

Erysiphaceae of New Zealand

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Preface

In 1974 I began the study of the New Zealand Erysiphaceae to satisfy my curiosity as to whether different species of powdery mildew are more or less indistinguishable in their imperfect state, as is generally believed, or whether, as is the case in most fungi, species which can be distinguished in their perfect state also possess morphological differences in their imperfect state. I also thought it was strange that only few species had been reported on few host plants although climatic conditions were suitable for the development on a wide range of plants.

Most of this study was carried out at the Mt Albert Research Centre, Ministry of Agriculture and Fisheries, Auckland, and extensive use was made of the library of the adjoining Plant Diseases Division, Department of Scientific and Industrial Research (D. S. I. R.). Many of my new recordings have been deposited in the herbarium of the Plant Diseases Division, DSIR. At the completion of my study of living collections of powdery mildews, I examined herbarium samples collected throughout New Zealand.

Introduction

The Erysiphaceae of New Zealand have never been extensively studied or monographically treated and information on the species and their host plants is scattered throughout various annual reports and plant pathological literature. HIRATA (1966), in a survey of world literature, and BLUMER (1967), in his famous monograph, concluded that powdery mildews are relatively poorly represented in New Zealand. In a list of plant diseases recorded in New Zealand, DINGLEY (1969) listed 14 species of Erysiphaceae but expressed doubt whether one of these, *Erysiphe carpophila*, was a powdery mildew. The list by DINGLEY does not include most of the records in the national herbarium at the Mt Albert Research Centre, nor, several published species. DINGLEY (1969) stated that cleistothecia were rare and occurred only in the South Island. BOESEWINKEL (1976a) reported the finding of cleistothecia in the North Island and compiled information on their occurrence

by studying records in the literature and herbarium. HAMMETT (1977) studied Erysiphaceae on 66 host plants and found no differences between *Erysiphe carpophila*, *E. cruciferarum*, *E. pisi*, *E. polygoni* and *E. ranunculi*. He stated that the characteristics of mycelium, appressoria, haustoria and conidial dimensions have little diagnostic value but gave no substantiating information on their morphology. BOESEWINKEL (1977) reported 34 species on 112 host plants and provided a key for their identification, based on characteristics of the imperfect state. The present work attempts to bring information together and gives 228 host records.

History

Most of the powdery mildews of New Zealand appear to have been introduced by settlers from Europe during the last two centuries. This would explain the preponderance of European species of mildew and the paucity of Asian and endemic species (BOESEWINKEL, 1978).

The oldest record is *Erysiphe densa* on *Aristotelia racemosa* (BERKELEY, 1855). Cleistothecia of this powdery mildew have been found on several occasions in both the North and the South Island.

Other early records (conidial states only) are: *Microsphaera grossulariae* on *Ribes uva-crispa* (KIRK, 1899); *Uncinula necator* on *Vitis vinifera* (KIRK, 1901); *Oidium chrysanthemi* on *Chrysanthemum* sp. and *Sphaerotheca pannosa* on *Rosa* sp. (KIRK, 1906); *Podosphaera leucotricha* on *Malus sylvestris* (KIRK, 1908) and *Blumeria graminis* on *Triticum aestivum* (KIRK, 1909).

Several of these plants had been introduced as cuttings or plants which may have been infected.

Further interesting recordings were made during the period when the excellent plant pathologist CUNNINGHAM investigated diseases of economically important crops throughout the country. *Podosphaera oxyacanthae* was reported on stonefruit (CUNNINGHAM, 1921) and *Sphaerotheca alchemillae* on *Fragaria* sp. (CUNNINGHAM, 1922). The first New Zealand description of cleistothecia of *Podosphaera leucotricha*, on shoots, leaves and petioles of apple, was given by CUNNINGHAM (1923). SYDOW (1924) received from CUNNINGHAM a species which formed cleistothecia on the indigenous *Weinmannia sylvicola* and gave it the name *Erysiphe carpophila*. A related fungus, *E. rubicola*, was newly described from two indigenous species of *Rubus* (MURRAY, 1927). Most of these records can be verified today.

During the next 42 years, *Microsphaera alphitoides* (BRIEN and DINGLEY, 1951), *Uncinula australiana* (DINGLEY, 1969) and 57 host records were reported, often without description. Several host records have not been verified, such as *Erysiphe cichoracearum* on *Begonia* spp. and *Kalanchoe* sp. and *E. polygoni* on *Phaseolus coccineus* and *Ph.*

vulgaris (DINGLEY, 1965); *Podosphaera leucotricha* on *Cydonia oblonga* (BRIEN and DINGLEY, 1951); *P. oxyacanthae* on *Prunus persica*, *Sphaerotheca alchemillae* on *Rubus* spp. (DINGLEY, 1969) and *S. pannosa* on *Rubus cissoides* (BRIEN and DINGLEY, 1955).

Recently the first recording of *Erysiphe ranunculi* and the first finding of cleistothecia of *E. cichoracearum* were published (BOESEWINKEL, 1976a); *Microsphaera begoniae* was newly recorded (BOESEWINKEL, 1976b). During a study of powdery mildews in the Auckland area, 19 new species were discovered and in total 34 species were reported (BOESEWINKEL, 1977). In this monograph, 39 species are included on 202 host plants. In the future more new host recordings can be expected, especially for species which are known to have a wide host range such as "*Erysiphe polyphaga*", *Phyllactinia guttata* and *Sphaerotheca fuliginea*. Several of the species which appear to be extending their area elsewhere in the world have not yet reached New Zealand. One of these, *Leveillula taurica*, can be expected to arrive sooner or later because in recent years it has spread from Asia to Australia and the Pacific Islands around New Zealand.

Taxonomy and Nomenclature

The delimitation of genera and species follows BLUMER (1933; 1967), HOMMA (1937), JUNELL (1967) and SPEER (1975a). The morphology of the imperfect states of all species is studied extensively, as for many species no cleistothecia have been found in New Zealand. Cleistothecia are only known to be produced by *Blumeria graminis*, *Erysiphe carpophila*, *E. cichoracearum*, *E. cruciferarum*, *E. densa*, *E. ranunculi*, *E. rubicola*, *Podosphaera leucotricha*, *Sphaerotheca fuliginea* and *S. pannosa*. Previous taxonomic treatments of Erysiphaceae do not provide adequate information on the imperfect states and therefore a detailed study of the world literature was necessary (BOESEWINKEL, in prep.) to establish the correlation with known perfect states. Valuable information was obtained from DE BARY (1870), BLUMER (1933), FOEX (1924), FRESSENIUS (1852), HIRATA (1942), NEGER (1902), SALMON (1905a), TULASNE (1861), VIENNOT-BOURGIN (1969) and ZARACOVITIS (1965).

Numerous measurements of conidia and conidiophores have been carried out. In agreement with BOUWENS (1924) the extreme values of the conidial size are considered of little value and therefore the most frequently occurring size is given with, in brackets, the extremes which may occur rarely.

Essential characteristics are the presence or absence of conspicuous, welldeveloped, fibrosin bodies; the production of conidia singly or in long chains; the size, shape and position of appressoria and haustoria; the size, shape and structure of the generally 3-celled

conidiophores, especially of their foot-cell; the size, shape and germination pattern of conidia; and the cell-size, shape, branching pattern and location of the mycelial hyphae. This is the first study which reports information on so many characteristics.

In several species a great variation occurred in the size and shape of the conidia, especially their length whereas the width showed more constant values. Variation was more obvious in species with large conidia such as *Erysiphe cruciferarum*, *E. pisi*, *E. trifolii*, *Microsphaera begoniae* and *Phyllactinia guttata*, than in species with small conidia such as *E. mougeotii*, *M. euonymi-japonici* and *Sphaerotheca pannosa*. Conspicuous variation occurred in the shape of germ tubes and the type of appressoria they produce, while the position of germ tubes, whether on the end or side of conidia, was more constant. I had previously studied the germination pattern on the host and on glass slides placed on the laboratory bench at room temperature (BOESEWINKEL, 1977) but during the present study conidia were also germinated in the dark at room temperature. This frequently resulted in a more uniform pattern of germination. Variation was also observed in the shape of appressoria and the foot-cells of conidiophores.

The nomenclature of JUNELL (1965, 1967) is followed.

Distribution and Occurrence

Many of the conspicuous species have been collected throughout the country and appear to have a wide distribution, such as *Erysiphe cichoracearum*, *Microsphaera euonymi-japonici*, *Podosphaera leucotricha* and *Sphaerotheca pannosa*. Less is known about the distribution of inconspicuous species such as *M. hypophylla*, *M. viburni*, *Phyllactinia guttata* and *Sawadaea bicornis*; several of these have only recently been discovered and have been collected from only few areas.

The climatic conditions in the Auckland area favour the growth of many plants and permit cultivation of all varieties of plants grown in New Zealand. Several deciduous trees and shrubs retain their leaves over a long period and diseases thrive. Many species of powdery mildew are extremely common and on a short walk through an area with gardens, eight or more species can be found. Many powdery mildews can be observed nearly all the year round for example *Blumeria graminis*, *E. asperifoliorum*, *E. cichoracearum*, *E. mougeotii*, "*E. polyphaga*", *M. begoniae*, *M. euonymi-japonici*, *M. polonica*, *Oidium oxalidis*, *Ph. guttata* and *S. fuliginea*. Whereas *M. viburni* and *Uncinula necator* are mainly found during the summer, *E. galeopsidis* and *M. hypophylla* have been observed during the winter months.

Host Plants

In many areas of the world, the sudden appearance of a powdery mildew on a previously uninfected plant species cannot be easily

explained. It is possible that either a new species arrived from another country or that a local species extended its host range. As New Zealand is well isolated by sea and air from other countries, and plant quarantine restricts the importation of plant material, new introductions of powdery mildews rarely occur. In many cases, new host records of powdery mildews can therefore be attributed to the extension of the host range of existing species rather than to the sudden appearance of new species.

Exotic host plants outnumber the indigenous hosts and include weeds of the genera *Aster*, *Bromus*, *Epilobium*, *Erodium*, *Fumaria*, *Hypericum*, *Lotus*, *Lupinus*, *Melilotus*, *Modiola*, *Oxalis*, *Papaver*, *Plantago*, *Poa*, *Ranunculus*, *Rosa*, *Senecio*, *Solanum*, *Solidago*, *Trifolium*, *Valerianella*, *Verbena*, *Veronica* and *Urtica*. As several weeds are widespread, they can function as a reservoir of infection. Economically important host plants include the genera *Brassica*, *Cucumis*, *Cucurbita*, *Cydonia*, *Cyphomandra*, *Fragaria*, *Hordeum*, *Lycopersicon*, *Malus*, *Pastinaca*, *Pisum*, *Prunus*, *Pyrus*, *Rosa*, *Solanum*, *Triticum* and *Vitis*. The numerous ornamental host plants include the genera *Acer*, *Aster*, *Begonia*, *Chrysanthemum*, *Cotinus*, *Dahlia*, *Eucalyptus*, *Euonymus*, *Hardenbergia*, *Hydrangea*, *Kalanchoë*, *Lagerstroemia*, *Sedum* and *Viburnum*.

Of great interest is that several European species of powdery mildew have found host plants amongst the rich indigenous flora which is present throughout the country in gardens, parks, road sides and farmland. Indigenous host plants include the genera *Alectryon*, *Aristotelia*, *Brachyglottis*, *Cardamine*, *Clematis*, *Coriaria*, *Dysoxylon*, *Geranium*, *Hebe*, *Hoheria*, *Olearia*, *Rubus*, *Solanum*, *Sophora*, *Vitex* and *Weinmannia*. Of these hosts, *Aristotelia*, *Rubus* and *Weinmannia* are infected with three endemic species of powdery mildew which closely resemble European species of powdery mildew. The remaining indigenous hosts are infected with the European species *E. cichoracearum*, *E. cruciferarum*, *E. galeopsidis*, *E. heraclei*, *E. pisi*, *E. ranunculi*, *E. trifolii*, *Ph. guttata*, *Sa. bicornis*, *S. jugax* and *S. fuliginosa*. Several of the susceptible indigenous host plants are closely related to host plants known overseas, for example, *Clematis* (Ranunculaceae), *Geranium* (Geraniaceae), *Solanum* (Solanaceae), *Brachyglottis* and *Olearia* (Compositae), *Hoheria* (Malvaceae) and *Sophora* (Papilionaceae). More interesting is *Sa. bicornis* on the indigenous host *Alectryon* which belongs to the same order Sapindales as the overseas host *Acer*. Unusual are the records on *Coriaria* (Coriariaceae), *Hebe* (Scrophulariaceae) and *Vitex* (Verbenaceae), on which powdery mildews have been found which occur overseas on unrelated host plants. Obviously the host range of many species of powdery mildew is still incompletely known because the literature does not yet include the hosts of the numerous unidentified species of *Oidium*, *Oidiopsis* and *Ovulariopsis*.

This work is based of freshly collected living samples of the conidial state, collected in the Auckland area, and on samples collected by me on field trips throughout the country and in my large garden in Waitakere, 30 km north of Auckland. Collections have been made daily and were studied microscopically, mounted in water. I took the microphotographs with an Asahi Pentax camera which was attached to a Nikon microscope with an adapter. Germination of conidia was studied on the host or on glass slides, as reported previously (BOESE-WINKEL, 1977) in the light or dark at room temperature and after one day incubation. Herbarium samples were examined but proved to be of little value as fibrosin bodies and the original shape of appressoria and conidia could not be observed. Cleistothecia were studied when freshly collected. They occurred on *Aristotelia fruticosa*, *A. serrata*, *Aster ericoides*, *Delphinium ajacis*, *D. cultorum*, *Plantago major*, *Ranunculus asiaticus*, *R. repens*, *Weinmannia racemosa* and *W. sylvicola*. In New Zealand cleistothecia have been frequently found on *Aristotelia*, *Delphinium*, *Ranunculus*, *Weinmannia*, and cereals. There are only few collections known from other hosts such as *Brassica*, *Coriaria*, *Cucurbita*, *Malus* and *Rosa*.

BLUMERIA GOLOVIN ex SPEER (1975)

Blumeria is characterised by cleistothecia with many 8-spored asci and unbranched or irregularly branched appendages. The cleistothecia possess a sub-cortical layer between the atro-sclerocortex and the hymenium.

The conidial state produces a characteristic conidiophore with a bulbous swelling of the foot cell. Conidia are produced in long chains and lack conspicuous fibrosin bodies. Appressoria are unlobed, well-developed, nipple-shaped. Conidia produce germ tubes on the side. Haustoria are characteristically multi-lobed and digitate. The genus is morphologically related to *Erysiphe* of which the section *Euoidium* produces conidia in long chains, lacks conspicuous fibrosin bodies and possesses unlobed, rarely moderately lobed, appressoria.

1. *Blumeria graminis* (DC. ex MÉRAT) SPEER 1975. — Sydowia 27: 2.

Type on *Triticum* sp.; France.

