An Introductory

Scanning Electron Microscope Atlas of Rust Fungi

by

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Preface

This atlas contains 600 photographs of the aecia and aeciospores, uredinia and urediniospores, telia and teliospores of the 164 species of rust fungi (Uredinales) found in Yorkshire, England, during the years 1880 to 1989 as seen using a scanning electron microscope.

We have tried to use language which can easily be understood, and to define all terms not in common parlance. Our general approach will offend experts, but we ask for their forbearance on behalf of readers in those parts of the world where many rusts have not yet been examined by scanning electron microscopy, and in the hope that others may be stimulated to produce further SEM atlas volumes, especially of tropical rusts. Other potential users of this atlas, concerned with identification of biological material (e.g. forensic scientists, archaeologists) will be confused by the complexity of the life-style of rust fungi. For them and for all students our object has been to clarify and make more intelligible surface features which can be seen only with difficulty using a light microscope. If our pictures point to the need for further research on these rust spores, and if this acts as a stimulus to further enquiry, that will be indeed a reward for our time-consuming efforts. We expect criticism, and look forward to the publication of more and better work by others, perhaps by full-time workers in this field.

T.F. Preece and A.J. Hick
Leeds 1990

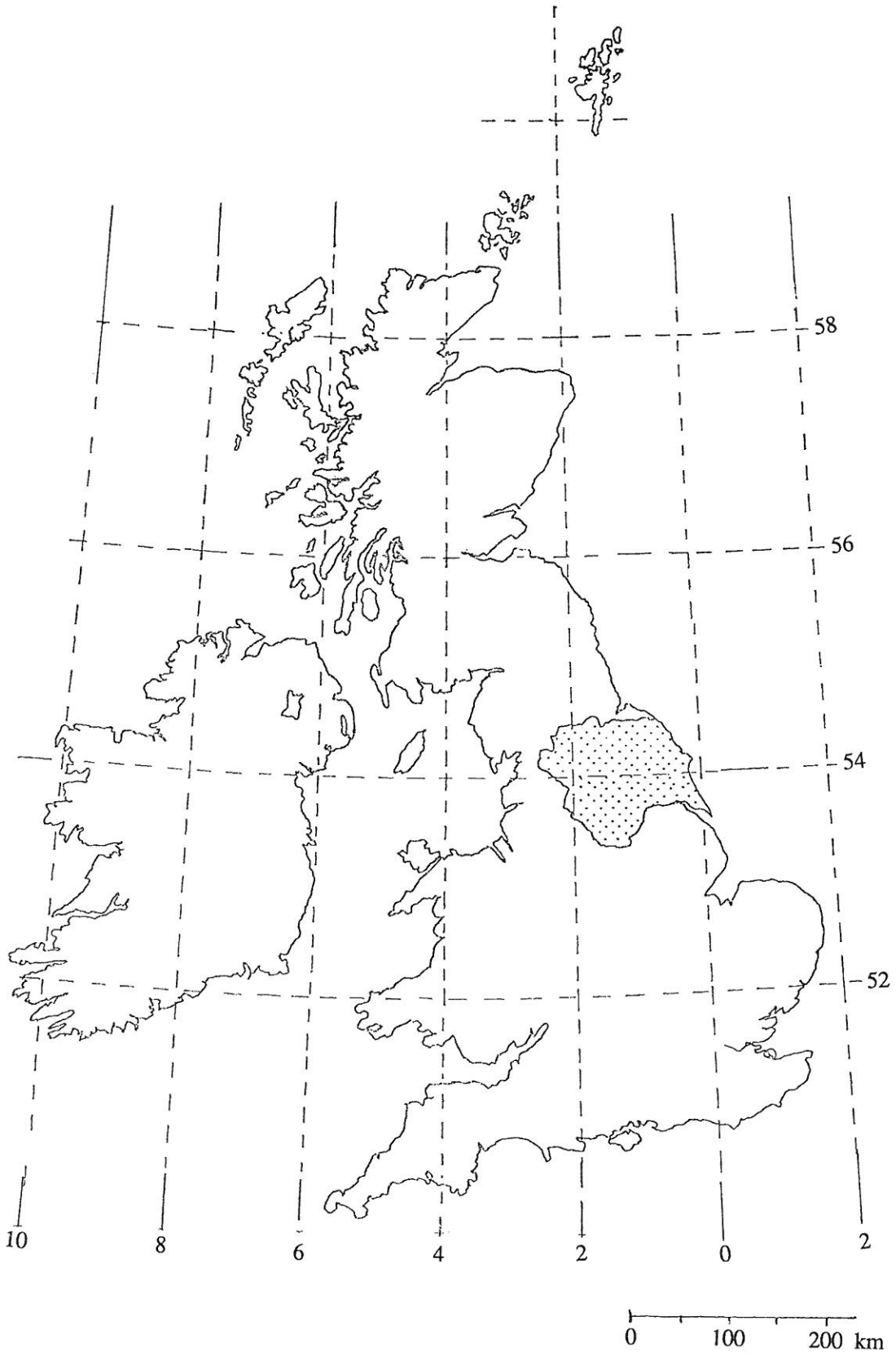


FIG.1. Map of the British Isles showing the location of Yorkshire – the source of the rusts illustrated in this Atlas.

The numbers indicate latitude and longitude. Changes in boundaries in recent years are ignored. The shaded area represents Watsonian Vice-Counties 61, 62, 63, 64 and 65.

Dedication and Acknowledgements

We wish to dedicate this book of SEM illustrations of Yorkshire rust fungi to Willis Bramley of Pickering, Yorkshire, who first interested Tom Preece in rust fungi in the field, and who has always been helpful and enthusiastic about them.

This atlas would never have been produced without the work of Shirley Preece in observing, collecting and making preparations of rust spores and we wish to thank her.

The University of Leeds contributed £1500 to enable the publication of the atlas and we wish to acknowledge this generous gift.

A Yorkshire naturalist, very active in the early part of this century left funds to the University of Leeds, and £1000 from this W.B. Crump bequest enabled us to take the photographs of the Yorkshire rusts in this book. W.B. Crump and C. Crossland published, under the auspices of the Halifax Scientific Society, "The Flora of the Parish of Halifax" in 1904. We reproduce below the list of rust fungi recorded in Crump and Crossland all of which are illustrated in this atlas, 85 years later, in gratitude for the Crump bequest.

We would like to thank the following people who have provided us with specimens (when we had not got our own) and in many cases discussed problems with us, over the years this book has been steadily put together:
W.G. Bramley, J.G. Manners, A. Bennell, E. Mordue, R. Shattock, D. Parry, D. Pegler, D. Redfern, G. Butler, D. Losel, J.E.E. Jenkins, K. Payne, M. Doherty, E.R. Boa, A. Norris, G.M. McPherson, T. O'Neill, R. Johnson, J. Lambert, P. Howard, C. Yeates, R. Cook, R. Watling, R. Western, J.T. Fletcher and many others.

Likewise the Directors of the following Institutes: Plant Pathology Laboratory, Harpenden; Royal Botanic Gardens, Kew; Royal Botanic Gardens, Edinburgh; Commonwealth Mycological Institute, Kew; York Museum; Leeds Museum (where all the specimens or parts of specimens on which this book is based are deposited).

Thanks are especially due to the staff of Farrand Press for their work and helpfulness at all times during the production of this book, and last but not least Noreen Cox for her careful typing.

TABLE I. *The 38 Rust species listed by William B. Crump and Charles Crossland in their Flora of the Parish of Halifax published in 1904 by the Halifax Scientific Society. All are illustrated in this Atlas. The names used by Crump and Crossland are replaced by their modern equivalents where necessary. The numbers are the Atlas Species numbers of this Atlas.*

2	Coleosporium tussilaginis	89	Puccinia menthae
15	Melampsora caprearum	92	Puccinia obscura
20	Melampsora populnea	97	Puccinia poarum
48	Puccinia betonicae	101	Puccinia pulverulenta
49	Puccinia bistortae	103	Puccinia punctiformis
51	Puccinia bulbocastani	112	Puccinia variabilis
53	Puccinia calcitrapae	113	Puccinia veronicae
56	Puccinia campanulae	115	Puccinia violae
57A	Puccinia caricina var. pringsheimiana	123	Trachyspora intrusa
66	Puccinia deschampsiae	124	Tranzschelia anemones
69	Puccinia epilobii	139	Uromyces dactylidis
72	Puccinia galli-verni	141	Uromyces ficariae
75	Puccinia graminis	147	Uromyces muscari
77	Puccinia hieracii var. hieracii	150	Uromyces polygoni-avicullariae
77A	Puccinia heiracii var. hypochoeridis	151	Uromyces rumicis
83	Puccinia lapsanae	153	Uromyces trifolii
84	Puccinia luzulae	154	Uromyces valerianae
85	Puccinia maculosa	156	Xenodocus carbonarius

(Crump and Crossland also listed a rust on a wild Rosa sp. which they called *Coleosporium miniatum*. This was probably a Phragmidium, but it is not possible now to say what it was - it never produced teliospores).

Introduction

Since man began producing crops, diseases of cereals and conifers called rusts have been especially troublesome, causing losses and when severe, cereal rusts have caused starvation of human beings. Speculation and superstition were rife in those centuries which have passed when microscopical organisms were not known, or understood. There is reason to think that rust fungi have existed on plants for thousands of years, although until recently biologists have not been able to assist archaeologists in the identification of rust fungi found in excavations. For example, unidentified rust teliospores were found in Bronze Age remains in England (Ashbee, 1957). Much older material from Canada (12 000 - 10 000 years before the present time) was seen by DeVries (1966) to contain *Puccinia caricina* (Atlas Species No. 57) on fragments of Carex. However, there seems to be a remarkable shortage of confirmed rusts from archaeological material. It is possible that this SEM Atlas may help here, since black stem rust of cereals has been seen and identified using scanning electron microscopy on wheat fragments dated 1400-1200 BC (Kislev, 1982), and the material is indistinguishable from that illustrated here as Atlas Species No. 75 (*Puccinia graminis*). Rust diseases are also a very serious problem in forests planted by man (Phillips and Burdekin, 1982). Perhaps the best known of the tree rusts is white pine blister rust caused by *Cronartium ribicola* (Atlas Species No. 2A) which has caused tremendous damage to five needled pines in Europe and America. Many other horticultural, agricultural, forest and ornamental plants are subject to rust diseases. Rusts have been noted on wild plants for hundreds of years. The drawing reproduced below (Fig. 2) was made by Hooke (1665) and records what he saw when he examined the black spores of a rust fungus on the lower surface of a rose leaf. This is the first drawing of a rust fungus as seen using a light microscope. Hooke noticed that in many ways the beautiful structures he saw on rose leaves resembled the easily visible capsules of mosses. They looked also like seed pods ("cods"). As in the case of moss capsules and, for example, pea-pods, he expected these spores to *contain* seeds of some kind. He clearly thought that the

function of the spores on the rose leaves was to spread the fungus to other leaves and also realized that the rose rust fungus was itself a separate but parasitic organism, living on the green leaf, in some way using it for food. He had also seen the similar rust on the "backsides" of blackberry leaves.

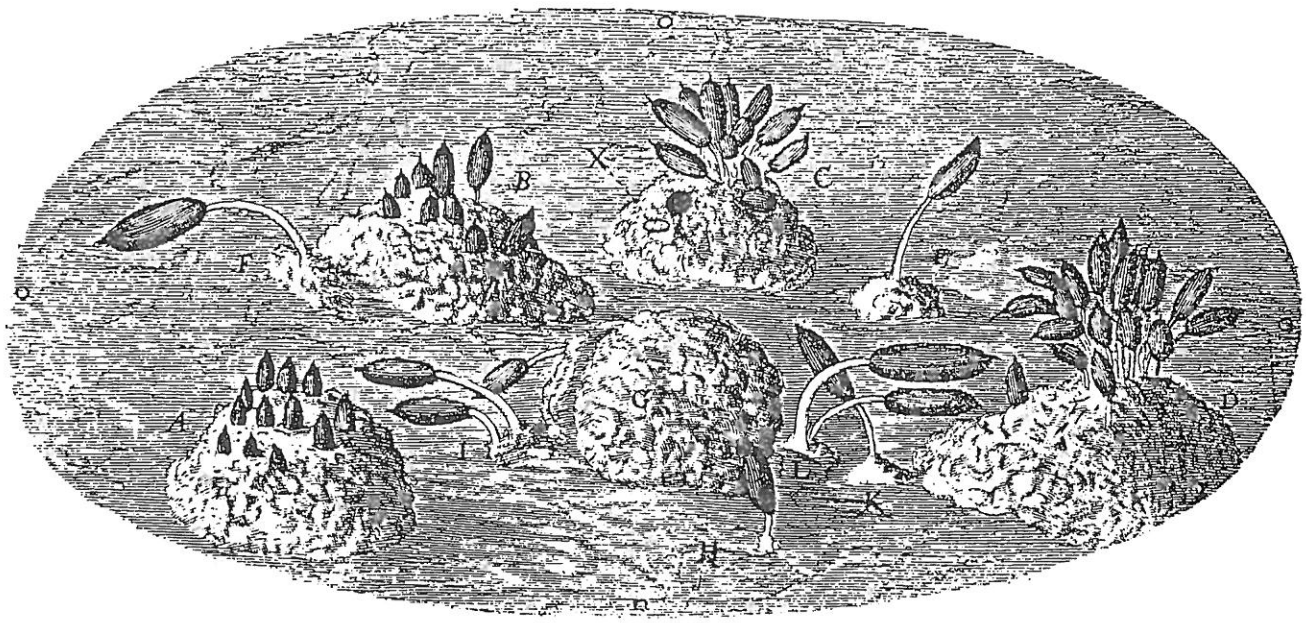


FIG. 2. Hooke's drawing of a "plant" growing in the leaves of damask rose, 1665. (Teliospores of a species of rust fungus, genus Phragmidium, very probably *P. tuberculatum*, on a leaf of *Rosa damascena*, a bluish-red flowered, very fragrant rose much grown in England in 1665).

