corymbosum L. (ADAMS 1919, p. 20; ARTHUR 1907, p. 114; 1934, p. 20; KERN, THURSTON Jr., ORTON & ADAMS 1929, p. 6; SEYMOUR 1929, p. 554; P. & H. SYDOW 1915, p. 472)—Massachusetts, Pennsylvania.

Vaccinium macrophyllum PIPER (HOTSON 1925, p. 282; 1934, p.

67; JACKSON 1918b, p. 205; SEYMOUR 1929, p. 555)—Oregon, Washington.

Vaccinium membranaceum DOUGL. (*V. myrtilloides* S. WATS.) (ARTHUR 1907, p. 114; 1934, p. 20; BLASDALE 1919, p. 107; HOSTON 1934, p. 67; JACKSON 1918b, p. 205; SEYMOUR 1929, p. 555; P. & H. SYDOW 1915, p. 472; WEIR 1926, p. 274)—Idaho, Washington, California, Montana, Oregon, Wyoming.

Vaccinium microphyllum RYDB. (SEYMOUR 1929, p. 555; WEIR 1918, p. 11)

Vaccinium Myrtillus L. (TROTTER 1914, p. 388)—Italy.

Vaccinium oreophilum RYDB. (*V. Myrtillus* A. GRAY) (ARTHUR 1907, p. 114; 1934, p. 20; HOTSON 1934, p. 67; SEYMOUR 1929, p. 555; P. & H. SYDOW 1915, p. 472)—Colorado, Montana, Washington; Alberta.

Vaccinium ovalifolium SM. (ARTHUR 1925, p. 682; 1934, p. 20; HOSTON 1925, p. 282; 1934, p. 67; JACKSON 1918b, p. 205; SEYMOUR 1929, p. 555)—Alaska; California, Oregon, Washington.

Vaccinium ovatum PURSH. (ARTHUR 1907, p. 114; 1934, p. 20; BLASDALE 1919, p. 107; HIRATSUKA, f. 1933b, p. 276; HOTSON 1925, p. 282; 1934, p. 67; JACKSON 1918b, p. 205; PATTERSON 1902, p. 8; SEYMOUR 1929, p. 553; P. & H. SYDOW 1915, p. 472)—Washington, California, Oregon.

Vaccinium parvifolium SM. (ARTHUR 1907, p. 114; 1934, p. 20; BLASDALE 1919, p. 107; HOTSON 1925, p. 282; 1934, p. 67; JACKSON 1918b, p. 205; PATTERSON 1902, p. 8; SEYMOUR 1929, p. 556; P. & H. SYDOW 1915, p. 472)—Washington, Oregon, California.

Vaccinium pennsylvanicum LAM. (*V. angustifolium* AIT.) (ARTHUR 1907, p. 114; 1910, p. 231 & 240; 1934, p. 20; DAVIS 1931, p. 260; FRASER 1912, p. 177 & 192; 1914, p. 27 & 28; POVAH 1935, p. 135; SEYMOUR 1929, p. 556; P. & H. SYDOW 1915, p. 472)—New Hampshire, Vermont, Michigan, Massachusetts, Wisconsin, Maine; Newfoundland, Nova Scotia, Ontario.

Vaccinium scoparium LEIBERG (*V. erythrocoecum* RYDB.) (ARTHUR 1925, p. 682; 1934, p. 20; HOTSON 1934, p. 67; JACKSON 1918b, p. 205; SEYMOUR 1929, p. 556; P. & H. SYDOW 1915, p. 472)—Colorado, Montana, New Mexico, Oregon; Alberta.

Vaccinium vacillans KALM. (SEYMOUR 1929, p. 556)

Vaccinium Vitis-Idaea L. (ARTHUR 1907, p. 114; 1934, p. 20; BECK 1889, p. 600; BUBÁK 1898, p. 19; 1899, p. 20; 1906, p. 154;