On leaves, stems and inflorescences. Mycelium thin or dense, white, occasionally ochreous or rusty brown-red late in summer. Brown sickles shaped bristles can be formed at the time of the formation of cleistothecia. Mycelial hyphae flexuous with geniculate and straight areas, branching at various angles including right angles, frequently near a septum. Hyphal cells $(35-43(-53) \times 3.5-5.5 \mu\text{m})$. Appressoria unlobed, nipple-shaped, $3.5-7 \mu\text{m}$ wide, produced singly or opposite in pairs on alternating or consecutive cells. Conidiophores $60-90 \times 4-7 \mu\text{m}$ producing conidia in chains. Foot-cells of conidiophores

20—40×5—7 μm , with a characteristic swelling of 12—15 μm wide at about half way their length and followed by cells 12.5—25 μm long. Conidia ellipsoid or lemon shaped, (20—)24—30(—35)×8—16 μm , occasionally up to 2 μm wider at one end or slightly constricted at the centre. No well-developed conspicuous fibrosin bodies present. Germ tubes on side or end of conidia, simple, straight or occasionally flexuous, about 12—50×2.5—4 μm and terminating in an unlobed appressorium 4—5 μm wide. Haustoria characteristically digitate. Cleistothecia have been found on cereal crops but were not studied by me.

The typical shape of the conidiophores and haustoria separate *Bl. graminis* from other species which produce conidia in long chains. This is the only species known to occur on Gramineae. Serious attack occurs on grasses richly supplied with nitrogen and/or growing in the shade. So far this mildew has not been found on any of the numerous indigenous grasses.

- on *Agropyron scabrum* (Labill.) Beauv. (BRIEN and DINGLEY, 1951)
- on *Alopecurus pratensis* L. (KIRK, 1909)
- on *Avena sativa* L. (CUNNINGHAM, 1922). Recently SMITH, SMITH and MARSHALL (1973) were unable to find powdery mildew of oats and concluded that it does not occur in the country.
- on *Bromus* spp. (KIRK, 1906)
- on *Dactylis glomerata* L. (BRIEN and DINGLEY, 1951)
- on *Hordeum vulgare* L. (NEILL, 1928)
- on *Phalaris tuberosa* L. (new record, collected by Dr. G. LATCH)
- on *Poa trivialis* L. (HAMMETT, 1977). This is a very common disease during the spring and early summer, especially in sheltered areas. It also occurs in winter.
- on *Triticum aestivum* L. (KIRK, 1909)

ERYSIPHE DC. ex FR. (1821)

Erysiphe is characterised by cleistothecia with many asci and unbranched or irregularly branched appendages. In species of the section Euoidium the asci contain generally 2 spores. In the Pseudoidium section the asci contain 3—6 or 6—8 spores.

The conidial state produces no conspicuous fibrosin bodies and can be divided into the Euoidium section, where conidia are produced in long chains and appressoria are generally unlobed, and the Pseudoidium section where conidia are formed singly and appressoria are generally lobed. The haustoria are globose or pear shaped and unlobed, rarely moderately lobed.

1. Conidiophores producing conidia in chains

- A. Appressoria moderately lobed; germ tubes on side of conidia
 - on Geraniaceae: *Geranium* *E. galeopsidis*
 - on Labiatae: *Rosmarinus* *E. galeopsidis*

B. Appressoria unlobed

- I. Appressoria well-developed, nipple-shaped; germ tubes generally produced on the end of conidia
on Compositae: *Aster* and many other

| genera | <i>E. cichoracearum</i> |
|--|-------------------------|
| on Cruciferae: <i>Cardamine</i> | <i>E. cichoracearum</i> |
| on Cucurbitaceae: <i>Cucumis</i> , <i>Cucurbita</i> | <i>E. cichoracearum</i> |
| on Gesneriaceae: <i>Sinningia</i> | <i>E. cichoracearum</i> |
| on Malvaceae: <i>Hibiscus</i> | <i>E. cichoracearum</i> |
| on Myrtaceae: <i>Eucalyptus</i> | <i>E. cichoracearum</i> |
| on Plantaginaceae: <i>Plantago</i> | <i>E. cichoracearum</i> |
| on Scrophulariaceae: <i>Penstemon</i> | <i>E. cichoracearum</i> |
| on Solanaceae: <i>Nicotiana</i> , <i>Petunia</i> , <i>Solanum</i> | <i>E. cichoracearum</i> |
| on Violaceae: <i>Viola</i> | <i>E. cichoracearum</i> |

- II. Appressoria nipple-shaped, often poorly developed and nearly inconspicuous; germ tubes frequently on side of conidia
on Scrophulariaceae: *Veronica* *E. asperifoliorum*
on Compositae: *Helianthus* "*E. polyphaga*"
on Cucurbitaceae: *Cucurbita*, *Cucumis* "*E. polyphaga*"
on Malvaceae: *Hibiscus*, *Modiola* "*E. polyphaga*"
on Myrtaceae: *Eucalyptus* "*E. polyphaga*"
on Solanaceae: *Lycopersicon*, *Nicotiana*,
Petunia, *Solanum* "*E. polyphaga*"

- III. Appressoria nipple-shaped, poorly developed; germ tubes on end of conidia
on Labiatae: *Thymus* *E. biocellata*

2. Conidiophores producing conidia singly

A. Appressoria moderately lobed

| | |
|---|----------------|
| on Papilionaceae: <i>Lathyrus</i> , <i>Lupinus</i> , <i>Melilotus</i> , <i>Pisum</i> | <i>E. pisi</i> |
| on Scrophulariaceae: <i>Hebe</i> | <i>E. pisi</i> |

B. Appressoria multi-lobed or moderately lobed

- I. Conidiophore straight; germ tubes simple
on Umbelliferae: *Pastinaca* *E. heraclei*
on Meliaceae: *Dysoxylum* *E. heraclei*
- II. Conidiophores straight or with a foot-cell which is slightly bent or decreases in width from the base upwards; germ tubes simple, rarely slightly branched
on Cruciferae: *Brassica*, *Cardamine*,
Iberis, *Raphanus* *E. cruciferarum*
on Papaveraceae: *Papaver* *E. cruciferarum*
on Capparidaceae: *Cleome* *E. cruciferarum*

- on Fumariaceae: *Fumaria* *E. cruciferarum*
 on Geraniaceae: *Erodium*, *Geranium* *E. cruciferarum*

C. Appressoria multi-lobed

- I. Conidiophores moderately long, flexuous at the base; conidia ellipsoid-cylindric
 on Papilionaceae: *Brachysema*, *Lathyrus*,
Lotus, *Trifolium*,
Wistaria *E. trifolii*
- II. Conidiophores moderately long, flexuous at the base; conidia cylindric-ovoid; germ tubes simple or branched or forked
 on Cunoniaceae: *Weinmannia* *E. carpopphila*
- III. Conidiophores moderately long, straight; conidia cylindric
 on Elaeocarpaceae: *Aristotelia* *E. densa*
- IV. Conidiophores short or moderately long, straight; conidia ovoid; germ tubes simple or branched
 on Ranunculaceae: *Anemone*, *Aquilegia*,
Clematis, *Delphinium*,
Nigella, *Ranunculus* *E. ranunculi*

2. *Erysiphe asperifoliorum* GREV. 1824. — Fl. Edin.: 461

Type on *Symphytum* sp.; Scotland.

On leaves, stalks and inflorescences. Mycelium thin or moderately dense. Hyphae moderately flexuous, branching at right angles, often near a septum. Hyphal cells (60—)67—75(—80) \times 5—7.5 μ m. Appressoria unlobed nipple-shaped or poorly developed. Conidiophores 105—200(—440) \times 10—12.5 μ m, simple or occasionally branched at the base, producing conidia in chains. Foot-cells of conidiophores either straight and occasionally constricted at the base or, rarely, branched near the top, (17—)30—63(—400) \times 10—12.5 μ m, followed by two cells of 14—20(—100) μ m long. Conidia ovoid-cylindric, 32—35(—42) \times (15—)16—18(—23) μ m. No well developed fibrosin bodies present. Germ tubes on side or end of conidia, simple, short, occasionally bent or helicoid, often broadened, 10—15 \times 5—10 μ m. Haustoria globose, 17.5—20 μ m.

The often poorly developed appressoria distinguish this species from *E. cichoracearum*. The characteristic germ tubes have been illustrated by ZARACOVITIS (1964, 1965).

on *Veronica arvensis* L. (new record).

3. *Erysiphe biocellata* EHRENB. 1821. — N. Acta phys.-med. Acad. Caes. Leopold — Carol. nat. cur. 10: 211.

Type on *Lycopus europaeus* L., Germany.

On leaves. Mycelium thin, white. Hyphae moderately flexuous, branching at right angles with cells 50—75 \times 5—7.5 μ m. Appressoria

poorly developed, nipple-shaped or nearly inconspicuous. Conidiophores $160\text{--}220 \times 12.5 \mu\text{m}$, producing conidia in long chains. Foot-cells straight but often attenuated at the base where there is an area of $5\text{--}10 \mu\text{m}$ wide which frequently collapses when examined in water. Foot-cells measure $(30\text{--})62(\text{--}70) \times (5\text{--})7.5\text{--}12.5 \mu\text{m}$ and are followed by one or two cells $(12\text{--})25\text{--}35 \times 12\text{--}13 \mu\text{m}$. Conidia ovoid-cylindric, $(0\text{--})35\text{--}37(\text{--}45) \times (15\text{--})18\text{--}20(\text{--}22.5) \mu\text{m}$. No well-developed fibrosin bodies formed. Germ tubes on end of conidia, simple, moderately long, $5 \mu\text{m}$ wide and terminating in a long appressorium about $30 \times 7.5 \mu\text{m}$.

This species occurs frequently in herb gardens and causes slight to moderate damage.

on *Thymus aureus* HORT. ex E. MORR. (new record)

on *Thymus serpyllum* L. (BOESEWINKEL, 1977).

4. *Erysiphe carpophila* SYDOW 1924. — Ann. mycol. 22: 294.

Type on *Weinmannia sylvicola*; New Zealand.

On leaves, stems and inflorescences. Mycelium thin, white. Hyphae flexuous or irregularly shaped, $(3\text{--})4\text{--}5 \mu\text{m}$ wide. Appressoria multilobed, $6\text{--}7.5 \mu\text{m}$ wide. Conidiophores $(50\text{--})94\text{--}127 \times 7\text{--}9 \mu\text{m}$, producing conidia singly. Foot-cells of conidiophores flexuous, $35\text{--}42 \times 7\text{--}9 \mu\text{m}$, followed by a second cell of $27\text{--}35 \times 7.5 \mu\text{m}$ and a third cell of $32.5\text{--}50 \times 8\text{--}8.7 \mu\text{m}$. Conidia cylindric-ovoid, $(25\text{--})30\text{--}32.5(\text{--}52.5) \times (12.5\text{--})15\text{--}16.5 \mu\text{m}$. No well-developed fibrosin bodies produced. Germ tubes on end, occasionally on side of conidia, simple, branched or forked, straight or flexuous, moderately long and $5\text{--}7.5 \mu\text{m}$ wide, terminating in a club-shaped or lobed appressorium about $17.5 \mu\text{m}$ wide (Pl. 1, fig. 1).

Cleistothecia $(100\text{--})140\text{--}200 \mu\text{m}$ diam. with numerous appendages $3\text{--}4.5 \mu\text{m}$ wide and $1.5\text{--}4$ times as long as the diameter of the cleistothecia, usually unbranched, rarely branched near the tip. Asci $6\text{--}22$ with 8 spores.

The numerous asci which frequently number $20\text{--}22$ and contain 8 ascospores clearly distinguish this species from *E. polygoni* s. lat. None of the species related to *E. polygoni* s. lat. in New Zealand resemble *E. carpophila* in the perfect state. SYDOW (1924) remarked that *E. carpophila* is very close to *E. aggregata* (PECK) FARLOW but differs in having smaller and fewer asci. Both species had at that time not been found on leaves but only on inflorescences and no conidial state had been found. Recently the conidial state of *E. carpophila* was recorded and both the conidial state and the cleistothecia occurred on inflorescences and on leaves of two species of *Weinmannia* (BOESEWINKEL, 1977). It is a harmless disease and occurs periodically throughout the year.

on *Weinmannia racemosa* L. f. (BOESEWINKEL, 1977). On this host the cleistothecia are frequently smaller, 100—170 μm and contain fewer asci, 10—12 in number. Also the conidia can be slightly smaller than on the other host.

on *Weinmannia sylvicola* SOL. ex A. Cunn. (SYDOW, 1924).

5. *Erysiphe cichoracearum* DC. ex MÉRAT 1821. — Nouv. fl. env. Paris ed. 2, 1: 132.

Type on *Scorzonera hispanica*; France.

On leaves, stalks and inflorescences. Mycelium moderately dense or dense, white. Hyphae moderately flexuous, occasionally geniculate, branching at tight angles near a septum. Hyphal cells (57—)60—70 (—90) \times 5—7.5 μm . Appressoria unlobed, nipple-shaped, smooth, rarely with slightly crenulated surface, one per cell or several in series or opposite. Conidiophores 75—160(—230) \times 10—12.5 μm , producing conidia in long chains. Foot-cells of conidiophores straight, occasionally slightly swollen at the base, 55—80 \times (7.5—)10—11 μm , followed by two cells of 22—27.5 \times 11—12.5 μm . Conidia cylindric-barrel shaped (25—)35(—42) \times (14—)18—19 μm . No well-developed fibrosin bodies formed. Germ tubes on end, rarely the side of conidia, simple or rarely forked, straight or occasionally flexuous, moderately long and 5 μm wide terminating in an unlobed club-shaped appressorium 5—8 μm wide.

Since 1900 this species has been reported from many host plants but the first cleistothecia were only recently found on *Aster ericoides* (BOESEWINKEL, 1976a) and, during the present study, on *Plantago major*. Many hosts in the following list are likely to be infected with "*E. polyphaga*".

on *Aster ericoides* L. (BRIEN and DINGLEY, 1955)

on *Aster laevis* L. (BRIEN and DINGLEY, 1955)

on *Aster novae-angliae* L. (BRIEN and DINGLEY, 1955)

on *Aster novi-belgii* L. (BRIEN and DINGLEY, 1955)

on *Aster subulatus* MICHX. (BOESEWINKEL, 1977)

on *Buphthalmum speciosum* SCHREB. (HAMMETT, 1977)

on *Callistephus chinensis* NEES (BRIEN and DINGLEY, 1955)

on *Cardamine hirsuta* L. (HAMMETT, 1977)

on *Coreopsis grandiflora* NUTT. (BOESEWINKEL, 1977)

on *Cosmos bipinnatus* CAV. (BOESEWINKEL, 1977)

on *Cucumis sativus* L. (KIRK, 1901)

on *Cucumis melo* var. *cantalupensis* NAUD.

(BRIEN and DINGLEY 1951)

on *Cucurbita maxima* DUCH. ex POIR. (GILLARD, 1951)

on *Cucurbita pepo* L. (BRIEN, 1946)

on *Cyphomandra betaceae* (CAV.) SENDT. (BOESEWINKEL, 1977)

on *Dahlia* sp. cult. (BOESEWINKEL, 1977)

- on *Eucalyptus leucoxydon* var. *rosea* HORT. (BOESEWINKEL, 1977)
- on *Gerbera jamesonii* BOLUS (BOESEWINKEL, 1977)
- on *Helianthus annuus* L. (BOESEWINKEL, 1977)
- on *Hibiscus mutabilis* L. (BOESEWINKEL, 1977)
- on *Nicotiana tabacum* L. (BRIEN and DINGLEY 1955)
- on *Olearia rani* (A. CUNN.) DRUCE (BOESEWINKEL, 1977)
- on *Penstemon hartwegii* BENTH. (DINGLEY, 1960)
- on *Petunia hybrida* VILM. (BOESEWINKEL, 1977)
- on *Plantago major* L. (BOESEWINKEL, 1977).

