New and unidentified Species of Synchytrium. IV.*)

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This paper is a further contribution to the knowledge of new and unidentified species of *Synchytrium* which are deposited in herbaria in the United States and elsewhere, and is part of an overall study in the preparation of a monograph of the genus. Except for *S. helianthemum* the species described herewith were studied from the dried herbarium material after which heavily infected bits of the host were soaked in water, fixed in a vacuum to remove air, embedded, sectioned at 7 μ and stained, as described previously by the author (1955—1956). Apparently, shrinkage from drying occurs in herbarium specimens, so that the dimension of the prosori, sori, sporangia and resting spores given below may be smaller than they are in living material.

Synchytrium oreganum sp. nov.

Prosorus subsphaericis, sphaericis, 120—186 μ diam., parietibus 2—2.5 μ crasso; soris subsphaericis, sphaericis, 140—195 μ diam., ovalibus, 132—140 ⇌ 160—180 μ diam.; sporangiis numerosis, 20—60, polyhedris, 25—54 μ diam.; sporis perdurantibus subsphaericis, sphaericis, 130—150 μ, parietibus laevis, brunneo, 3.8—4.2 μ crasso; germinatione ignoto.

Specimen typicum in Herb. Cornell Univ. conservatum, no. 15598.

Prosori solitary, enveloped by small amount of residue, subsphaerical, 120—186 μ, with a light-amber wall, 2—2.5 μ thick; lying in base of infected cell when empty. Sori enveloped by a sparse amount of residue, spherical, 140—195 μ, or ovoid, 132—140 ⇌ 160—180 μ, with a hyaline wall. Sporangia 20—60 per sorus, polyhedral and very irregular in shape, 25—54 μ in greatest diam., exceptionally large ones 60—84 μ diam., with hyaline walls and yellowish-orange content. Resting spores partly filling host cell, spherical, 130—150 μ, or slightly ovoid, 122—138 ⇌ 140—156 μ, with a smooth reddish-brown wall, 3.8—4.2 μ thick; enveloping residue sparse; germination unknown.

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Compositely dihomeogallic, galls abundant on both surfaces of leaves and on petioles, separate and scattered, or frequently crowded and confluent, protruding conspicuously. Sporangial galls light-yellow, dome-shaped, hemispherical, or subspherical, 170—306 μ high by 234—300 μ broad, with a sheath 2—4 cells thick; sheath cells greatly enlarged and fairly thick-walled. Resting spore galls reddish-brown to slightly lavender, usually of same shape as sporangial galls, 220—252 μ high by 260—288 μ broad; sheath 2—4 cells thick.

On the leaves and petioles of *Potentilla uniflora,* Corvallis, Oregon, U.S.A. (Leg. F. Weiss, 4-26-1927.)

This is the first long-cycled species to be reported on *Potentilla* and the only one with a prosorus in the summer phase which is known to occur on species of the Rosaceae. *Synchytrium fragariae* on *Fragaria* sp. is long-cycled also, but it's initial cell develops directly into a sorus of sporangia. The other species, *S. aureum, S. cupulatum, S. duchesniae, S. ulmariae, S. pilificum, S. globosum, S. potentillae* and *Synchytrium* spp., which have been reported on the Rosaceae are short-cycled and develop only resting spores. Accordingly, *S. oreganun* differs markedly from these fungi and is therefore, regarded as a different species. Although germination of its resting spores is unknown, it is placed temporarily in the subgenus *Microsynchytrium.*

Synchytrium helianthemum nom. nov.

Syn.: *S. aureum* Rayss, 1942. Palestine Jour. Bot. **2**: 247.

Empty collapsed prosori lying in apex of infected cell above sori; enveloped usually by residue. Sori spherical 110—130 μ, usually ovoid 90—108 ⇌ 112—135 μ. Plug between empty prosori and sori, 5—7 ⇌ 12—14 μ. Sporangia 28—48 per sorus, polyhedral, 24—52 μ in greatest diam., with thin hyaline walls. Resting spores usually solitary, rarely 2—3, filling only part of host cell, spherical, 83—96 μ, usually ovoid, 58—75 ⇌ 86—98 μ, occasionally plano-convex, 60—75 ⇌ 90—108 μ, with a smooth amber wall, 4—4.8 μ thick; enveloped by a dense, resin-like, amber-red to reddish-brown residue which is very abundant as a cone shaped cap in apex of infected cell; germination unknown.