His drawings and notes can be compared with those in the standard British book on rust fungi (Wilson and Henderson, 1966). The page reproduced below (Fig. 3) is of the commonest rust on cultivated roses in England today, *Phragmidium tuberculatum*. There is now a wealth of detailed information about this (and many other) rusts and we are still acquiring more (see left hand side of page 166 from Wilson and Henderson). The language used to describe a rust fungus is now specialized and technical and descriptions are often telegraphic in style. It is also immediately obvious from the page of information about *Phragmidium tuberculatum* that the fungus produces several different types of spore other than of the kind seen by Hooke.

There are still arguments about what to call these spores but the most widely accepted ones, (Hawksworth *et al.*, 1983) devised by Japanese workers (Y. Hiratsuka and Sato, 1982), are: teliospores borne on sori called telia (for example the spores drawn of Phragmidium by Hooke, and the large spores illustrated in the page from Wilson and Henderson and in our scanning electron micrographs); basidiospores produced on a basidium; spermatia borne in spermagonia; aeciospores borne in aecia; and urediospores borne in uredinia. In many books and papers, the terms teleutospores in teleutosori, aecidiospores in aecidia and uredospores in uredosori are used. Roman numerals are often used to denote the spore producing structures:

0 spermogonium, plural spermogonia.
I aecium, plural aecia.
II uredinium, plural uredinia.
III telium, plural telia.
IV basidium, plural basidia.

This atlas contains pictures taken using the scanning electron microscope of aecia and aeciospores, uredinia and urediniospores, and telia and teliospores only. This is because, whilst recent studies have shown that the morphology of the small spermagonia has uses in separating rusts into groups of families, the spermatia have no diagnostic value at the species level. More research may reveal differences between spermatia. Likewise basidiospores have not yet been studied sufficiently in the rusts to enable us to use them in identifying rust species (Cummins and Hiratsuka, 1983).

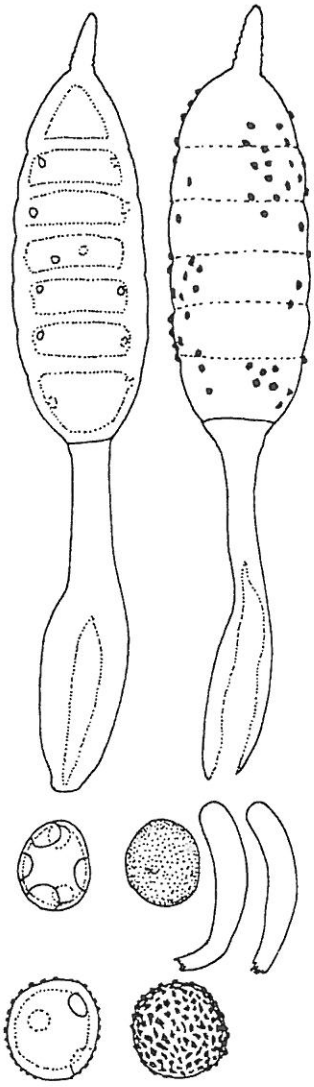
What *are* these strangely-named spores and spore-bearing structures? We need to discuss them all (O, I, II, III and IV), notwithstanding the fact that only three of them: I (aecia): II (uredinia) and III (telia) are shown in this Atlas. The fore-going tale of the telia of rose-rust, in the genus Phragmidium has already revealed the long period of slow progress towards present-day knowledge of rust fungi. What we now outline is the product of many workers over the last 400 years and especially in the last 100 years. Readers needing to delve into the past will find excellent historical accounts in Large (1940) and Ainsworth (1976), especially of *Puccinia graminis,* the cause of black stem rust of wheat. Perhaps we should start at the beginning.

Phragmidium tuberculatum J. Müller

Ber. D. Bot. Ges. 3, 391 (1885); Grove, Brit. Rust Fungi, p. 388; Gäumann, Rostpilze, p. 1188.

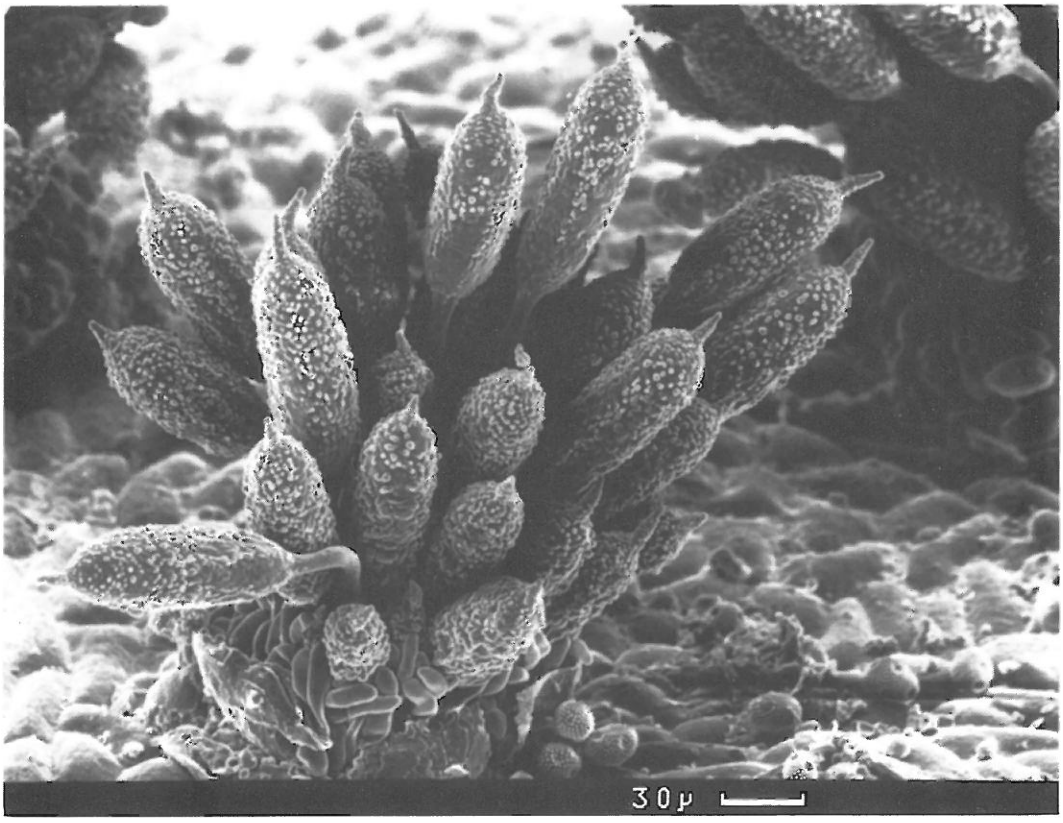
Spermogonia epiphyllous in minute groups, honey-coloured, 90–100 μ diam., 20–40 μ high; spermatia ovoid, 2·5–3·3 × 1·6 μ. Aecidia on branches, petioles and nerves of the leaves in elongate pustules, on the leaves in smaller, rounded pustules, surrounded by clavate, hyaline paraphases; aecidiospores globoid, subgloboid or ellipsoid, densely verrucose, hyaline, 20–30 × 18–24 μ, wall rather thick with 6–8 scattered pores 4·5 μ diam. with membranes apparently hemispheric in optical section. Uredosori hypophyllous, scattered or in groups, very small, pale yellow, surrounded by inwardly curved, clavate paraphyses, up to 60 μ long and 6–18 μ wide, uredospores globoid, subgloboid, ellipsoid or ovoid, verrucose-echinulate, yellow, 20–25 × 16–24 μ, wall 1·5 μ thick with 6–8 scattered pores, 4·5 μ, pore membrane in optical section hemispheric, intruding into the lumen of the spore. Teleutosori hypophyllous, scattered or in groups, small, black; teleutospores ellipsoid-oblong to cylindroid, 4–6-celled, not constricted at the septa, base rounded, the uppermost cell longer than the rest, with a pale or hyaline apical papilla up to 22 μ long abruptly passing into the apical spore membrane, verrucose, chestnut-brown, 55–110 × 30–36 μ, wall 6–7 μ thick with 2–3 pores in each cell; pedicel hyaline, persistent, equal to the spore, base enlarged up to 30 μ diam. Auteu-form.

Spermogonia, aecidia, uredospores and teleutospores on *Rosa rubiginosa*, *R. rugosa* and various undetermined cultivars. Probably common, but not hitherto adequately differentiated.



P. tuberculatum. Teleutospores, aecidiospores, uredo-paraphyses and uredospores.

FIG. 3. A page reproduced from Wilson and Henderson's classic book on British rust fungi, showing the teliospores, aeciospores and urediniospores of *Phragmidium tuberculatum* and containing a detailed description of the spores of this fungus as seen by light microscopy. (Reproduced with permission from Cambridge University Press).



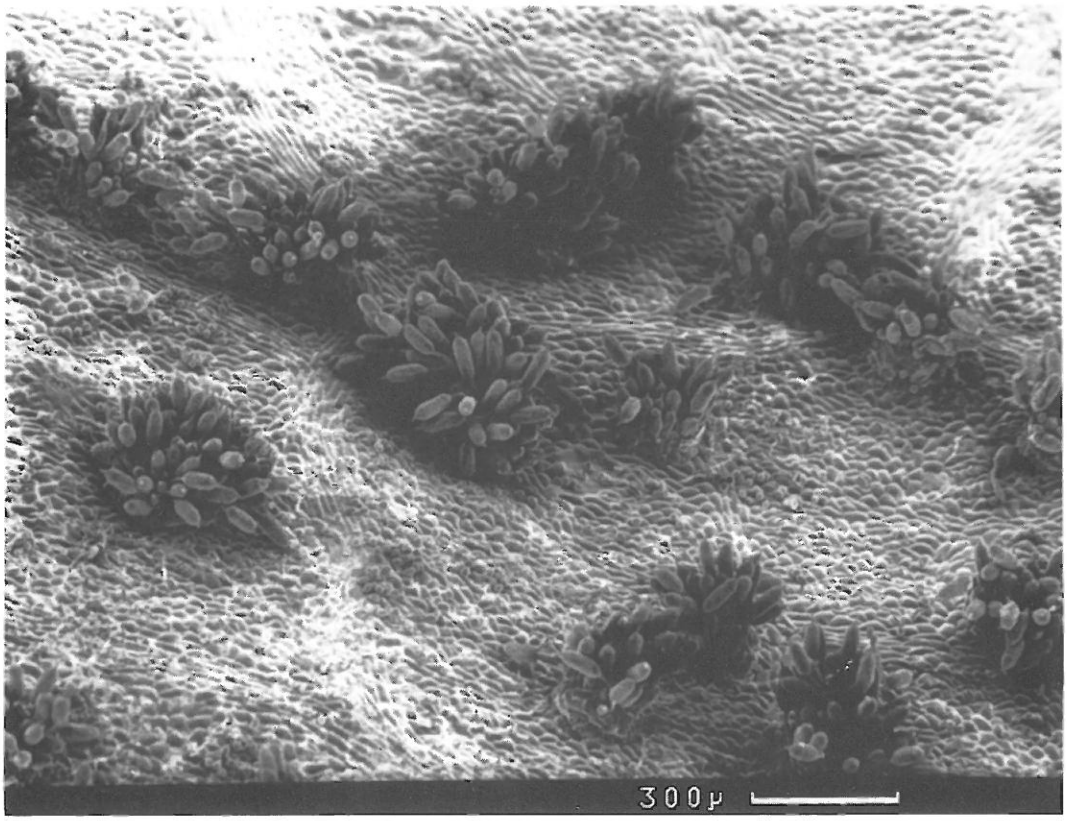


FIG. 4. Surface features of telia and teliospores of the rust *Phragmidium tuberculatum* (Atlas Species 35) on a hybrid tea rose, cultivar "Queen Elizabeth" growing in the Yorkshire garden of one of the authors (A.J.H.) in the summer of 1988.

"septa") contain two haploid nuclei lying close to one another. These two nuclei are genetically different and remain unfused for most of the life of the fungus. The protoplasms of different parents in fungi fuse easily (plasmogamy) but nuclear fusion (karyogamy) is a rarer event as in rust fungi. Crude and inaccurate though it may be, it is useful to think of the paired nuclei which arise by plasmogamy to be as it were "anticipating" sexual fusion of nuclei "karyogamy" for most of the time in the life of a fungus. This notion assists in the understanding of rust fungi. These typical pairs of genetically different nuclei in hyphae are called dicaryons (two "nuts") and the process by which they arrive at this paired position as "dicaryotization". Mycologists are all satisfied that rusts, organisms which have all the characters of fungi, are part of a huge group of fungi known as Basidiomycetes. The -mycete ending to words signifies "fungal".

Basidiomycetes are characterized by possessing at some stage in their life history a structure called a basidium. A basidium is a specialized part of the mycelium of fungus, cut off by a septum and in the development of which karyogamy of a dicaryon momentarily occurs followed by the immediate production of four haploid nuclei. Typically, at the outer end of the basidium, four tips emerge. These tips enlarge and oval structures (spores) form on the end of the basidium. These "basidiospores" have one haploid ("n") nucleus. There are variations on this story, but such is a typical basidium of a basidiomycete. A mushroom (such as *Agaricus bisporus,* the mushroom of commerce in Britain) has gills under the cap covered with millions of basidia producing basidiospores at their tips as the mushroom "ripens". Mushrooms, toadstools, bracket fungi, coral fungi, puffballs, earthstars, stinkhorns and birds-nest fungi, are all bodies ("basidiocarps") packed with the basidia and basidiospores of a basidiomycete fungus.

