On the genetic Connection between *Peridermium giganteum* (Mayr) Tubeuf¹⁾ and *Cronartium quercuum* (Cooke) Miyabe.

By

M. Shirai.

With Pl. IV-V.

Since the discoveries of the genetic connection between *Coleosporium senecionis* and *Peridermium oblongisporium* by R. Wolff in 1876, and of that between *Cronartium asclepiadeum* and *Peridermium Cornui* by Cornu in 1886, eminent observers such as Hartig, Rostrup, Von Thümen, Plowlight, Klebahn, Fischer and others have repeatedly studied these relations as well as the connections between other winter-spore generations of these two genera and their peridermium fructifications; and it is from the effort of these workers that several perfect species of these heteröcious fungi have been established.

Here in Japan, we find at least two different forms of *Peridermium* attacking pines, (*Pinus densiflora*, *P. Thunbergii*, *P. parviflora* and *P. liuchuensis*.) one on the leaf and the other in the bark.

The exact name of the leaf-infecting species is not yet determined, while that found on the bark was first examined by H. Mayr during his stay in Tokyo, and was named by him *Aecidium* or *Peridermium giganteum*.²⁾

A *Cronartium* is also found on the leaves of some deciduous species of *Quercus*, such as *Quercus serrata*, *Q. variabilis*, *Q. glandulifera*, etc.

This species has been identified by K. Miyabe of Sapporo with *Cronartium asclepiadeum* (Willd) Fr. var. *quercuum* Cooke, which he proposes to call *Cronartium quercuum*.

1) F. Tubeuf, Pflanzenkrankheiten. Page. 429.

2) H. Mayr, Über die Kiefern des japanischen Reihs. Bot. Centralbl. 1894. Bd. LVIII. Page 149.

This latter fungus and *Peridermium giganteum*, as far as my observation goes, are usually found on their respective hosts only when they grow in the same place; and when one of these host-plants does not occur, these two parasites are also absent.

Thus for example, in an extensive pine plantations of Miono-matsubara in the province of Suruga where no deciduous quercus is found, I could not find any pine having excrescences caused by the parasitic action of *Peridermium giganteum*.

On the other hand in Kashima-gori in the province of Hidachi, where the plantations of these species of host plants stand side by side, we see a luxuriant growth of both of these parasitic fungi.

From these facts and from similar instances in Europe, I thought it highly probable that these two forms of fungi must have genetic connection and belong to one and the same species, and was induced to make a culture experiment on this subject.

I conducted the experiment during the last two years (1897-1898)¹⁾ in the Botanical Laboratory of the Agricultural College of the Imperial University and obtained a positive result.

Unlike other species of *Peridermium* our present species excites the growth of the cambium of the attacked portion very much, and causes the abnormal increase of the wood and bark, so that one year's growth corresponds to 3 or 4 year's growth of the healthy portion.

This fungus at first attacks young branches, stems, or even exposed portions of roots, and produces in the first year a small hemispherical swelling of the size of a hemp-seed.

This small swelling or excrescence gradually increases in size year by year, and after many years' growth it assumes a spherical form, sometimes attaining an enormous size of half a meter or more in diameter.

But as the wood and cortex of the diseased portions are softer and not well developed, they are liable to be killed by severe cold and also liable to be attacked by insects and other fungi before they attain such a large size.

In the latter case, the interior of the excrescence commences to decay and gradually becomes hollow; and at last it is broken by the action of a violent wind or by the pressure of a heavy snow.

The mycelium which extends through the cortical parenchyma and is formed of a thick matrix of an interlaced hyphæ, completely fills the

3) This year also I am continuing the experiment and have already seen the uredo-layer.

intercellular spaces, sending out one or two rod-like haustoria into the cell-cavity of each cell. (Pl. IV, fig. 4.)

The close application of the haustoria on the nuclei of the cells of the diseased tissue is also to be observed in this case, as was first noticed by Rosen in the haustoria of *Puccinia asarina*.