1908, p. 190; 1915, p. [48]; FISCHER 1904, p. 467; FRAGOSO 1925, p. 275; FREEMAN 1901, p. 540; GROVE 1913, p. 373; HARIOT 1908, p. 253; HEIM 1927, p. 93; HIRATSUKA, f. 1927b, p. 233; 1927c, p. 310; 1928a, p. 31; 1929c, p. 62; 1930a, p. 85; 1933a, p. 151; 1933b, p. 277; 1935g, p. 137, 150, 156, 162 & 216; JAAP 1906, p. 123; 1908, p. 201; 1914b, p. 432; KAWAI & ÔTANI 1931, p. 238; KLEBAHN 1914, p. 846; LIRO 1908, p. 518; MAGNUS 1894, p. 54; 1900, p. 20; MAYOR 1919, p. 412; MAYOR & CRUCHET 1925, p. 3; MIGULA 1910, p. 471; MURASHKINSKY & SIELING 1928, p. [5]; NAGAI & SHIMAMURA 1933, p. 84; PETRAK 1920, p. 132; PICBAUER 1927, p. 439; 1929, p. 11; 1930, p. 136; 1933a, p. 6; POEVERLEIN 1926, p. [41]; POEVERLEIN & BERTSCH 1927, p. 196; SCHRÖTER 1887, p. 367; P. & H. SYDOW 1915, p. 472; TROTTER 1914, p. 388; VOSS 1889, p. 339; WETTSTEIN 1885, p. 551; 1888, p. 173; WILSON 1934, p. 430; WINTER 1881, p. 245)—Alaska; Minnesota, New Hampshire, Saskatchewan; Great Britain, France, Holland, Belgium, Denmark, Austria, Hungary, Germany, Czechoslovakia, Yugoslavia, Poland, Italy, Switzerland, Finland, Russia, Norway, Sweden; Siberia, North Saghalien, Japan.

Vaccinium sp. (TROTTER 1914, p. 388)—Italy.

Vaccinium sp. (THURSTON Jr. & KERN 1931, p. 78)—Wyoming.

Exsiccati. FOR THE AECIDIAL STAGE: ALLESCHER & SCHNABL, Fung. bavar. no. 424; BARTHOLOMEW, Fung. Columb. no. 4609; BARTHOLOMEW, N. Amer. Ured. no. 1203 & 2107; COOKE, Fung. brit. no. 314; KRIEGER, Fung. saxon. no. 1154; RABENHORST, Fung. eur. no. 3316 & 3521; P. & H. SYDOW, Myc. march. no. 4121; P. & H. SYDOW, Ured. no. 90 & 2240; VESTERGREN, Micromyc, rar. sel. no. 754. FOR THE TELEUTOSTAGE: ALLESCHER & SCHNABL, Fung. bavar. no. 121; BARTHOLOMEW, Fung. Columb. no. 3104 & 4610; BARTHOLOMEW, N. Amer. Ured. no. 104, 303, 403, 1204, 1704, 1705 & 2611; CLEMENTS, Crypt. Form. Colo. no. 589; ELLIS, N. Amer. Fung. no. 1073; ELLIS & EVERHART, Fung. Columb. no. 555; KRIEGER, Fung. saxon. no. 517; KUNZE, Fung. sel. no. 231; LINHART, Fung. hung. no. 44; PETRAK, Fl. Bohem. no. 651; RABENHORST, Fung. eur. no. 1384, 2543 & 3521; RACIBORSKI, Fung. polon. no. 23; ROUMEGUÈRE, Fung. gall. no. 3720; D. SACCARDO, Myc. ital. no. 712; SCHNEIDER, Herb. no. 669; P. & H. SYDOW, Myc. germ. no. 765; P. & H. SYDOW, Myc. march. no. 3239; P. & H. SYDOW, Ured. no. 44, 1743 & 1792; THAXTER, Rel. FARL. no. 210; THÜMEN, Fung. austr. no. 393; THÜMEN, Myc. univ. no. 1052; Krypt. exs. Vindob. no. 816; Fl. exs. Austr.-Hung. no. 773; Pacific Slope Fung. no. 3719.

Habitat in Japan

On *Abies sachalinensis* Fr. SCHM. (*Aka-todomatsu*). *S. Saghalien*:—Ôdomari (Ôdomari). Toyohara (Sakaehama). Shisuka (Shisuka).