The species present on this host is variously reported in the literature as *E. cichoracearum*, "*E. polyphaga*" and *E. sordida* JUNELL. LAUNDON (1973) reported *E. sordida* from New Zealand but stressed that this was only on a host basis as no cleistothecia were found and the conidial state lacked diagnostic features. NEGER (1902) reported that the germ tubes of *E. sordida* are simple, straight or flexuous, or branched and BLUMER (1933) mentioned long and narrow conidia produced by *E. sordida*. The New Zealand species, however, does not differ in conidial size, shape and germ tubes from *E. cichoracearum*. SAWADA (1914) reported that the conidiophores of *E. sordida* are bent and produced from the side of mycelial hyphae. This has not been observed in New Zealand collections. Recently I found a small number of cleistothecia on the inflorescences only and with characteristics of *E. cichoracearum*.

- on *Sanvitalia procumbens* LAM. (BOESEWINKEL, 1977)
- on *Sinningia speciosa* (LODD.) BENT. et HOOK. (new record)
- on *Solanum aviculare* FORST. f. (BOESEWINKEL, 1977)
- on *Solanum laciniatum* AIT. (BOESEWINKEL, 1977)
- on *Solanum mauritianum* SCOP. (BOESEWINKEL, 1977)
- on *Solanum tuberosum* L. (DINGLEY, 1960)
- on *Solidago altissima* L. (BOESEWINKEL, 1977)
- on *Solidago canadensis* L. (BOESEWINKEL, 1977)
- on *Tragopogon porrifolius* L. (new record)
- on *Veronica arvensis* L. (BOESEWINKEL, 1977)
- on *Viola tricolor* var. *hortensis* DC. (BOESEWINKEL, 1977)
- on *Viola* sp. cult. (BOESEWINKEL, 1977)

6. *Erysiphe cruciferarum* OPIZ ex JUNELL 1967. — Sv. Bot. Tidskr. 61: 217.

Type on *Alyssum alyssoides*; Czechoslovakia.

On leaves, stems and pods. Mycelium dense or thin, white. Hyphae not very flexuous, occasionally geniculate, branched at right angles near a septum. Hyphal cells $45-75 \times (2.5-5)(-10) \mu\text{m}$. Appressoria moderately to strongly lobed, $5-7 \mu\text{m}$ wide, single or opposite in pairs. Conidiophores $(60-70-85(-150) \times 7.5-8.7 \mu\text{m}$, producing conidia singly. Foot-cells of conidiophores straight or rarely slightly bent,

occasionally decreasing in width from 8—8.3 μm at the base to 7.5 μm at the top, 20—35 \times 7.5—8.5 μm , followed by one, two or occasionally four straight walled cells of (7.5—)25—27(—40) \times 8.7 μm . Conidia cylindric or ellipsoid cylindric, (27—)38(—55) \times (11—)15—17.5 (—20) μm . On Cruciferae a large number of conidia of 47 \times 17.5 μm and a few of 52 \times 12.5 μm have been observed. No well developed fibrosin bodies produced. Germ tubes on end of conidia, simple or rarely slightly branched, short or long and terminating in a strongly to moderately lobed appressorium 7.5—20 \times 7.5 μm .

Cleistothecia have been observed on the midrib of a leaf of *Brassica rapa*, but the contents were not studied. BOUWENS (1924) noticed that the species on Cruciferae could be distinguished by the relatively long and narrow conidia. It is rarely harmful to the plants.

- on *Brassica campestris* L. (new record)
- on *Brassica napo-brassica* (L.) MILL. (BOESEWINKEL, 1977)
- on *Brassica napus* L. (BOESEWINKEL, 1977)
- on *Brassica napus* var. *napo-brassica* (L.) REICHENB. (new record)
- on *Brassica oleracea* var. *botrytis* L. (BOESEWINKEL, 1977)
- on *Brassica oleracea* var. *racemosa* ALEF. (new record)
- on *Brassica rapa* L. (new record)
- on *Cardamine debilis* BANKS ex DC. (BOESEWINKEL, 1977)
- on *Cardamine hirsuta* L. (new record)
- on *Cleome spinosa* JACQ. (new record)
- on *Erodium moschatum* (L.) L'HÉRIT (BOESEWINKEL, 1977)
- on *Fumaria officinalis* L. (BOESEWINKEL, 1977)
- on *Geranium homeanum* TURCZ. (BOESEWINKEL, 1977)
- on *Iberis umbellata* L. (new record)
- on *Papaver nudicaule* L. (BOESEWINKEL, 1977)
- on *Papaver rhoeas* L. (BOESEWINKEL, 1977)
- on *Papaver somniferum* L. (BOESEWINKEL, 1977)
- on *Raphanus maritimus* SM. (new record)

7. *Erysiphe densa* BERKELEY in HOOKER 1855. — Fl. Novae-Zelandiae 2: 172—210.

Type on *Aristolelia serrata*; England.

On leaves, stalks and inflorescences. Mycelium white, thin to dense. Hyphal cells 50—60 \times 4—5 μm . Appressoria strongly lobed. Conidiophores (60—)75—110(—115) \times 7.5—12.5 μm , producing conidia singly. Basal septum 0—12.5(—30) μm from the branching point of the mycelium. Foot-cells of the conidiophores straight or swollen up to 10 μm at the base and about 7.5 μm wide towards the apex, 37—42.5 \times 7.5—10 μm , followed by two slightly shorter cells. Conidia long cylindric (25—)35—38(—45) \times (13—)16.2—17.5 (—19.2) μm , occasionally up to 2.5 μm wider at one end. No welldeveloped fibrosin bodies produced.

Cleistothecia (90—)100—130(—140) μm with transparent outer cells of about $13 \times 17.5 \mu\text{m}$. Appendages straight or slightly geniculate or flexuous, hyaline, simple 100—180(—300) \times 3—5 μm , forming a dense web. Asci (2—)8—18 in number, with (5—)7—8 ascospores (pl. 1, fig. 2).

The cleistothecia of the type collection from the Wairarapa in the North Island were described containing six asci with about eight ascospores. Over the last sixty years several unreported collections with cleistothecia have been made from various areas. SALMON (1900) included the species in *E. polygoni*. *E. polygoni* DC. ex ST. AM., the species on *Polygonum aviculare* L., has not been recorded in New Zealand and this species differs in having (2—)3—4-spored asci which number 3—12. The large number of ascospores of *E. densa* is a feature which has been reported for only few species of *Erysiphe* such as *E. aggregata*, *E. carpophila*, *E. mayorii* BLUMER, *E. rubicola*, *E. ulmariae* DESM. and *E. vernalis* KARST. The species on *Aristotelia* is occasionally serious on young growing tips.

on *Aristotelia fruticosa* HOOK. f. (new record)

on *Aristotelia serrata* (J. R. & G. FORST.) W.R.B. OLIVER
(SALMON, 1900)

8. *Erysiphe galeopsidis* DC. ex MÉRAT 1821. — Nouv. fl. env. Paris, ed. 2, 1: 134.

Type on *Galeopsis tetrahit*; France.

On leaves. Mycelium white, thin. Hyphae moderately flexuous and geniculate, branched at right angles near a septum. Hyphal cells (50—)60(—75) \times 5—7.5 μm . Appressoria moderately lobed or multi-lobed, well-developed, 2—8.5 \times 2—5 μm and provided singly or opposite in pairs. Conidiophores 77(—110) \times 10—12.5 μm , producing conidia in long chains. Foot-cells of conidiophores straight or decreasing in width from 12.5 μm at the lower half to 10—11 μm at the apex, followed by two straight walled cells of 12—20(—50) μm long. Conidia cylindric-ovoid, (25—)35—45(—57) \times (15—)17—20 μm . No well-developed fibrosin bodies formed. Germ tubes on side or end of conidia, simple or forked, straight or flexuous, short or moderately long 3—7.5 μm wide and terminating in a moderately lobed or multi-lobed appressorium.

This species is similar to *E. cichoracearum* but can be distinguished by the lobed appressoria (SALMON, 1900). Also characteristic are the position and shape of the germ tubes which resemble, when short and more or less forked, those of *S. epilobii* (WALLR. ex LINK) SACC. and *S. fuliginea*. It is mainly found during the winter and can occur on the same geranium plants which during the summer become infected with *S. fugax*. Of interest is the fact that the unusual host genus *Geranium*

has also been recorded in Japan by HOMMA (1937). The disease is mainly hypophyllous and produces only slight reddening of the leaves.

on *Geranium molle* L. (new record)

on *Geranium homeanum* TURCZ. (new record)

on *Rosmarinus officinalis* L. (BOESEWINKEL, 1977)

9. *Erysiphe heraclei* DC. ex ST. AM. 1821. — Fl. Agen.: 615.

Type on *Heracleum sphondylium*; France.

On leaves, stalks and inflorescences. Mycelium dense, white. Hyphal cells (50—)62—65(—80) \times (2.5—)4—5(—10) μ m, branching at right angles near the ends of the cells. Appressoria moderately or multi-lobed, produced singly or opposite in pairs. Conidiophores 60—140 \times 7.5—10 μ m, producing conidia singly. Foot-cells (20—)32—35(—45) \times 9—10 μ m, straight or decreasing in diameter towards the top to 7.5 μ m wide, followed by one, two or three cells of 17.5—50 (—105) \times 7.5 μ m. Although conidiophores are usually 3-celled, one of four cells and 130 μ m long was observed on the underside of a leaf. Conidia cylindric-ovoid, (35—)42.5—45(—47.5) \times (12.5—)17—18 (—21.2) μ m. No well-developed fibrosin bodies produced. Germ tubes on the ends of conidia, simple or moderately branched, straight or flexuous, very short or up to 60 μ m long and terminating in a clubshaped or moderately lobed appressorium 8—10 μ m wide. This species resembles *E. cruciferarum* but can be distinguished by the more regular shape of the conidia which in *E. cruciferarum* are frequently wider on one end. Furthermore no 5-celled conidiophores have been observed for *E. heraclei*. Serious infection can cause reduction in growth.

on *Dysoxylum spectabile* (FORST. f.) HOOK. f. (new record)

on *Pastinaca sativa* L. (BOESEWINKEL 1977)

10. *Erysiphe mougeotii* (LÉV.) DE BARY 1870. — Abh. Senckenb. naturf. Ges. 7: 412.

Type on *Lycium barbarum*; France.

On leaves, stalks and inflorescences. Mycelium well-developed, white. Hyphae flexuous, occasionally geniculate, branching at various angles including right angles, frequently near a septum. Hyphal cells (40—)42—45(—112) \times (3—)5(—9) μ m. Appressoria unlobed, nipple-shaped, well-developed and numerous, 4—7 μ m wide. Conidiophores simple, rarely branched near the base, 75—120 \times (7.5—)9—10(—12.5) μ m, producing conidia in chains. Foot-cells of conidiophores (30—)37—50(—60) \times (7.5—)10 μ m, followed by two or three straight cells of about 17—25 \times 9—10(—12.5) μ m. Conidia oblong-cylindric with nearly flattened ends, occasionally ovoid or barrel-shaped, (20—)27.5(—38) \times (10—)13.7(—19) μ m. No well-developed fibrosin

bodies formed. Conidia show a conspicuous papilla at the place where they have been attached. Germ tubes on end, rarely the side of conidia, simple short or long, 4—5 μm wide and terminating in an unlobed appressorium 5—6 μm wide. Haustoria globose, about 17.5 μm diameter (pl. 2, fig. 3).

According to DE BARY (1870) this species can even in the conidial state be easily identified by the small and typically cylindric conidia. These characteristics of the conidia on *Lycium* species in Europe have also been reported from other areas of the world such as Japan (HOMMA, 1937), the Canary Islands (JÖRSTAD, 1962), Formosa (YEN and WANG, 1973) and New Zealand (BOESEWINKEL, 1977). Although this species on *Lycium* has no typical characteristics of the genus *Microsphaera* and lacks the multi-lobed appressoria, it is frequently referred to as *M. mougeotii* LÉV. because of the branching of the appendages, characteristics which appear to vary according to the different descriptions in the literature. In the genus *Microsphaera*, *M. mougeotii* would be the only species with 2-spored asci. BLUMER (1967) thinks it possible that *M. mougeotii* forms a transition between the genera *Microsphaera* and *Uncinula* and several authors have suggested creating a new genus, such as *Arthrocladiella* VASIL'KOV, to accommodate this species. However, the important characteristics of 2-spored asci, unlobed and nipple-shaped appressoria, conidia which lack fibrosin bodies and are produced in a chain, are typical of the Euoidium section of the genus *Erysiphe*. The disease occurs throughout the year. on *Lycium chinense* MILL. (BOESEWINKEL, 1977).

11. *Erysiphe pisi* DC. ex St. — Am. 1821. — Fl. Agen.: 614.

Type on *Pisum* sp.; France.

On flowers, pods and leaves. Mycelium dense or thin, white. Hyphae moderately flexuous, branching at right angles near a septum, occasionally forming two branches which are nearly opposite. Hyphal cells (50—)65—88 \times 5—7.5(—10) μm . Appressoria moderately lobed, occasionally unlobed with a crenulated surface of forming many very small lobes, generally produced singly, 5—10 μm wide. Conidiophores more or less straight, rarely slightly flexuous at the base, simple, 62—105(—178) \times 7—10 μm producing conidia singly. Foot-cells (22—)38—50(—75) \times 7—10 μm , followed by a slightly longer or shorter second cell of 20—55 μm and a third cell of 20—42 μm . Foot-cells 7.2—8.5 μm wide at the base and tapering to 6.2—7 μm wide at the top. Conidia ellipsoid-cylindric, (32—)40—47(—100) \times 15—17(—20) μm . No well-developed fibrosin produced. Germ tubes formed on the ends or sides of conidia, simple, short or up to 50 μm long, 2.5—3.7 μm wide and terminating in an unlobed or moderately lobed appressorium 5—10 μm wide. Haustoria (17—)20(—25) μm diameter.

It differs from *E. trifolii* in the shape of the foot-cells of the conidiophores, the appressoria and the germ tubes of the conidia. This species occurs throughout the year but is apparently harmless.

on *Hebe speciosa* (A. CUNN.) CKN. & ALLAN (new record)

on *Lathyrus odoratus* L. (BOESEWINKEL, 1977)

on *Lathyrus pubescens* HOOK. & ARN. (new record)

on *Lupinus angustifolius* L. (new record)

on *Lupinus argenteus* PURSH. (new record)

on *Lupinus polyphyllus* LINDL. (new record)

on *Melilotus indica* L. (new record)

on *Pisum sativum* L. (BOESEWINKEL, 1977)

12. "*Erysiphe polyphaga*" HAMMARL. 1945. — Bot. Not. 1945: 108 (nomen nudum).