The spermogonia of this fungus are formed in the month of January in the intercellular spaces between the corky bark and the cortical parenchyma as flat continuous layers,¹⁾ when large yellow drops of viscous fluid of sweet taste loaded with an immense number of spermatia flow out from the fissures of the cracked bark.

This viscid drops of sweet taste are known by the name of Matsu-mitsu²⁾ (Pine-honey) and are eaten by boys and girls when they happen to find them.

The aecidium fruit is developed in the month of April in the cortical parenchyma, ten or more layers deeper than the spermogonia forming net-like layers of irregular meshes as shown in Pl. IV, fig. 1.

In consequence of the formation of the spermogonia and of the subsequent cracking of the corky bark, the pressure of the latter on the inner bark greatly lessens and thus secures the formation of the aecidium layers in the deeper tissues.

From this cause also, the division of the cambium and the expansion of the newly formed tissues take place in the diseased portion easier than in the healthy portion, and thus the abnormal development of its wood and bark is greatly facilitated.

The pseudoperidium formed of tolerably thick walled cells is colorless and of very firm texture.

One peculiarity which may be mentioned here in connection with the aecidium layer is the postlike prolongations of the end of some medullary rays, which penetrate the cortex and the aecidium layer so as to reach and support the pseudoperidium and which also probably serve in lifting up the overlying layers of the cortex (Pl. IV, fig. 3) when the spores of the aecidium layers are fully developed, they are set free by the rupture of the pseudoperidium and come to the surface of the bark through its fissures, and are dispersed by wind and rain in every directions.

These spores, when they fall on the leaves of deciduous species of *Quercus*, germinate and give rise to the mycelia which are destined to

1) A character which does not exactly agree with that of the spermagonia of the known species of *Cronartium* which are hemispherical in form.

2) 曾尙啓 本草綱目纂疏 Vol. 1, Page 6.

produce the uredo as well as the teleutospore layers on the surface of the leaves.

In order to prove this fact experimentally, I took seedlings of three species of *Quercus*, i.e. *Quercus serrata*, *glandulifera* and *variabilis*, and planted them in six flower-pots separately, each containing 2-5 seedlings of the same species; thus I had 2 sets of pot-cultures of these three species of *quercus*.

I then covered each of the pots with a glass bell-jar with its opening at the top plugged with cotton.

The soil in the pots was always kept moist by supplying water from time to time, and consequently the air in the bell-jar was saturated with moisture. The results of experiments in last two years were essentially the same, so I will mention here only that of last year.

On the 30th of April 1898, I sowed a good deal of spores of *Peridermium giganteum* on the upper surface of the leaves of the seedlings in three of these pots, after moistening them with distilled water by means of a spraying apparatus. I left the three other pots untouched for controlling experiments.

I then placed these six pots near a window facing the south.

After 10 days, on the 9th of May, I saw on the under surface of some of the leaves on which I had sown the spores yellow spots consisting of the sori of uredospores beginning to appear; and after 5 weeks heaps of teleutospores began to be formed.

These teleutospores immediately germinated on the leaves into 4-celled promycelia, from each cell of which a spherical colorless sporidium was produced (Pl. V, fig. 13.)

The form of the uredo-spore layer is circular in outline; and its pseudoperidium, which is composed of a felt of fine hyphæ, is lacinated in its ruptured margin (Pl. V, fig. 11.)

Plate V, Fig. 11 shows a vertical section of a uredolayer formed on a leaf of *Quercus glandulifera*.

The structure of pseudoperidium of the uredolayer seem to me very different from those of *Cronartium flaccidum* which is also common in Tokyo, and also from those of the other known species of the same genus given by Dietel in Engler's *Natürlichen Pflanzenfamilien*.

In regard to this points, I intend to make a further investigation, for I had no time to study them in detail this time.

The following is the dimensions of the median sized spores of this fungus.