Looking at rust fungi in more detail, the visible "rust" on rust-infected plants is a large number of microscopically small pieces or "spores" of the rust fungus in the process of becoming detached from the body of the fungus. These pieces of the fungus, commonly round, egg-shaped or cylindrical, are what are known as fungal spores. ("Spore" is derived from Greek meaning a seed). Spores are the means by which a fungus propagates itself vegetatively, hence aecio-*spores* and uredinio-*spores* in rust fungi. The spores of rust fungi (as Hooke saw in 1665!) are them-

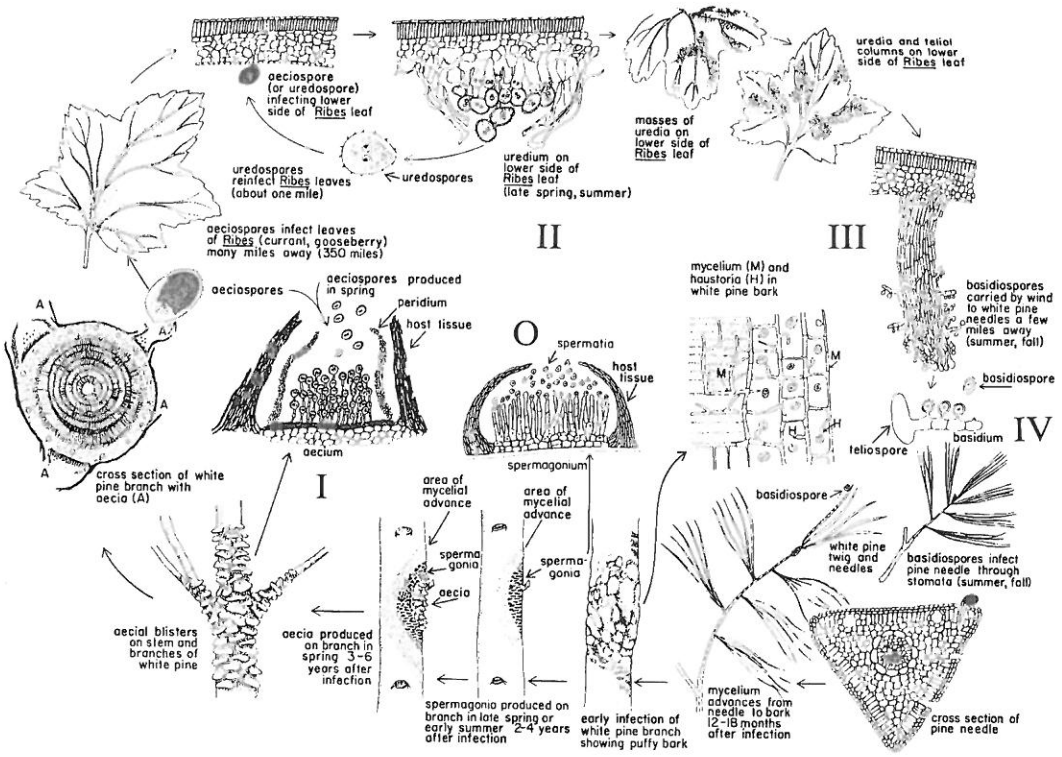


FIG. 5. Disease cycle of white pine blister rust caused by *Cronartium ribicola* (Atlas species 2A) from Agrios (1978). The O (Spermogonium) and I (aecium) stages are on Pinus stems and branches. The II stage (uredinia) and the telia, III, are on the leaves of Ribes. A long mass of teliospores (a "horn") develops on the telium, and the basidia, IV, develop on the telial column and produce their basidiospores there. An unusual feature is that the basidiospores germinate on the pine needles and the O and I stages are seen 2-4 years later. (Reproduced with permission from Academic Press).

selves living things of great beauty – a beauty confirmed by perusal of the pages of this Atlas. Sometimes spores are divided within by partition walls, called as in the fungal mycelium, "septa". The mycelium is the main "working part" of fungi. The spores of rusts are borne on this mycelium. The spores are visible to the naked eye only *en masse*, and because they are commonly "rusty" in appearance.

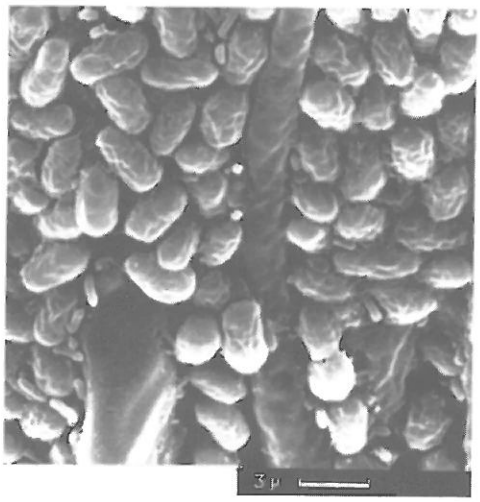
Most fungi are saprophytes living on decaying plants and animals. Rust fungi are "biotrophic" organisms – parasites dependent on green living plants for their nutrients and existence. Most people are aware of the complexity of living things as well as their physical beauty. It seems likely that, *amongst all living things*, the rust fungi present to us

the most complex known series of events in their life cycles and nuclear arrangements (Petersen, 1974).

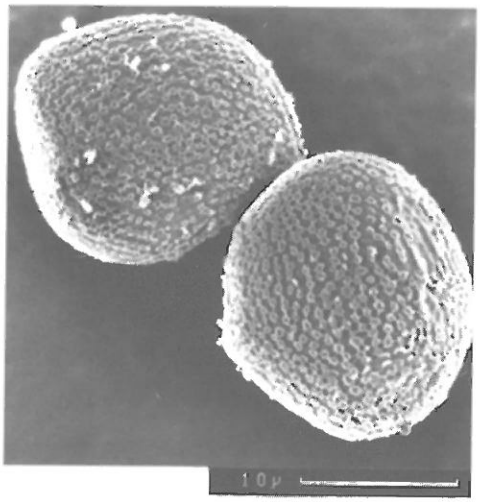
As has been made clear, rust fungi are not plants. Rust fungi are genetically very different from their hosts. A rust fungus may have part of its life cycle on two kinds of plants, again very different from each other. Figure 5 reproduced from Agrios (1978) shows the life cycle of white pine blister rust, caused by *Cronartium ribicola* (Atlas Species 2A). The two host plants of this rust are five-needled pines (Pinus species) and currants (Ribes species). In the case of black stem rust of cereals caused by *Puccinia graminis* (Atlas Species 75) the two host plants are *Berberis vulgaris,* the barberry, and grasses (including the wheat plant, *Triticum vulgare*). Other rusts may live on one plant only (e.g. *Phragmidium tuberculatum,* Atlas Species 35 on roses). If there are two different host plants, stages O and I (spermogonia and aecia) are borne on one plant and II and III (uredinia and telia) on the other. In many rusts, one or other of these stages is "missing", or not yet discovered. The outline below (Fig. 6) is hopefully a clarification of the stages O to IV in rusts and will prevent this part of the Atlas becoming unduly long and tedious. The most recently elucidated stage is that of the spermatia bringing together two genetically different haploid nuclei which persist as the "dicaryophase" until transitory nuclear fusion occurs in the teliopore. Dicaryotization (e.g. rusts on many flowering plants) may take days or sometimes years to develop (rusts on pines – see the life cycle, for example, of *Cronartium ribicola*).

The literature on rust fungi is enormous. Plant pathologists – the plant equivalent of doctors dealing with human diseases, and whose job it is to know, understand and control plant diseases such as plant rust diseases – have many books to help them.

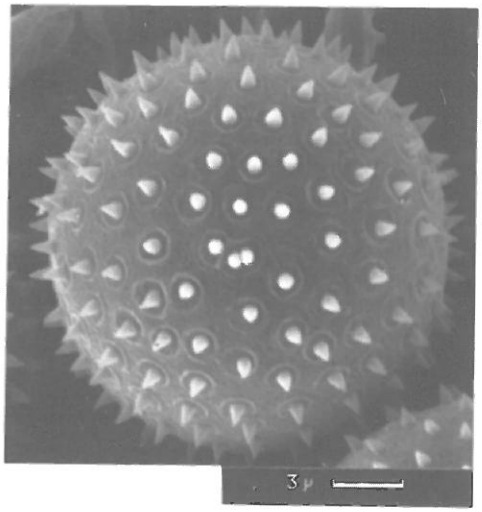
Cereals are large-seeded grasses bred by man. Grasses are the most important of all plants to mankind. Drawings and descriptions of the rust fungi of grasses, cereals and bamboos were put together by Cummins (1971). (Cummins, who assisted J.C. Arthur in his all-embracing book "Manual of the Rusts of the United States and Canada" which covered the North American rusts on all plants known up to 1934, was, as he says in the Preface to his book, personally influenced and inspired by Arthur as far as rusts were concerned). So important are the cereal rusts to our very survival that there are, for



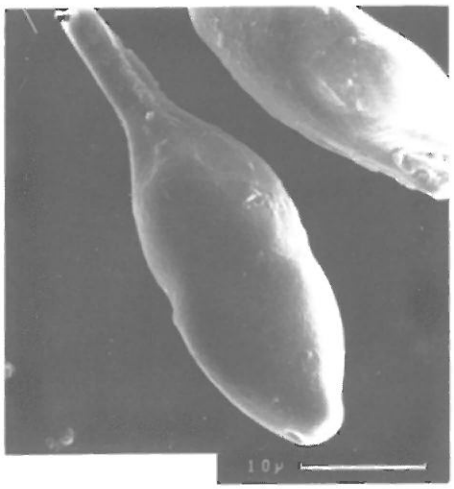
(i) Many spermatia, borne on a [O] Spermogonium. Each is a monocaryotic gamete with a haploid nucleus (with the "n" number of chromosomes); brings about pairing, but not fusion, of different haploid nuclei in the aecial initials – "dicaryotization"; not illustrated for each species in this Atlas. A spermatium resembles a bacterium in size.



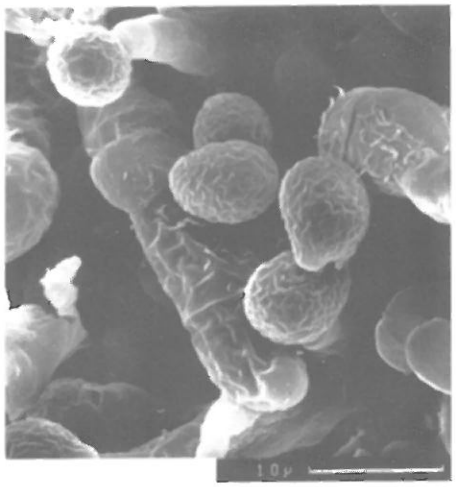
(ii) Two Aeciospores, borne on an Aecium [I], is associated with spermagonia. Contains 2 different haploid nuclei. ("n" + "n"). [A] in this Atlas. Aeciospores may sometimes resemble urediniospores in appearance. (If the rust has 2 host plants, O and I are borne on one host plant and II, III, IV on the other one.)



(iii) A Urediniospore, borne on a Uredinium [II]. A "repeating" spore (urediniospores infect leaves, etc. and produce more uredinia and urediniospores). "n + n" as are aeciospores. [U] in this Atlas.



(iv) A Teliospore. Teliospores produce basidia which bear basidiospores. During the life of a teliospore, the two nuclei of the dicaryon fuse transitorily to give a diploid "2n" nucleus. This divides meiotically to give "n" nuclei in the basidiospores. Teliospores are 1 to several celled and are borne on Telia [T] in this Atlas. Teliospores are often "resting" structures, surviving adverse weather conditions and producing basidia and basidiospores when the new season's green host tissue becomes available again.



(v, vi) Basidiospores. Borne on Basidia nucleus "n"; gives rise to a spermogonium after the basidiospore has infected a leaf, etc. In some rusts the basidia and basidiospores develop on the teliospores without a "resting" period; not illustrated for each species in this Atlas; the characteristic spore of basidiomycete fungi.

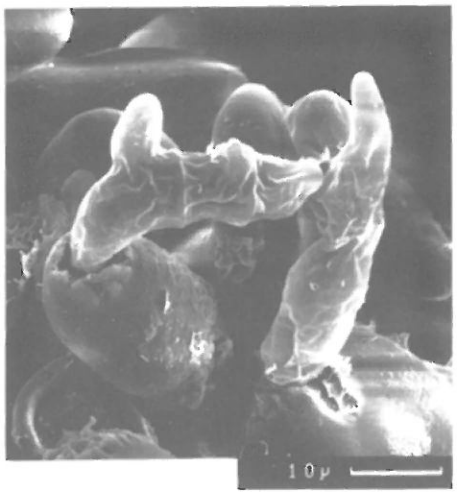


FIG. 6. Outline of the parts played by the five kinds of spores produced by a "full-cycled" rust on the five kinds of spore-producing structures (O, I, II, III and IV) in a rust life-cycle.
(i) Spermatia of *Puccinia punctiformis* (Atlas Species 103); (ii) Aeciospores of *Puccinia chaerophylli* (Atlas Species 58); (iii) Urediniospore of *Puccinia sessilis* (Atlas Species 107); (iv) Teliospores of *Puccinia glechomatis* (Atlas Species 73); (v) and (vi) Basidiospores of *Puccinia malvacearum* (Atlas Species 88) borne on basidia emerging from teliospores.