On *Vaccinium Vitis-Idaea* L. (*Kokemomo*). *S. Saghalien*:—Ôdomari (Ôdomari). Toyohara (Sakaehama, Aihama). Motodomari (Mt. Tosso, Mt. Nupuripo, Mt. Kashipo, Mt. Shiritori, Manui). Shisuka (Shisuka). Tomarioro (Mt. Ushoro, Ambetsu). *Kuriles*:—Kunashiri (Mt. Chacha-nupuri). *Hokkaidô*:—Ishikari (Mt. Hakuundake). Kushiro (Mt. Oakan-dake, Akan-Kutcharo-sandô). Tokachi (Mt. Upepesanke, Mt. Tsurugi). *Honshû*:—Shinano (Mt. Komagatake [Kiso], Mt. Tsubakuro-dake, Mt. Yatsugatake). Shimotsuke (Mt. Shirane). Suruga (Mt. Fuji). *Korea*:—Kannan.

The present species is widely distributed in the northern hemisphere, especially on *Vaccinium Vitis-Idaea*.

HARTIG (1880) was the first to prove the relation of the aecidiospores on *Abies alba* to the teleutospores on *Vaccinium Vitis-Idaea*, by transferring cultures in both directions. KÜHN, BUBÁK and WINTER fully verified the results of HARTIG. The most extensive cultures were made by WINTER in 1885 and 1886 in the garden of the Experiment Station at Halle, Germany. He successfully sowed the teleutospores from *Vaccinium Vitis-Idaea* on thirteen different species of *Abies*.

ARTHUR in 1909 made the first culture with American material, infecting *Abies Fraseri* with teleutospores on *Vaccinium pennsylvanicum*. In 1911 and again in 1913, FRASER also infected on *Abies balsamea* with teleutospores from *Vaccinium pennsylvanicum*. In 1926, WEIR reported that aecidia on *Abies lasiocarpa* and teleutospores on *Vaccinium membranaceum* were used to obtain infections in both directions.

The infected branches or stems of *Vaccinium* stand perfectly erect; the host plant becomes taller and leaves stunted. The mycelium is perennial in *Vaccinium*, producing fresh teleutospores year after year; this may be the origin of the erroneous statement in the Kew Bulletin (1907) that the basidiospores are able to infect the *Vaccinium* again, as well as *Abies*. This statement was originally made by HARTIG, but is unsupported by any experimental evidence.

Until the report of WEIR and HUBERT was made in 1918, the spermogonia of this fungus had not been recorded for a long time.

However, they found the spermogonia in a collection on *Abies grandis* made by WEIR at Columbia Falls, Montana, and reported them the first time in *Phytopathology*, vol. VIII, 1918. They also reported that *Peridermium Holwayi* P. et H. SYD., *P. ornamentale* ARTH. and *P. columnare* KZE. et SCHM. are to be considered identical.

As far as the writer knows, it has been shown that the aecidial stage can be developed in artificial cultures on the leaves of *Abies*, but not on *Tsuga* or *Pseudotsuga*. SACCARDO's citation of "*Abies canadensis*" (*Tsuga canadensis*) in the *Sylloge Fungorum* and STANDLEY's record of *Pseudotsuga mucronatum* are probably errors.

Through the courtesy of Prof. MURASHKINSKY, a specimen of the present species on *Abies sibirica* LEDEB. collected by him in Siberia has been examined by the writer. *Abies sibirica* has not previously been recorded as a host plant of this species, so far as the writer knows.

In Japan, HENNINGS in 1900 first recorded the aecidial stage of the present species on *Abies sachalinensis* collected by M. SHIRAI in Hokkaidô. But the specimen has not been examined by the writer. The teleutostage of this fungus was for the first time recorded from this country by the writer in 1927, based upon a specimen on *Vaccinium Vitis-Idaea* which was collected by himself at the top of Mt. Oakan-dake in the province of Kushiro, Hokkaidô. It is rather common on *Vaccinium Vitis-Idaea* in the higher mountains in the middle districts of Honshû, Hokkaidô, S. Saghalien, Korea and the Kuriles in this country.

In Japan, no inoculation experiment with the present fungus has yet been made. Field observations, however, point to an aecidial connection on *Abies sachalinensis* in S. Saghalien. Near Ôdomari, S. Saghalien in 1927, the writer collected this fungus on *Vaccinium Vitis-Idaea* in direct association with a *Peridermium* on the needles of *Abies sachalinensis*. The microscopical character of this aecidial stage on the latter host fully agrees with the aecidial stage of the present species on *Abies alba* from Europe.