Compositely dihomeogallic, galls reddish-brown, separate and scattered or crowded and confluent, usually buried in the host tissue and protruding only slightly, sometimes hemispherical and protruding fairly conspicuously on surface of leaf. Sporangial galls broadly pyriform or subspherical, 192—234 μ high by 195—260 μ broad with a sheath 4—6 cells thick, sheath consisting usually of a layer of outer thin-walled cells and an inner layer of thick-walled cells which are lignified. Resting-spore galls broadly pyriform to subspherical, 208—312 μ high by 208—260 μ broad; sheath 4—7 cells

thick and usually 3-layered, an outer thin-walled layer, a middle thick-walled layer of cells filled with a resin-like reddish-brown substance, and an inner very thin-walled layer.

On leaves, sepals, petioles and stems of *Helianthemum salicifolium,* Innaba and Wadi Fara, Israeli, causing thickening and crinkling of leaves.

This diagnosis is based on prepared slides and embedded material which Dr. M. T. Cook sent me shortly before his death and which he had received earlier from Prof. T. Rayss of the Hebrew University, Jerusalem. Rayss reported it briefly as *S. aureum,* but in Cook's slides empty prosori, sori, sporangi and resting spores are present and show that this fungus is a long-cycled species. In all of the sporangial galls an empty collapsed vesicle is present in the apex of the host cell above the sorus, and I interpret this to mean that the initial cell functions as a prosorus, although no migration states were found. Accordingly, *S. helianthemum* is placed temporarily in the subgenus *Microsynchytrium* until germination of its resting spores has been observed.

The galls caused by this species are usually embedded largely in the host tissue, and under low magnification of cross sections of the leaf look somewhat like pyriform islands or aggregations of proliferated cells. They consist of the greatly enlarged flask-shaped infected cells and a surrounding sheath of relatively small, frequently divided epidermal, palisade and mesophyll cells. Usually, in the sporangial galls the sheath is made up of an outer layer of thin-walled cells and an inner layer of cells whose walls are usually thick, lignified and rarely perforated by scalariform openings. These cells may sometimes be filled with a dense reddish-brown substance but usually they appear to be almost empty. In resting-spore galls, however, they are nearly always filled with this reddish-resin-like material, and as a result the galls stand out sharply in sections of the leaf. On each side of the thick-walled cells is a layer of thin-walled cells, so that the sheath in resting-spore galls appears to be 3-layered. The cells of the inner layer are very thin-walled and quite delicate in structure.

Synchytrium helianthemum is the only species besides *S. aureum* which is reported to occur on *Helianthemum* or any other member of the family Cistaceae. Inasmuch as it is long-cycled it is obviously different from *S. aureum.*

Synchytrium africanum sp. nov.

Soris ovalibus, 115—130 ⇌ 175—208 μ diam.; sporangiis polyhedris, 38—57 μ; sporis perdurantibus sphaericis, 130—160 μ, ovalibus, 110—120 ⇌ 132—168 μ, parietibus laevis, brunneo, 3.5—4.6 μ crasso; germinatione ignoto.

Specimen typicum in Herb. New York Bot. Gard.

Prosori lying above sorus in apex of infected cell when empty and collapsed. Sori usually ovoid, 115—130 ⇌ 175—208 μ, with a hyaline to light-amber wall, 2—2.3 μ thick. Sporangia up to 60 in a sorus, polyhedral, 38—57 μ in greatest diameter, with hyaline walls and yellowish orange content. Zoospores unknown. Resting spores solitary, not filling host cell completely, spherical, 130—160 μ, or ovoid, 110—120 ⇌ 132—168 μ, with a smooth, amber wall, 3.5—4.6 μ thick, and yellowish content; enveloping residue sparse, usually lacking; germination unknown.

Compositely dihomeogallic, galls separate and scattered, or crowded and confluent, buff to yellowish when young but becoming purplish when mature, subspherical to hemispherical and mound-shaped with a well-defined apical crater, largely superficial and protruding conspicuously on surface of leaves. Sporangial galls 192—260 μ high by 246—480 μ broad, becoming cupulate after dehiscing; sheath 4—8 cells thick, sheath cells greatly enlarged. Resting-spore galls 208—234 μ high by 296—340 μ broad; sheath 5—8 cells thick, sheath cells greatly enlarged.

On leaves and petioles of *Helianthemum aculeatum,* North Africa. (Leg. R. M a i r e, 3-3-1917).