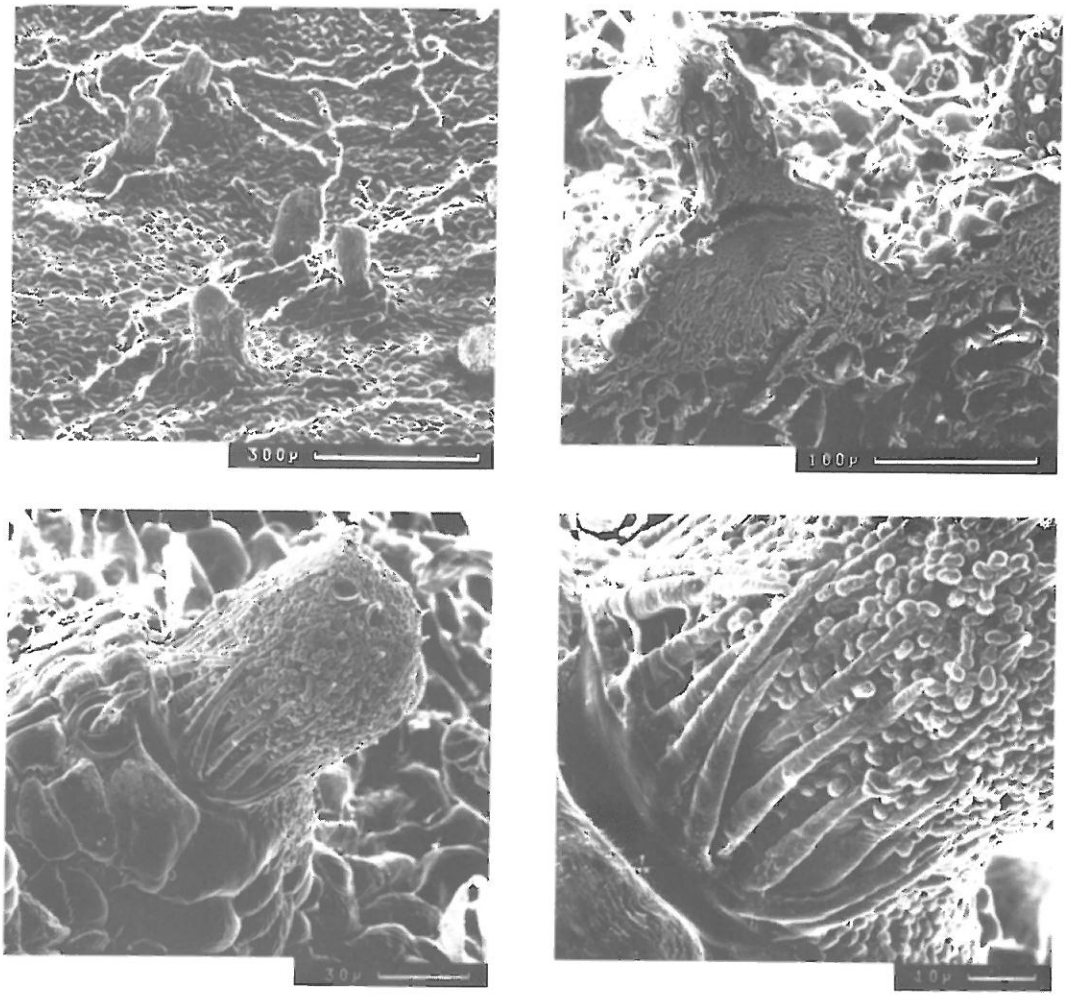


FIG. 7. Four views of the spermagonia [O] of *Puccinia punctiformis* (Atlas Species 103) on a thistle (*Cirsium arvense*) leaf from a plant growing in the centre of Leeds, Yorkshire, March 1989.

example, two recent whole volumes (Bushnell and Roelfs, 1984) on their origins, specificity, structure and physiology, as well as accounts of individual rust diseases. The important rust diseases of cereals in the world are probably *Puccinia graminis* (Atlas Species 75) *Puccinia coronata* (Atlas Species 64), *Puccinia recondita* (Atlas Species 105); *Puccinia hordei* (Atlas Species 78), *Puccinia striiformis* (Atlas Species 110A) and *Puccinia sorghi* (Atlas Species 109).

Forestry The various rust diseases important to foresters in Britain are dealt with, from a very practical viewpoint, in Phillips and Burdekin (1982) which also covers diseases of trees caused by other fungi. Of the tree rusts, *Cronartium ribicola* is perhaps the most serious (Atlas Species 2A) as it has halted the planting of the valuable Weymouth pine (*Pinus strobus*). In the USA, this rust, introduced from Europe, has caused enormous losses in the native 5-needled pines. Large sums have been spent on attempts to control it by eradication of the aecial host (Ribes). (See the life cycle on page 8). Almost all the rusts of forest trees discussed by Phillips and Burdekin are illustrated in this SEM *Atlas*.

Distribution Rusts are found in every part of the world. Hawksworth *et al.* (1983) give "rounded" figures suggesting there are perhaps over 100 genera of rusts on earth, and perhaps 6000 species. Many rusts and stages in the life-history of known rusts are probably still not yet discovered. There may be 3000 species in the genus Puccinia and 600 in Uromyces. There are 200 or so British species of which 164 are illustrated, (many for the first time), in this introductory SEM Atlas. Cummins and Hiratsuka (1983) in their Illustrated Genera of Rust Fungi give descriptions and line drawings of the important stages in 105 genera, covering the world rust flora. To enable the user to refer to *generic* characteristics not given in the captions to the SEM plates of rust *species* in this Atlas, the genus numbers of Cummins and Hiratsuka are tabulated below alongside the Atlas Species numbers (Table II).

In a remarkable attempt to describe, for practical use, the important diseases of plants in Europe as a whole, the Director General of the European and Mediterranean Plant Protection Organisation, Dr I.M. Smith, and others (Smith *et al.*, 1987) list the rust diseases they consider may be important in Europe as a whole. Fifty of these "European" rusts out of a total of 61, are illustrated in this Atlas. As we have indicated in our preface, it is our hope that this introductory Atlas may stimulate others to fill the gaps and do more SEM studies.

TABLE II. *Alphabetical list of the 25 genera of rusts illustrated in this Atlas, showing where more detail can be found in Cummins and Hiratsuka (1983)*, Illustrated Genera of Rust Fungi (CH).

Genera	*Atlas species*	*CH Genus*
Chrysomyxa	1	21
Coleosporium	2	12
Cronartium	2A	30
Cumminsiella	3	71
Endophyllum	4	63E
Frommea	5 (as Frommeella)	83
Gymnosporangium	6,7,8,9,	59
Hyalopsora	11	3
Kuehneola	12	81
Melampsora	13, 14, 15, 16, 17, 18, 19, 19A, 20, 21, 22A	7
Melampsorella	23, 24	5
Melampsoridium	25	6
Milesina	26, 27, 27A	2
Miyagia	28	62
Ochropsora	29	14
Phragmidium	30, 31, 32, 33, 34, 35, 36	85
Puccinia	37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 50A, 50B, 51, 52, 53, 54, 55, 56, 57, 57A, 57B, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 77A, 77B, 78, 78A, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 92A, 93, 94, 95, 97, 98, 98A, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 110A, 110B, 111, 112, 113, 114, 115	63
Pucciniastrum	116, 117, 118, 119, 120, 121, 122,	4
Trachyspora	123	77
Tranzschelia	124, 125, 126	69
Triphragmium	127, 128	101
Uredinopsis	129	1
Uredo	130	(not recognised by CH)
Uromyces	131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147,148, 149, 150, 151, 152, 153, 154, 155	55
Xenodocus	156	84

Imaging techniques Prior to the introduction of the SEM for general use in the mid-1960s, progress was made by studying dry mounted spores using the Transmission Electron Microscope (TEM), producing a black silhouette. For example, Mielke and Cochran (1952) were able to present clear differences and similarities between the surface warts of the aeciospores of three species of Cronartium rusts by this method. The interest of one of us (T.F.P.) in the microscopic ecology of leaf surfaces (Preece and Dickinson, 1971) led to what was probably the first use of the SEM (Littlefield, 1974) to examine the spores of plant pathogenic fungi and fungus infected clover leaves by G. Barnes when he was a research student at Leeds in 1965 (Barnes and Neve, 1968). Slowly this led (with much field collecting of rusts in Yorkshire) to this SEM Atlas. The SEM has thus been used by biologists to examine fungal spores including rusts for 25 years. Very important studies have been made by Beckett and associates at Bristol University, using low temperature scanning electron microscopy. They have produced quite outstanding SEM pictures (e.g. Woods and Beckett, 1987). For *fresh material,* the method has great advantages, including rapid specimen preparation, no use of chemicals possibly causing distortion and no shrinkage due to dehydration. Disadvantages are that fresh specimens can be examined only once whilst frozen, it is unsuitable for long-dried herbarium specimens, and the equipment is very costly. The future value of this work by Beckett should not be underestimated. One important part of that paper is the emphasis on possible size-changes of spores in the SEM.

Originally pointed out to us as a problem by Dr Kevin Swindin (personal communication), the "actual size" question is difficult to assess on SEM pictures of herbarium material. It can be clearly stated only that the magnifications shown on our pictures must be regarded as approximately correct, and at least all the material has been processed in exactly the same way!

We have experimented with objects and graticules of accurately measured size in our (Camscan) SEM, and the largest error detected was of the order of 4 per cent of the actual size, as distinct from that shown on the photographs by means of the scale printed with it. However, this question of probable errors in magnification needs much further study – one difficult aspect is that several workers have shown that the water content (and apparent size) of rust spores varies with

the particular environmental conditions in which they (and their host plants) were grown. Thus there will be differences (due to *water content*) to be considered in addition to errors produced by our SEM *processing* and that inherent in the SEM "magnification" as shown by the instrument.

Nomenclature There are difficulties, too, connected with the nomenclature of what can be seen in these SEM pictures – the warts, spines and surface features.

"Verrucose" versus "Echinulate" and other problems To understate the problem, the light microscope descriptions of the surface ornamentation of rust spores are (often) difficult to understand. It seems most likely that the difficulties of seeing surface ornamentation at all using the light microscope has led to these difficulties. It might have been better if the terms *spines* (for echinulations) and the straight English *warts* (for verrucas) had been used all along! We have chosen to put the terms used by Wilson and Henderson (1966) and Ellis and Ellis (1985) in plate captions and let the plates speak for themselves. There is a whole host of research problems here. Probably only very detailed work, on each rust, such as the beautiful SEM pictures of the urediniospores of *Uromyces appendiculatus* (Atlas Species 135) in the detailed thesis by Hardwick (1969) will solve this kind of problem. Cummins and Hiratsuka (1983) give drawings and a list of surface sculpture types on rust spores, but there is as yet no general agreement on nomenclature. Urediniospores are commonly echinulate, and the surfaces of aeciospores considered to be verrucose or verruculose. (See captions to SEM plates and the actual photographs in this Atlas). Similar difficulties arise with the descriptions of pollen grain surfaces. With pollen grains, the terminology for ornamentations has stabilized (with imperfections!) and is now so complex as to be difficult to follow, so we must not expect *too* much as regards rust spores! A recent readable book on pollen grains and their surface ornamentation with 302 SEM pictures is Iwanami, Sasakuma and Yamada (1988).

Other illustrated sources There are relatively few SEM pictures of rust spores, very scattered in the world rust literature. Very few of them are useful for identification purposes. Many are superbly excuted, but

illustrate only one or the other of the aecial (A), urediniospore (U) and teliospore (T) stages. Many are concerned for example with the process of infection and biology. As far as we are aware there exists no collection of SEM plates as contained in this Atlas, which takes the first faltering steps towards a systematic treatment for use in identification, adding to the drawings of spore stages already available and an up-to-date floristic list (1985 in this case) of rusts in a specific geographical area.

Littlefield and Heath (1979) succinctly review rust ultrastructural work generally including SEM, to that date, much of it transmission electron microscopy (TEM). They illustrate *some* of the A, U and T stages of Atlas species 2A, 8, 19, 32, 64, 75, 95, 105, 116 and 123. Other beautiful plates presented there of another 23 species including species in 8 genera (Aecidium, Dasyspora, Diabole, Hemiliea, Nyssopsora, Pileolaria, Prospodium and Ravenelia) not found in Britain. It must again be emphasized that the object of Littlefield and Heath was to present pictures leading to understanding of ultrastructure in rust fungi, not *identification*, and thus only some spore stages of rusts are presented. The general morphology and taxonomy of rust fungi are also reviewed, with some SEM plates of the A, U and T stages of a very few species of rusts in Hiratsuka and Sato (1982) which also presents the spermagonia types mentioned earlier and a useful overview of the whole rust taxonomic scene, expanding greatly on the account given in this Atlas. These authors have SEM plates of *some* spore stages of Atlas species 64, 75, 126, 128, 150 and 156.

Several difficult decisions had to be made about the production of this book. These included

(i) *Comprehensiveness*: whilst Yorkshire rusts certainly provide a good introductory collection of these fungi, it may have been preferable to attempt to cover all British rusts, of which the usually cited list is that of Wilson and Bisby (1954) which lists some 271 rusts, a number of which (13?) may be forms or varieties of species. We can only say that, though the Yorkshire rust flora (164 species) may appear geographically parochial, mycologically it is very important and well-studied compared with many other parts of Britain and the world. Futhermore, a complete revision of Wilson and Henderson's classic "British Rust Fungi" (1966) is a major task for several full-time workers if it is to contain SEM pictures and light microscope pictures, as well as a

completely revised text. The introductory Atlas presented here has been an enjoyable and rewarding task done in spite of, not because of, other professional commitments. It seemed to us (time-limited!) that the provision of SEMs of a large proportion of British rusts would be better than none being available at all!
(ii) *Magnification:* we originally prepared the plates at half a page of A4 each. If the book was not to be so costly as to be unavailable to field workers this had to be abandoned in favour of 4 plates to an A4 page. Little detail has been lost.
(iii) *Details*: (other than pictures of a sorus and few spores). There are omissions such as paraphyses (sterile hairs) and fungal *peridial cells* – a layer of fungal units often surrounding the sori. Again considerations of time and of space may have made the Atlas less desirable to some workers. *Germ pores* are not visible in SEM surface views of rust spores. We have had to compromise and suggest using the references – in particular Ellis and Ellis (1985) which is freely available; (Wilson and Henderson (1966) is out of print). The relatively few *Commonwealth Mycological Institute Descriptions* of (rust) fungi are of course models of what could be done with each species at some length, especially if SEM pictures are included in them, and they should be used whenever they exist (see captions to plates of each species).

Collection, selection and preparation of rusts (illustrated in this book) for scanning electron microscopy

The plates in this book are all from ordinary dried herbarium material. Some of the specimens were very old and extremely brittle. Usually a leaf was examined, and temporary preparations of spores made in IN NaOH. This restores "collapsed" spores and we find it preferable to the usual lactophenol for light microscope work with rust spores. Usually permanent preparations were made by simply mounting in Polyvinyl Alcohol Mountant (PVAM) as described by Omar *et al.* (1979) consisting of 1.66 polvinyl alcohol (Sigma Chemicals), 10ml distilled water, 10ml lactic acid and 1ml glycerol. Many of these permanent mounts are superb, 10 years and more after they were made. The surface ornamentation of spores, with which this Atlas is concerned, is often extremely difficult (in some cases impossible!) to see in either lactophenol, NaOH or PVAM preparations examined by

ordinary transmission light microscopy, unless the surface of the spores is viewed *dry*. (Quite often the ornamentation – spines, warts, ridges, etc. – is clear in an accidentally produced air bubble which has spores in it, and is quite invisible in the mountant). Users of this Atlas not having access to a scanning electron microscope should deposit a few spores on a small drop of liquid clear (transparent) nail varnish on a slide and examine the spores *on* the dry solidified varnish, in air, without a cover glass, and compare them with the SEM photograph.