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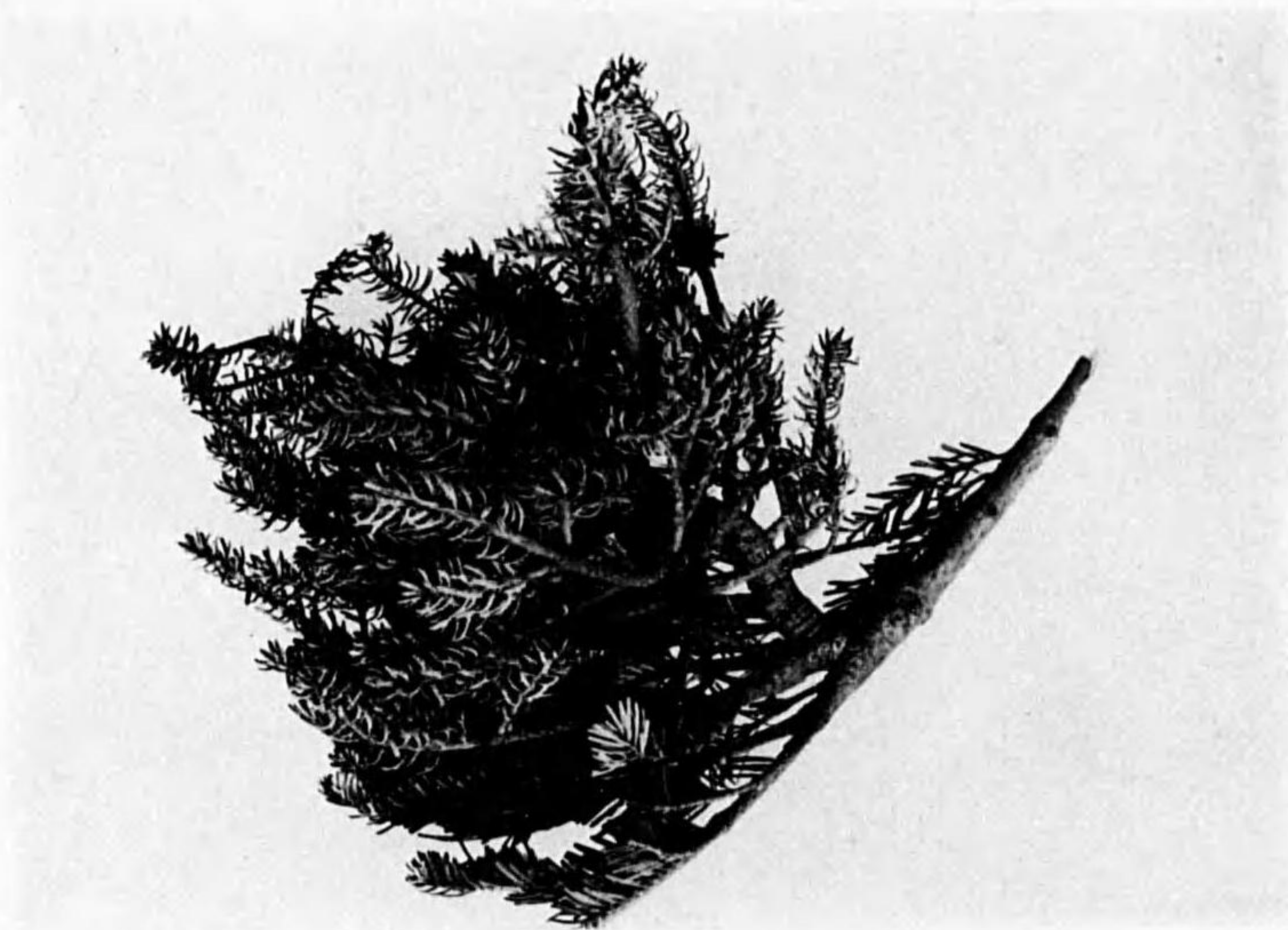
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Plate I

In Botanical Laboratory,
Tottori Agricultural College,
Tottori, Japan
April 15, 1936

EXPLANATION OF PLATE I

- Fig. 1. Witches' broom of *Abies Veitchii* which is caused by the aecidial stage of *Melampsorella Caryophyllacearum* SCHRÖT. (Mt. Komagatake, Shinano, Japan, Aug., 1932, leg. HIRATSUKA, f.). Reduced.
- Fig. 2. The aecidial stage of *Melampsorella Caryophyllacearum* SCHRÖT. on a twig of *Abies Veitchii*. (Mt. Komagatake, Shinano, Japan, Aug., 1932, leg. HIRATSUKA, f.). Reduced.
- Fig. 3. ditto.



