FORESTRY COMMISSION

BOOKLET No. 4

# RUSTS OF BRITISH FOREST TREES

LONDON

HER MAJESTY'S STATIONERY OFFICE

1955

PRICE 2*s.* 6*d.* NET

FORESTRY COMMISSION
BOOKLET No. 4

# RUSTS OF BRITISH FOREST TREES

*BY*

J. S. MURRAY, B.Sc.

ASSISTANT FOREST PATHOLOGIST,
FORESTRY COMMISSION

LONDON
HER MAJESTY'S STATIONERY OFFICE
1955

# RUSTS OF BRITISH FOREST TREES

THE RUST FUNGI or Uredinales are an important group of plant parasites, causing great losses to agricultural and forest crops each year. All members of the group are obligate parasites, that is to say they are able to attack and carry out their development only on living plants. Many other parasitic fungi spend part of their life cycle growing actively on dead tissue; this is known as their saprophytic phase. Because rust fungi are obligate parasites, they do not have a saprophytic phase. The life cycle of a typical rust is complex, as five types of spores are produced on two different and unrelated hosts, certain of the spore types being always borne on one host and the remainder on the other. Occasionally, however, the life cycle is incomplete and the fungus needs only one host. A rust is termed *heteroecious* if it requires two different hosts and *autoecious* if it is restricted to one. The production of each different spore form constitutes a separate stage in the life cycle of the rust, and each spore form, also, performs a specialised role. The mycelium of the fungus may be perennial, living in the host tissues and producing spores for a number of years, or it may live for less than a year, its existence coming to an end with the death of its host, or the death of that part of its host on which it has been subsisting.

**The Life Cycle**

The following table shows the various stages and spore forms of a generalised rust:

| *Stage* | *Fruit Bodies* | *Spores* |
|---|---|---|
| 0 | pycnia | pycniospore |
| I | aecia | aeciospore |
| II | uredia | uredospore |
| III | telia | teliospore |
| IV | | sporidia |

The life cycle of a typical rust, *Coleosporium senecionis* Fr., is shown diagrammatically in Fig. 1. The various stages are marked by the appearance on the surface of the host of fructifications which arise from the mycelium of the rust in the tissues of the host, and which are differentiated according to the type of spores they produce. They are of four main types, pycnia and aecia on one host and uredia and telia on the other. Pycnia are generally small insignificant bodies producing minute, one-celled pycniospores which are discharged with drops of nectar. The spores are incapable of causing infection and fulfil the function of male fertilising cells in the production of aecia.

Aecia, often termed "cluster cups", are always produced on the same host and in close proximity to pycnia where the latter occur in the life cycle. They are much more

conspicuous bodies than pycnia, opening generally by the rupture of a thin, tissue-like membrane, the peridium. The aeciospores are one-celled, produced in chains, and are of an orange or yellow colour which makes the aecia conspicuous. They are borne on Host 1 and transmit infection to Host 2, though exceptionally in some species they re-infect Host 1.

Uredia arise as rust coloured spots on Host 2 from the mycelium produced by the infection from aeciospores. They can also arise following secondary infection by a uredospore produced on Host 2. Uredospores are one-celled, spiny or warty, produced on stalks or in chains and are brown or yellow. They can infect only Host 2 and many generations of the uredial stage can occur, typically during the summer, but occasionally at other times of year under favourable conditions. There is some evidence to suggest, however, that in some rust species the uredospores can overwinter and re-attack Host 2 the following year.

Telia also are produced on Host 2. They are usually darker in colour, less conspicuous and borne at a later date than uredia. Teliospores are often termed "winter spores" because their general function is to tide the fungus over that period. They germinate to produce four, less often two, sporidia on short stalks or sterigmata. Sporidia are small, one-celled and comparatively short lived and transfer the disease from Host 2 to Host 1 where infection results in the formation of pycnia and aecia and the cycle is recommenced. The development of a typical rust takes one year but there are exceptions which require a longer period.

In many instances the same rust was given two different names before the connection between its stages on two hosts was appreciated. Subsequently the name applied to the telial stage was adopted.

The needle rust of Scots pine, *Coleosporium senecionis*, which alternates between two-needled pines and species of *Senecio* (groundsel and ragwort) may be taken as a good example of a heteroecious rust. In autumn, the pine needles are infected by sporidia. In April to June of the following year, pycnia (stage 0) appear as small yellowish spots, and minute pycniospores are exuded along with a sticky "nectar" or pycnial fluid. Soon afterwards the aecia (I) are produced on the needles in close proximity to the pycnia. Each aecium is initially covered with a white, raised blister of thin tissue, the peridium, under which the orange coloured aeciospores are developed. These are set free by the rupture of the peridium and can infect the leaves and stems of groundsel or ragwort, but not other pines. *Senecio vulgaris*, the common groundsel, is probably the commonest host. From the resulting mycelium in the groundsel, uredia (II) are produced as golden yellow spots on stems and the undersides of the leaves. Their surface is powdery due to the mass of uredospores which are carried by the wind to infect other groundsel plants. In favourable weather conditions, several generations of uredospores may be produced in one summer, so that a relatively small source of infected pine may give rise to a very widespread infection of groundsel. Also, uredo-

spores have been recorded all through the year, so that the fungus can exist solely on groundsel without the intervening stage on pine. As autumn approaches, telia (III) are formed on the stems and on the undersides of the groundsel leaves. These are dark red-brown, waxy crusts. The teliospores are at first one-celled, later dividing in four by the formation of three cross-walls. Each of the resulting cells produces a sporidium on a stalk. The sporidia are incapable of infecting groundsel but germinate on pine needles, producing mycelium which invades the needles and overwinters there. The following season, pycnia are produced and the cycle is recommenced.