On flowers, stems and leaves of many unrelated plants. The morphological characteristics are similar to those of *E. asperifoliorum* and *E. cichoracearum* but a few differences may be observed. The unlobed nipple-shaped appressoria are frequently poorly developed and occasionally inconspicuous. In several collections conidiophores have been observed which were branched near the apex or, less frequently, the middle of their foot-cell. The germ tubes of conidia are more frequently produced on the side than occurs in *E. cichoracearum* and they are often short, terminating in a conspicuous appressorium (pl. 2, fig. 4). Whereas *E. cichoracearum* generally produces 2-spored asci and is thought to occur mainly on Compositae, HAMMARLUND (1945) distinguished „*E. polyphaga*” by the presence of 2—4-spored asci, which he observed in cleistothecia on *Begonia*, *Cucumis*, *Dahlia* and *Veronica*, and by the ability to infect plants of many unrelated families. JUNELL (1967) remarked that in *E. cichoracearum* 2—4-spored asci can also occur but used "*E. polyphaga*" because of the wide host range. HAMMARLUND (1945) was able to infect *Kalanchoë blossfeldiana* with conidia from *Begonia* cv. Gloire de Lorraine and subsequently inoculated 100 different plant species belonging to 11 families. On 62 different species a positive reaction was obtained but unfortunately no descriptions of the morphology of the mildews on the different hosts were provided and it cannot be ascertained whether in all cases the same "*E. polyphaga*" developed. Although some infection may have been accidental, due to airborne conidia or the build up of latent infection it is unlikely that all 62 plant species became infected accidentally. BLUMER (1952) suggested that "*E. polyphaga*" might be a synonym of *E. asperifoliorum*. A study of the New Zealand collections is being carried out and, while I at present agree with BLUMER's opinion, "*E. polyphaga*" is in the meantime retained for those host plants on which a species resembling *E. cichoracearum* and *E. asperi-*

foliorum was found which could be transmitted to plants of unrelated families such as Cucurbitaceae and Solanaceae. "*E. polyphaga*" occurs throughout the year.

- on *Chrysanthemum hortorum* BAILEY (new record)
- on *Chrysanthemum morifolium* RAMAT (new record)
- on *Cucumis angurica* L. (new record)
- on *Cucumis melo* var. *cantalupensis* NAUD. (new record)
- on *Cucumis sativus* L. (new record). Infection occurs in early spring and before it disappears, the same infected plants can become infected simultaneously with *Sphaerotheca fuliginea*.
- on *Eucalyptus leucoxylon* var. *rosea* HORT. (new record)
- on *Helianthus annuus* L. (new record)
- on *Helichrysum bracteatum* ANDR. (new record)
- on *Hibiscus mutabilis* L. (new record)
- on *Lycopersicon esculentum* MILL. (new record)
- on *Modiola caroliniana* G. DON (new record)
- on *Nicotiana tabacum* L. (new record)
- on *Petunia hybrida* VILM. (new record)
- on *Solanum integrifolium* POIR. (new record)
- on *Solanum mauritianum* SCOP. (new record)

13. *Erysiphe ranunculi* GREV. 1824. — Fl. Edin.: 461.

Type on *Ranunculus muricatus*; Scotland.

On stalks, inflorescences and leaves. Mycelium dense, white. Hyphae moderately flexuous and branched at right angles. Hyphal cells 45—66(—87) \times 5—7 μ m. Appressoria multi-lobed, single or opposite in pairs, sometimes sparingly produced. Conidiophores 50—74(—95) \times 7.8—8(—10) μ m, straight, simple, producing conidia singly. Foot-cells of conidiophores straight, (15—)25(—30) \times 7.5—10 μ m, slightly shorter or longer than the second cell which is 10—35 μ m long. Conidia ovoid, (30—)37.5(—40) \times (17.5—)20—22.5 μ m. On one occasion an unusually large conidium of 62.5 \times 20 μ m occurred. No well-developed fibrosin bodies present. Germ tubes produced on the end of conidia, branched or simple, either moderately long and terminating in an inconspicuous or lobed appressorium or short, up to 20 μ m long, and terminating in a multi-lobed appressorium about 22 \times 12 μ m.

Cleistothecia globose, 88—130 μ m. Appendages basally inserted, mycelioid, hyaline to dark brown, 2—5 times as long as the diameter of the cleistothecia, up to 5 μ m wide, simple or rarely branched near the end, up to 35 in number. Asci 5—8, subovate, 40—70 \times 25—40 μ m. Ascospores 4—6 per ascus, 17.5—22.5 \times 10—12.5 μ m. Cleistothecia have been found on several species of *Delphinium* and *Ranunculus*.

E. ranunculi can in New Zealand be separated from other recorded

species of the *E. polygoni* complex by the relatively short, straight conidiophores, the moderately large ovoid conidia, the branching of germ tubes and the multi-lobed appressoria. The form on *Aquilegia vulgaris*, which occurs only occasionally, is overseas frequently identified as *E. aquilegiae* DC. ex MÉRAT. Although slightly larger conidia were produced on this host, it could not be distinguished from *E. ranunculi*. No diagnostic characteristics of the imperfect state on *Aquilegia* could be found in the literature and it is included in *E. ranunculi* until cleistothecia are found.

on *Anemone coronaria* L. (new record)

on *Aquilegia vulgaris* L. (BOESEWINKEL, 1977)

on *Clematis australis* var. *rutifolia* (HOOK. f.) ALLAN

(BOESEWINKEL, 1977)

on *Clematis jackmanii* MOORE (new record)

on *Clematis paniculata* GMEL. (BOESEWINKEL, 1977)

on *Delphinium ajacis* L. (BOESEWINKEL, 1977)

on *Delphinium cultorum* VOSS (BOESEWINKEL, 1977)

on *Nigella damascena* L. (new record)

on *Ranunculus acris* L. (new record)

on *Ranunculus asiaticus* L. (BOESEWINKEL, 1977)

on *Ranunculus parviflorus* L. (new record)

on *Ranunculus repens* L. (BOESEWINKEL, 1976a)

on *Ranunculus sardous* CRANTZ. (BOESEWINKEL, 1977)

on *Ranunculus sceleratus* L. (BOESEWINKEL, 1977)

14. *Erysiphe rubicola* (MURRAY) BOESEW. 1976. — Trans. Br. mycol. Soc. 67: 144.

Type on *Rubus australis*; New Zealand.

On Leaves, twigs and inflorescences. Mycelium thin or dense, white. Hyphae 3—6 μm wide. Appressoria multi-lobed. Conidiophores 50—100 \times 7—9 μm , producing conidia singly. Foot-cells 35—40 μm long. Conidia oblong-cylindric, (28—)35—40 \times (13—)18(—20) μm . No well-developed fibrosin bodies present. Germ tubes produced on the end of conidia, branched or simple.

Cleistothecia 90—140 μm diameter. Appendages sparse or numerous mycelioid, hyaline or faintly fuliginous, 25—100(—210) \times 3—5 μm . Asci 4—17 with 8 ascospores.

This species was first described by MURRAY (1927) from Nelson in the South Island and has been observed on a few occasions in several areas of the North Island.

on *Rubus australis* FORST. f. (MURREY, 1927)

on *Rubus cissoides* A. CUNN. (BOESEWINKEL, 1976a)

on *Rubus squarrosus* FRITSCH (BOESEWINKEL, 1976a)

15. *Erysiphe trifolii* GREV. 1824. — Fl. Edinb.: 459.

Type on *Trifolium medium* L.; Scotland.

On leaves. Mycelium thin, white. Hyphae moderately flexuous, branching at right angles. Hyphal cells $45-68 \times 2.5-7.5 \mu\text{m}$. Appressoria multi-lobed, $5 \times 10 \mu\text{m}$, single or in pairs. Conidiophores ($50-$) $75-110 \times 6.5-7.5(-10) \mu\text{m}$, generally (1-)2-3-celled but occasionally 4-celled and about $120 \mu\text{m}$ long, producing conidia singly. Foot-cells moderately to strongly flexuous near the base, occasionally straight, ($18-$) $37.5(-55) \times 6.5-7.5 \mu\text{m}$ and followed by two straight walled cells of ($18-$) $20-30(-43) \mu\text{m}$ long. Conidia ellipsoid-cylindric, ($30-$) $32.5-42.5(-50) \times 16.5-17.5(-20) \mu\text{m}$. No well-developed fibrosin bodies present. Germ tubes produced on ends of conidia, simple or occasionally branched, short or up to $140 \mu\text{m}$ long and $3-4 \mu\text{m}$ wide, terminating in an unlobed appressorium $4-7.5 \mu\text{m}$ diameter.

In the literature this species is frequently confused with *E. pisi* but it was discovered that the conidial state can be distinguished easily by the foot-cell of the conidiophores, the appressoria and the germ tubes. It is also very similar to *O. hardenbergiae* but can be distinguished by the germination pattern of the conidia. It is generally of little consequence. On some hosts such as *Sophora* and *Trifolium* spp. it is present throughout the year.

It is interesting that HOMMA (1937), who did not differentiate between *E. pisi* and *E. trifolii*, reported the host *Sophora angustifolia* SIEB. & ZUCC. from Japan.

- on *Brachysema lanceolata* MEISSN. (new record)
- on *Lathyrus odoratus* L. (new record)
- on *Lotus corniculatus* L. (BOESEWINKEL, 1977)
- on *Sophora microphylla* AIT. (new record)
- on *Trifolium dubium* SIBTH. (BOESEWINKEL, 1977)
- on *Trifolium micranthum* VIV. (new record)
- on *Trifolium pratense* L. (new record)
- on *Trifolium striatum* L. (new record)
- on *Trifolium subterraneum* L. (new record)
- on *Wistaria floribunda* DC. (new record)

16. *Erysiphe verbasci* (JACZ.) BLUMER 1933. — Beitr. Krypt.-Fl. Schweiz 7: 284.

Type on *Verbascum* sp.; Russia.

On leaves. Mycelium dense, white. Hyphae with cells about $57 \times 4-7 \mu\text{m}$. Appressoria unlobed, nipple-shaped, $5-10 \mu\text{m}$ wide. Conidiophores $164-250 \times 11-15 \mu\text{m}$, producing conidia in chains. Foot-cells $140-150 \times 11-15 \mu\text{m}$, increasing in diameter from $11-12 \mu\text{m}$ at the base to $15 \mu\text{m}$ at the top. Conidia cylindric-ovoid,

(32—)47(—60)×(20—)22(—30) μm . No conspicuous fibrosin bodies produced. Germ tubes on end, rarely the side of conidia, about 150 μm long or longer, straight or occasionally flexuous and terminating in an unlobed appressorium 9—10 μm wide.

This species can be distinguished from *E. cichoracearum* by the large conidiophores and conidia, and by the long germ tubes which NEGER (1902) first mentioned. It occurs throughout the summer but is inconspicuous due to the hairy surface of the host and apparently causes little damage.

on *Verbascum thapsus* L. (BOESEWINKEL, 1977)

MICROSPHAERA LÉV. (1851)

The genus *Microsphaera* is characterised by cleistothecia with several asci usually up to 12 containing 3—8 ascospores and with appendages which are dichotomously branched near their apex. The imperfect state differs from *Podosphaera*, *Sawadaea* and *Sphaerotheca* by the absence of conspicuous fibrosin bodies and by singly produced conidia. The appressoria are multi-lobed, frequently opposite in pairs, and more numerous than in many species of the morphologically related *Pseudoidium* section of *Erysiphe*.

1. Conidiophores flexuous at the base; conidia cylindric

| | |
|----------------------------------|----------------------------|
| on Celastraceae: <i>Euonymus</i> | <i>M. euonymi-japonica</i> |
| on Rutaceae: <i>Severinia</i> | <i>M. euonymi-japonica</i> |
| on Fagaceae: <i>Quercus</i> | <i>M. hypophylla</i> |

2. Conidiophores more or less straight

A. Conidia cylindric

| | |
|------------------------------------|-------------------|
| on Caprifoliaceae: <i>Viburnum</i> | <i>M. viburni</i> |
|------------------------------------|-------------------|

B. Conidia cylindric-ovoid

| | |
|--------------------------------|--------------------|
| on Begoniaceae: <i>Begonia</i> | <i>M. begoniae</i> |
|--------------------------------|--------------------|

C. Conidia ellipsoid-cylindric

| | |
|--------------------------------|------------------------|
| on Saxifragaceae: <i>Ribes</i> | <i>M. grossulariae</i> |
|--------------------------------|------------------------|

D. Conidia ellipsoid-ovoid; foot-cells of conidiophores relatively short and not slender

| | |
|---|-----------------------|
| on Fagaceae: <i>Castanea</i> , <i>Quercus</i> | <i>M. alphitoides</i> |
| on Sapindaceae: <i>Cotinus</i> | <i>M. alphitoides</i> |

E. Conidia ellipsoid-ovoid, foot-cells of conidiophores relatively long and slender

| | |
|--|--------------------|
| on Crassulaceae: <i>Kalanchoë</i> , <i>Sedum</i> | <i>M. polonica</i> |
| on Saxifragaceae: <i>Hydrangea</i> | <i>M. polonica</i> |
| on Scrophulariaceae: <i>Acanthus</i> | <i>M. polonica</i> |

17. *Microsphaera alphitoides* GRIFF. & MAUBL. 1912. — Bull. Soc. mycol. Fr. 28: 100.

Type on *Quercus robur*; France.

On leaves and inflorescences. Mycelium moderately dense to dense, white. Hyphae branching at nearly right angles, frequently near a septum, occasionally two opposite branches are formed. Hyphal cells $(20-50(-58) \times 3-7 \mu\text{m})$. Appressoria multi-lobed, single or opposite in pairs. Conidiophores $42.5-60(-105) \times 6.5-10 \mu\text{m}$, producing conidia singly. Occasionally 4—5-celled conidiophores occur on the underside of leaves. Foot-cells of conidiophores straight, $(15-)20-22(-60) \times (6.5-)7.2-7.5(-8.7) \mu\text{m}$, followed by one or two cells of $10-27 \times 7.5-10 \mu\text{m}$, the apex of the last cell often broadened up to $10 \mu\text{m}$. Conidia ellipsoid-ovoid, occasionally cylindric-ovoid, $35-37.5(-45) \times (15-)17.5-21.2(-22) \mu\text{m}$. No well-developed fibrosin bodies produced. Germ tubes on end, simple or forked, short or moderately long about $5 \mu\text{m}$ wide and frequently ending in a lobed appressorium $10 \times 15 \mu\text{m}$. Haustoria about $32 \mu\text{m}$ wide (pl. 1, fig. 2).

This species is characterised by the shape of the conidia, germ tubes and conidiophores, the latter including short 3-celled and long 5-celled ones. The disease is very common during the growing season on species of *Castanea* and *Quercus* where it can seriously injure the growing tips. On *Castanea* spp. it also infects the fruit. On *Cotinus* it was observed only once, sporulating on the inflorescences of a shrub under an infected tree of *Quercus robur*. No cleistothecia have been reported from New Zealand.

on *Castanea dentata* BORKH. (BOESEWINKEL, 1977). The conidia on this host are frequently ellipsoid-cylindric and measure most frequently $38 \times 17.5 \mu\text{m}$.

on *Castanea sativa* MILL. (BOESEWINKEL, 1977)

on *Cotinus coggygria* SCOP. (BOESEWINKEL, 1977)

on *Quercus lusitanica* LAM. (new record)

on *Quercus robur* L. (BRIEN and DINGLEY, 1951)

This first-record lacks a description.

on *Quercus sessiliflora* SALISB. (BOESEWINKEL, 1977)

This host retains its leaves during the winter months but the mildew ceases its activity until spring.