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Plate II

EXPLANATION OF PLATE II

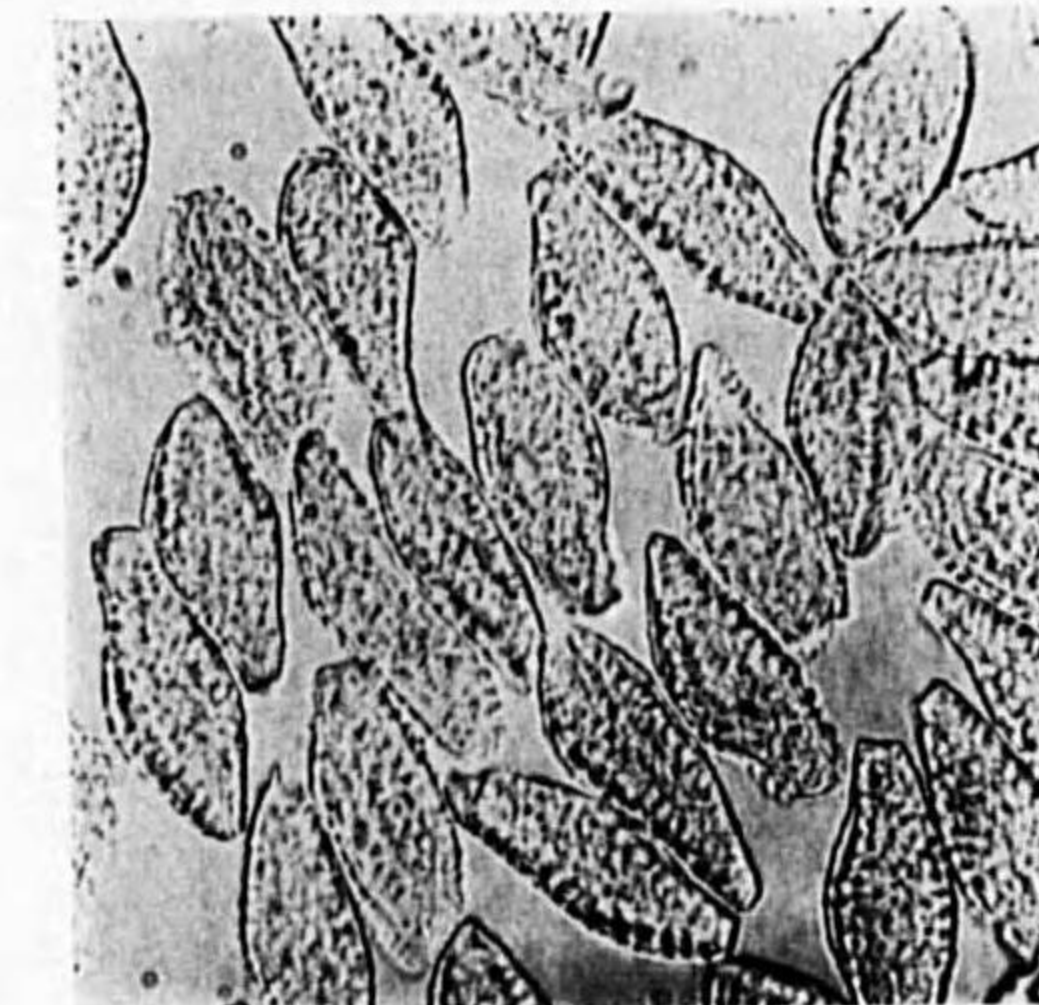
- Fig. 1. Uredospores of *Uredinopsis flicina* (NIESSL) MAGN. on *Dryopteris Phegopteris*. (Heinchen, Kreis Siegen, Westfalen, Germany, July, 1922, leg. A. LUDWIG). $\times 420$.
- Fig. 2. Uredospores of *Uredinopsis macrosperma* MAGN. on *Pteridium* sp. (Rio de Janeiro, Brazil, Aug., 1921, leg. E. W. D. HOLWAY). $\times 420$.
- Fig. 3. Uredospores of *Uredinopsis Struthiopteridis* STÖRM. on *Matteuccia Struthiopteris*. (Hudson, Prince Edward Island, Canada, July, 1913, leg. W. P. FRASER). $\times 420$.
- Fig. 4. Uredospores of *Uredinopsis Copelandi* P. et H. SYD. on *Athyrium Filix-foemina*. (Ingleby, Center Co., Penn., U.S.A., July, 1931, leg. H. W. THURSTON Jr.). $\times 420$.
- Fig. 5. Uredospores of *Uredinopsis hirosakiensis* KAMEI et HIRATSUKA, f. on *Dryopteris Thelypteris*. (Mt. Komagatake, Shinano, Japan, Aug., 1932, leg. HIRATSUKA, f.). $\times 420$.
- Fig. 6. Uredospores of *Uredinopsis Woodsiae* KAMEI on *Woodsia polystichoides* var. *nudiuscula*. (Jōzankei, Ishikari, Japan, Oct., 1924, leg. HIRATSUKA, f.). $\times 420$.