Rusts attack both conifers and hardwoods among British forest trees, causing greater damage and occurring on a wider range of hosts in the conifers. Spruce, pine, larch and silver fir of the usually planted conifers and poplar, birch and willow of the hardwoods are attacked. It is remarkable that the more important broadleaved trees in Britain, oak, beech, elm, ash and sweet chestnut are free from rust parasites, except for one rare species of *Uredo*, which has been reported on the leaves of oak. In the case of hardwoods, the leaves are the part usually attacked, resulting in loss of increment. Conifers may be attacked on the needles, cones, shoots or stems. The effects, depending on the rust, may be partial defoliation, production of witches' brooms, dieback of shoots, canker of stems and branches; these injuries sometimes result in the death of the tree.

The majority of rusts affecting British forest trees are described below, arranged alphabetically.

**Calyptospora goeppertiana** Kühn

This rust attacks the silver firs *Abies pectinata* and *A. nordmanniana* and cowberry (*Vaccinium vitis-idaea*). In spring, sporidia infect the new leaves of silver fir. Pycnia have not been recorded, but in summer two rows of white, cylindrical aecia are produced, one on either side of the midrib on the underside of the needle. Aeciospores infect young shoots of cowberry causing a swelling and a pink or white discoloration. The mycelium is perennial in the cowberry and there is no uredial stage in the life cycle. Sporidia from telia borne on the cowberry infect silver fir.

This rust is rare and is not important in Great Britain.

Two other rusts which produce aecia on the lower surfaces of the needles of silver fir cannot be distinguished from *C. goeppertiana* Kühn except by microscopical examination. They have, however, quite different alternate hosts. They occur only rarely and are of no importance to the silver fir.

**Aecidium pseudo-columnare** Kühn

This term collectively describes a number of rusts which have their uredial and telial stages on ferns, but which are indistinguishable on the silver fir.

**Pucciniastrum epilobii** Otth.

The alternate hosts of this rust are the rosebay willow herb (*Chamaenerion angustifolium*) and the marsh willow herb (*Epilobium palustre*). The uredia appear as very small yellow spots on the under surfaces of leaves and are followed by the dark brown telia.

**Chrysomyxa abietis** Unger. **Spruce Needle Rust.** Fig. 5

This rust occurs mainly on Norway spruce, but it has also been reported on Sitka spruce, *Picea rubra*, *P. pungens* and *P. engelmannii*. No alternate host is known. In early summer, young developing needles are infected by sporidia, the site of each infection being marked by a light yellow transverse band on the needle. Needles older than one year cannot be infected. The colour deepens to bright golden yellow through the season as telia develop under the epidermis. The needles remain on the tree during the following winter and spring, until May or June, when the telia complete their development and are exposed by the rupture of the epidermis, when they appear as elongated pustules on the lower surfaces of the needles. Sporidia from the teliospores are carried to young flushing needles of spruce, so completing the life cycle. The year-old diseased needles then drop. Young needles are susceptible for only a short period of their development. If the period of maximum sporidia production coincides with the period of greatest susceptibility of the needles, the amount of infection can be extensive, affected stands appearing yellow instead of green. This coincidence is relatively infrequent, however, so that heavy infection does not usually occur in consecutive years. The defoliation caused by the rust is probably important in causing some loss of increment, but never the death of trees. If heavy infection did take place annually this would be a very serious disease.

**Chrysomyxa rhododendri** de Bary. Fig. 4

This rust also is found chiefly on Norway spruce, but it has lately been reported on Sitka spruce in Scotland. The alternate hosts are *Rhododendron hirsutum* and *R. ferrugineum*, which are fairly widely planted in gardens in this country, and one or two rarer varieties. Considerable importance may be attached to the recent discovery of this rust on *R. ponticum* which is the commonest species in Britain. Young developing needles of spruce are infected by sporidia blown from rhododendron leaves in early summer. Older needles cannot be infected. Pale yellow bands appear, on which the pycnia occur as small dots, soon followed by the aecia, which are borne on the lower surfaces of the needles; each æcium has a conspicuous, white, columnar peridium. Rupture of the peridium about August, leads to the discharge of the aeciospores which infect leaves of rhododendron. The fungus overwinters in the rhododendron as mycelium until the following spring when the uredial stage appears as orange spots on the young shoots and on the undersides of leaves. The uredospores

spread infection among rhododendrons. Later, telia are formed as dark brown patches and the resulting sporidia infect spruce needles and complete the life cycle.

*Chrysomyxa rhododendri* can survive on rhododendron in the absence of spruce, but not on spruce in the absence of rhododendron. Thus the eradication of rhododendron in the vicinity of the spruce would probably result in their safety; but it is not possible, on our present knowledge, to stipulate the size of the area to be cleared. Damage done by the rust on spruce is sporadic and appears, as in the case of *Chrysomyxa abietis*, to depend on weather conditions in early summer.

**Chrysomyxa pyrolae** Rostr.

This rust produces its aecial stage on the cones of Norway spruce, but this stage has not been recorded in Britain, though it is common in some parts of the Continent. The aecia are large, whitish, and produced on the outside of the cone-scales. Only one or two occur on each scale. The uredial and telial stages, which do occur in Britain, are on the leaves of species of *Pyrola* (wintergreen), which in any case is not a common plant.