18. *Microsphaera begoniae* SIVANESAN 1971. — Trans. Br. mycol. Soc. 56: 304.

Type on *Begonia* sp.; England.

On leaves, stalks and inflorescences. Mycelium dense or thin, white. Hyphae not very flexuous, sparingly branched at about the centre of hyphal cells and at about right angles, with a septum near the base of the new branch. Hyphal cells $(62-)87.5(-130) \times 5-6.5 \mu\text{m}$, Appres-

soria multi-lobed, in pairs, one or several pairs can be present on a hyphal cell. Conidiophores $75-120 \times 7.5-10 \mu\text{m}$, straight simple or rarely branched at the base, producing conidia singly. Conidiophores generally 3- occasionally 2- or 5-celled. Foot-cells of conidiophores straight, occasionally slightly swollen up to $12.5 \mu\text{m}$ at the base, $(37-40)(-52) \times 8.7-11.5 \mu\text{m}$, followed by two shorter cells of $15-42 \times 8.7-10 \mu\text{m}$. Conidia ovoid to long-cylindrical, extremely variable in size, $(25-55-62.5)(-72.5) \times (12.5-17.5-18.7)(-25) \mu\text{m}$. Long conidia often of uneven width, up to $1 \mu\text{m}$ wider at one end and slightly attenuated at the centre. They collapse easily when placed in water. No well-developed fibrosin bodies present. Germ tubes on end, multibranched or single, straight or flexuous, short or moderately long, with or without a multi-lobed appressorium $15 \times 22 \mu\text{m}$. Haustoria uninucleate, globose, $30-32 \mu\text{m}$ wide in large epidermal cells and $20-25 \mu\text{m}$ wide in smaller epidermal cells.

The presence of huge conidia and large haustoria are a characteristic feature which distinguish this species from *Oidium begoniae* PUTTEM. and "*Erysiphe polyphaga*". Moreover in "*E. polyphaga*" the appressoria are unlobed and the conidia are produced in long chains. Cleistothecia have not been found in New Zealand. The disease is generally harmless.

- on *Begonia masoniana* IRMSCH. (BOESEWINKEL, 1976b)
- on *Begonia rex-cultorum* BAILEY (BOESEWINKEL, 1976b)
- on *Begonia semperflorens* LINK & OTTO (BOESEWINKEL, 1976b)
- on *Begonia tuberhybrida* VOSS (BOESEWINKEL, 1976b)
- on *Begonia* cv. Gloire de Lorraine (BOESEWINKEL, 1976b)

19. *Microsphaera euonymi-japonici* (ARC.) HERTER 1933. — Florula Urug. Pl. Avasc. 33.

Type on *Euonymus japonicus*; Uruguay.

On leaves, stalks and inflorescences. Mycelium dense, white. Hyphae rather straight, occasionally flexuous, or geniculate, sparingly branched at various angles or at right angles, with a septum near the base of the new branch. Hyphal cells $(40-55-75)(-85) \times 4-5 \mu\text{m}$. Appressoria multi-lobed, $8-12.5 \mu\text{m}$ wide, opposite in pairs, one to several per cell generally on alternating hyphal cells. Conidiophores $50-80 \times 7-8 \mu\text{m}$, simple or rarely branched near the centre of the third cell, more or less straight except for the basal part, producing conidia singly. Foot-cells slightly flexuous at the base, $(10-20-30)(-50) \times 7.5-8.7 \mu\text{m}$, followed by two shorter cells of $(10-20-22) \mu\text{m}$ long. Conidia cylindric or ellipsoid cylindric, $(30-32.5)(-45) \times (12-17) \mu\text{m}$. No conspicuous fibrosin bodies present. Germ tubes produced on the end of conidia, short and terminating in a multi-lobed appressorium $10-12.5 \mu\text{m}$ wide.

Cleistothecia are not present in the New Zealand collections, and, following the description from Uruguay, cleistothecia have only been reported from France and Yugoslavia (VIENNOT—BOURGIN, 1966). The conidial state is distinct due to the rather cylindrical, small and narrow conidia and the slightly flexuous base of the conidiophores. This species occurs wherever susceptible species of *Euonymus* are grown and is active throughout the year, especially on new growing tips and young fruit.

on *Euonymus japonicus* L. (BOESEWINKEL, 1977)

on *Euonymus japonicus* var. *aureo-marginatus* REHD. (new record)

on *Severinia buxifolia* (POIR.) TEN. (BOESEWINKEL, 1979)

20. *Microsphaera grossulariae* WALLR. ex LÉV. 1851. — Ann. Sci. Nat., bot. 3 sér., 15: 160—381.

Type on *Ribes uva-crispa* L.; Germany.

On leaves. Mycelium thin or dense, white. Hyphae flexuous. Appressoria lobed. Conidiophores $40-90 \times 6.5-8.7 \mu\text{m}$, producing conidia singly. Conidia cylindric or ellipsoid cylindric, $(21-30) \times (11-17) \mu\text{m}$. No well-developed fibrosin bodies produced. Only one sample in poor condition was collected. This species can be distinguished from the American gooseberry powdery mildew, which has not been found in New Zealand, by the absence of conspicuous fibrosin bodies and the singly produced conidia. It is apparently harmless.

on *Ribes nigrum* L. (CUNNINGHAM, 1922)

on *Ribes sylvestre* (LAM.) MERT. & KOCH (CUNNINGHAM, 1922)

on *Ribes uva-crispa* L. var. *sativum* DC. (KIRK, 1899)

21. *Microsphaera hypophylla* NEVOD. 1952. — Griby SSSR 1, 4.

Type on *Quercus robur* L.; USSR.

On leaves. Mycelium evanescent, white or grey white. Hyphae moderately flexuous and moderately geniculate, branching at more or less right angles and frequently near a septum. Hyphal cells $(27-45-50(-62)) \times (3-5) 5-6 \mu\text{m}$. Appressoria multi-lobed, $5-7.5 \mu\text{m}$ wide, frequently opposite in pairs. Conidiophores about $90-100 \times 7.5-10 \mu\text{m}$, producing conidia singly. Foot-cells of conidiophores about $20-28 \times 7.5 \mu\text{m}$, flexuous, followed by one or two straight walled cells of $10-35 \times 8.7-10 \mu\text{m}$. Conidia cylindric with rounded ends, $(32-40-45(-55)) \times (12-16.2-17.5(-18.5)) \mu\text{m}$. No conspicuous fibrosin bodies produced. Germ tubes on end of conidia, simple, short, about $3-5 \mu\text{m}$ wide and with or without lobed appressoria on their ends.

By the shape and size of the conidiophores, conidia and germ tubes this species can be distinguished from *M. alphonseoides*. Furthermore *M. hypophylla* produces evanescent mycelium, especially on the

underside of leaves and attacks the areas around the mid ribs and veins, whereas, *M. alphitoides* produces conspicuous white areas all over the leaves, especially on the upperside. *M. hypophylla* was found sporulating in July at a time when *M. alphitoides* had disappeared. The conidia of *M. hypophylla* have been photographed by CRUCHET (1962) and further characteristics of the imperfect state are given by BLUMER (1967) and JUNELL (1967). Not reported before however are the hyphal cells, the type of appressoria and the flexuous shape of the foot-cells of the conidiophores. SPEER (1975b) suggested that *M. hypophylla* was a synonym of *M. alphitoides* but he apparently only studied material of *M. alphitoides*.

on *Quercus sessiliflora* SALISB. (new record)

22. *Microsphaera polonica* SIEM. 1933. — Rev. de Pathol. Végét. d'Entomol. Agric. 3: 142.

Type on *Hydrangea hortensis* (cult.); Poland.

On leaves, stems and flowers. Mycelium dense or evanescent, white. Hyphae moderately flexuous, branching more or less at right angles with a septum near the base of a new branch. Hyphal cells 40—50 × 5—7 µm, often of irregular diameter. Appressoria multi-lobed, 5—25 µm wide, often opposite in pairs, series of three pairs can occur on one hyphal cell. Conidiophores (57—)70—90(—175) × 7.5—8.7 µm, producing conidia singly. A few 5-celled conidiophores occur on both sides of the leaves. Foot-cells of conidiophores (10—)17—37.5 (—50) × 7.5—10 µm, followed by a longer cell of about 27—31 µm long. Conidia ovoid or ellipsoid-ovoid, (27.5—)37.5(—45) × (14—)17.5 (—20) µm. No conspicuous fibrosin bodies produced. Germ tubes on ends of conidia, simple, often rather short and terminating in a multi-lobed appressorium 8—12 µm wide. Haustoria globose, about 17.5—18.7 µm diameter (pl. 1, fig. 6, 7, 8). Cleistothecia have only been described from Poland in the original description.

This species is active on susceptible *Hydrangea* species throughout the year and generally harmless.

on *Acanthus mollis* L. (BOESEWINKEL, 1977). This unusual record is rare and was found on plants close to infected *Hydrangea* plants.

on *Hydrangea macrophylla* (THUNB.) SER. (BOESEWINKEL, 1977)

on *Kalanchoë tubiflora* (HARV.) HAMET (new record). This occurs occasionally.

on *Sedum praealtum* DC. (new record). This is a very common disease but due to the generally evanescent mycelium it is difficult to detect.

23. *Microsphaera viburni* (DUBY) BLUMER 1933. — Beitr. Krypt. Fl. Schweiz. 7: 310.

Type on *Viburnum opulus*; France.

On leaves. Mycelium evanescent, rarely dense, white. Hyphae moderately flexuous, sparingly branched at right angles near a septum. Hyphal cells (50—)57—75 \times (3.5—)4—5(—10) μ m. Appressoria multi-lobed, opposite in pairs or single, 3—12 μ m wide. Conidiophores (50—)75—120(—130) \times 5—7.5 μ m, producing conidia singly. Foot-cells 30—85 μ m long, decreasing in width from 5.5—7.5 μ m at the base to 5 μ m at the top, straight or occasionally slightly flexuous at the base, followed by one or two cells of 15—20(—40) \times 7.5 μ m. Conidia cylindric, (32—)35—37(—47.5) \times (11—)15—17(—17.5) μ m, occasionally abruptly narrowed at the base up to 7.5 μ m wide, over a distance of 7.5 μ m. No conspicuous fibrosin bodies produced. Germ tubes on the ends of conidia, simple, short or moderately long and terminating in a multi-lobed appressorium. In contrast to *M. hedwigii* Lév., which does not occur in New Zealand, this species is mainly hypophyllous and produces mainly inconspicuous mycelium.

The disease occurs during the summer and is often difficult to detect. It is harmless.

on *Viburnum opulus* L. (new record)

on *Viburnum trilobum* MARSH. (BOESEWINKEL, 1977)

OIDIUM LINK 1824

This form genus includes the conidial states of those species of *Blumeria*, *Brasiliomyces*, *Cystotheca*, *Erysiphe*, *Microsphaera*, *Podosphaera*, *Sawadaea*, *Sphaerotheca* and *Uncinula* for which no connection with cleistothecia is known.

24. *Oidium chrysanthemi* RABENH. 1853. — Hedwigia 1: 19—21.

Type on *Chrysanthemum indicum*; Germany.

On leaves, stalks and inflorescences. Mycelium dense or thin, white. Hyphae flexuous, branching at right angles near a septum. Hyphal cells (62—)80—100(—105) \times (5—)6.5—7.5(—8) μ m. Appressoria unlobed, inconspicuous, occasionally nearly nipple-shaped, 5—12 μ m wide. Conidiophores (62—) 105—190(—230) \times 10—12.5 μ m, producing conidia in long chains. Foot-cells 75—130(—140) \times 12.5(—15) μ m, followed by one or two straight walled cells of 20—35 μ m long. Basal septum of the conidiophore about 10.5 μ m wide whereas the septa higher up the conidiophore measure about 12.5 μ m. Conidia variable in shape, ellipsoid, occasionally cylindric or barrel-shaped with rounded ends, (35—)52.5(—80) \times (16.2—)22.5(—30) μ m. No conspicuous fibrosin bodies formed. Germ tubes on side or end of conidia, simple or, rarely, branched, short or long and terminating in an unlobed or slightly

lobed appressorium $22 \times 7-10 \mu\text{m}$. Haustoria globose, $17.5-22.5 \mu\text{m}$ wide. This species can be distinguished from *Erysiphe cichoracearum* and "*E. polyphaga*" by the large conidia and inconspicuous appressoria. It is present throughout the year and moderately harmful.

on *Chrysanthemum hortorum* BAILY (BOESEWINKEL, 1977)

on *Chrysanthemum indicum* L. (new record)

on *Chrysanthemum morifolium* RAMAT (BOESEWINKEL, 1977)

25. *Oidium hardenbergiae* BOESEW. 1977. — Revue de Mycol. 41: 497.

Type on *Hardenbergia monophylla*; New Zealand.

On leaves. Mycelium evanescent, white. Hyphae flexuous, branching at right angles near a septum, with a septum near the base of the new branch. Hyphal cells $(40-45-55(-70) \times 3.5-7 \mu\text{m}$. Appressoria multi-lobed, $5-12.5 \mu\text{m}$ wide, single or opposite in pairs. Conidiophores $(68-87-92(-125) \times 6.5-8 \mu\text{m}$, producing conidia singly. Foot-cells flexuous or nearly straight at the base, $35-45 \times 6.5-8.8 \mu\text{m}$, followed by cells about $20-35 \mu\text{m}$ long. Conidia cylindric-ellipsoid, $(32-40(-55) \times (12.5-17(-21) \mu\text{m}$, occasionally up to $2.5 \mu\text{m}$ wider at one end. No conspicuous fibrosin bodies produced. Germ tubes on end of conidia, simple and straight or branched, occasionally coralloid, either short with a moderately lobed or multi-lobed appressorium or long, $4.5 \mu\text{m}$ wide and terminating in an unlobed or moderately lobed appressorium (pl. 1, fig. 10; pl. 2, fig. 9). This species is very similar to *E. trifolii* and differs mainly in the germ tubes. It occurs on both sides of leaves throughout the year, and is harmful to the young growth.

on *Hardenbergia monophylla* BENTH. (BOESEWINKEL, 1977)

26. *Oidium helichrysi* BOESEW. 1977. — Revue de Mycol. 41: 495.

Type on *Helichrysum bracteatum*; New Zealand.

On leaves. Mycelium evanescent, white. Hyphae $6.2-7.5 \mu\text{m}$ diam. Appressoria unlobed, inconspicuous. Conidiophores $210-330 \times 10-15 \mu\text{m}$, producing conidia in long chains. Foot-cells straight, about $150-250 \mu\text{m}$ long, with basal septum $15-85 \mu\text{m}$ away from the branching point of the mycelium, followed by two straight walled cells about $30-40 \mu\text{m}$ long. Conidia ovoid-cylindric or ellipsoid, $(35-40-45(-72) \times (17.5-20-22(-25) \mu\text{m}$. No conspicuous fibrosin bodies produced. Germ tubes on end or side of conidia, simple, straight, moderately long and $6-7.5 \mu\text{m}$ wide, terminating in a club-shaped appressorium. Haustoria $(17.5-20-25(-30) \mu\text{m}$ diameter.

