The Two Rust Diseases of the Spruce.

BY

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With Plate CXLIX.

Chrysomyxa Rhododendri, De Bary. The Spruce Blister Rust, Rust of Rhododendrons.

Chrysomyxa Rhododendri was first recorded in Britain by D. A. Boyd in June 1913, who discovered the uredospore and teleutospore stages on *Rhododendron hirsutum* at Douglas Castle, Lanarkshire.

Shortly afterwards, in October 1913, material of the aecidial stage of the fungus on *Picea excelsa* was sent for identification to one of the writers from the south-west of Scotland, and its discovery was recorded in the Proceedings of the Botanical Society of Edinburgh in June 1914.*

The life-history of this species was first described in 1879 by De Bary,† who showed that the forms previously known as *Aecidium abietinum* and *Uredo Rhododendri* were stages in the development of one species to which he assigned the present name.

This species is found frequently in the Alps wherever the Alpine Rose (*Rhododendron hirsutum* and *R. ferrugineum*) occurs. The yellow clusters of uredospores are developed in September on the lower surface of the leaves and also on the bark of the

* Proc. Bot. Soc. Edinburgh, vol. xxvi, 1913–14, p. xxxiii.
† Bot. Zeit., Bd. xxxvii, 1879, p. 761.

shoots of the previous year. The uredospores are oval in form and are produced in chains; they may further propagate the disease on the Rhododendron. Slightly later the development of the teleutospores commences, and in the following spring the sori appear as small dark red cushions on the lower surface of the leaf.

The teleutospores are formed closely together in groups covered by the epidermis, and each spore consists of a series of superimposed cells. A section of a mature sorus is shown in fig. 1. Immediately before germination the epidermis is ruptured and the terminal cell of the teleutospore, the only one capable of germination, gives rise to a four-celled promycelium, each cell of which produces a sporidium. The sporidia are set free in June, and if they alight on the young leaves of the spruce may cause infection. A well-developed mycelium is produced in the leaf, and the infected area becomes yellow in colour. In some cases almost the whole of the leaf is infected, but generally the fungus is confined to certain zones and the remaining portions retain their normal green colour. As a result of infection small yellow spermagonia are first produced, and these are soon followed by the aecidia. Each aecidial sorus is surrounded by a long white pseudoperidium which, in the early stages, completely encloses the spores. The aecidiospores are arranged in chains and are produced from the base of the aecidium; they are orange-yellow in colour. At maturity the pseudoperidium breaks down at its apex and allows the aecidiospores to escape as a powdery orange-yellow mass. Before dehiscence the pseudoperidium has the form of a cylinder terminated by a rounded cone and possesses a yellow tint due to the colour of the enclosed spores. After the spores are shed the form is that of an open cylinder and the pseudoperidium is perfectly white. The aecidiospores are distributed by the wind, and if they alight on the leaves of the Rhododendron are capable of producing infection.

The material of the aecidial stage of the fungus was obtained in October, some time after its maturity and the greater part of the spores had already been shed. An examination showed that in addition to the aecidia small yellow spermagonia are present. The number of aecidia present on a leaf varies.

Fig. 2 is from a photograph of a leaf bearing two pseudoperidia; several other aecidia were present, but the pseudoperidia surrounding them had fallen away. The pseudoperidium consists of a single layer of thick-walled pitted cells with strongly verrucose walls (see fig. 3, in which the upper cells are shown in surface view and the lower in optical section). The aecidiospores are subglobose or ellipsoid, usually with a somewhat

flattened side, 20–24 × 20–23 μ in size. The wall is strongly verrucose and pitted except at the flattened portion; fig. 4 shows a spore in surface view, and fig. 5 one in optical section. The peculiar flattening of the aecidiospore depends on its method of development. A number of rows of cells are produced in the young aecidium, and in each row only every alternate cell gives rise to a spore. The intermediate cells which do not produce spores remain thin-walled and at maturity become gelatinous and almost disappear. The flattened part of the wall of the aecidiospore is the portion which was originally in contact with the intermediate cell below it, and, in some cases, the shrivelled remains of this cell are still attached and may be seen as a black line when the aecidiospore is seen in optical section (fig. 5).

In districts where the spruce does not occur it is probable that the fungus may exist through the winter in the form of hibernating uredospores, which, in the following spring, can infect the Rhododendron; it appears therefore that the presence of the spruce is not essential to the continued existence of the fungus. The aecidial stage on the spruce, however, can only exist where the Rhododendron is present, as the infection of the needles is only brought about by the sporidia. Since this is the case, the removal of the Rhododendron will completely check the disease.