Maire labeled this species *S. aureum* but the presence of empty prosori, sori, sporangia and resting spores in his material shows that it is a long-cycled species which probably belongs in the subgenus *Microsynchytrium.* It differs from *S. helianthemum* by its slightly larger sporangia, much larger resting spores, and the effects produced on its host. In *S. helianthemum* the induced galls are largely embedded in the leaf, while in *S. africanum* they are largely superficial and protrude conspicuously. Occasionally, they may project on both surfaces of the leaf, and their appearance is quite different from the galls caused by *S. helianthemum.* Also, the sheath is not differentiated into layers of thin- and thick-walled cells.

M a i r e also collected, 4-13-1913, another fungus on *Helianthemum echioideum* at Zeralda, Africa (Mycotheca Boreali-Africana no. 151) which he identified as *S. aureum.* However, empty prosori, sori with sporangia and resting spores are present in the herbarium material, and it is obvious that this species is not *S. aureum.* The empty and collapsed prosorus lies above the sorus in the apex of the infected cell as in *S. africanum.* The sori are usually ovoid, 93—120 ⇌ 135—160 μ, and bear 30—50 sporangia which are polyhedral, 24—35 μ in greatest diameter with yellowish content. The resting spores are usually solitary, fill the host cell almost completely, subspherical to spherical, 90—120 μ or ovoid, 80—110 ⇌ 120—128 μ, with light-yellow content and amber-brown walls, 3—4 μ thick. The enveloping residue is usually sparse and may be lacking entirely.

Like *S. africanum* this species is compositely dihomeogallic in relation to its host. The sporangial and resting-spore galls may be separate and scattered or crowded and confluent, sometimes compound, violet, protruding, and often asymmetrical with the broad opening to the infected cell subapical in position. The sheath is 3—6 cells thick and consists of greatly enlarged, globular and thin-walled cells. The sporangial galls vary from 210 to 234 μ high by 297—390 μ broad. The resting-spore galls are 215—335 μ high by 290—572 μ broad. Infection of the trichomes occurs commonly with the result that somewhat conical galls 280—335 μ high by 285—300 μ broad, are formed. The sporangia and resting spores in the material available are smaller than those of *S. africanum,* and this may prove to be a different species.

Synchytrium taraxaci.

This species is widely distributed and has been reported from Europe, Asia, Africa, Australia, North and South America on species of *Taraxacum, Crepis, Cirsium, Carduus, Achyrophorus* and *Hieracium.* However, the reports of its occurrence on other hosts besides *Taraxacum* species are questionable in light of L u d i's (1901—1902) extensive cross inoculation experiments. He tested 19 species in 11 genera of non-Cichoraceae plants and 21 species in 9 genera of the Cichoraceae, all of which were immune to infection. Among the species of *Taraxacum* tested only 6 species and 4 varieties were susceptible, while *Crepis biennis* ond *Cirsium palustre* were resistant. According to these tests *S. taraxaci* is limited in host range to a few species of *Taraxacum.* None of the collectors who reported in on other hosts studied their fungi intensively to determine whether or not they are identical to *S. tarxaci.* Therefore, it is essential that their collections be carefully restudied.

Recently through the courtesy of the New York Botanical Garden and Cornell University the author received herbarium material labeled *S. taraxaci* on *Cirsium palustre, Cirsium* sp., *Crepis taraxifolia* and *Taraxacum* sp. which had been collected in Germany, Africa, and Oregon, U.S.A. These specimens were studied intensively to determine their characteristics, identy and relationship to *S. taraxaci* as far as was possible in herbarium material, and a description of them is presented herewith. In none of these species has a prosorus been found in relation to the summer sporangial phase, and apparently the initial cell becomes a sorus at maturity.

S y n c h y t r i u m t a r a x a c i (?) on *Crepis taraxifolia.* Leg. R. M a i r e, A. Affreville, Africa, 2-3-1917. (Spec. in herb. N. Y. Bot. Gard.).

Sori subspherical, 68—90 μ, or ovoid, 75—120 ⇌ 109—132 μ. Sporangia 8—30 per sorus, polyhedral, 36—60 μ in greatest diam., excep-

tionally large ones 66—72 μ, with yellowish content and hyaline walls. Zoospores unknown. Resting spores usually solitary, not filling host cell completely, subspherical, 60—84 μ, or ovoid, 54—60 ≒ 66—75 μ, with a smooth wall, 3—3.8 μ thick; enveloping residue very sparse or lacking entirely; germination unknown.