This species resembles *O. chrysanthemi* but differs in the shape and size of the conidia, the size of the haustoria and the placement of the basal septum of the conidiophores. Apparently a harmless disease.

on *Helichrysum bracteatum* ANDR. (BOESEWINKEL, 1977). This

species was collected during the winter in Waitakere in my garden where so far no *O. chrysanthemi* has been found in spite of the presence of several species of *Chrysanthemum*.

27. *Oidium oxalidis* MC ALPINE 1894. — Roy. Soc. Victoria, 219

Type on *Oxalis corniculata*; Australia.

On leaves and inflorescences. Mycelium thin to dense, white. Hyphae geniculate with many straight areas, branching at right angles near a septum. Hyphal cells (37—)65—67(—70) \times 2.5—5 μ m. Appressoria multi-lobed, single or opposite in pairs, 2.5—5 μ m wide. Conidiophores (67—)92(—150) \times 5 μ m, producing conidia singly. Foot-cells of conidiophores (8—)18—22(—33) μ m long and often decreasing in width from 5.5 μ m at the base to 4—4.5 μ m at the top. The relatively short foot cells are followed by longer cells (19—)32—50(—115) μ m. Conidia ellipsoid — lemon-shaped, (20—)35(—43) \times (10—)13.7(—15) μ m, without conspicuous fibrosin bodies. Germ tubes on end, occasionally on side, simple or occasionally branched, straight, 37—50 \times 2.5—3 μ m and terminating in an unlobed or moderately to multi-lobed appressorium.

This species is characterised by the small ellipsoid conidia, the narrow mycelium and conidiophores, and the relative length of the conidiophore cells.

SAWADA (1914) and HOMMA (1937) found only the imperfect state on *Oxalis* in Japan but regarded *O. oxalidis* as a synonym of *M. russellii* CLINT., although the correlation has not yet been proven. The disease occurs throughout the year in glasshouses and gardens.

on *Oxalis corniculata* L. var. *microphylla* HOOK. (BOESEWINKEL, 1977)

PHYLLACTINIA LÉV. (1851)

The genus *Phyllactinia* is characterised by cleistothecia with numerous 2-spored asci and characteristic appendages which have a bulbous area at the base. The conidial state differs markedly from that of the other genera in New Zealand and belongs to the genus *Ovulariopsis*. Both epiphytic and endophytic mycelium occur, the latter producing haustoria. The conidiophores are long and slender and produce conidia singly. The conidia of many species are characteristically clavate and large. Conspicuous fibrosin bodies are generally absent.

28. *Phyllactinia guttata* (WALLR. ex FR.) LÉV. 1851. — Ann. Sci. Nat. bot., 3 sér., 15: 144.

Type on *Corylus avellana*; Germany.

On leaves. Mycelium thin, evanescent, greyish. Hyphae flexuous, and moderately geniculate, branched at right angles, often with a

septum at the base of the new branch. Hyphal cells (50—)67—80 (—150) \times 4—5(—10) μ m. Appressoria generally unlobed, nipple or hook-shaped, occasionally branched to moderately lobed, 7.5—12.5 μ m wide, single or frequently opposite in pairs. Conidiophores (100—)150—330(—570) \times 7.5—8.7 μ m, producing conidia singly. Conidiophores generally 3-celled but occasionally 2 or 4—5-celled. Foot-cells (20—)55—200 μ m long, with the basal septum (10—)17.5—37 μ m, away from the branching point of the mycelium, followed by cells of 15—40 μ m long. Conidia clavate or rhomboid in outline, often with a protrusion at the apex and a narrow area of about 7—5 μ m long at the base, (50—)75(—125) \times (22.5—)26(—35) μ m. No conspicuous fibrosin bodies produced. Germ tubes on side of conidia, simple, about 20—30 \times 5(—7) μ m and ending in an unlobed appressorium (pl. 2, fig. 11). Several of these characteristics were depicted by TULASNE (1861) and SALMON (1905b).

This species is hypophyllous and inconspicuous. Leaf symptoms are frequently absent and the fungus can be detected only by holding leaves obliquely to the light. It occurs throughout the year in gardens, streets and forests.

on *Vitex lucens* KIRK (BOESEWINKEL, 1977)

PODOSPHAERA KUNZE (1823)

The genus *Podosphaera* is characterised by cleistothecia with one ascus containing 6—8 spores and by appendages dichotomously branched near the apex. The branching of the appendages and the absence of secondary brown mycelium help to distinguish this genus from *Sphaerotheca*. The conidial state is of the Euoidium type and produces slender or broad conidiophores which form conidia in long chains. The conidia contain well-developed conspicuous fibrosin bodies. Germ tubes are frequently produced on the side and are simple.

1. Conidiophores plump, not slender, 75—112 \times 9—10 μ m
on Rosaceae: *Malus*, *Photinia*, *Pyrus* *P. leucotricha*
2. Conidiophores moderately slender, 70—120 \times 7.5 μ m
on Rosaceae: *Prunus* *P. tridactyla*
3. Conidiophores long and slender, 125—275 \times 7.5 μ m
on Rosaceae: *Crataegus*, *Cydonia* *P. clandestina*

29. *Podosphaera clandestina* (WALLR. ex FR.) LÉV. 1851. —Ann. Sci. Nat. bot., 3 sér., 15: 136

Type on *Crataegus oxyacantha*; Germany.

On leaves. Mycelium thin, evanescent. Hyphae flexuous, occasionally geniculate, branching at right angles with a septum at the base, sometimes producing two opposite branches. Hyphal cells (50—)52.5 (—75) \times 3.5(—5) μ m. Appressoria unlobed, nipple-shaped, well-

developed or occasionally poorly developed, single or in sequence. Conidiophores long and slender, $125-275 \times 7.5 \mu\text{m}$, producing conidia in long chains. Foot cells $(36-55-87(-125) \times 7.5 \mu\text{m}$ with basal septum $(7-15-30 \mu\text{m}$ away from the branching point of the mycelium, followed by two to five straight-walled cells of $20-25 \times 7.5 \mu\text{m}$ after which bulging cells of $10-12 \mu\text{m}$ wide occur. Conidia ellipsoid-cylindric, $25-27.5(-32.5) \times 11-12.5(-15) \mu\text{m}$. Well-developed conspicuous fibrosin bodies are present, about $2-3(-6) \mu\text{m}$ diameter. Germ tubes on side or end of conidia.

This species can be distinguished from *P. leucotricha* by the remarkably slender conidiophores and conidia and the position of the basal septum of the conidiophores. It is generally inconspicuous on both sides of leaves and appears to cause little damage.

on *Crataegus monogyna* JACQ. (new record)

on *Cydonia oblonga* MILL. (new record)

BRIEN and DINGLEY (1951) listed *P. leucotricha* on this host but this species cannot be found on herbarium material and all New Zealand samples show the characteristically slender conidiophores. DINGLEY (1969) reported *P. clandestina* (instead of *P. tridactyla*) on *Prunus domestica* without description or herbarium sample and this unusual record cannot be verified.

30. *Podosphaera leucotricha* (ELL. & EVERH.) SALM. 1900. — Mem. Torrey bot. Club 9: 40

Type on "living twigs"; America.

On leaves, stalks, inflorescences and fruit. Mycelium moderately dense to dense, white. Hyphae moderately flexuous, branching at right angles and $3.5-5 \mu\text{m}$ diameter.

Appressoria unlobed, nipple-shaped and well-developed. Conidiophores $(57-75-112(-115) \times 9-10 \mu\text{m}$, producing conidia in long chains. Foot-cells $(35-37(-77) \times 9-12.5 \mu\text{m}$, straight but often slightly swollen at the base, followed by one or two straight walled cells of $20-35 \mu\text{m}$ long. Conidia ovoid, $27.5-30 \times 17.5-18 \mu\text{m}$. Well-developed conspicuous fibrosin bodies of $2.5-5 \mu\text{m}$ diameter produced. Germ tubes on sides or near ends of conidia, simple, straight, long or short and ending in an unlobed appressorium (pl. 1, fig. 12).

Cleistothecia, containing a single, 8-spored ascus and with 5-6 long apical appendages, have been collected on several occasions and they were first described by CUNNINGHAM (1923). The broad, plump, conidiophores distinguish this mildew from other species in New Zealand. It is common on many varieties and cultivated rootstocks of apple throughout the year. Serious damage can occur when in spring the flowers, leaves and young twigs are attacked.

on *Malus sylvestris* (L.) MILL. (KIRK, 1908). Until 1908, powdery mildew of apple had been reported from New Zealand as *P. oxyacanthae*. CUNNINGHAM (1921) pointed out that two

species, *P. leucotricha* and *P. oxyacanthae*, occurred on pip fruit but that these could not be identified from the conidial state alone. In 1925, CUNNINGHAM made it clear that *P. leucotricha* had only been recorded on apple.

on *Photinia serrulata* LINDL. (BOESEWINKEL, 1977). This is a very common mildew in the Auckland area and causes malformation of the spring growth.

on *Pyrus communis* L. (BRIEN and DINGLEY, 1951)

31. *Podosphaera tridactyla* (WALLR.) DE BARY 1870. — Abh. Senckenb. naturf. Ges. 7: 408

Type on *Prunus padus* L.; Germany.

On leaves and shoots. Mycelium evanescent, white. Appressoria unlobed, nipple-shaped. Conidiophores $70-120 \times 7.5 \mu\text{m}$, producing conidia in long chains. Conidia ellipsoid cylindric, $23-32 \times 14-18 \mu\text{m}$.

Only one sample was studied in January 1968 and no further information was obtained. Unfortunately the characteristics of this fungus have not previously been described from New Zealand.

on *Prunus avium* L. (CUNNINGHAM, 1921)

on *Prunus domestica* L. (new record). This disease is very inconspicuous and was only observed once.

on *Prunus lusitanica* L. (DINGLEY, 1969)

SAWADAEA MIYABE (1914)

The genus *Sawadaea* is characterised by large cleistothecia which contain many 8-spored asci and have many apically coiled, simple or branched appendages. The imperfect state is characterised by the production of both micro and macroconidiophores and micro and macroconidia, which produce conspicuous fibrosin bodies.

32. *Sawadaea bicornis* (WALLR. ex FR.) HOMMA 1937. — Jour. Fac. Agric. Hokkaido Imp. Univ., 38: 371

Type on *Acer pseudoplatanus*; Germany.

On leaves and inflorescences. Mycelium evanescent, white. Hyphal cells $(45-50(-65) \times (2.5-4-5(-6) \mu\text{m})$. Appressoria unlobed, either poorly developed and inconspicuous or occasionally well-developed, nipple-shaped, $5-6 \mu\text{m}$ wide. Conidiophores straight, simple, rarely branched, producing conidia in chains. Macroconidiophores $57-95(-125) \times 4-8(-10.5) \mu\text{m}$, with basal septum $0-15 \mu\text{m}$ from the branching point of the mycelium. Foot-cells $17-50 \times 6.2-10.5 \mu\text{m}$, occasionally tapering from $7.5 \mu\text{m}$ at the base to $5.2 \mu\text{m}$ at the top. Microconidiophores $20-190 \times 5-7.5 \mu\text{m}$. Foot-cells $20-40(-100) \times 5-7.5 \mu\text{m}$, often tapering to $5 \mu\text{m}$ at the top. Conidia cylindric with characteristic angular outline, occasionally ellipsoid-ovoid. Macroconidia $(23-27(-37.5) \times (13-15(-20) \mu\text{m})$, microconidia 12.5

(—17.5) × (5—)6(—12.5) μm . Well-developed conspicuous fibrosin bodies present in both micro and macroconidia and in conidiophore cells. Germ tube on sides or ends of conidia, short or moderately long, 5—40 × 2.5 μm and terminating in an unlobed or rarely in a moderately lobed appressorium 25 × 5(—12) μm . On rare occasions branching of the base of foot cells and the base of the second conidiophore cells occurred (pl. 1, fig. 13). The shape of the conidia and the evanescent, hypophyllous mycelium distinguish this species from *Sa. tulasnei* (FUCK.) HOMMA which occurs overseas. *Sa. bicornis* is found from late spring until winter, but is easily overlooked as the symptoms are slight.

on *Acer negundo* L. (BOESEWINKEL, 1977)

on *Acer pseudoplatanus* L. (BOESEWINKEL, 1977)

on *Alectryon excelsus* GAERTN. (BOESEWINKEL, 1979)

on *Dodonaea viscosa* JACQUIN (new record)

SPHAEROTHECA LÉV. (1851)

The genus *Sphaerotheca* is characterised by cleistothecia containing one ascus with (6—7—)8 ascospores and with unbranched or irregularly branched appendages. The conidiophores produce conidia in long chains. Conspicuous fibrosin bodies are produced. Several species form a secondary, brown and straight walled mycelium. The germ tubes are frequently produced on the side of conidia and are either bent or straight and simple or broadly forked.

1. Conidiophores long with basal septum 20—45 μm from branching point of mycelium. Chains of immature conidia moderately long or long.

on Rosaceae: *Fragaria*

S. alchemillae

on Myrtaceae: *Eucalyptus*

S. alchemillae

2. Conidiophores moderately long, 100—140 × 8—9.5 μm , and basal septum 0—85 μm from branching point of mycelium. Chains of immature conidia long.

3. Conidiophores moderately long, slender, 75—80 × 7.5—8.7 μm , basal septum at branching point of mycelium. Chains of immature conidia long.

on Rosaceae: *Rosa*

S. pannosa

4. Conidiophores moderately long, not slender, 80—100 × 10—12.5 μm , basal septum at branching point of mycelium. Germ tubes occasionally short and broadly forked.

on Compositae: *Calendula*, *Gaillardia*,

Helianthus, *Olearia*,

Petasites, *Senecio*

S. fuliginea

on Coriariaceae: *Coriaria*

S. fuliginea

on Cucurbitaceae: *Citrullus*, *Cucumis*,

Cucurbita, *Lagenaria*

S. fuliginea

| | |
|--|---------------------|
| on Gesneriaceae: <i>Saintpaulia</i> | <i>S. fuliginea</i> |
| on Malvaceae: <i>Hibiscus</i> , <i>Hoheria</i> | <i>S. fuliginea</i> |
| on Papilionaceae: <i>Phaseolus</i> | <i>S. fuliginea</i> |
| on Acanthaceae: <i>Acanthus</i> | <i>S. fuliginea</i> |

5. Conidiophores moderately long, not slender, $70-140 \times 10-12.5 \mu\text{m}$. Chains of immature conidia long or moderately long. Germ tubes occasionally short and forked.

| | |
|--------------------------------|--------------------|
| on Verbenaceae: <i>Verbena</i> | <i>S. verbenae</i> |
|--------------------------------|--------------------|

33. *Sphaerotheca alchemillae* (GREV.) JUNELL 1965. — Trans. Br. mycol. Soc. 48: 547

Type on *Alchemilla vulgaris*; Scotland.