**Coleosporium senecionis** Fr. **Needle Rust of Scots Pine.** Figs. 1, 2 and 3

Under this rust, which has already been described, may be grouped a number of related forms which produce pycnia and aecia on the needles of two-needled pines, especially Scots pine, and uredia and telia on the leaves and stems of a number of herbaceous plants. On the pine, the aecial stages of the different forms are practically indistinguishable, but each form is specific to the herbaceous host; e.g. the form on *Senecio* (groundsel) will not attack *Tussilago* (coltsfoot) though both attack pine. *Coleosporium* has been divided on the basis of the herbaceous hosts, but as far as the pine is concerned these forms may be grouped together. Alternate hosts for the different forms of the fungus are:

(*a*) *Senecio vulgaris* and other species (groundsel and ragwort).
(*b*) *Tussilago farfara* (coltsfoot).
(*c*) *Petasites* spp. (butterbur).
(*d*) *Sonchus arvensis* and other species (sow-thistle).
(*e*) *Campanula* spp., *Phyteuma* spp. (rampion).
(*f*) *Melampyrum* spp. (cow-wheat).
(*g*) *Euphrasia* spp. (eyebright).

This rust is common in Britain, but its effects are seldom important, so that control measures are not normally applied. The fungus can almost certainly overwinter by means of uredospores without the pine host. Infected pine needles may produce aecia for at least two years. It can occasionally be troublesome on pine in nurseries, when the alternate host is abundant. Removal of the alternate host will prevent further

infection, and since the commonest form, by far, is that on groundsel, a cleanly weeded nursery is usually safe.

**Cronartium ribicola** J. C. Fischer. **Blister Rust of Five-needled Pines.** Figs. 10, 12, and 13

This rust attacks many of the five-needled pines and several species of *Ribes* (currant). In spring and summer, sporidia infect pine needles of any age, producing mycelium which grows down through the conducting tissue of the needle into the shoot where an area of bark is killed. Pycnia appear on this area as small yellowish elevations of the bark followed in early summer of the next season by the aecia. These are prominent white blisters, full of orange aeciospores, which are wind borne to the leaves of *Ribes*. The infected pine shoot becomes thickened, as the mycelium develops in the bark tissues. The fungus, which is perennial in the pine, spreads both laterally and longitudinally, completely girdling small shoots and also growing downwards into larger branches and the main stem where cankers are formed; frequently the tree is killed. Each year the mycelium produces fresh crops of aeciospores, which cannot infect pine but which may travel as much as 150 miles to germinate on the lower surfaces of leaves of *Ribes*, and thus start a new outbreak. There, uredia are produced within a few weeks as small yellow pustules. The uredospores, several generations of which can occur in a summer, infect nearby *Ribes* to produce other uredia, but cannot infect pines. In late summer, telia appear on the lower surfaces of infected leaves as brownish, bristle-like structures, which are often matted so as to resemble a close felt. Sporidia from the teliospores are harmless to *Ribes* but infect pine needles, starting a new cycle of infection. In contrast to the aeciospores, the sporidia are relatively short-lived, so that the limit of their spread is seldom more than a quarter of a mile.

*Cronartium ribicola* is the most serious rust on British forest trees as it has prevented the planting of the valuable Weymouth pine (*Pinus strobus*). In North America, the disease, introduced from Europe, has caused enormous losses to the native five-needled pines *P. strobus* and *P. monticola*. Large sums have been spent on attempts to control it by the eradication of *Ribes*, which occurs mostly as wild species. As both hosts are necessary for the fungus, elimination of *Ribes* from the plantation to be protected, and for one or two miles round it, might ensure safety for the pine, but this is not practicable in Britain owing to the value and commonness of currants as a garden fruit and also to the scattered existence of wild species. It is not possible in Great Britain to find areas suitable for *P. strobus*, which are free from currants. This means that there is scarcely anywhere that the pine can safely be planted. Until resistant species of *P. strobus* are developed, and work on these lines is now in progress in America, the species should only be planted on an experimental scale, and always in mixture, the other component of which will form a crop, if the pine becomes

diseased. Species of both the *Ribes* and five-needled pine show different degrees of resistance towards the rust. Of the *Ribes* species, blackcurrant (*R. nigrum*) is very susceptible, redcurrant (*R. rubrum*) is generally resistant, while gooseberry (*R. uva-crispa*) occupies a somewhat intermediate position, some varieties being more susceptible than others. In practice in Great Britain blackcurrant is the important cause of spread. It is probable that *Cronartium* can attack all the five-needled pines, but *P. strobus*, *P. monticola*, *P. flexilis*, and *P. lambertiana* are particularly susceptible, *P. parviflora*, *P. excelsa* and *P. cembra* appear to be more resistant, while *P. peuke* may be nearly immune.

**Cronartium asclepiadeum** (Willd.) Fr.

This rust affects Scots pine in much the same way as *C. ribicola* affects *P. strobus* and has its alternate stage in Britain on the garden peony (*Paeonia officinalis*). Pycnia appear usually on young branches but also on stems followed by the prominent yellowish, blister-like aecia in June. Aeciospores are liberated by the rupture of the peridium, and on affected peony leaves the small brown uredia appear in mid-summer. Uredospores infect other peonies and later, brown, horny telia are formed from which the sporidia are wind borne to infect pine. The fungus can live in the tissues of the pine for many years, producing a crop of aeciospores each year. It is uncommon in Great Britain and not regarded as a serious pest of pine.

**Gymnosporangium clavariiforme** (Pers.) DC.

This rust infects the native junipers, *Juniperus communis* and *J. nana*, and also *J. sibirica*, *J. oxycedrus* and *J. hibernica*, which are occasionally planted in gardens. Its alternate hosts are mainly *Crataegus oxyacanthoides* and *C. monogyna*, our two native hawthorns, but it has been recorded on *Pyrus communis* (wild pear), and it may well occur on other members of the Rosaceae. The pycnia and aecia occur as yellowish orange spots on leaves, fruits and stems of the Rosaceous host. The aecia project as elongated horns from the infected host organ which is usually swollen, so that the whole structure, when mature, is rather like a honeycomb. The mycelium of this stage is not perennial. In early summer, aeciospores infect young shoots of juniper producing elongated swellings on which the telial stage may be produced the following year. The teliospores are extruded as conspicuous brown gelatinous tendrils, which are horny when dry. The mycelium is perennial in the juniper. In early spring, sporidia carry infection anew to the hawthorn.