It appears, therefore, that the spread of the disease on the spruce will be limited in this country since *Rhododendron hirsutum* and *R. ferrugineum*, although frequent in parks and gardens, are not usually grown in plantations. The fungus has been found on *R. dahuricum*, but does not attack *R. ponticum*, *R. catawbiense*, and their hybrids which are so commonly grown.

The effect of the disease on the Rhododendron is not serious; on the spruce the diseased needles fall in the summer of infection, and in severe cases the trees may be almost stripped of foliage.

Chrysomyxa abietis, Wallr. The Needle Rust of the Spruce.

Chrysomyxa abietis was first recorded in Scotland by Somerville,* from Durris near Aberdeen, and, writing in January 1915,† the same investigator stated that up to that time he had received no further reports of its occurrence. A quantity of the fungus was recently obtained from Aberdeenshire, and in view of the omission of this species from recent works on British Uredineae as well as its importance as a disease of the spruce, further inquiries as to its distribution in Scotland have been made.

* Quart. Journ. Forestry, vol. v, 1911, p. 277.
† Quart. Journ. Forestry, vol. ix, 1915, p. 68.

Professor Trail has kindly forwarded the following information:—

"It is not more than six or seven years ago that I first observed *Chrysomyxa abietis* in Aberdeenshire, and it is probable that the fungus has only recently made its appearance in the north of Scotland. I have seen trees attacked by the disease in the Monymusk and Farland districts. The disease is now also very common in the spruce woods on the banks of the Findhorn, where it was first noted some three or four years ago by Mr. William Watt, Assistant Forester on the Moray estates. When the infected trees in this locality are standing singly and foliaged to the ground, only the leaves on the lower branches are as yet attacked."

Mr. P. Leslie, Lecturer in Forestry at the North of Scotland College of Agriculture, informs us that *Chrysomyxa abietis* is stated to be quite common on the Novar estate, Ross-shire. It is evident, therefore, that the disease is spreading to a considerable extent.

Chrysomyxa abietis, which is widely spread in Switzerland and Germany, is an autoecious species completing its life-history on the spruce. It differs from *C. Rhododendri* in producing only one kind of spore, the teleutospore. The hibernating teleutospores germinate about May and produce sporidia which infect the young leaves of the spruce. An abundant intercellular mycelium is developed in the tissue of the leaf which sends haustoria into the cell cavities. The hyphae contain numerous yellow oil-drops, and in consequence yellow bands appear on the leaf. Soon afterwards teleuto-sori are produced which take the form of elongated yellow cushions on both the under surfaces of the leaf (fig. 6). During the winter the sori are covered, but in the following spring the epidermis is ruptured and the teleutospores project as an orange-yellow mass (fig. 7). Each teleutospore is cylindrical and consists of 8–12 superposed cells of which only the terminal one produces a promycelium (fig. 8). At about the middle of May the sorus becomes brighter yellow and the promycelia grow out. Each produces four small spherical sporidia, which become easily detached and are distributed by the wind. When the sporidia have been shed, the sorus loses its bright colour and shortly afterwards the diseased leaf falls. On coming into contact with the young needles of the spruce the sporidium produces a germ tube which bores through the epidermis and so brings about infection.

It frequently happens that certain spruces in a wood remain free from the disease, while others are badly attacked. This may be explained by the fact that infection of the young leaves only takes place at a certain stage in their development; trees

which are in a backward condition when the sporidia are ripe are not infected, while at the same time others may have passed the susceptible stage and thus escape the disease.

As a result of the attack the infected leaves die and fall from the tree, and thus a considerable defoliation may take place. The disease, however, usually fails to maintain itself through a long series of years on any one tree and in consequence felling is not desirable.

In the last issue of the Quarterly Journal of Forestry,* which we have just received on going to press, Dr. Somerville states that on April 21st specimens of spruce branches badly attacked by *Chrysomyxa abietis* were sent to him by Mr. Neil MacGregor, Bridge of Dye, Banchory, Kincardineshire. The specimens were from trees about twenty years old which were planted under old larch and Scots pine, and were situated about seven miles from the nearest part of the Durris Woods, in which Dr. Somerville discovered the disease in 1911.

We desire to thank Professor Trail and Mr. P. Leslie, M.A., B.Sc., who have kindly supplied information as to the distribution of *Chrysomyxa abietis*.

* Quart. Journ. Forestry, ix (1915), 253.

EXPLANATION OF PLATE CXLIX.