Uredospore	{	length	...	...	...	...	...	24 μ .
	{	breadth	...	...	...	...	...	19.2 μ .
Teleutospore	{	length	...	...	...	...	...	33.6 μ .
	{	breadth	...	...	...	...	...	14.4 μ .
Diameter of Sporidium			...	...	...	...	...	9.6 μ .
Aecidiospore	{	length	...	...	...	...	...	28.8 μ .
	{	breadth	...	...	...	...	...	2.16 μ .
Spermatium	{	length	...	...	...	...	...	5 μ .
	{	breadth	...	...	...	...	...	2 μ .

Explanations of the Plates.

Plate IV.

- Fig. 1. Aecidium layer exposed, by taking off the overlying corky bark of the excrescence of a diseased branch of *Pinus densiflora*.
- Fig. 2. Transverse section of a diseased branch through the excrescence, showing the annual growth of the diseased tissue.
- Fig. 3. A portion of transverse section of a diseased branch of *Pinus densiflora* magnified; K, corky bark; S, spermogonium layer; F, pseudoperidium; A, aecidium layer; R, cortical parenchyma, C, cambium layer; D, new wood; E, prolongations of meduallary rays.
- Fig. 4. Portion of cortex and spermogonium layer magnified. $\times 200$.
- Fig. 5. Portion of aecidium layer magnified. $\times 200$.
- Fig. 6. Aecidiospores magnified.

Plate V.

- Fig. 7. Leaf of the seedling of *Q glandulifera* used in the experiment, with the group of uredolayers formed in its under surface, seen 10 days after infection.
- Fig. 8. Leaf of *Q glandulifera* in the open air with teleutospores produced by natural infection.
- Fig. 9. Leaf of *Q. serrata*, used in the experiment with uredolayers seen 10 days after infection.

- Fig. 10. Leaf of *Q. serrata* with teleutospore columns.
Fig. 11. Transverse section of uredospore layer on a leaf of *Q. glandulifera* produced by artificial infection. $\times 200$.
Fig. 12. Uredospores of the same magnified.
Fig. 13. A column of teleutospores produced on a leaf of *Q. serrata* by artificial infection, with some of its spores germinating.
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Plantæ Japonenses novæ vel minus cognitæ.

(Continued from p. 65.)

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Nephrodium erythrosorum Hook. **var. obtusum** Makino nov. var.

Stipe slender, hard, scaly throughout, but densely clothed towards the base with rufo-castaneous or darkish-brown subulate-lanceolate to subulate-linear acuminate scales. Frond deltoid-ovate or ovate-oblong, acuminate, bipinnate, subcoriaceous, naked above, sparingly covered with small vesiculose acuminate rufous scales towards the rachis of pinnæ and costa of pinnules beneath; main rachis slender, dispersed with rufous or darkish-rufous linear scales; pinnæ spreading, triangular-lanceolate or lanceolate, often falcate, acuminate, pinnate, but pinnatifid at the apex, shortly petioled, not closed from one another, alternate, or subopposite; pinnules ovate-oblong, often slightly falcate, obtuse or rounded obtuse at the apex, truncate, subcordato-truncate, or obtuse-truncate at the base, but adnate in the superior ones, crenato-serrate, often pinnatifid into obtuse and ovate lobes in the lower ones, the both lowest lobes usually larger than the rest, largest one about $3\frac{1}{2}$ cm long, $1\frac{1}{2}$ cm broad. Sori closer, when mature confluent to each other, in 2 rows near the costa of pinnules and often also in 2 rows on the lower lobes.

Nom. Jap. *Maruba-benishida* (T. Makino nom. nov.).

Hab. Prov. Tosa: Sakawa (T. Makino! Autumn 1884, July 16, 1887); Prov. Awa in Isl. Shikoku: Nishiu-mura (R. Yatabe! herb. Sc. Coll. Imp. Univ. Tokyo, July 24, 1888).