In Britain, there are other species of *Gymnosporangium* with life histories very similar to that of *G. clavariiforme*. All alternate between juniper and Rosaceous hosts. One of them, *G. juniperi*, occurs on mountain ash (*Sorbus aucuparia*). It is noteworthy that in the genus *Gymnosporangium* there is no uredial stage, so that the

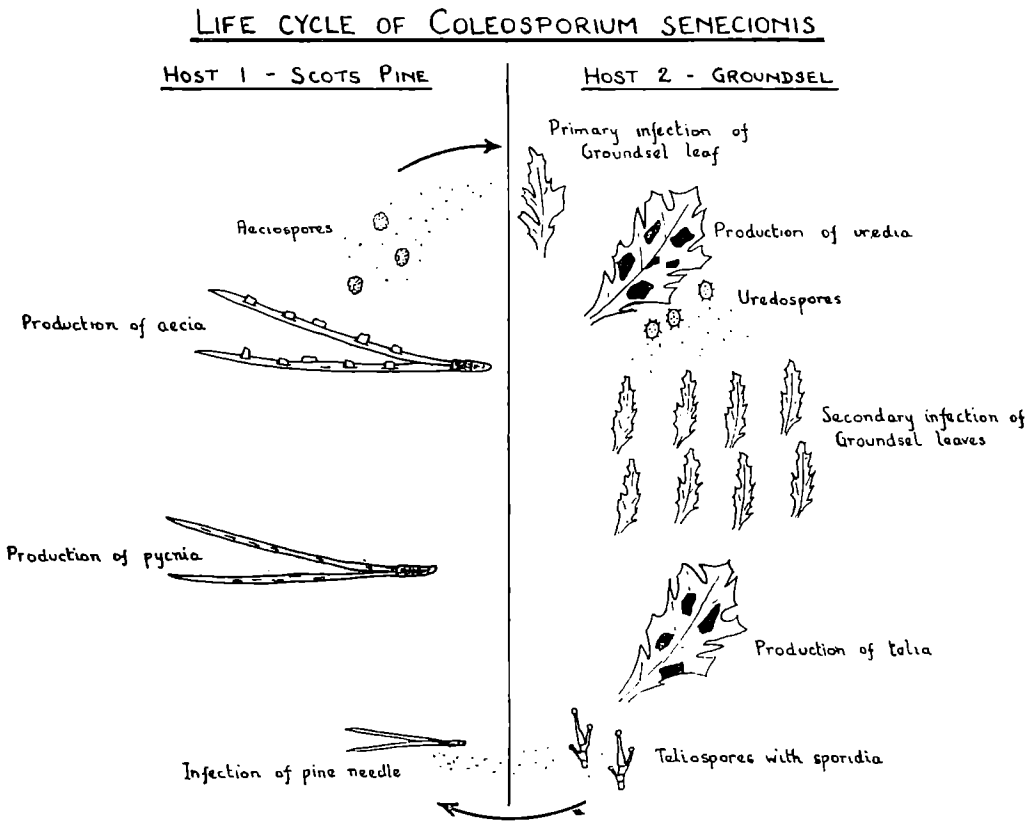


FIG. 1. Diagram showing the life cycle of a typical rust, *Coleosporium senecionis*, with alternate host plants, Scots pine and groundsel.