Compositely dihomeogallic, sometimes diheterogallic, galls scattered and separate or crowded and confluent. Sporangial galls yellowish, usually almost hemispherical with base embedded in host tissue, 80—108 μ high by 115—170 μ broad; sheath 2—3 cells thick. Restingspore galls dark-lavender, 72—80 μ high by 102—114 μ broad; sheath 1—2 cells thick; fairly often simple and consisting of an enlarged, 42—50 ≒ 65—72 μ, slighlty protruding epidermal cell.

The sori of this fungus also are generally smaller than those of *S. taraxaci* from Europe, but the size of its resting spores fall within the ranges of those of the latter species. The sporangial galls, however, usually protrude more conspicuously than those of *S. taraxaci*. ***Synchytrium taraxaci*** (?) on ***Cirsium palustre***. Leg. P. Sydow, 6-1887. Rangsdorf bei Lossen, Germany (Spec. in herb. N. Y. Bot. Gard.).

Sori usually solitary, sometimes 2 in a cell, subspherical, 110—170 μ, ovoid, 108—144 ≒ 144—180 μ, with a wall, 2—2.5 μ thick. Sporangia 18—35 per sorus, polyhedral, 39—60, in greatest diam., exceptionally large ones 70—98 μ, with a hyaline wall which is thickened at the angles, and yellowish-orange content. Zoospores unknown. Resting spores small, spherical, 49—66 μ, ovoid, 45—48 ≒ 60—66 μ; with a smooth amber-brown wall 4.5—5 μ thick; enveloped by a dense homogeneous layer of residue which fills remainder of host cell; germination unknown.

Compositely dihomeogallic, galls separate and scattered or crowded and confluent, frequently compound. Sporangial galls usually hemispherical on surface of leaf with base embedded in host tissue, broadly crateriform, 156—240 μ high by 210—324 μ broad; sheath 2—3 cells thick, sheath cells markedly enlarged. Restingspore galls hemispherical, small, 96—120 μ high by 126—156 μ broad; sheath 1—2 cells thick, occasionally almost simple with only a basal fringe of sheath cells.

Sydow labeled this material *S. taraxaci*, but in light of Ludi's cross inoculation results which showed that *S. taraxaci* will not infect *Cirsium palustre* in Germany, Sydow's identification may be incorrect. In the material studied the sori and resting spores are generally smaller than those of *S. taraxaci*, and the induced galls protrude more conspicuously on the surface of the host. In general morphology and effect produced on the host it resembles also *S. sanguineum* which Schroeter and P. Sydow collected in 1876 and 1905, respectively, on *Cirsium palustre* in Germany. However, the galls

and content of the sporangia are not blood-red as reported for *S. sanguineum*. Both of these mycologists collected *S. taraxaci* as well as *S. sanguineum* on *Cirsium palustre* and apparently were well aware of the difference in color between the two. Therefore, it is not likely that they mistook one for the other, but it may be noted that the galls of *S. taraxaci* have been reported occasionally to be blood-red in color also.

In connection with this fungus the author studied one on *Cirsium* sp. that F. Weiss collected at Corvallis Ore., 3-26-1927, which has the following characteristics: Sori usually solitary, ovoid, 110—120 ⇌ 118—144 μ, or subspherical, 102—162 μ, with a light-amber wall, 1.5—2 μ thick. Sporangia 8—52 per sorus, polyhedral, highly variable in size, 36—66 μ, large ones, 84—108 μ in greatest diameter, with hyaline walls and yellowish-orange content. Zoospores unknown. Resting spores usually solitary and partly filling host cell; sometimes 2 in a cell, subspherical, 38—52 μ, or ovoid, 30—36 ⇌ 40—56 μ, with a smooth wall, 3.5—4.6 μ thick; residue sparse or lacking entirely; germination unknown.

Compositely dihomeogallic, rarely diheterogallic, galls separate and scattered or frequently crowded and confluent. Sporangial galls dirty-white in herbarium specimens, usually protruding conspicuously, dome-shaped or hemispherical with a fairly broad apical crater, large ones 120—264 μ high by 208—276 μ broad with a sheath 2—5 cells thick; small ones 96—168 μ high by 120—160 μ broad with a sheath 1—2 cells thick. Resting-spore galls sometimes compound with sporangial galls, separate composite ones 66—80 ⇌ 120—130 μ broad with a sheath 1—2 cells thick; sometimes simple, ovoid, 30—38 μ high by 42—54 μ broad.

A comparison of the descriptions of these fungi on *Cirsium* shows that they are strikingly similar with the exception that simple resting-spore galls are more common in Weiss' material. Accordingly, I am inclined to regard them as identical, and in light of Ludi's results I doubt that they are *S. taraxaci*. Obviously, they need to be studied more intensively from living material, and extensive host range studies must be made before their identities can be determined. Possibly, they may prove to be biological races of *S. taraxaci* or *S. sanguineum*.