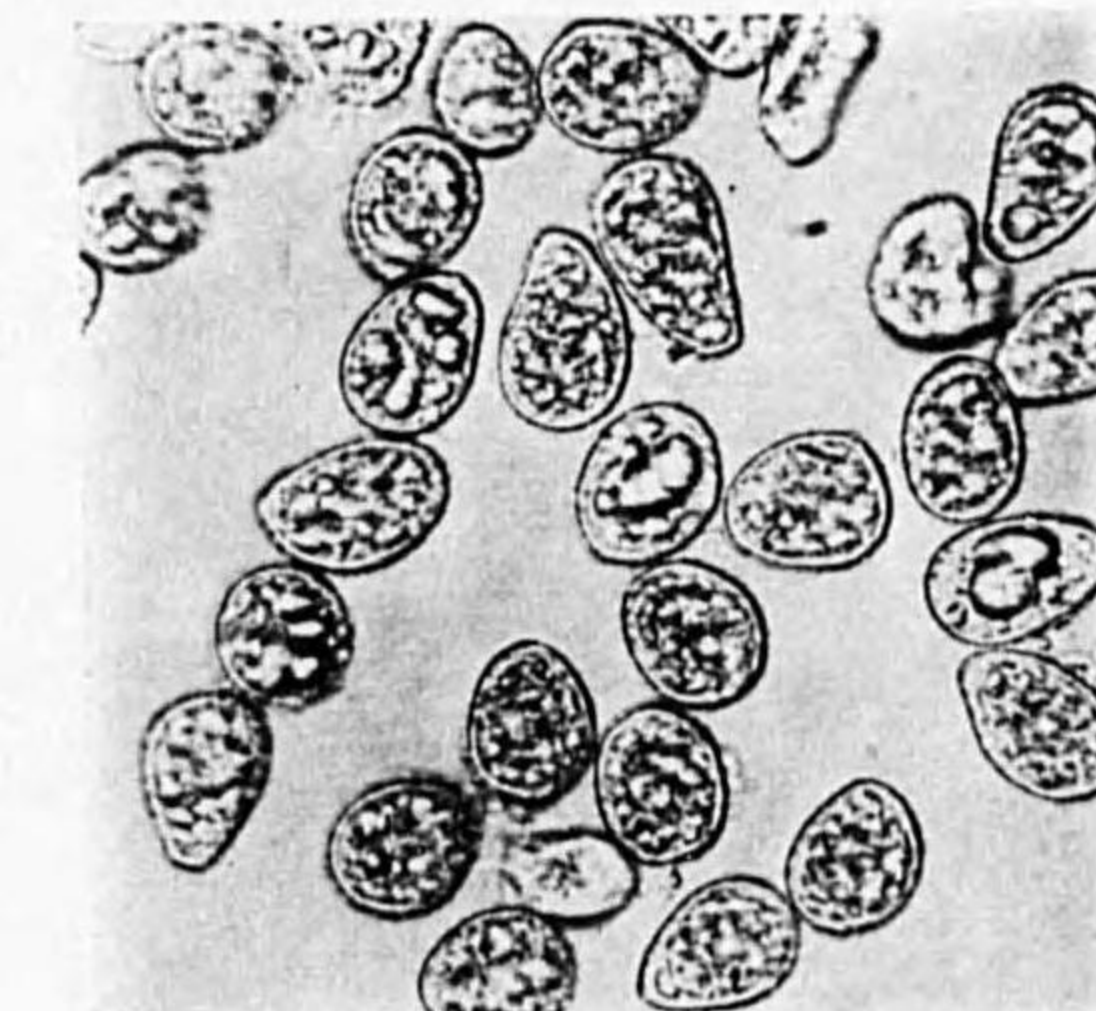
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