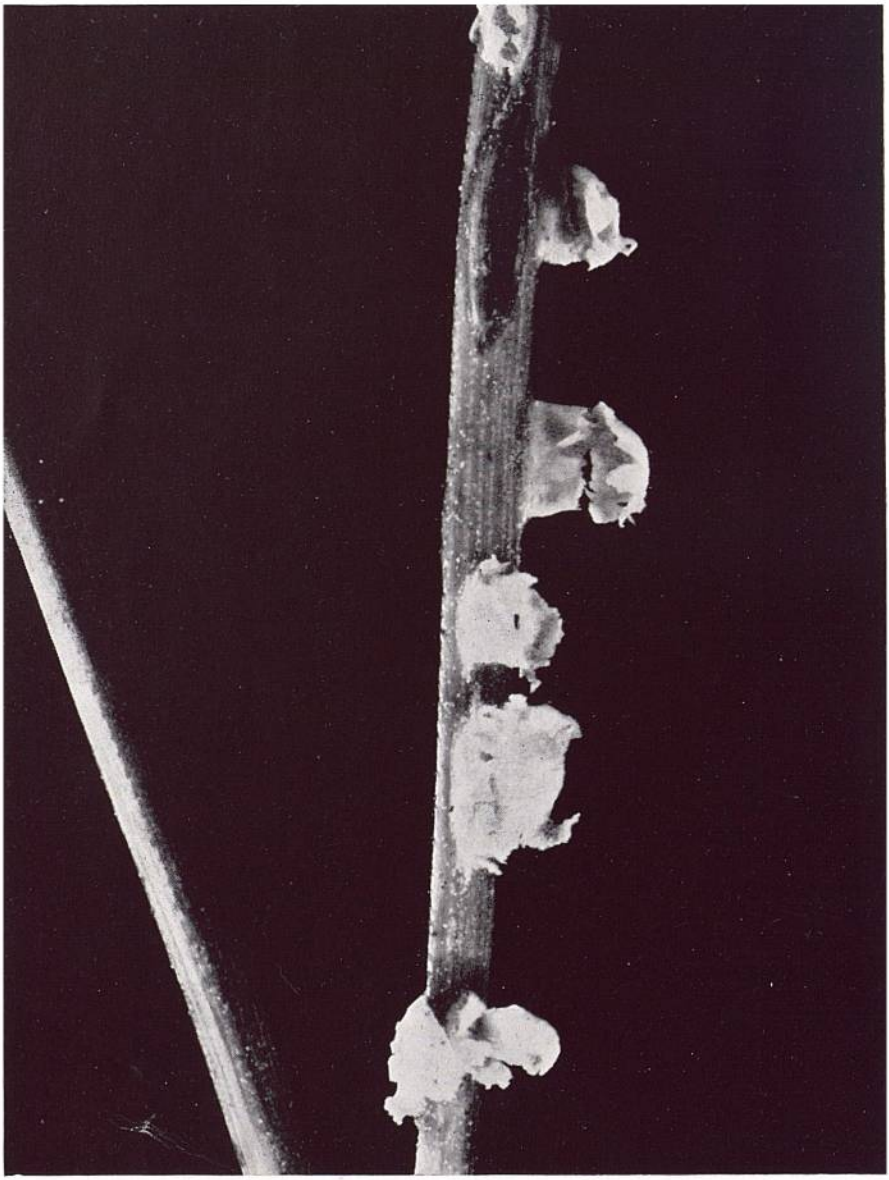

FIG. 2. *Coleosporium senecionis.* One lesion and several aecia on a needle of Scots pine, in May.

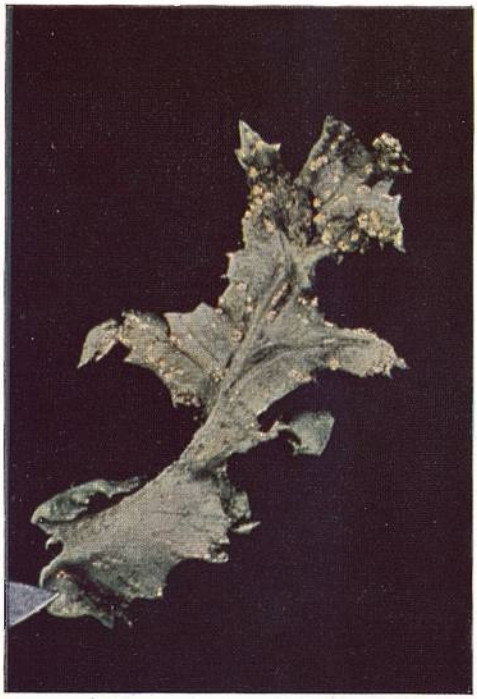

FIG. 3. *Coleosporium senecionis.* Uredia borne on a leaf of groundsel, in August.

FIG. 4. *Chrysomyxa rhododendri.* Prominently developed æcia on current year's needles of Norway spruce, October.

FIG. 5. *Chrysomyxa abietis.* Golden yellow banding of current year's needles of Norway spruce, October.

FIG. 6. *Melampsora pinitorqua.* An attack by this fungus on a shoot of Scots pine has led first to its bending over, and then to its death. June.

FIG. 7 *Melampsora pinitorqua.* Fruiting body on a Scots pine shoot, showing lesion and the production æciospores. June.

FIG. 8. *Melampsoridium betulinum*—Nursery plant of birch attacked by this fungus, which has caused browning of leaves and premature leaf-fall early in October; the leaves bear uredia.

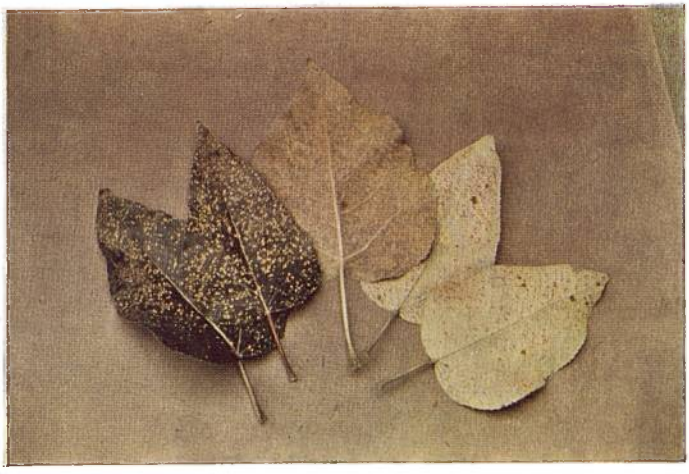

FIG. 9. *Melampsora* species. The uredial stage on poplar leaves in September.

FIG. 10. *Cronartium ribicola.* Blister-like æcia and a characteristic swelling on a shoot of limber pine, *Pinus flexilis*, in April.

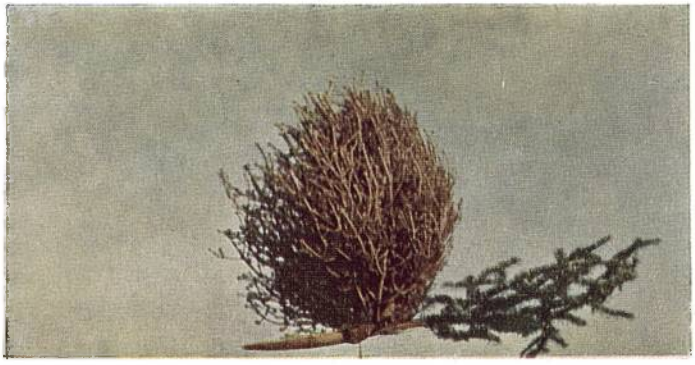

FIG. 11. *Melampsorella caryophyllacearum.* A witch's broom on European silver fir, *Abies alba*, in September. The short deciduous needles of the fir bear the æcia of the fungus.