Synchytrium taraxaci on *Taraxacum* sp., Corvallis, Oregon, U.S.A. (Leg. F. Weiss, 3-26-1927; spec. no. 15594, Cornell Univ.).

Sori solitary, subspherical, 150—230 μ, or ovoid, 120—200 ⇌ 160—210 μ. Sporangia 30—62 per sorus, irregularly polyhedral, 60—130 μ in greatest diam., small ones 42—57 μ, large ones 140—180 μ, with hyaline walls which are usually thickened at the angles. Zoospores unknown. Resting spores solitary, partly filling host cell,

spherical, 60—70 μ, or ovoid, 50—55 ⇌ 60—66 μ, with a smooth wall, 3—3.8 μ thick; enveloping residue sparse; germination unknown.

Compositely dihomeogallic, galls separate and scattered or crowded and confluent. Sporangial galls protruding conspicuously, large, subspherical to oval, 208—320 μ high by 220—364 μ broad, with a sheath 3—5 cells thick; frequently protruding almost equally on both sides of leaves; oftentimes projecting only on one side and hemispherical to mound-shaped. Resting-spore galls small, usually embedded largely in the host tissue and protruding only slightly, 72—156 μ high by 144—156 μ broad; sheath 1—3 cells thick.

The herbarium specimens of this species are labeled *S. taraxaci,* but it produces larger sporangia and causes larger, more protruding and conspicuous galls than *S. taraxaci* from Europe. The galls frequently project almost equally on both surfaces of the leaf, so that cross sections of leaves usually have a beaded appearance. In *S. taraxaci* from Europe the galls are largely embedded in the leaf and do not protrude conspicuously, according to De Bary and Woronin's (1863) and Rytz's (1917) illustrations. Possibly, this may prove to be a variety of *S. taraxaci* or a different species when it has been studied more intensively from living material.

Weiss 3-26-1927, collected another species on *Taraxacum* sp. at Corvallis (spec. no. 15595 in herb. Cornell Univ.) which is much smaller than the one described above. The galls which it causes are brilliantly lavender-red and give the infected leaf a very distinct and characteristic dubonnet color. The characteristics of this fungus are as follows: Sori solitary, subspherical, 60—90 μ, ovoid, 48—80 ⇌ 60—120 μ, with a hyaline wall, 2—2.5 μ thick, and yellowish-orange content. Sporangia 4—17 per sorus, irregularly polyhedral, 30—66 μ, with hyaline walls which may be thickened at the angles. Resting spores solitary and filling a part or most of host cell, spherical, 66—90 μ, or ovoid, 60—65 ⇌ 66—84 μ, with a smooth wall, 2.5—3 μ thick; enveloped by a sparse amount of residue; germination unknown. Compositely or simply dihomeogallic, galls separate and scattered but usually crowded and confluent, embedded largely in leaf and protruding only slightly. Composite sporangial galls, 60—94 μ high by 84—140 μ broad, sheath 1—2 cells thick; simple sporangial galls consisting of an enlarged submerged epidermal cell. Composite resting-spore galls 58—72 μ high by 120—136 μ broad, sheath 1—2 cells thick; simple resting-spore galls consisting of an enlarged epidermal cell.

The galls induced by this fungus are considerably smaller than those of *S. taraxaci* and are often simple and unicellular, particularly when they are crowded. Also, the sori are usually smaller and may bear as few as four sporangia. Otherwise, this species resembles *S. taraxaci* and may prove to be identical to it.

In this connection it may be noted that H. E. Parks, 6-1933, collected what is labeled as *S. taraxaci* on *Taraxacum* sp. near Oreck, Humboldt Co., Calif. (Spec. no. 4454, herb. Univ. Calif., Berkeley). I have studied this fungus also and it appears to be identical to *S. taraxaci*. I have already described (1955) the species which Spegazzini (1881) reported as *S. taraxaci* on *Hieracium* sp. from Argentina. Its sporangia and resting spores resembles those of *S. taraxaci* fairly closely, but the galls which it causes appear to be very different, protrude more conspicuously, and are largely superficial on the host.

Synchytrium sp. on *Sphaeralcea* sp., Range Reserve, South Rita Mts., Arizona, U.S.A. (Leg. J. J. Thornber, 4-22-1905; spec. no. 25880, Farlow Crypt. Herb., Harvard Univ.).