On leaves and fruit. Mycelium evanescent, occasionally dense. Hyphal cells about $50-70 \times 3-5 \mu\text{m}$. Appressoria unlobed, well-developed nipple-shaped, $5 \times 7.5 \mu\text{m}$. Conidiophores $(88-250-350 \times 7.5-12.5 \mu\text{m})$, producing conidia in long or moderately long chains with about $(2-3-8)$ immature conidia. Foot-cells $(80-110-170 \mu\text{m})$ long, straight or increasing in diameter from $7-10 \mu\text{m}$ at the base to $12.5 \mu\text{m}$ at the top. Basal septum of conidiophores $(8-20-45 \mu\text{m})$ away from the branching point of the mycelium. Conidia ovoid or sub-spherical, $(22-26-33(-38) \times 16-22(-25) \mu\text{m})$ with well-developed fibrosin bodies. Germ tubes on side of conidia, simple, straight, very long and about $6.2 \mu\text{m}$ wide, ending in an unlobed appressorium.

Of interest, is, that the host range includes *Eucalyptus*, a genus on which this mildew has also been reported by BRANDENBURGER (1961) from Germany.

- on *Eucalyptus cinerea* F. J. MUELL. ex BENTH. (new record)
- on *Eucalyptus diversicolor* F. J. MUELL. (new record). Affected areas of the leaves become purple.
- on *Eucalyptus grossa* F. J. MUELL. (new record)
- on *Eucalyptus megacarpa* F. J. MUELL. (new record)
- on *Eucalyptus nutans* F. J. MUELL. (new record)
- on *Eucalyptus torquata* LUEHM. (new record)
- on *Fragaria* sp. cult. (CUNNINGHAM, 1922). This disease is probably more common than is generally thought, but frequently the mildew is hypophyllous and too inconspicuous to be detected easily. Occasionally fruits have a "hairy" appearance due to the presence of numerous conidiophores.

34. *Sphaerotheca fugax* PENZ. & SACC. 1884. — Atti r. Ist. Ven. sci. 6: 2, 586

Type on *Geranium silvaticum*.

On leaves, stems and inflorescences. Mycelium sparse to dense, hyphae flexuous and geniculate. Hyphal cells $40-55 \times 5-7.5 \mu\text{m}$.

Appressoria unlobed, inconspicuous, up to $8.2\ \mu\text{m}$ wide. Conidiophores $100\text{--}140 \times 8\text{--}9.5\ \mu\text{m}$, producing conidia in chains with about 3—7 (—9), immature conidia. Foot-cells of conidiophores $65\text{--}90 \times 8.7\text{--}9.5\ \mu\text{m}$ and followed by cells $12\text{--}10\ \mu\text{m}$ long. Basal septum of conidiophores $0\text{--}85\ \mu\text{m}$ away from the branching point of the mycelium. Conidia ovoid or nearly globose, $(21.2\text{--})22.5\text{--}25(=40) \times (15\text{--})17.5\text{--}18.7(=21)\ \mu\text{m}$. Well-developed fibrosin bodies present, often 6—8 in number. Germ tubes produced on the side, less frequently the end of conidia, simple, either short and broadly swollen, about $22.5 \times 6\text{--}9\ \mu\text{m}$, or moderately long. Haustoria $15 \times 18\text{--}23\ \mu\text{m}$.

This species is easily distinguished by the shape and small size of the conidia and by the placement of the basal septum of the conidiophores. It is common during the summer when in sheltered areas affected plants can become conspicuously white.

on *Erodium moschatum* (L.) L'HÉR. (BOESEWINKEL, 1977)

on *Geranium homeanum* TURCZ. (BOESEWINKEL, 1977)

on *Geranium molle* L. (new record)

35. *Sphaerotheca fuliginea* (SCHLECHT. ex FR.) POLL. 1905. — Atti r. Ist. bot. Univ. Pavia 2: 9, 8

Type on *Veronica longifolia*; Germany.

On leaves, stalks and inflorescences. Mycelium dense. Hyphae flexuous with straight and irregular areas, occasionally slightly geniculate, branching at various angles, including right angles, near a septum and sometimes producing two opposite branches. Hyphal cells $(37\text{--})62\text{--}67(=80) \times 3\text{--}8.7\ \mu\text{m}$. Appressoria unlobed and inconspicuous. Conidiophores $(32\text{--})80\text{--}100 \times 10\text{--}12.5\ \mu\text{m}$, producing conidia in chains with 1—4 immature conidia. Foot-cells of conidiophores $(15\text{--})35\text{--}50 \times 10\text{--}12.5\ \mu\text{m}$ followed by one or two straight walled cells of $15\text{--}22(=30) \times 12.5\ \mu\text{m}$. The foot-cells can be slightly swollen at the base, measuring about $7.5\ \mu\text{m}$ at the basal septum and increasing to $12.5\ \mu\text{m}$ wide at the base after which the diameter decreases to $11\text{--}12.5\ \mu\text{m}$. Conidia ovoid, $27.5\text{--}31(=58.2) \times 15\text{--}17.5(=22.5)\ \mu\text{m}$, with well-developed fibrosin bodies which are $2\text{--}7.5\ \mu\text{m}$ wide and number up to 24 per conidium. Germ tubes on side of conidia, simple or forked, short or moderately long, frequently characteristically short, broadened and forked. Haustoria about $20\text{--}27.5\ \mu\text{m}$ diameter (pl. 2, fig. 14). Cleistothecia have been reported from *Coriaria* (DINGLEY and BRIEN, 1956) and *Cucurbita* (DINGLEY, 1959).

This species is common throughout the year on *Calendula*, *Coriaria*, *Cucumis* and *Cucurbita*. During the summer it is also common on *Hibiscus* and *Phaseolus*.

So far no characteristics have been reported by which the conidial state can be split up into the different species used by JUNELL (1967).

Until cleistothecia are found on a wider range of plants and their characteristics are compared, it is best to accommodate all records in *S. fuliginea*.

- on *Acanthus mollis* L. (new record)
- on *Calendula officinalis* L. (DINGLEY, 1960)
- on *Citrullus lanatus* (THUNB.) MATSUM & NAKAI (HAMMETT, 1977)
- on *Coriaria angustissima* HOOK. (DINGLEY and BRIEN, 1956)
- on *Coriaria arborea* LINDSAY (BOESEWINKEL, 1977)
- on *Coriaria lurida* KIRK (DINGLEY and BRIEN, 1956)
- on *Cucumis angurica* L. (BOESEWINKEL, 1977)
- on *Cucumis melo* var. *cantalupensis* NAUD. (BOESEWINKEL, 1977)
- on *Cucumis sativus* L. (LAUNDON, 1971)
- on *Cucurbita maxima* DUCH. (LAUNDON, 1971)
- on *Cucurbita moschata* DUCH. ex POIR (DINGLEY, 1969)
- on *Cucurbita pepo* L. (DINGLEY, 1959)
- on *Gaillardia lanceolata* MICHX. (new record)
- on *Helianthus annuus* L. (BOESEWINKEL, 1977)
- on *Hibiscus syriacus* L. (BOESEWINKEL, 1977)
- on *Hoheria populnea* A. CUNN. (BOESEWINKEL, 1977)
- on *Hoheria lyallii* HOOK. (BOESEWINKEL, 1977)
- on *Lagenaria siceraria* (MOL.) STANDL. (BOESEWINKEL, 1977)
- on *Olearia furfuracea* (A. RICH.) HOOK. f. (BOESEWINKEL, 1979)
- on *Petasites fragrans* PRESL. (BOESEWINKEL, 1977)
- on *Phaseolus coccineus* L. (BOESEWINKEL, 1977)
- on *Phaseolus mungo* L. (new record)
- on *Phaseolus vulgaris* L. (new record)
- on *Saintpaulia ionantha* WENDL. (new record)
- on *Senecio cruentus* DC. (DINGLEY, 1969)

36. *Sphaerotheca pannosa* (WALLR. ex Fr.) LÉV 1851. — Ann. Sci. Nat. bot., 3 sér., 15: 138

Type on *Rosa villosa* L.; Germany.

On leaves, stalks and inflorescences. Mycelium moderately dense to dense, primary mycelium white, secondary mycelium brown. Hyphae of primary mycelium moderately flexuous, branched at right angles, occasionally near a septum. Hyphae of secondary mycelium straight. Hyphal cells $(12-25-40(-120) \times (3-5-6(-7) \mu\text{m})$. Appressoria unlobed, well-developed nipples shaped. Conidiophores $70-80(-200) \times 7.5-8.7(-10) \mu\text{m}$, producing conidia in long chains with about 3-7(-9) immature conidia. Foot-cells of conidiophores $45-75(-120) \times 7.5-11 \mu\text{m}$, often slightly swollen at the base where they are up to $11 \mu\text{m}$ wide with a basal septum about $7.5 \mu\text{m}$ wide. Foot-cells are followed by two straight-walled cells of about $12-16 \times 10 \mu\text{m}$. Conidia ovoid, $25-30 \times 13.5-17.5 \mu\text{m}$, producing conspicuous,

well-developed fibrosin bodies about 3—5 μm wide. Germ tubes on side or end of conidia, simple, about 4—5 μm wide. Cleistothecia containing single 8-spored asci have been collected on *Rosa rubiginosa* and *Rosa* sp. cult., but they have not been described.

This mildew is very serious on *Rosa multiflora* on which it frequently forms cleistothecia on the killed flowers. It damages fruit of *Prunus persica*.

on *Prunus persica* (L.) BATSCH (CUNNINGHAM, 1925)

on *Rosa multiflora* THUMB. (HAMMETT, 1977)

on *Rosa rubiginosa* L. (BRIEN and DINGLEY, 1953)

on *Rosa* sp. cult. (KIRK, 1906)

37. *Sphaerotheca verbenae* SAVULESCU & NEGRU 1953. — Bull. stiint. Acad. române 5: 415

Type on *Verbena hybrida*; Rumania.

On leaves and inflorescences. Mycelium sparse to dense, white or grey. Hyphae very flexuous or geniculate, occasionally moderately flexuous, branching at right angles, often near a septum. Hyphal cells (35—)67(—95) \times (5—)7.5(—10) μm . Appressoria unlobed, inconspicuous, about 8—10 μm wide. Conidiophores 70—140 \times 10—12.5 μm , producing conidia in long chains, with 2—6(—9) immature conidia. Foot-cells of conidiophores 35—100 \times 11—12.5 μm , occasionally 10 μm wide at basal septum, followed by one or two straight-walled cells 15—27.5 \times 11 μm . Conidia ellipsoid to ovoid-cylindric, 32—35 (—47.5) \times (15—)17.5—20 μm on *V. hybrida* and 35—42(—57) \times 15.5—16.2(—21) μm on *V. bonariensis*. Conspicuous fibrosin bodies present, about 2.5—5 μm wide and about ten per conidium. Germ tubes on side of conidia, simple or occasionally forked, often short, about 17 μm long, more or less similar to those of *S. fuliginea* but often less broad, about 13 μm wide, and when forking occurs this is often more pronounced. This is a very common mildew. It is mainly hypophyllous.

on *Verbena bonariensis* L. (BOESEWINKEL, 1977)

on *Verbena hybrida* VOSS (BOESEWINKEL, 1977)

UNCINULA LÉV. (1851)

The genus *Uncinula* is characterised by cleistothecia containing several or many asci with 2—8 ascospores. The appendages are often numerous and are characteristically coiled at the apex.

1. Conidiophores straight, not slender or long
on Lythraceae: *Lagerstroemia* *U. australiana*
2. Conidiophores frequently flexuous at the base, short or slender and long
on Vitaceae: *Vitis* *U. necator*

38. *Uncinula australiana* McALPINE 1899. — Proc. Linn. Soc. N. S. W.
24: 302

Type on *Lagerstroemia indica*; Australia.

On leaves and stalks. Mycelium thin or dense, white. Hyphae sparsely branched at right angles, with or without a septum at the point of branching. Hyphal cells $(38-45-65 \times (3-5) \mu\text{m})$. Appressoria multi-lobed, $5-6 \mu\text{m}$ wide, single or in pairs, often several pairs formed per hyphal cell. Conidiophores $55-80 \times 5-8.7 \mu\text{m}$, producing conidia singly. Foot-cells of conidiophores straight, occasionally narrowed up to $5 \mu\text{m}$ near the centre, or, rarely, slightly flexuous at the base, $27-30(-55) \times (5-6-7 \mu\text{m})$, occasionally only $5 \mu\text{m}$ wide at the insertion point, followed by two slightly shorter cells of $20-25(-30) \times 6.5-8.7 \mu\text{m}$. Conidia ovoid or cylindric-ellipsoid, $(27-30-35(-47) \times (12.5-13-15(-20) \mu\text{m})$. No well-developed fibrosin bodies produced. Germ tubes formed on the end of conidia, straight or flexuous, either very short and immediately producing one or two multi-lobed appressoria, or, moderately long, ending in a multi-lobed or unlobed appressorium.

HIRATA (1942) and VIENNOT-BOURGIN (1971) reported the formation of two multi-lobed appressoria upon germination, which distinguishes this species from species of *Microsphaera* for which this characteristic has not been observed. This species is common on its host in the Auckland area and occurs throughout the year. It seriously affects the young growth.

on *Lagerstroemia indica* L. (DINGLEY, 1969)

39. *Uncinula necator* (SCHW.) BURR. in ELL. & EVERH. 1892. — N. Amer. Pyrenom. p. 15

Type on *Vitis labrusca* L.; North America.

On leaves, stalks and fruit. Mycelium thin or dense, white. Hyphae flexuous, with cells $45-75 \times 5 \mu\text{m}$. Appressoria multi-lobed, $7-8 \mu\text{m}$ wide, single or opposite in 1, 2 or 3 pairs. Epiphyllous conidiophores 1, 2 or 3-celled, $70-100 \times 5-7.5 \mu\text{m}$, with foot-cells $25-60 \times 5-7.5 \mu\text{m}$. Hypophyllous conidiophores 1, 2, 3, or 4-celled, $220-400 \times 5-7.5 \mu\text{m}$ with foot-cells $80-160 \times 5-7.5 \mu\text{m}$, followed by one long and one or two shorter cells. Foot-cells are moderately to extremely flexuous at the base. Conidia ovoid $(27-32.5-35(-47) \times (15-17.5-18(-19.5) \mu\text{m})$, without conspicuous fibrosin bodies. Germ tubes on end, rarely on side of conidia, simple, irregularly branched or forked, short or moderately long and terminating in an unlobed or multi-lobed appressorium (pl. 2, fig. 15). A special feature of this species is the extremely flexuous base of the conidiophore which was first drawn by FRESenius (1852) and which occurs to a lesser degree in a few other species. The difference in length of the conidiophores on

upper- and under-side of the leaves could be due to the presence of numerous hairs on the underside of the leaves. This powdery mildew is common during the summer and can cause serious damage.

on *Vitis vinifera* L. (KIRK, 1901)

40. Unidentified species of *Oidium* occur on *Brachyglottis repanda* J. R. & G. FORST., *Epilobium pubens* A. RICH., *Erica* sp., *Hypericum gramineum* FORST. f., *Limosella lineata* GLÜCK, *Magnolia* sp., *Nasturtium* sp., *Olearia nummularifolia* HOOK. f., *Salvia officinalis* L., *Senecio jacobaea* L., *Urtica ferox* FORST. f., *U. incisa* POIR., *Valerianella locusta* (L.) BETSCHE and *Zinnia elegans* L. Of these I have not been able to find a good collection to make identification possible. LUCAS and SHERIDAN (1977) recorded *Oidium* sp. on a number of *Eucalyptus* species. Examination of their herbarium collections showed that several are *S. alchemillae*.