S.E. & CO. 51-639

FIG. 12. *Cronartium ribicola*. A leaf of black currant showing numerous telia, March.

FIG. 13. *Cronartium ribicola*. Characteristic swellings on attacked shoots of limber pine, *Pinus flexilis*, in April. The swollen shoots bear the aecial blisters of the fungus.

fungus cannot be spread or survive indefinitely in the absence of either host. The effects are less severe on the juniper than on the alternate host.

**Melampsora pinitorqua** Rostr. Figs. 6 and 7

This rust affects mainly Scots pine though it has been recorded on mountain pine, maritime pine, Corsican pine and Weymouth pine. The alternate hosts are aspen (*Populus tremula*) which is far the most important, white poplar *P. alba*, and grey poplar *P. canescens*. It does not occur on Black or Balsam poplars. On the pine, pale yellow patches appear in June on the green developing shoots of the current year. Pycnia are produced on the patches as small yellow flecks, later followed by the golden yellow aecia, which have no peridium. Sometimes shoots are killed, and hang down in a withered condition, when the damage superficially resembles that due to Pine Shoot Moth (*Evetria buoliana*). It can, however, easily be distinguished, because shoots attacked by the insect are hollowed out, whereas those killed by *Melampsora* are still solid. Frequently, however, a patch on only one side of the shoot is killed by the fungus, the opposite side continuing to elongate, causing the top to bend over. Subsequently the tip turns upward again leaving an S-shaped bend which is very characteristic of the rust. The mycelium is not perennial in the pine shoot. The aeciospores, released by the rupture of the epidermis, infect leaves of the aspen. On the underside of infected leaves the uredia appear as yellow flecks, and the uredospores produced in these infect other aspens. Later, telia develop as brown patches, the leaves fall and the fungus overwinters in the telial stage on the fallen leaves. In June of the following year sporidia from the teliospores infect the young pine shoots. It is locally serious, causing distortion rather than death.

The damage done by this fungus can be quite serious, since it causes distortion of the stem and multiplication of leaders. It is, however, very local, occurring only where pine and aspen are in close proximity. This may be the case, when pine is planted on a cleared hardwood area, where aspen formed part of the hardwood growth.

The disease can be partially controlled by cutting aspen suckers early in the summer, and by felling aspen trees in the immediate neighbourhood of pine plantations. The sporidia do not appear normally to travel more than 200 yards. Once a plantation has suppressed the aspen suckers, the disease tends to disappear.

It is much better to avoid planting Scots pine on aspen sites. If pines are desired, Corsican or maritime pine, both of which are so resistant as to suffer no appreciable damage, can be used instead.

**Other Melampsora Species.** Fig. 9

There are a number of other so-called species of *Melampsora*, the uredial and telial stages of which occur on poplar or willow, and the aecial stage on larch, or on

certain herbaceous plants. *Melampsora larici-tremulae* can be taken as a typical example of these.

This rust parasitises European larch and some poplar species, especially aspen. White poplar, *P. alba*, is affected also. Yellow flecks about one twenty-fifth of an inch across appear on larch needles, on which, in May, the pycnia, later followed by the aecia, develop. The aecia are very small and pale red. The stage on larch is not easily seen, but that on aspen is obvious. Aeciospores infect the aspen leaves in summer causing angular yellow patches, which can be seen on the upper surface of the leaf. Uredia develop on the lower surface as small yellow pustules, from which uredospores infect other aspens. Later dark coloured telia develop on the same patches. The leaves fall prematurely, the telia overwintering in them and then in early spring producing sporidia, which infect the developing larch needles.

The following species of interest to forestry have been described:

| *Species of Rust* | *Aecial Host* | *Uredial and Telial Host* |
|---|---|---|
| *Melampsora larici-tremulae* Kleb. | Larch | Aspen and White poplar (including *P. canescens*). |
| *M. larici-populina* Kleb. | ,, | Black, Hybrid Black and Balsam poplars. |
| *M. larici-caprearum* Kleb. | ,, | Goat willow (*S. caprea* L.). |
| *M. larici-pentandrae* Kleb. | ,, | Bay willow (*S. pentandra* L.). |
| *M. larici-epitea* Kleb. | ,, | Willow spp. |
| *M. rostrupii* Wagn. | Dog's Mercury (*Mercurialis perennis*) | Aspen and White poplar. (including *P. canescens*). |
| *M. allii-populina* Kleb. | Wild onion (*Allium* spp.) | Black, Hybrid black and Balsam poplars. |

There are several other similar rusts occurring on willow, with a variety of herbaceous and shrubby aecial hosts.

In practice it is almost impossible to separate the species on any one host, for instance on poplar or on larch, except by microscopical botanical characters. The relative importance of the so-called species is therefore not really known, since in practice they are seldom identified.

As far as forestry is concerned the damage to larch is entirely negligible, and indeed seldom observed. On poplar, however, especially in the nursery, and particularly on many Balsam varieties and a few Black hybrids, damage is very obvious and occasionally severe. There is some suspicion that the fungus can survive on poplar without infecting larch.

A considerable amount of information on the susceptibility of various poplars to these rusts has been collected and is summarized in "Poplars", Forestry Commission Bulletin No. 19.