Empty and collapsed prosorus lying above sorus in host cell; plug between prosorus and sorus, 6—7 μ thick in center by 9—10 μ diam. Sorus subspherical, 160—240 μ, or ovoid, 120—214 ⇌ 182—234 μ. Sporangia very numerous, polyhedral, 60—145 μ in greatest diam. with hyaline walls, 2.5—4.5 μ thick. Zoospores and resting spores unknown.

Compositely monogallic (?), sporangial galls separate and scattered, or crowded and confluent on leaves, petioles and stems, forming large protruding outgrowths or crusts on stems, covered with branched trichomes like remainder of leaf surface, blackish-violet or dark lavender-violet, almost hemispherical, mound- or dome-shaped, base often protruding on opposite side of leaf, 168—230 μ high by 268—336 μ broad; sheath 5—8 cells thick.

The sori and sporangia of this species are usually quite large, and the walls of the latter may be up to 4.5 μ thick, the thickest sporangial walls so far known in *Synchytrium* species. They do not, however, react positively to tests for cellulose. The content of the sporangia was lavender-violet in sporangial galls which had been thoroughly soaked in water, but I believe this color is due to diffused pigment from the sheath cells. Except for its generally larger sporangia with slightly thicker walls and the violet to lavender-violet galls which it induces, this species resembles the one which I (1955) described on *Sphaeralcea bonaerensis* from La Buenas Chaco, Argentina. Until the resting spores of both fungi and differences in their method of germination have been found, I shall regard these species as closely related or possibly identical.

Synchytrium sp. on *Sphaerostigma pallida,* Colorado Desert near Whitewater, Calif., U.S.A. (Leg. M. F. Barrus, 3-6-1920; spec. no. 15572, Cornell Univ.).

Prosori predominantly ovoid, 85—120 ⇌ 132—180 μ, almost filling host cell and enveloped by a small amount of residue, lying in base of cell when empty and collapsed. Sori ovoid, 90—132 ⇌ 108—216 μ,

oblong, fusiform, 90—110 ⇌ 115—175 μ, or spherical, 108—160 μ, with a light-amber to almost hyaline wall, enveloped by a small amount of residue; plug between empty prosorus and sorus 18—24 ⇌ 9—12 μ; sporangia 22—60 per sorus, polyhedral, 24—54 μ in greatest diam., with thin hyaline walls and yellowish to slightly orange content. Zoospores unknown. Resting spores solitary or up to 3 in a cell, spherical, 60—80 μ, or ovoid, 40—70 ⇌ 50—80 μ, with a smooth amber wall, 3.5—4.6 μ thick; enveloping reddish-brown residue fairly abundant, compact and dense; germination unknown.

Compositely dihomeogallic, occasionally diheterogallic, galls abundant, separate and scattered or crowded and confluent on leaves, petioles and stems. Sporangial galls whitish to yellow, mound-shaped or hemispherical, 96—140 μ high by 132—264 μ broad, with a broad crater exposing the top of the infected cell; sheath 1—3 cells thick. Resting-spore galls frequently forming extensive, slightly raised reddish-brown crusts on stems, composite, reddish-brown to lavender-purple, mound-shaped or hemispherical, 70—100 μ high by 110—120 μ broad; sheath 1—2 cells thick; sometimes simple and consisting of an enlarged fusiform epidermal cell.

On heavily infested parts of the host almost every epidermal cell is infected with the result that crusts of resting-spore galls are formed. In such areas the galls are usually unicellular and simple. *Sphaerostigma pallida* is a new host for *Synchytrium* and its discovery as such increases the reported (Karling, 1956 a) number of genera and species of the Onagraceae which are parasitized by these chytrids. The present species resembles *S. brownii* very closely except for its larger sori and may prove to be identical to it when it has been studied more intensively in the living state. It may be noted, however, that the mature sporangia in the available herbarium material are not dispersed on the surface of the host around the galls as occurs in *S. brownii* and *S. fulgens.*

In connection with this fungus, I wish to report that I have sectioned material of *S. fulgens* on *Oenothera sinuata* and *Gaura* sp. (Leg. H. S. Jennings, 4-16-1890, College Station, Texas) and *O. sinuata* (Leg. K. Togashi, 6-18-1928, Koganebaba, Moriaka, Japan). In all of these collections the initial cell of the fungus functions as a prosorus and gives rise to a sorus of sporangia as I (1954) have described for *S. brownii.* This is contrary to Kusano's reports (1930) that the initial cell of the fungus on *O. lamarkiana* and *O. sinuata* develops directly into a sorus of sporangia. So far, with the exception of the fungi on *Meriolix serrulata* and *Oenothera gregii* var. *pringlei,* I (1956 a) have found a prosorus in all specimens which are labeled *S. fulgens,* which suggests that Schroeter's (1873) and Kusano's description of *S. fulgens* are incorrect in this

respect. In that event my *S. brownii* becomes a synonym of *S. fulgens.*

Synchytrium aureum (?) on *Waldsteinia fragaroides,* Ithaca, New York, U.S.A. (Leg. H. M. Fitzpatrick, 7-19-1927; spec. no. 9915 in herb. Cornell Univ.).