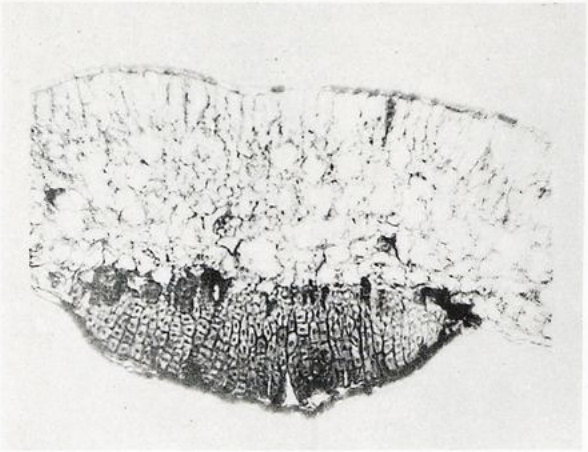
Figs. 1–5 refer to *Chrysomyxa Rhododendri*; figs. 6–8 to *Chrysomyxa abietis*.

Chrysomyxa Rhododendri.

FIG. 1. Photograph of transverse section of leaf of *Rhododendron hirsutum* bearing teleuto-sorus. × about 126.
FIG. 2. Photograph of leaf of *Picea excelsa* bearing two aecidia. × 3.5.
FIG. 3. Part of pseudoperidium; the upper cells are shown in surface view, the lower in optical section. × 480.
FIG. 4. Aecidiospore seen in surface view. × 960.
FIG. 5. Aecidiospore seen in optical section. × 960.

Chrysomyxa abietis.

FIG. 6. Photograph of leaves of *Picea excelsa* bearing teleuto-sori. × 3.5.
FIG. 7. Photograph of transverse section of leaf of *Picea excelsa* bearing two teleuto-sori, × 57.
FIG. 8. Two teleutospores. × about 192.



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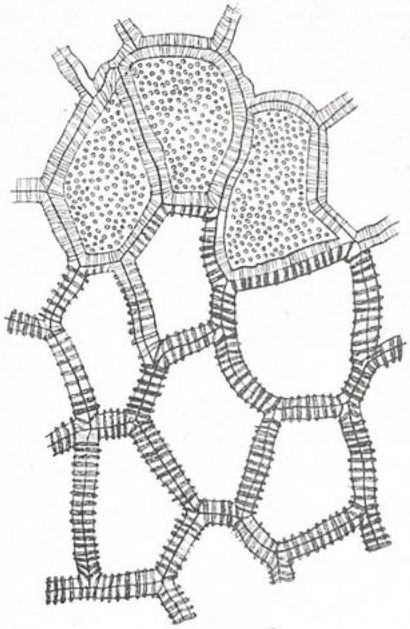

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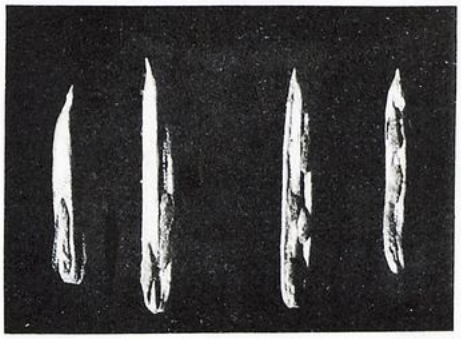

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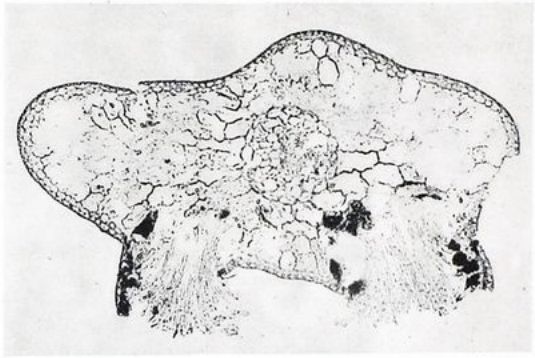

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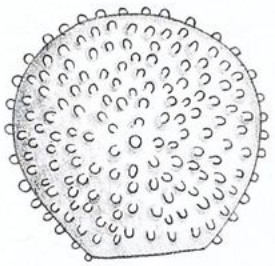

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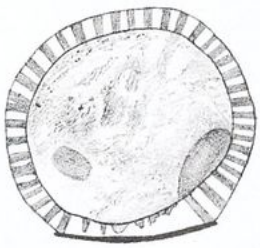

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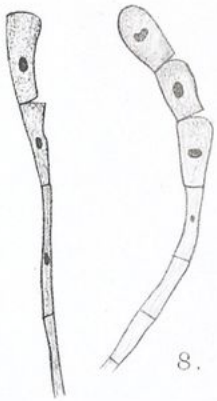

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1-5 Chrysomyxa Rhododendri 6-8 Ch. Abietis.