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Host Index

Bl. = *Blumeria*; *E.* = *Erysiphe*; *M.* = *Microsphaera*; *O.* = *Oidium*;
Ph. = *Phyllactinia*; *P.* = *Podosphaera*; *Sa.* = *Sawadaea*; *S.* = *Sphaerotheca*;
U. = *Uncinula*.

Acanthus
mollis *M. polonica*
S. fuliginea

Acer
negundo *Sa. bicornis*
pseudoplatanus *Sa. bicornis*

Agropyron
scabrum *Bl. graminis*

Alectryon
excelsus *Sa. bicornis*

Alopecurus
pratensis *Bl. graminis*

Anemone
coronaria *E. ranunculi*

Aquilegia
vulgaris *E. ranunculi*

Aristotelia
fruticosa *E. densa*
serrata *E. densa*

Aster
ericoides *E. cichoracearum*
laevis *E. cichoracearum*
novae-angliae . . *E. cichoracearum*
novae-belgii . . . *E. cichoracearum*
subulatus *E. cichoracearum*

Avena
sativa *Bl. graminis*

Begonia
masoniana *M. begoniae*
rex-cultorum . . . *M. begoniae*
semperflorens . . . *M. begoniae*
tuberhybrida . . . *M. begoniae*
cv. Gloire de
Lorraine . . . *M. begoniae*

Brachyglottis
repanda *Oidium sp.*

Brachysema
lanceolata *E. trifolii*

Brassica
campestris *E. cruciferarum*
napo-brassica . . . *E. cruciferarum*
napus *E. cruciferarum*
napus var.
 napo-brassica . *E. cruciferarum*
oleracea
 var. botrytis . . *E. cruciferarum*
oleracea
 var. ramosa . . . *E. cruciferarum*
rapa *E. cruciferarum*

Bromus spp. *Bl. graminis*

Bupththalmum
speciosum *E. cichoracearum*
Calendula
officinalis *S. fuliginea*
Callistephus
chinensis *E. cichoracearum*
Cardamine
debilis *E. cruciferarum*
hirsuta *E. cichoracearum*
E. cruciferarum
Castanea
dentata *M. alphitoides*
sativa *M. alphitoides*
Chrysanthemum
hortorum *E. polyphaga*⁴⁴
O. chrysanthemi
indicum *O. chrysanthemi*
morifolium *E. polyphaga*⁴⁴
O. chrysanthemi
Citrullus
lanatus *S. fuliginea*
Clematis
australis var.
 rutifolia *E. ranunculi*
jackmanii *E. ranunculi*
paniculata *E. ranunculi*
Cleome
spinosa *E. cruciferarum*
Coriaria
angustissima *S. fuliginea*
arborea *S. fuliginea*
lurida *S. fuliginea*
Coreopsis
grandiflora *E. cichoracearum*
Cosmos
bipinnatus *E. cichoracearum*
Cotinus
coggygria *M. alphitoides*
Crataegus
monogyna *P. clandestina*
Cucumis
 angurica *E. polyphaga*⁴⁴
 S. fuliginea
melo var.
 cantalupensis *E. cichoracearum*
 *E. polyphaga*⁴⁴
 S. fuliginea
sativus *E. cichoracearum*
 *E. polyphaga*⁴⁴
 S. fuliginea

| | | | |
|------------------------|----------------------------|-------------------------|-------------------------|
| Cucurbita | | Gerbera | |
| maxima | <i>E. cichoracearum</i> | jamesonii | <i>E. cichoracearum</i> |
| | <i>S. fuliginea</i> | Hardenbergia | |
| moschata | <i>S. fuliginea</i> | monophylla | <i>O. hardenbergiae</i> |
| pepo | <i>E. cichoracearum</i> | Hebe | |
| | <i>S. fuliginea</i> | speciosa | <i>E. pisi</i> |
| Cydonia | | Helianthus | |
| oblonga | <i>P. clandestina</i> | annuus | <i>E. cichoracearum</i> |
| Cyphomandra | | | „ <i>E. polyphaga</i> “ |
| betaceae | <i>E. cichoracearum</i> | | <i>S. fuliginea</i> |
| Dactylis | | Helichrysum | |
| glomerata | <i>Bl. graminis</i> | bracteatum | <i>E. polyphaga</i> “ |
| Dahlia | | | <i>O. helichrysi</i> |
| sp. cult. | <i>E. cichoracearum</i> | Hibiscus | |
| Delphinium | | mutabilis | <i>E. cichoracearum</i> |
| ajacis | <i>E. ranunculi</i> | | „ <i>E. polyphaga</i> “ |
| cultorum | <i>E. ranunculi</i> | syriacus | <i>S. fuliginea</i> |
| Dodonaea | | Hoheria | |
| viscosa | <i>Sa. bicornis</i> | lyallii | <i>S. fuliginea</i> |
| Dysoxylum | | populnea | <i>S. fuliginea</i> |
| spectabile | <i>E. heraclei</i> | Hordeum | |
| Epilobium | | vulgare | <i>Bl. graminis</i> |
| pubens | <i>Oidium</i> sp. | Hydrangea | |
| Erica | | macrophylla | <i>M. polonica</i> |
| sp. | <i>Oidium</i> sp. | Hypericum | |
| Erodium | | gramineum | <i>Oidium</i> sp. |
| moschatum | <i>E. cruciferarum</i> | Iberis | |
| | <i>S. fugax</i> | umbellata | <i>E. cruciferarum</i> |
| Eucalyptus | | Kalanchoë | |
| cinerea | <i>S. alchemillae</i> | tubiflora | <i>M. polonica</i> |
| diversicolor | <i>S. alchemillae</i> | Lagenaria | |
| grossa | <i>S. alchemillae</i> | siceraria | <i>S. fuliginea</i> |
| leucoxylon var. | | Lagerstroemia | |
| rosea | <i>E. cichoracearum</i> | indica | <i>U. australiana</i> |
| | „ <i>E. polyphaga</i> “ | Lathyrus | |
| megacarpa | <i>S. alchemillae</i> | odoratus | <i>E. pisi</i> |
| nutans | <i>S. alchemillae</i> | | <i>E. trifolii</i> |
| torquata | <i>S. alchemillae</i> | pubescens | <i>E. pisi</i> |
| Euonymus | | Limosella | |
| japonicus | <i>M. euonymi-japonici</i> | lineata | <i>Oidium</i> sp. |
| japonicus var. | | Lotus | |
| aureo- | | corniculatus | <i>E. trifolii</i> |
| marginatus | <i>M. euonymi-japonici</i> | Lupinus | |
| Fragaria | | angustifolius | <i>E. pisi</i> |
| sp. cult. | <i>S. alchemillae</i> | argenteus | <i>E. pisi</i> |
| Fumaria | | polyphyllus | <i>E. pisi</i> |
| officinalis | <i>E. cruciferarum</i> | Lycium | |
| Gaillardia | | chinense | <i>E. mougeotii</i> |
| lanceolata | <i>S. fuliginea</i> | Lycopersicon | |
| Geranium | | esculentum | „ <i>E. polyphaga</i> “ |
| homeanum | <i>E. cruciferarum</i> | Magnolia | |
| | <i>E. galeopsidis</i> | sp. | <i>Oidium</i> sp. |
| | <i>S. fugax</i> | Malus | |
| molle | <i>E. galeopsidis</i> | sylvestris | <i>P. leucotricha</i> |
| | <i>S. fugax</i> | | |

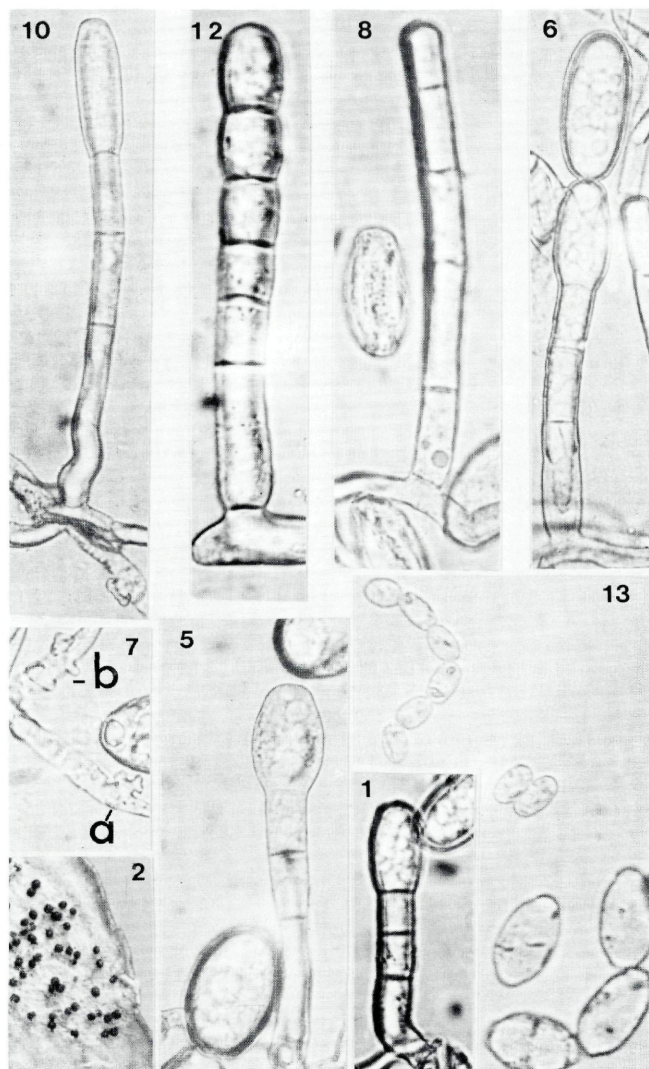
| | | | |
|------------------------|-------------------------|----------------------|--------------------------|
| Thymus | | Veronica | |
| aureus | <i>E. biocellata</i> | arvensis | <i>E. asperifoliorum</i> |
| serpyllum | <i>E. biocellata</i> | | <i>E. cichoracearum</i> |
| Tragopogon | | Viburnum | |
| porrifolius | <i>E. cichoracearum</i> | opulus | <i>M. viburni</i> |
| Trifolium | | trilobum | <i>M. viburni</i> |
| dubium | <i>E. trifolii</i> | Viola | |
| micranthum | <i>E. trifolii</i> | tricolor var. | |
| pratense | <i>E. trifolii</i> | hortensis | <i>E. cichoracearum</i> |
| striatum | <i>E. trifolii</i> | sp. cult. | <i>E. cichoracearum</i> |
| subterraneum | <i>E. trifolii</i> | Vitex | |
| Triticum | | lucens | <i>Ph. guttata</i> |
| aestivum | <i>Bl. graminis</i> | Vitis | |
| Urtica | | vinifera | <i>U. necator</i> |
| ferox | <i>Oidium</i> sp. | Weinmannia | |
| incisa | <i>Oidium</i> sp. | racemosa | <i>E. carpophila</i> |
| Valerianella | | sylvicola | <i>E. carpophila</i> |
| locusta | <i>Oidium</i> sp. | Wistaria | |
| Verbascum | | floribunda | <i>E. trifolii</i> |
| thapsus | <i>E. verbasci</i> | Zinnia | |
| Verbena | | elegans | <i>Oidium</i> sp. |
| bonariensis | <i>S. verbenae</i> | | |
| hybrida | <i>S. verbenae</i> | | |

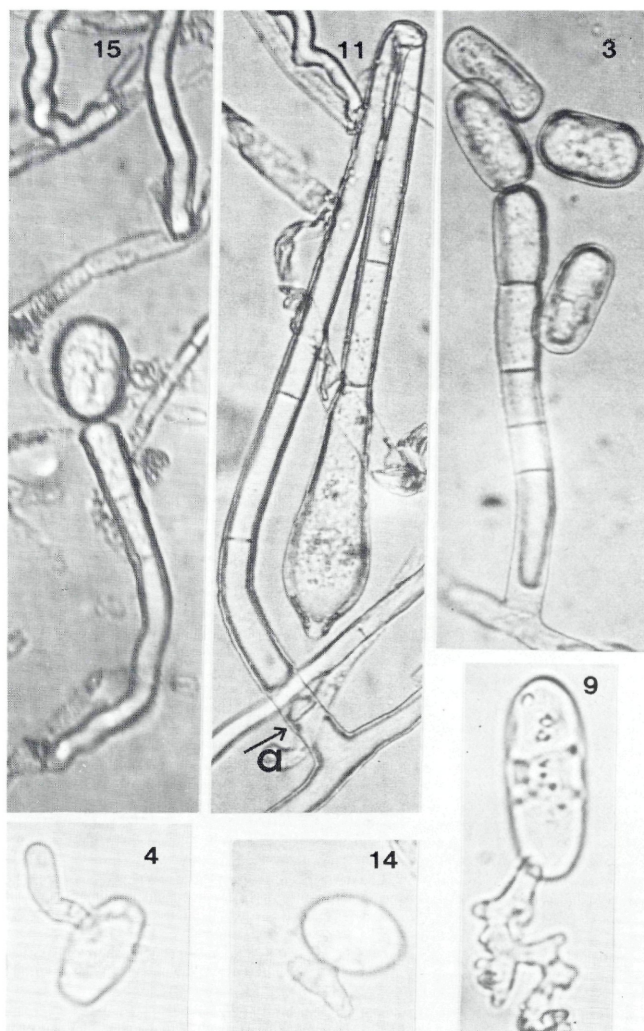
Plate 1

- Fig. 1. *Erysiphe carpophila*. Conidiophore with a flexuous footcell, $\times 670$.
 Fig. 2. *Erysiphe densa*. Dark cleistothecia on a part of a leaf of *Aristotelia fruticosa*, $\times 10$.
 Fig. 5. *Microsphaera alphitoides*. Conidiophore producing conidia singly, $\times 670$.
 Fig. 6. *Microsphaera polonica*. Conidiophore producing conidia singly, $\times 670$.
 Fig. 7. *Microsphaera polonica*. Mycelium with multi-lobed appressoria which are either single (a) or in pairs (b), $\times 670$.
 Fig. 8. *Microsphaera polonica*. Conidium and a 5-celled conidiophore, $\times 670$.
 Fig. 10. *Oidium hardenbergiae*. Conidiophore with flexuous foot-cell, $\times 670$.
 Fig. 12. *Podosphaera leucotricha*. Plump conidiophore and conidia with fibrosin bodies, $\times 670$.
 Fig. 13. *Sawadaea bicornis*. Macroconidia and microconidia with fibrosin bodies, $\times 670$.

Plate 2

- Fig. 3. *Erysiphe mougeotii*. Conidiophore producing cylindric conidia in a chain, $\times 670$.
 Fig. 4. "*Erysiphe polyphaga*". Conidium with short germ tube produced on the side, $\times 670$.
 Fig. 9. *Oidium hardenbergiae*. Conidium with coralloid germ tube, $\times 670$.
 Fig. 11. *Phyllactinia guttata*. Artificially bent conidiophore showing a basal septum (a) far away from the branching point of the mycelium, $\times 670$.
 Fig. 14. *Sphaerotheca fuliginea*. Conidium with broadly forked germ tube, $\times 670$.
 Fig. 15. *Uncinula necator*. Conidiophore with a long flexuous foot-cell, $\times 670$.





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