Resting spores usually solitary, partly filling host cell, spherical, 192—264 μ, or ovoid, 156—170 ⇌ 186—220 μ, with faintly yellow content and a light-amber to almost hyaline wall, 3—4.6 μ thick; enveloped by a crumbly or dense and compact layer of reddish-brown residue which fills remainder of host cell; germination unknown.

Compositely monogallic, galls abundant on undersurface of leaves, usually separate and scattered, sometimes crowded and confluent, dirty-white in dried specimens, protruding conspicuously, dome- or mound-shaped with a narrow apical crater, 280—390 μ high by 300—540 μ broad; sheath 3—5 cells thick, sheath cells enlarged, outwardly elongate at apex.

This is a new host for *Synchytrium* and the fungus was identified by H. S. Jackson as *S. aureum* which has been reported on 19 other species of the family Rosaceae. However, very few of these fungi were described by the collectors, and it is difficult to compare them with the one on *W. fragaroides.* The size of its esting spores fall within the range of those reported for *S. aureum,* but the galls which it induces are quite large. In this respect it is somewhat similar to *S. duchesniae* on *Duchesnia indica* from Louisiana.

S. aureum (?) on *Viola conspersa,* McLean, New York, U.S.A. (Leg. W. H. Fitzpatrick, 5-16-1918; spec. no. 30692, Cornell Univ.).

Resting spores usually solitary and filling host cell only partly, sometimes 2—3 in a cell, subspherical, 42—80 μ, or ovoid, 50—60 ⇌ 66—74 μ, with a smooth wall, 3—4.2 μ thick, and almost hyaline content; enveloping residue reddish-brown, compact and dense or crumbly, filling remainder of host cell; germination unknown.

Usually compositely monogallic, sometimes simply monogallic, resting-spore galls usually separate but sometimes crowded and confluent, reddish-brown, small, inconspicuous and protruding only slightly. Composite galls 72—98 μ high by 114—156 μ broad, sheath 1—2 cells thick, sheath cells greatly enlarged; simple galls ovoid to broadly fusiform, 60—90 μ high by 85—114 μ broad.

The herbarium specimens of this species are labeled *S. aureum,* but it appears to be a different species. Its resting spores and the galls it causes are much smaller than those of *S. aureum* or *S. globosum* which have been reported on numerous species of *Viola.* In longitudinal sections of composite galls the sheath usually consists of a single greatly enlarged epidermal cell on each side of the infected one, and the gall as a whole protrudes only slightly as a

low mound. The simple galls consist only of an enlarged ovoid or fusiform epidermal cell which projects inward on the mesophyll layer and protrudes outwardly even less than the composite galls. Inasmuch as the content of the spore is hyaline and thus unlike that of *S. aureum* I am placing this species temporarily in *Leucochytrium.* I believe it will prove to be a different species from *S. aureum* or *S. globosum,* but it must be studied more intensively before this becomes certain. Until this is done it is hardly worthwhile to give it a specific name.

Synchytrium sp. on *Daucus laserpitoides* var. *stenopterus,* Reghaia, Africa. (Leg. R. Maire, 3-22-1914, Mycotheca boreali-Africana no. 176; spec. in herb. N. Y. Bot. Gard.).

Resting spores solitary or up to 4 in a host cell and filling it almost completely; spherical, 72—200 μ, or ovoid, 48—198 ⇌ 6—220 μ, with a smooth amber-brown wall, 4.5—6 μ thick; enveloping reddish-brown residue compact, dense and filling remainder of host cell, sometimes lacking entirely; germination unknown.

Compositely monogallic, resting-spore galls abundant, separate, or crowded and confluent, sometimes compound, broadly mound-shaped, 132—192 μ high by 240—440 μ broad, or hemispherical, 174—210 μ high by 260—336 μ broad, sometimes protruding conspicuously, usually embedded partly in host tissue; sheath 3—6 cells thick, consisting largely of outwardly elongate epidermal cells.