**Melampsorella caryophyllacearum** Schröt. Fig. 11

This rust attacks species of silver fir and, as alternate hosts, certain herbaceous plants including *Cerastium arvense* (mouse-ear chickweed), *Stellaria media* (stitchwort) and other related species. Sporidia infect the young shoots of *Abies* in early summer. A swelling develops at the point of infection, on which often a dormant bud is stimulated to abnormal branching to such a degree that a mass of upright interlacing twigs is produced. This is known as a "Witch's broom" and may persist and enlarge for many years. Sometimes, however, only a canker is formed. The needles on the witch's broom are dwarfed, yellowish and persist only for one year. Pycnia and aecia appear on the needles in June and July, the aeciospores infecting the herbaceous host. On it, uredia and telia are produced, the telia overwintering in the leaves and stems, and producing sporidia in the following year, which infect silver fir shoots. The fungus can survive on the herbaceous hosts in the absence of *Abies*. The rust is not common in Britain, and the damage done is negligible.

**Melampsoridium betulinum** (Desm.) Kleb. Fig. 8

This rust attacks European and Japanese larch and birch species, including our two native birches *Betula pendula* and *B. pubescens*. The pycnia and reddish orange aecia, about 1/20 inch across, are borne on the underside of larch needles. Infection of the birch results in the production of uredia as yellow flecks on the under surfaces of the leaves, followed later by the dark brown telial stage and premature defoliation. The fungus can apparently exist on birch alone without the larch host.

This fungus seldom does appreciable damage to birch outside the nursery. On dense seedbeds it can cause almost complete premature defoliation, resulting in some reduction of growth. This may lead on occasion to dieback, probably as a result of secondary infection by other fungi. Birch should not be grown for some years on nurseries known to be heavily infected.

**Melampsoridium alni** Diet.

This rust attacks the common alder (*Alnus glutinosa*), the grey alder (*A. incana*) and species of larch. The fungus is closely related to *Melampsoridium betulinum* and produces similar aecia on the larch needles. Uredia and telia are produced as yellowish flecks on the under surfaces of the leaves of the alder, the symptoms closely resembling those of *M. betulinum* on the birch.

The fungus is uncommon and not important.

**Peridermium pini** (Pers.) Lev.

This rust has been found mainly on Scots pine, but it has also been reported on Corsican pine. Young shoots of pine are infected by means of aeciospores in summer. The rust overwinters as mycelium in the shoots, producing, in the following summer,

flat pycnia and numerous large, white, blister-like aecia on the affected swollen shoots. This rust is abnormal in that the aeciospores directly infect the shoots of pines, there being no uredial or telial stage in the life cycle. The mycelium can live in the host tissues for many years, gradually spreading downwards into older branches and sometimes the main stem. Severe dieback of the crown or death of the tree may result. The wood under the affected part is usually permeated with resin. The fungus is not common generally, though in some districts, such as North and East Scotland, it may be locally common.

**Thekopsora areolata** (Fr.) Magn. **Spruce Cone Rust**

This rust attacks the cones of Norway spruce and the leaves of the native bird cherry (*Prunus padus*). It also occurs on planted *Prunus virginiana* and *Prunus serotina*. In spring, sporidia infect the female flowers of the spruce. As the cones develop, whitish pycnia with a characteristic strong smell are formed on the scales followed in summer by numerous small, brownish, spherical aecia on the upper sides of the scales. The scales of attacked cones remain open in wet weather when unattacked ones are shut. The uredia are borne on small, brownish spots on the under surface of the cherry leaves; the dark brown telia, which are usually carried on the upper surface, appear later.

This rust is not very common in Britain and the amount of seed destroyed by it is probably small. In Scandinavia, it has been reported attacking the shoots of Norway spruce, but this type of damage has not been reported in Great Britain.

# SUMMARY TABLE OF RUSTS OF BRITISH FOREST TREES

| *Tree Host* | *Part Affected* | *Symptoms* | *Rust* |
|---|---|---|---|
| **Norway spruce** (also Sitka spruce) | Needles | Golden yellow pustules on current year's needles which fall during the following spring. Fig. 5. | *Chrysomyxa abietis* |
| (very rare on Sitka spruce) | Needles | Golden yellow pustules with white cylindrical aecia on current year's needles. Needles fall in autumn. Fig. 4. | *Chrysomyxa rhododendri* |
| | Cones | Numerous small, brown aecia on inner sides of cone scales. | *Thekopsora areolata* |
| | Cones | Usually two large, white aecia on outer sides of cone scales. | *Chrysomyxa pyrolae* |
| **Scots pine** | Shoots | Yellowed patches in summer on young shoots followed by twisting, distortion and often death of the shoots. Figs. 6 and 7. | *Melampsora pinitorqua* |
| | Shoots | Death of shoots with production of large, white, blister-like aecia. | *Peridermium pini* |
| | Shoots | As *Peridermium pini* but blisters yellowish. | *Cronartium asclepiadeum* |
| (also some other two-needled pines) | Needles | White cylindrical aecia on needles. Fig. 2. | *Coleosporium senecionis* |
| **Pinus strobus** (and other five-needled pines) | Needles, shoots, and sometimes stems | Dieback of shoots with swelling of bark and production of white aecia. Figs. 10 and 13. | *Cronartium ribicola* |

SUMMARY TABLE—*continued*

| *Tree Host* | *Part Affected* | *Symptoms* | *Rust* |
|---|---|---|---|
| **Larch** | Needles | Whitish aecia with orange contents about 1/20 inch diameter. | *Melampsoridium betulinum* |
| | Needles | Orange-yellow spots about 1/25 inch in diameter. | *Melampsora* spp. |
| **Silver fir** | Young shoots | Witches' brooms with yellow pustules on the short deciduous needles, also cankers on stems and branches. Fig. 11. | *Melampsorella caryophyllacearum* |
| | Needles | White pustules on either side of the midrib on underside of needle. | *Calyptospora goeppertiana* *Aecidium pseudocolumnare* *Pucciniastrum epilobii* |
| **Juniper** | Stems | Swellings of shoots bearing orange-yellow gelatinous horns. | *Gymnosporangium clavariiforme* and other spp. |
| **Poplars** (also Willows) | Leaves | Yellow spots later turning dark brown on undersides of leaves, which often shrivel and fall prematurely. Fig. 9. | *Melampsora* spp. |
| **Birch** | Leaves | Yellow pustules later turning brown on lower sides of leaves. Fig. 8. | *Melampsoridium betulinum* |
| **Oak** | Leaves | Yellow round spots about $\frac{1}{4}$ inch in diameter on undersides of leaves. Very rare. | *Uredo quercus* |
| **Alder** | Leaves | Yellow flecks on under surfaces of leaves. | *Melampsoridium alni* |