Many of the very old leaf collections we examined had gone mouldy – almost certainly in the early stages of imperfect slow drying. The use of polythene bags also caused difficulty. Rust specimens should be rapidly pressed and dried, changing the paper often, and *never* put into plastic bags, if "moulds" are not to be troublesome. Insects, too, ravage field and herbarium collections. They are killed by a domestic "deep freeze" at minus 10°C. Other methods, such as the use of "mothballs" are undesirable, but are better than no attempt to control insects which eat the sori and spores of rusts.

Having selected portions of the specimen for scanning electron microscopy with the least mould contamination, and with sori, the contents of less than 1cm square were soaked in 5% KOH for 2 hours. This was then followed by two washes of distilled water, standing the pieces in the water for 30 minutes each time. The samples were then fixed with 1% osmium tetroxide overnight, followed by dehydration in an ascending dilution series of acetone (20-40-60-80-100%). Each dilution was used for 1 hour, and the material left in 100% pure acetone overnight. Specimens were then critically point dried in a Polaron E3000 critical point drying apparatus (Polaron Equipment Ltd., Greenhill Crescent, Watford Business Park, Watford, Herts, UK) using liquid carbon dioxide as the transition fluid. The square of leaf was then viewed and orientated using a stereo-microscope. Portions were then mounted on a 13mm diameter stub using either carbon cement, or double-sided adhesive tape depending on the nature and size of the specimen.

For preparations to show a few spores, the latter were teased from the leaf squares using the point of a scalpel and were allowed to fall onto the moist surface of pre-softened photographic film emulsion. The emulsion plus the spores was then stuck onto a stub, again using double-sided sticky tape.

All specimens were coated with a 50 nanometre film of gold in a Polaron E5300 freeze drier with sputtering attachment. These critical point dried, gold coated stubs were then observed and photographed in a Camscan 3-30BM scanning electron microscope (Cambridge Scanning Co. Ltd., Saxon Way, Bar Hill, Cambridge, CB3 85L UK). The images were produced using an accelerating voltage of between 2kV and 10 kV. All photographs were taken on Ilford HP5 120 roll film.

TABLE III. *Alphabetical list of the genera of plants on which the commoner rusts, illustrated in this Atlas, are found in Britain. [Name changes in Clapham, Tutin and Moore (1987) are included. The number given is the species number of this Atlas. This list excludes rarities and an array of doubts and difficulties. Consult W.H. and E.E..]*

Abies 23, 26, 27, 27A, 119
Achillea 62
Adoxa 38, 40
Aegopodium 39
Agrimonia 116
Agropyron (now Elymus) 64, 75, 105, 110A
Agrostis 64, 75, 105
Alchemilla 123
Allium 41, 107, 133
Alopecurus 64, 75, 105
Althaea 88
Ammophila 68, 104
Anchusa 105
Anemone 29, 124, 125
Angelica 42
Anthoxanthum 50B, 75
Anthriscus 58
Anthyllis 134
Antirrhinum 44
Apium 45
Aquilegia 105
Arctium 53
Arenaria 46
Armeria 136
Arrhenatherum 50, 50B, 75
Artemisia 110B
Arum 107
Asplenium (includes Phyllitis) 27A
Aster 62, 67
Astragalus, 149
Avena 64, 75
Avenula (formerly Helictotrichon) 75, 99

Bellis 82, 92
Berberis 75
Beta 137
Betula 25
Blechnum 26
Brachypodium 50A, 110A
Briza 75
Bromus 75, 105, 110A
Bunium 51
Buxus 52

Calamagrostis 64, 104
Calamintha 89
Calendula 2, 82
Caltha 54, 55
Campanula 2, 56
Carduus 53
Carex 57, 57A, 57B, 67
Carlina 53
Centaurea 53, 77
Cerastium 23
Chaerophyllum 58
Chamaenerion 119
Chrysanthemum 78A, 110B
Chrysosplenium 59
Circaea 60, 118
Cirsium 53, 61, 62, 103
Clinopodium 89
Colchicum 138
Conium 63
Conopodium 49, 111
Crataegus 6, 7
Crepis 65, 87
Cruciata 71 (see Galium)
Cystopteris 11

Dactylis 64, 75, 110, 139
Deschampsia 66, 75, 132
Dianthus 46, 140
Dryopteris 27

Elymus (formerly Agropyron, and for what was Elymus (68) see Leymus) 64, 68, 75, 105, 110, 110A
Empetrum 1
Endymion (now Hyacinthoides) 147
Epilobium 69, 101, 119
Euphorbia 17, 149
Euphrasia 2

Fallopia 98 (see Polygonum)
Festuca 64, 70, 75, 139
Filipendula 127, 128
Frangula 64
Fuchsia 119

Gagea 142
Galium 71, 72, 102, 120 *(Galium cruciata,* 71, is now *Cruciata laevipes)*
Genista 149
Geranium 98, 143
Glaux 146
Glechoma 73 (formerly Nepeta)
Glyceria 50B

Helictotrichon (now Avenula) 75, 99
Heracleum 76
Hieracium 77, 77B
Holcus 64, 105
Hordeum 75, 78, 110A
Hyacinthoides (formerly Endymion) 147
Hydrocotyle 79
Hypericum 18
Hypochoeris 77A

Postscript

Some readers of this Atlas may ask why it is rust spores have this beautiful ornamentation? Why have they got spines and warts? What are they, exactly? Do they do anything for rusts? These questions cry out for study. Perhaps only Savile (1954) has written anything on this, and probably only mechanical, essentially physical, studies accompanied by use and extension of existing biological knowledge, will lead to answers. The material of which the spines of rust urediniospores are made is not known. There seems to be evidence of fibrils within them. They originate (in very crude analogy) like human teeth. They arise inside the urediniospore wall, and grow up through it and out of it as a sharp projection. The outermost layer of the wall remains thinly intact. As the spine grows the spore wall itself thickens, so that the spine appears to be a surface structure. In aeciospores the origin of warts is somewhat similar, but the ornamentation is electron-lucent and maybe different in nature from that of urediniospores. The detailed origins of teliospore spines and warts (where these occur) have not been investigated to the same extent as urediniospores. (See, for example, Littlefield and Heath, 1979).

Some have suggested the spines aid buoyancy in the air (Hardwick, 1969); that they assist in adhesion to surfaces; that they aid in dispersal by pushing the spores apart in development; that they protect the spores against insects, and so on. All these hypotheses need experimental testing. The possibility of the involvement of the ornamentation in "recognition" phenomena – enabling the "right" rust to recognise the "right" host plant needs study. Anatomical studies (as have been done with pollen grains) relating the pattern of the ornamentation to the pattern of host cells in some way seems one approach. The lovely SEM plates of surfaces of stigmas and pollen (Lewis, 1979) are very suggestive of a line of investigation. The authors of this Atlas hope that readers will be stimulated to try to answer these questions. Even gene transfer – information passing from fungus to plant – might be seriously considered (Pirozynski, 1988)!

Perhaps a quote from the abstract of Wilson and Bisby's list of British rusts (1954) is the best note on which to end this postscript: "There is still much work to be done on the rusts of the British Isles".

LIST OF PLATES

An alphabetically arranged list of the 164 British Rust Species and varieties of species illustrated in this Atlas, all of which occur or have occurred in Yorkshire, U.K.

In italics, also alphabetically listed, are the names of 34 rust species which have perhaps been recorded once in Britain, of 51 rust species which are rare or very scarce here and 6 others of which specimens were not available. None of these species occurs in Yorkshire.

Rust Species	*Atlas Species*	*Page(s)*
Puccinia malvacearum	88	138
Puccinia menthae	89	139, 140
Puccinia microsora		
Puccinia moliniae	90	140, 141
Puccinia nemoralis		
Puccinia nitida	91	141, 142
Puccinia obscura	92	143, 144
Puccinia oxalidis	92A	144, 145
Puccinia opizii		
Puccinia oxyriae		
Puccinia pazschkei var. pazschkei		
Puccinia pazschkei var. jueliana		
Puccinia pelargonii-zonalis	93	145, 146
Puccinia phragmitis	94	146, 147
Puccinia physospermi		
Puccinia pimpinellae	95	148, 149
Puccinia poarum	97	149, 150
Puccinia polemonii		
Puccinia polygoni-amphibii var. convolvuli	98	151, 152
Puccinia polygoni-amphibii var. polygoni-amphibii	98A	152, 153
Puccinia pratensis	99	153
Puccinia primulae	100	154, 155
Puccinia prostii		
Puccinia pulverulenta	101	155, 156
Puccinia punctata	102	157, 158
Puccinia punctiformis	103	158, 159
Puccinia pygmaea	104	160
Puccinia recondita	105	161, 162
Puccinia ribis		
Puccinia rugulosa		
Puccinia saniculae	106	162, 163
Puccinia satyrii		
Puccinia saxifragae		
Puccinia schismi		
Puccinia schoeteri		
Puccinia scirpi		
Puccinia septentrionalis		
Puccinia sessilis	107	164, 165
Puccinia smyrnii	108	166
Puccinia soldanellae		
Puccinia sorghi	109	166, 167
Puccinia striiformis var. dactylidis	110	167, 168
Puccinia striiformis var. striiformis	110A	168, 169
Puccinia tanaceti	110B	169, 170
Puccinia thesii		
Puccinia thymi		
Puccinia tumida	111	170, 171
Puccinia umbilici		
Puccinia variabilis	112	171, 172
Puccinia veronicae	113	173
Puccinia vincae	114	173, 174
Puccinia violae	115	175, 176
Puccinia virgae-aureae		
Pucciniastrum agrimoniae	116	176
Pucciniastrum areolatum	117	177, 178
Pucciniastrum circaeae	118	178
Pucciniastrum epilobii	119	179
Pucciniastrum goeppertianum		
Pucciniastrum guttatum	120	180
Pucciniastrum pyrolae	121	180
Pucciniastrum vaccinii	122	181
Tranchyspora intrusa	123	181, 182
Tranzschelia anemones	124	182
Tranzschelia discolor	125	183, 184
Tranzschelia pruni-spinosae	126	184, 185
Triphragmium filipendulae	127	185, 186
Triphragmium ulmariae	128	186, 187
Uredinopsis americana		
Uredinopsis filicina	129	188
Uredo behnickiana	130	189
Uredo epidendri		
Uredo festucae		
Uredo goodyerae		
Uredo oncidii		
Uredo quercus		
Uromyces acetosae	131	190
Uromyces aecidiiformis		
Uromyces airae-flexuosae	132	191
Uromyces aloes		
Uromyces ambiguus	133	191, 192
Uromyces anthyllidis	134	192, 193
Uromyces appendiculatus	135	193, 194
Uromyces ari-triphylli		
Uromyces armeriae	136	195, 196
Uromyces behenis		
Uromyces betae	137	196, 197
Uromyces chenopodii		
Uromyces colchici	138	198
Uromyces croci		
Uromyces dactylidis	139	198, 199
Uromyces dianthi	140	200
Uromyces ervi		
Uromyces erythronii		
Uromyces eugentianae		
Uromyces fallens		
Uromyces ficariae	141	201

Notes to the Plates

The *numbers* assigned to species and varieties of rusts have no significance apart from cross-reference and order within this book.

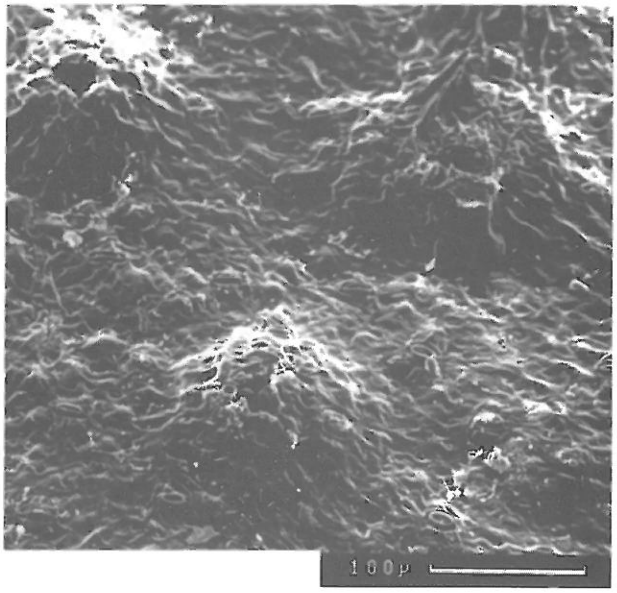
The *order* in which the species are arranged is, almost entirely, that given in Bramley, W.G. (1985) "A Fungus Flora of Yorkshire" published by the Yorkshire Naturalists Union, and has no intentional, taxonomic or speculative-phylogenetic significance.

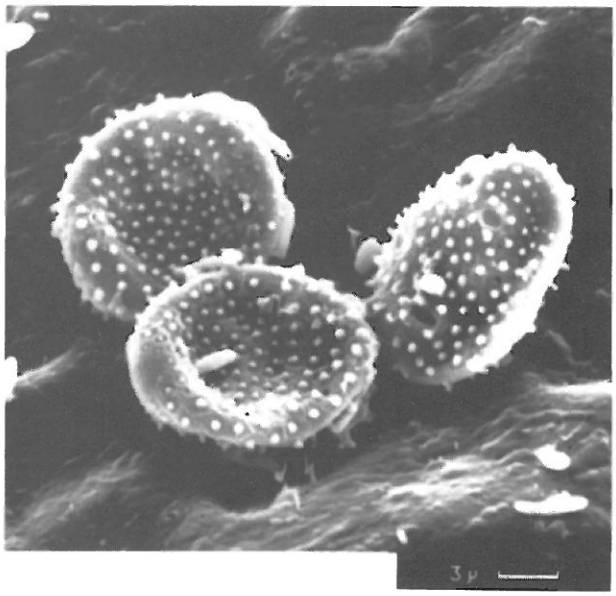
The *SEM pictures* are usually in pairs, one of a sorus on a leaf, and one of several detached spores. The magnification is shown beneath each picture. Where a telial stage is known, it is presented first, followed by the uredinial stage and then the aecial stage.