This may be *S. aureum* which Schroeter (1885) reported but did not describe on *Daucus carota* in Germany. However, the content of the spore is almost hyaline, but in toto it appears faintly yellow. The African fungus causes marked distortion and stunting of young leaves.

Synchytrium sp. on *Ambrosia trifida,* Austin, Texas, U.S.A. (Leg. W. H. Long, 4-25-1901; spec. no. 806, in herb. Cornell Univ.).

Resting spores solitary, sometimes 2 in a cell and not filling it completely, spherical, 104—160 μ, or ovoid, 96—140 ⇌ 126—174 μ, with a dark-amber, smooth wall, 4—6 μ thick, and yellow content; enveloping reddish-brown residue usually sparse but adhering closely to spore wall; germination unknown.

Compositely monogallic, resting-spore galls abundant on both surfaces of leaves, separate and scattered or crowded and confluent, protruding conspicuously, sometimes from both surfaces of leaf, 232—315 μ high by 260—340 μ broad with a fairly broad apical depression; sheath 4—6 cells thick, sheath cells greatly enlarged.

This is the first species to be reported on *Ambrosia,* but its identity is not certain. The size of its resting spores fall within the dimensions of those reported for *S. aureum,* but whether or not

it is identical to that species will not be certain until it has been studied more intensively.

Synchytrium sp. on *Fragaria virginiana,* New Haven, Conn. (Leg. R. Thaxter, 7-1889; spec. in Farlow Crypt. Herb., Harvard Univ.).

Resting spores usually solitary and filling only part of host cell, spherical, 195—244 μ, or ovoid 200—210 ⇌ 230—250 μ, with a smooth, amber-brown wall, 5—6.5 μ thick and yellow content; enveloping residue reddish-brown, compact, dense and filling remainder of host cell; germination unknown.

Compositely monogallic, resting-spore galls abundant on leaves, petioles and flowers, separate and scattered or crowded and confluent, protruding conspicuously, largely superficial or partly embedded in host tissue and often protruding on both sides of leaves, 364—520 μ high by 416—572 μ broad with a broad cone-shaped apical pore; sheath 4—6 cells thick, sheath cells greatly enlarged and thick-walled but not lignified.

This is a large species which induces very large galls whose cell walls are quite thick. The wall of the infected cell also may be up to 12 μ thick. As a result the galls are difficult to dissect, and in this process the pyriform infected cell with its residue and spore usually comes out intact. The spore frequently lies in the upper or outer part of the gall instead of being deeply buried.

This fungus was collected also on seedlings of *Rubus* sp. which were growing among the infected *F. virginiana* plants. Whether or not it is *S. aureum* remains to be proven, but I am inclined to regard it as different. It resembles fairly closely the species described previously on *Waldsteinia fragaroides,* although its resting spores and galls are somewhat larger. Also, it is considerably larger than the one I (1945 c) described on *Fragaria cuneifolia* from Washington and the so-called *S. aureum* on *F. virginiana* which Fitzpatrick (7-19-1917, spec. no. 9911, Cornell Univ.) collected at Ithaca, N. Y. In the latter specimens the resting spores are spherical, 88—126 μ, or ovoid, 108—216 ⇌ 127—150 μ, with a smooth, amber wall and yellow content. It induces composite, conspicuously protruding, highly dome-shaped, 220—240 μ high by 336—360 μ broad, galls with a conspicuous apical crater. The sheath is 2—4 cells thick and composed of greatly enlarged cells.

A simply monogallic species also was collected on *F. virginiana* at Cowling, Conn. by H. N. Richards in 1893 and deposited in the Farlow Herbarium. Its unicellular galls are abundant on the leaves and petioles, lavender-red, and invaginated at the apex, but when they are soaked in water overnight they become globular again. They are broadly obpyriform, 156—204 μ in broadest diameter by 200—240 μ high, or almost spherical, 144—240 μ, and filled with a reddish-

lavender pigment. The resting spores fill only a part of the host cell, and are spherical, 90—110 μ, with smooth walls, 3 μ thick, and hyaline content. It resembles *S. cupulatum* fairly closely.

Summary.

Three new species, *S. oreganum, S. helianthemum* and *S. africanum* from Oregon, U.S.A., Africa and Israeli, respectively, are described. These are long-cycled species and develop prosori, sori, sporangia and resting spores and are placed temporarily in the subgenus *Microsynchytrium*. In addition several short-cycled species which develop only resting spores are described. Inasmuch as their full life cycles are unknown they are not given specific names.

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