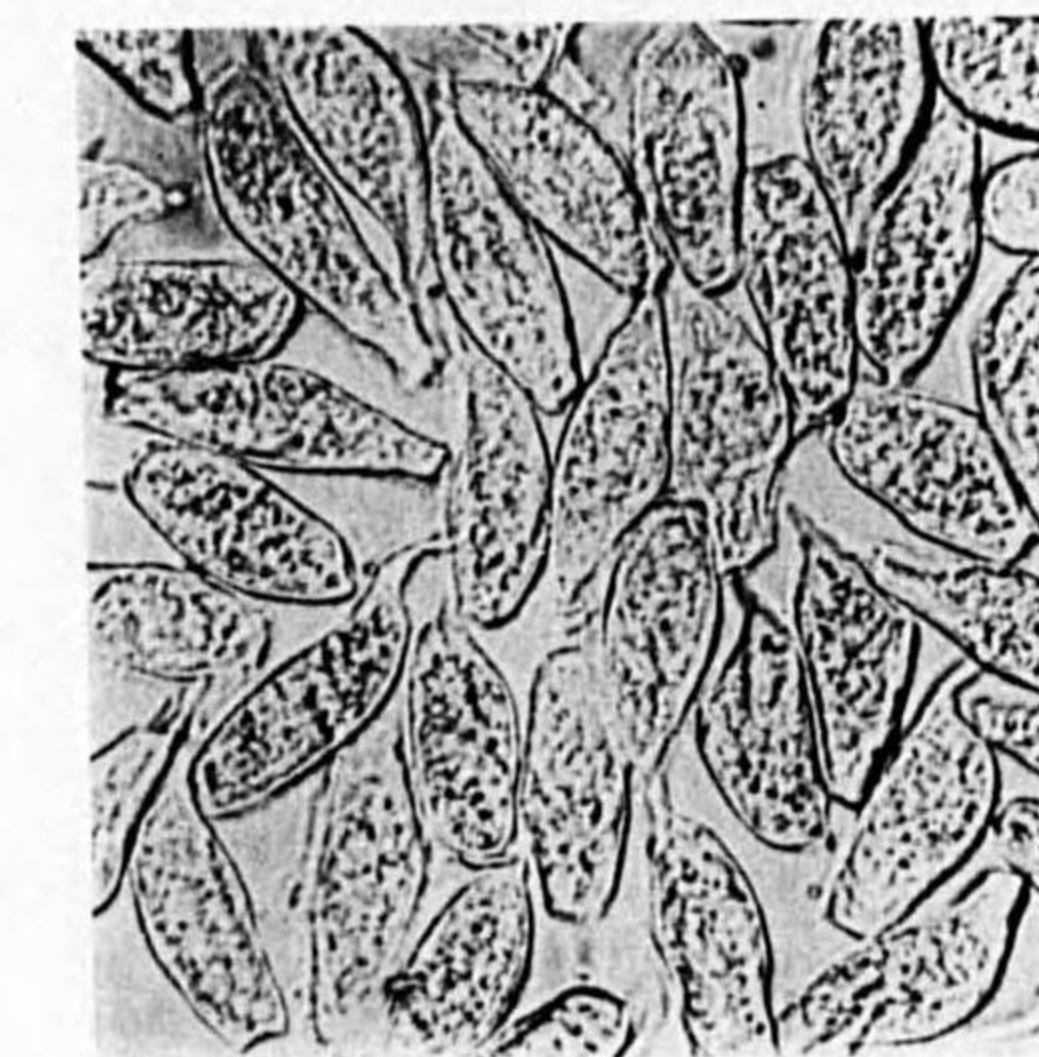
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Plate III