The *captions* use several abbreviations. B means the page number in Bramley (1985) where some further information may be found. A, U, and T mean those stages have been found in Yorkshire during the last 100 years. The square brackets thus: [A], [UT], indicate separate host plants. WH means Wilson, M. and Henderson, D.M. (1966) "British Rust Fungi" Cambridge University Press, with the Additions and Corrections thereto by Henderson, D.M. and Bennell, A.P. (1979) in "Notes from the Royal Botanic Garden" Edinburgh **37**(3), 475-502. EE means Ellis, M.B. and Ellis, J.P. (1985). "Microfungi on Land Plants" (an identification handbook) Croom Helm, London. CMID means Commonwealth Mycological Institute, Kew, Surrey, U.K. "Descriptions of Pathogenic Bacteria and Fungi".

PLATES

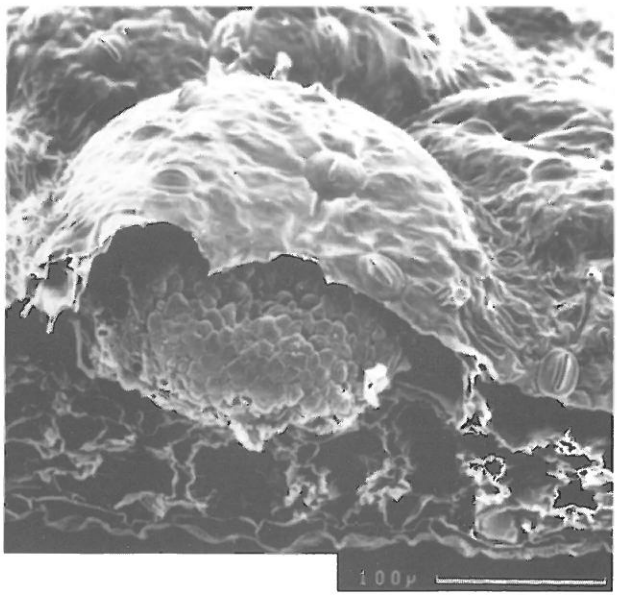
Species 1. *Chrysomyxa empetri*: uredinia and urediniospores.

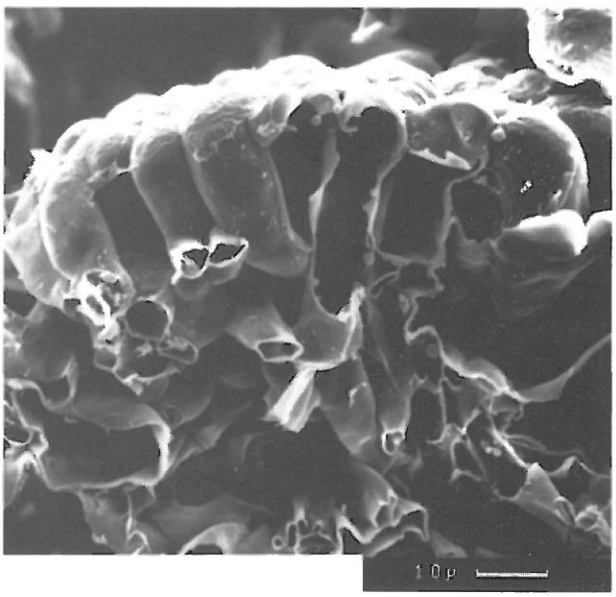




Yorks in B, 190, [U] on Empetrum spp. (T not in Britain).
Drawing of urediniospore in WH 60 and EE Fig. 513. Description EE 119.
Urediniospore surface: closely and coarsely verrucose (WH), closely verrucose to echinulate (EE).

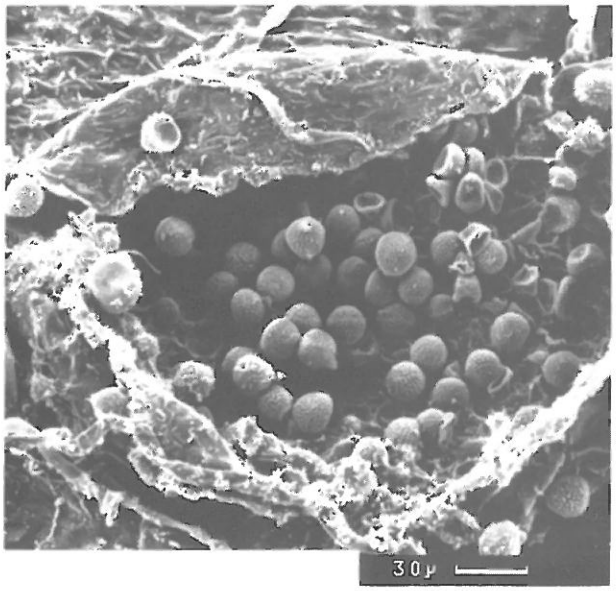
Species 2. *Coleosporium tussilaginis*: telia and teliospores.

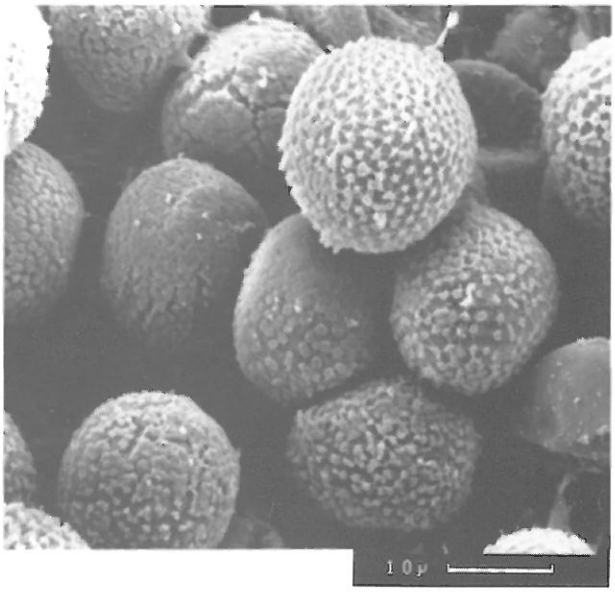




Yorks in B, 190. [A] e.g. on Pinus, [UT] on, e.g Senecio.
Drawings of U and T in WH 3. Descriptions of U and T in EE 440 and of in EE 169. Teliospore surface: smooth (WH, EE). The thin-sided teliospores develop as sub-epidermal waxy crusts which become exposed by weathering.

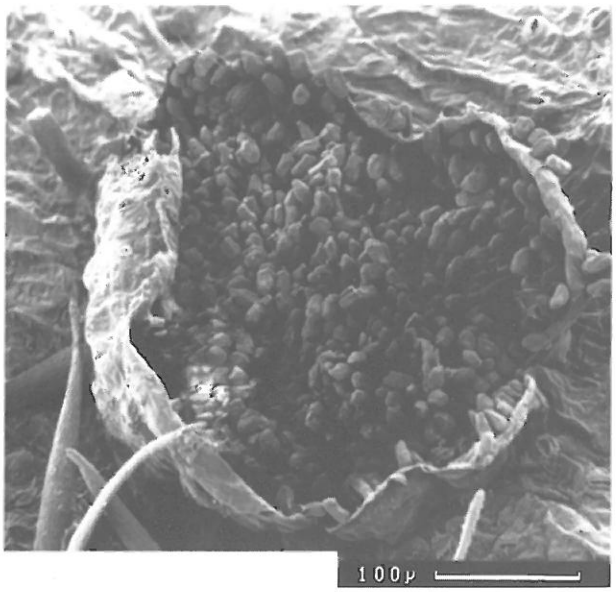
Species 2. *Coleosporium tussilaginis*: uredinia and urediniospores.

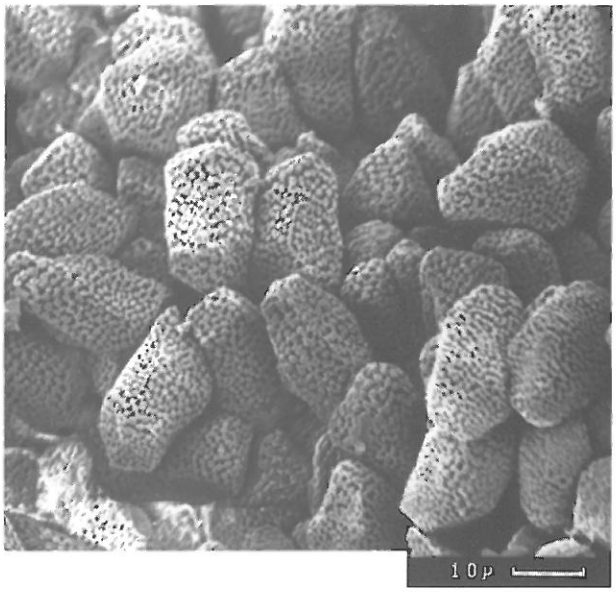




(See caption to photographs of telia and teliospores). Urediniospore surface: densely and finely verrucose (WH), densely verruculose (EE).

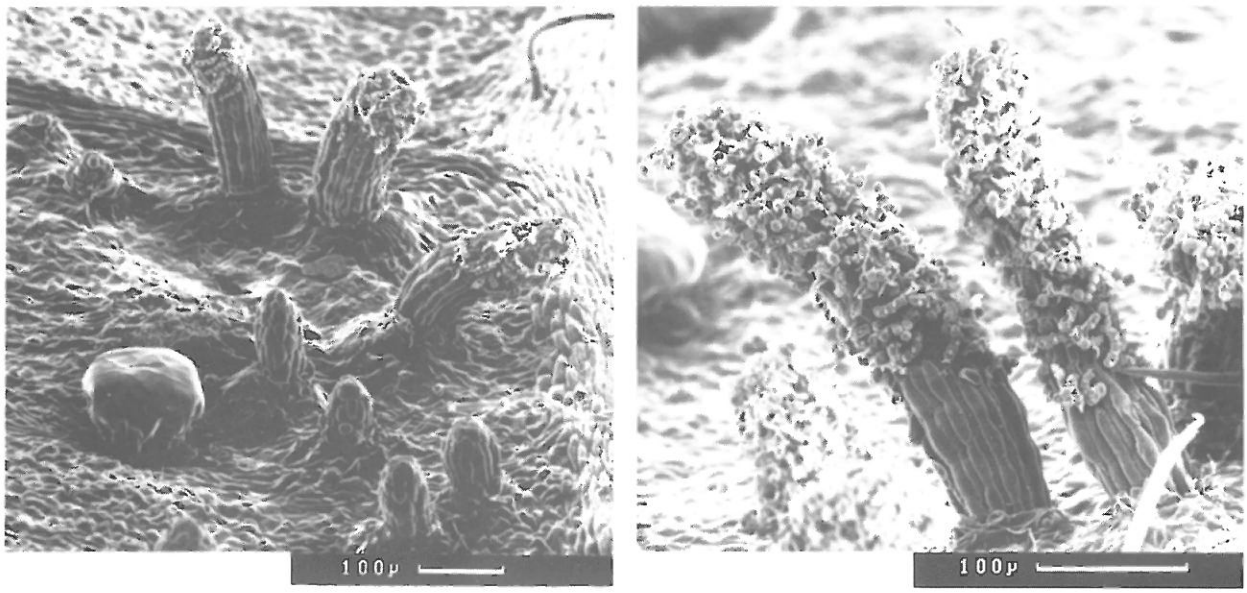
Species 2. *Coleosporium tussilaginis*: aecia and aeciospores.





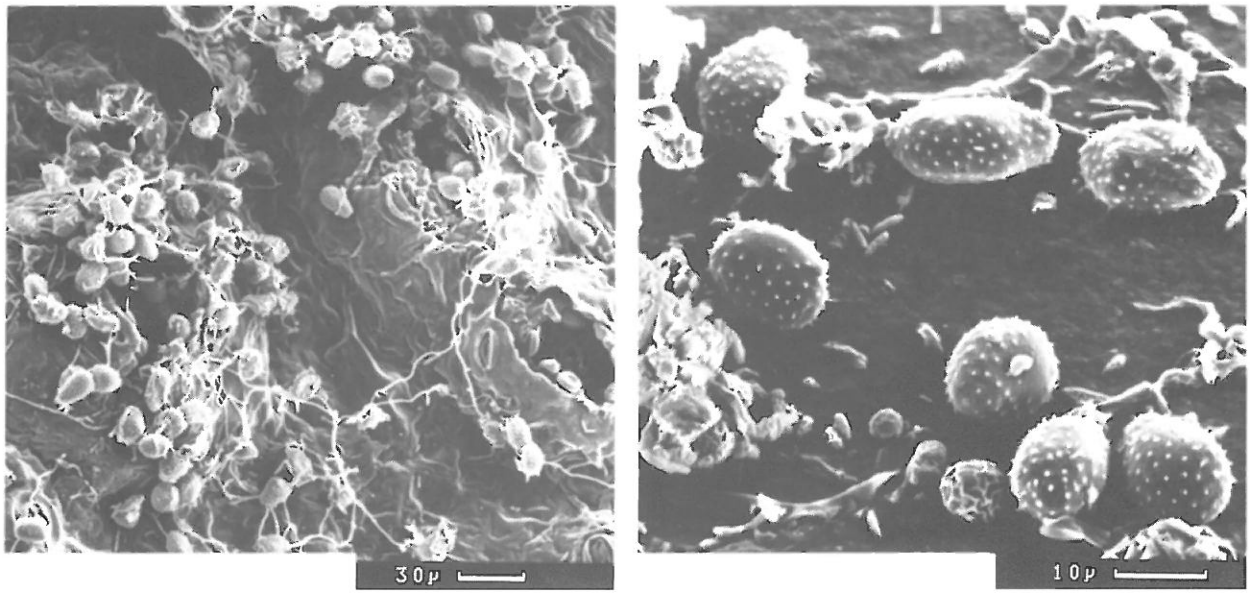
(See caption to photographs of telia and teliospores). Aeciospore surface: densely verrucose (WH), verruculose (EE).

Species 2A. *Cronartium ribicola*: telia and teliospores.