# CONTROL OF RUSTS

Direct control of rusts is difficult and there is little information on it. In some cases a reduction in attack has been obtained using standard sprays, but owing to lack of data no specific recommendations on spraying can be made. Control measures at present are thus necessarily indirect. Susceptible species of trees should not be planted where the alternate host exists, e.g. Scots pine should not be used on sites where aspen occurs, but another species should be substituted for it. In the case of nurseries, the best method of control is again the avoidance of the alternate host. This may be obtained either by its eradication during routine weeding if it is a common weed such as groundsel, or by not using the nursery for susceptible tree species where it is not practicable to get rid of the alternate host.

Printed in Great Britain under the authority of Her Majesty's Stationery Office
by Joseph Wones Ltd., West Bromwich

(2782) Wt. 4871/2178 K32 4/55 J.W. Ltd. Gp. 517

# FORESTRY COMMISSION PUBLICATIONS

## RECENT FOREST RECORDS

No. 21. Use and Manufacture of Wood Flour .... .... .... 6d. (7½d.)
No. 22. Shelterbelts for Welsh Hill Farms .... .... .... .... 2s. 0d. (2s. 1½d.)
No. 23. Fires in State Forests, 1929-52 .... .... .... .... 1s. 6d. (1s. 7½d.)
No. 24. Revised Yield Tables for Conifers in Great Britain .... 1s. 3d. (1s. 4½d.)
No. 25. Japanese Larches at Dunkeld, Perthshire. A Study in Variation .... .... .... .... .... .... .... 2s. 0d. (2s. 1½d.)
No. 26. Drought Crack of Conifers .... .... .... .... 2s. 6d. (2s. 7½d.)
No. 27. Use of Home-Grown Timber in Wood Turning and Related Trades in Scotland in 1953 .... .... .... 1s. 3d. (1s. 4½d.)
No. 28. Volume Table for Small Hardwood Trees .... .... 9d. (10½d.)
No. 29. Use of Forest Produce in Sea and River Defence in England and Wales .... .... .... .... .... 1s. 6d. (1s. 7½d.)

## BOOKLETS

1. Woodland Mosses 2s. 6d. (2s. 7½d.)
2. Dedication of Woodlands 2s. 0d. (2s. 1½d.)
3. Chestnut Blight 2s. 6d. (2s. 7½d.)

## NATIONAL FOREST PARK GUIDES

Argyll .... .... 4s. (4s. 3d.)
Snowdonia .... .... 5s. (5s. 3d.)
Hardknott (Lake District) 2s. (2s. 2d.)
Glen Trool (Galloway) 5s. (5s. 3d.)
Queen Elizabeth (Trossachs) .... 3s. 6d. (3s. 9d.)

## GUIDE BOOKS

Bedgebury .... .... (*Reprinting*)
New Forest .... 3s. 6d. (3s. 9d.)

## FOREST OPERATIONS SERIES

1. The Thinning of Plantations 1s. 9d. (1s. 10½d.)
2. The Establishment of Hardwoods 1s. 6d. (1s. 7½d.)

BULLETIN 14: Forestry Practice 3s. 0d. (3s. 2d.)

## BRITAIN'S FORESTS

Forest of Ae .... .... 6d. (7½d.)
Culbin .... .... 1s. 0d. (1s. 1½d.)
Rheola .... .... .... 6d. (7½d.)
Tintern .... .... 9d. (10½d.)
Kielder .... .... 1s. 0d. (1s. 1½d.)
Drumtochty .... 1s. 3d. (1s. 4½d.)
Glentress .... .... 1s. 0d. (1s. 1½d.)
Loch Ard .... .... 1s. 0d. (1s. 1½d.)
Strathyre .... .... 1s. 0d. (1s. 1½d.)
Thetford Chase .... 1s. 0d. (1s. 1½d.)
Thornthwaite .... 1s. 0d. (1s. 1½d.)

ANNUAL REPORT, 1954, 3s. 6d. (3s. 8d.)

REPORT ON FOREST RESEARCH FOR THE YEAR ENDING MARCH, 1954
6s. (6s. 3d.)

*Prices in brackets include postage*

Obtainable from H.M. Stationery Office, at the addresses shown overleaf, or through any Bookseller. A complete list of publications (Sectional List No. 31) is obtainable, on request, from H.M. Stationery Office or from the Secretary, Forestry Commission, 25 Savile Row, London, W.1

PUBLISHED BY HER MAJESTY'S STATIONERY OFFICE

To be purchased from

York House, Kingsway, LONDON, W.C.2 423 Oxford Street, LONDON, W.1

P.O. Box 569, LONDON, S.E.1

13a Castle Street, EDINBURGH, 2 109 St. Mary Street, CARDIFF

39 King Street, MANCHESTER, 2 Tower Lane, BRISTOL, 1

2 Edmund Street, BIRMINGHAM, 3 80 Chichester Street, BELFAST

or from any Bookseller

1955

Price 2s. 6d. net

S.O. Code No. 71-6-4