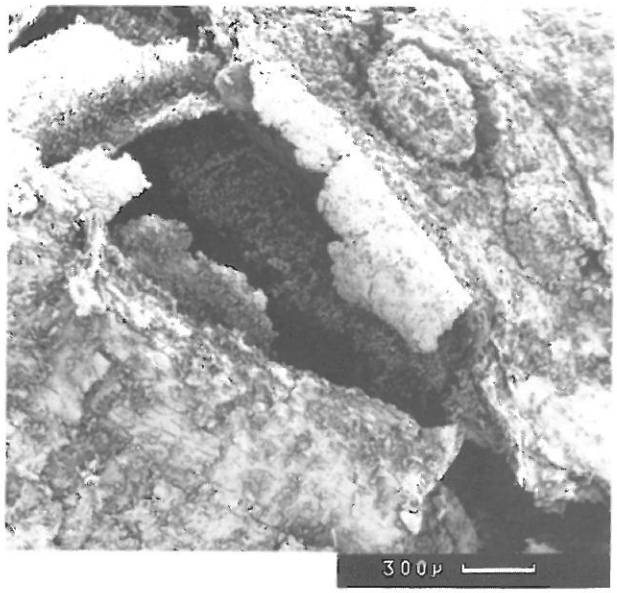
Not in B, first seen in Yorks in garden, Leeds (TFP) 1985.
[A] on Pinus spp. [UT] on Ribes spp. Drawing of T in WH 55, CMID 283 (AU and T) and of U and T in EE Fig. 1016. Descriptions in EE 180 (A) and 225 (UT). Teliospore surface: smooth (WH, EE).

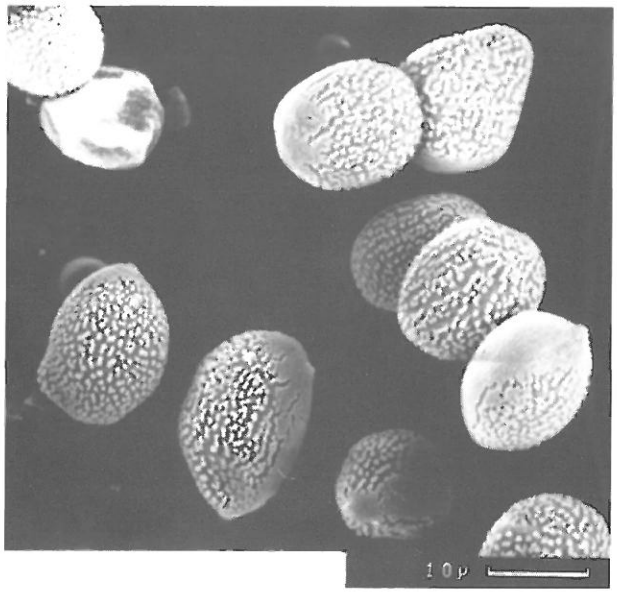
Species 2A. *Cronartium ribicola*: uredinia and urediniospores.



(See caption to photographs of telia and teliospores). Urediniospore surface: distantly and sharply echinulate (WH), echinulate (EE), finely echinulate with spines 2-3 μm apart and 1 μm high (CMID).

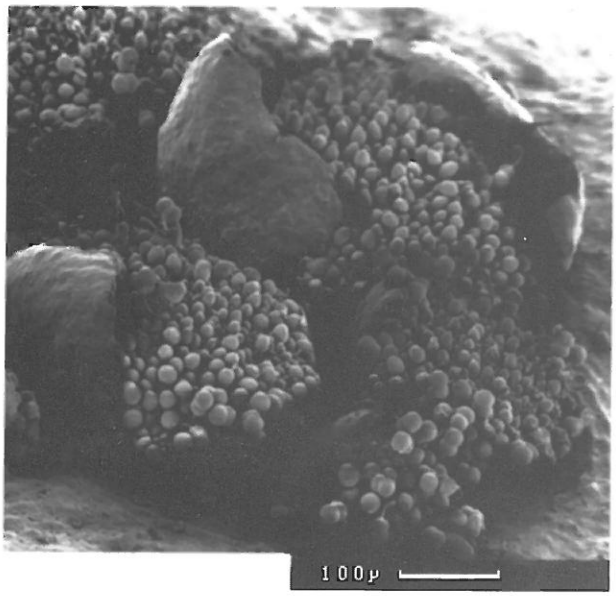
Species 2A. *Cronartium ribicola*: aecia and aeciospores.

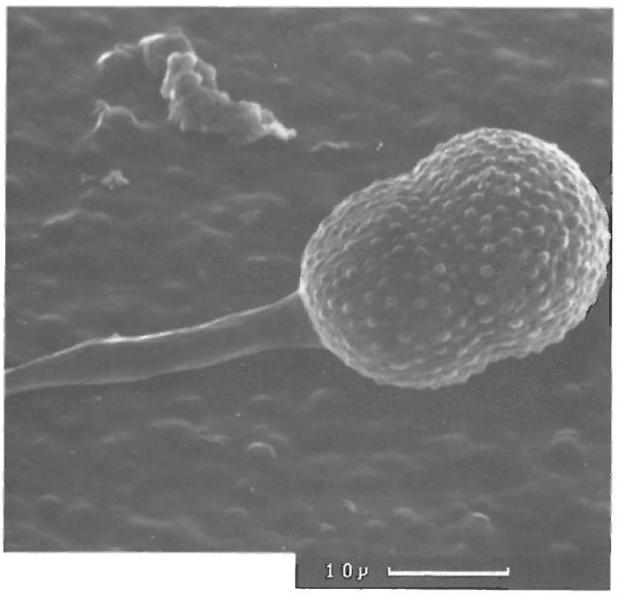




(See caption to photographs of telia and teliospores). Aeciospore surface: coarsely verrucose except on a thickened smooth elliptic area (WH), mostly verrucose but with a small smooth area (EE), strongly verrucose except for the rather well defined smooth spot, the warts 1-2 μm diam. × 1-2 μm high (CMID).

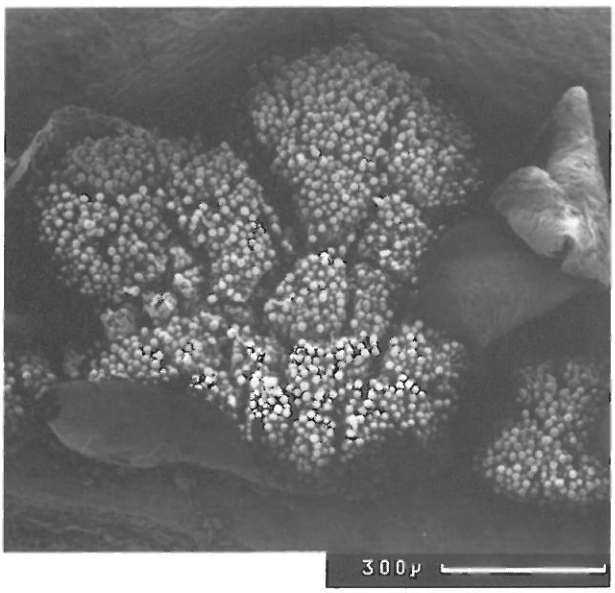
Species 3. *Cumminsiella mirabilissima*: telia and teliospore.

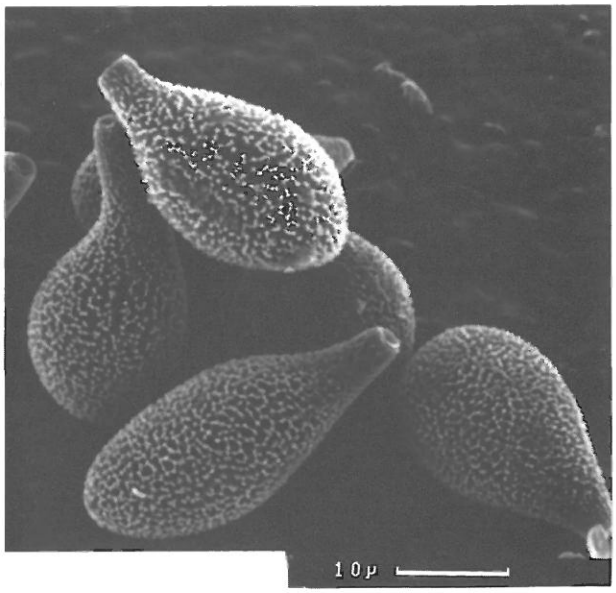




Yorks in B, 191 [AUT] on Mahonia spp. Drawings of U and T in WH 300 and EE Fig. 711. Description EE 162. Teliospore surface: warted layer in complex wall (WH).

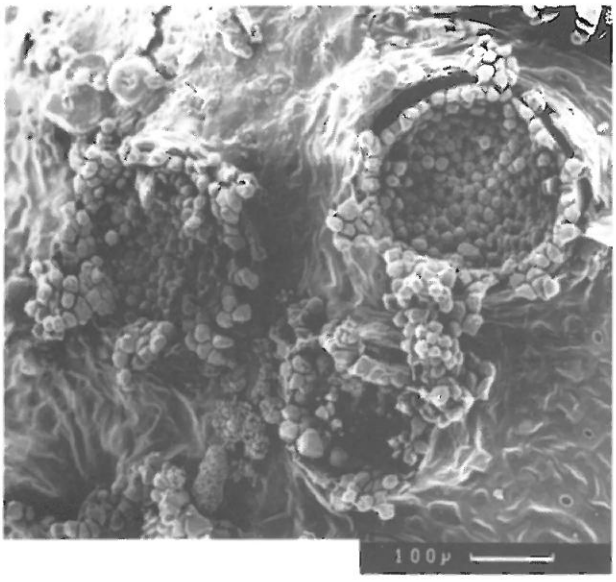
Species 3. *Cumminsiella miribilissima:* uredinia and urediniospores.

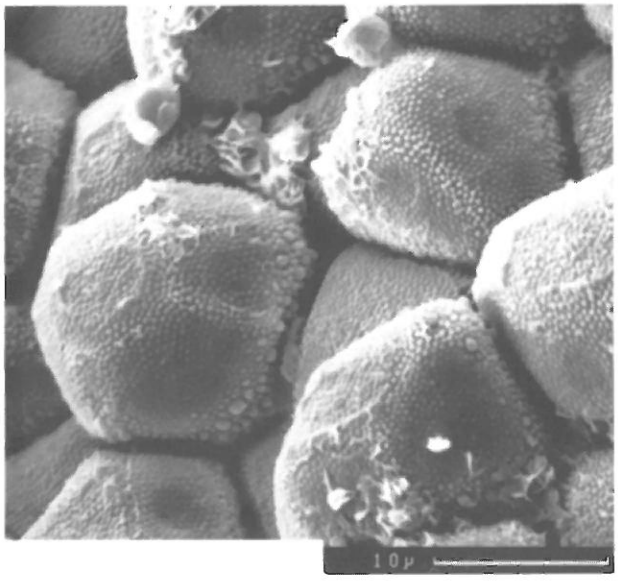




(See caption to photographs of telia and teliospores). Urediniospore surface: minutely echinulate (WH).

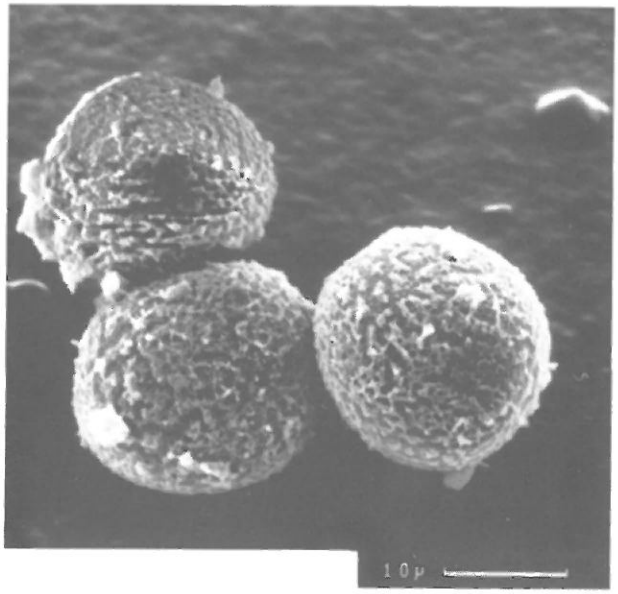
Species 3. *Cumminsiella mirabilissima*: aecia and aeciospores.





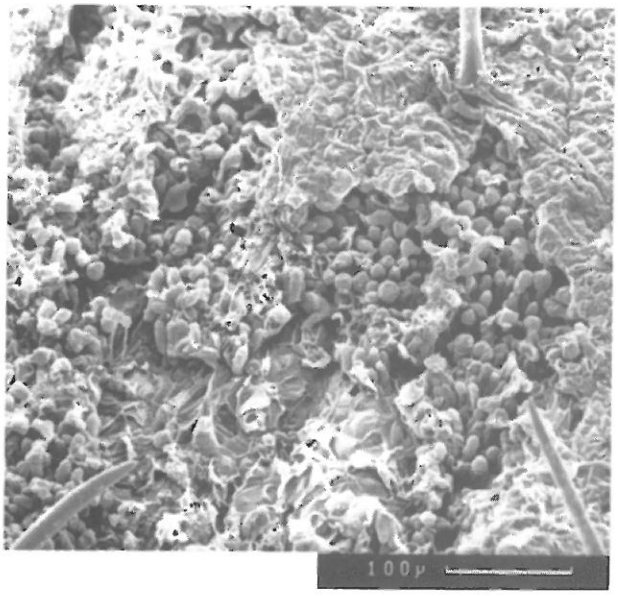
(See caption to photographs of telia and teliospores). Aecidiospore surface: very finely echinulate (WH).

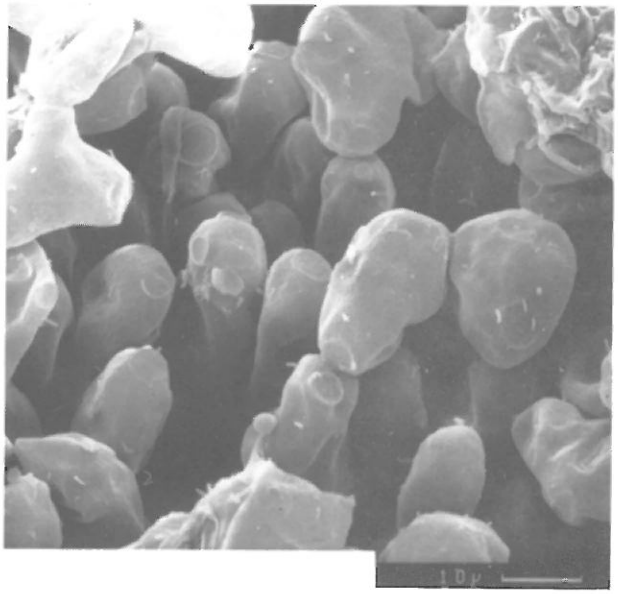
Species 4. *Endophyllum sempervivi*: telia and teliospores.



Yorks in B, 191 [T] on Sempervivum spp. Drawing of T in WH 309. Description in EE 420. Teliospore surface: minutely verrucose (WH), minutely verruculose (EE).

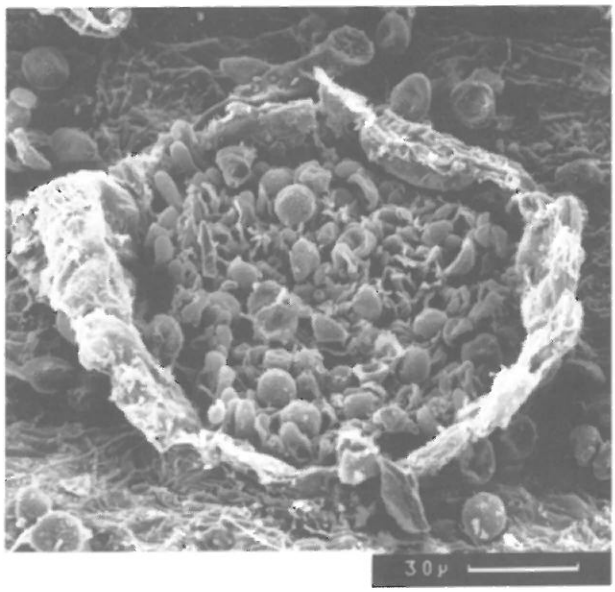
Species 5. *Frommea obtusa*: telia and teliospores.

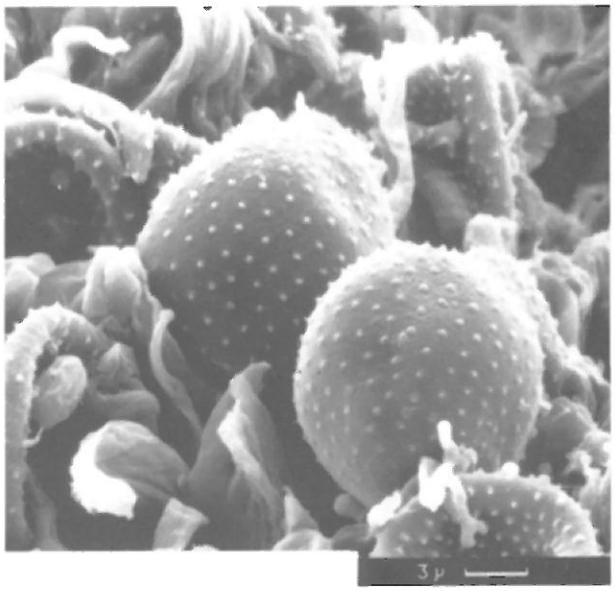




Yorks in B, 191 [AUT] on Potentilla spp. Drawings of U and T in WH 110 and EE Fig. 1624. Description EE 406. Teliospore surface: smooth (WH, EE). The thin-walled several-celled teliospores are breaking up into single cells in this SEM picture.

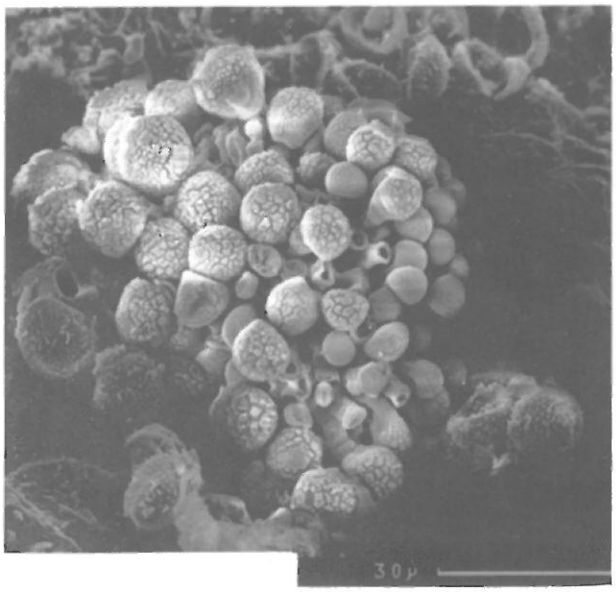
Species 5. *Frommea obtusa*: uredinia and urediniospores.

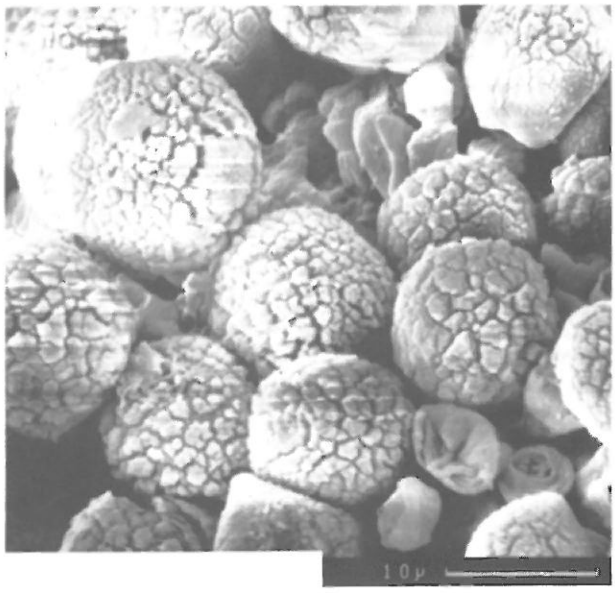




(See caption to photographs of telia and teliospores). Urediniospore surface: finely echinulate (WH), echinulate (EE).

Species 5. *Frommea obtusa*: aecia and aeciospores.



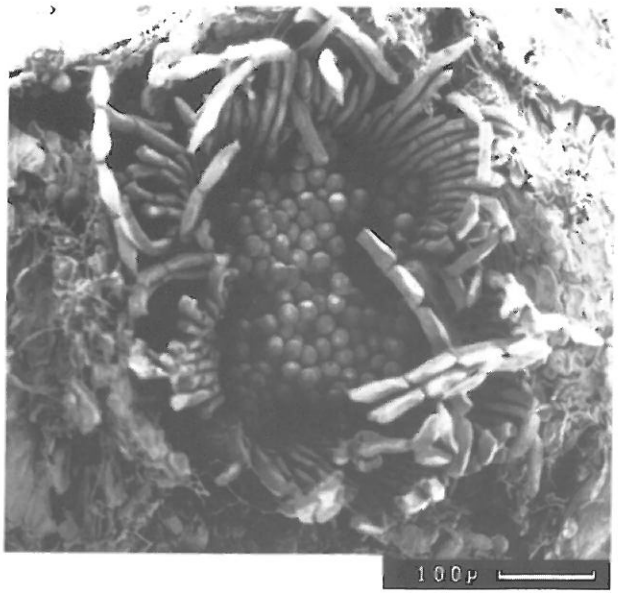


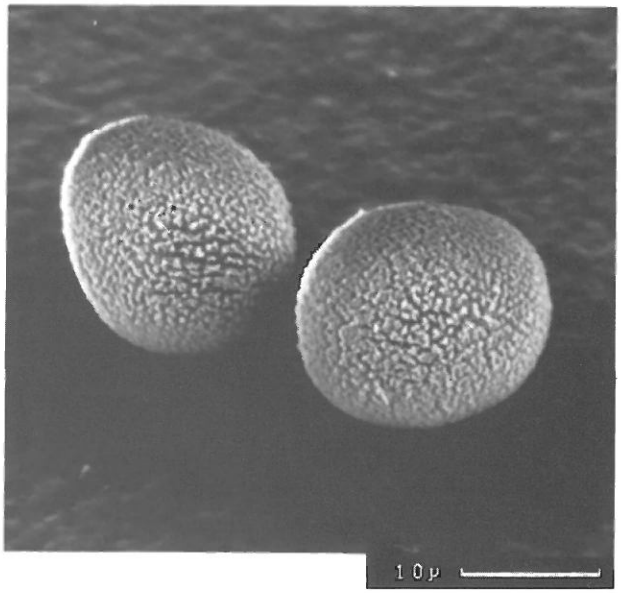
(See caption to photographs of telia and teliospores). Aeciospore surface: verrucose-echinulate above, nearly smooth below (WH).

Species 6. *Gymnosporangium clavariiforme*: telia and teliospores.

Yorks in B, 191. [A] on Crataegus spp. [T] on *Juniperus communis*. Drawings of A and T in WH 116, EE Fig. 487 and CMID 542. Descriptions in EE 113 (A) and 150 (T). Teliospore surface: presumably smooth.

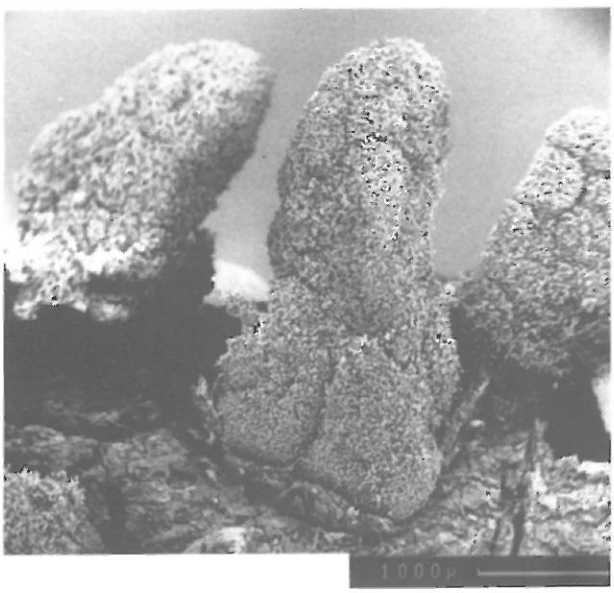
Species 6. *Gymnosporangium clavariiforme*: aecia and aeciospores.

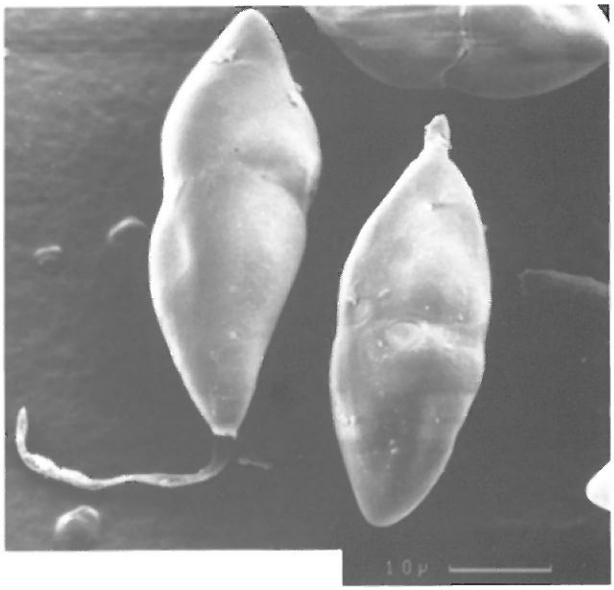




(See caption to photographs of telia and teliospores). Aeciospore surface: densely and minutely verrucose (WH).

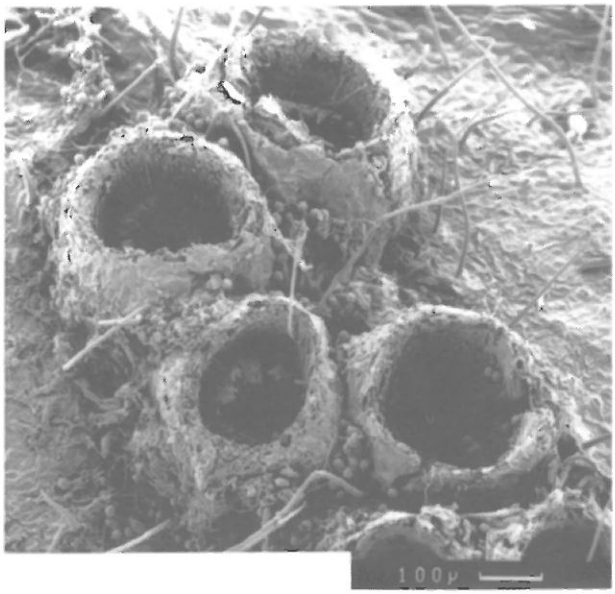
Species 7. *Gymnosporangium confusum*: telia and teliospores.

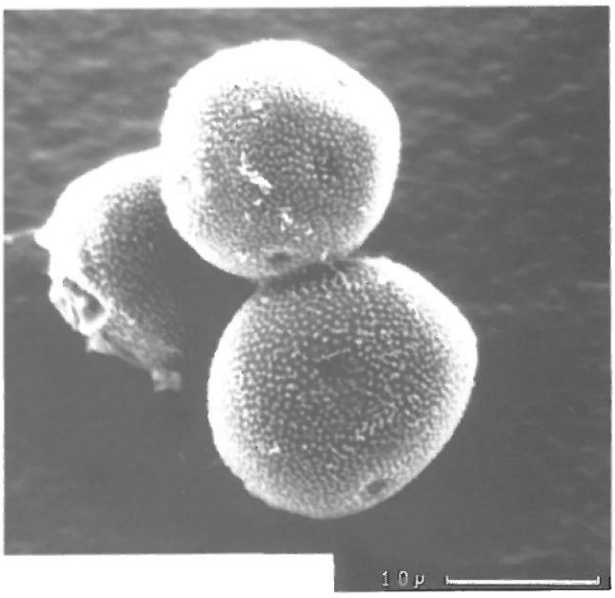




Yorks in B, 191 [A] on Crataegus spp. [T] on *Juniperus sabina*. Teliospores of two different shapes, with thick walls and a rounded apex, or (as shown in this SEM picture) with thin walls and a pointed apex. Drawings of A and T in WH 118 and CMID 544. Descriptions of A in EE 113 and T in EE 150. Teliospore surface: presumably smooth.

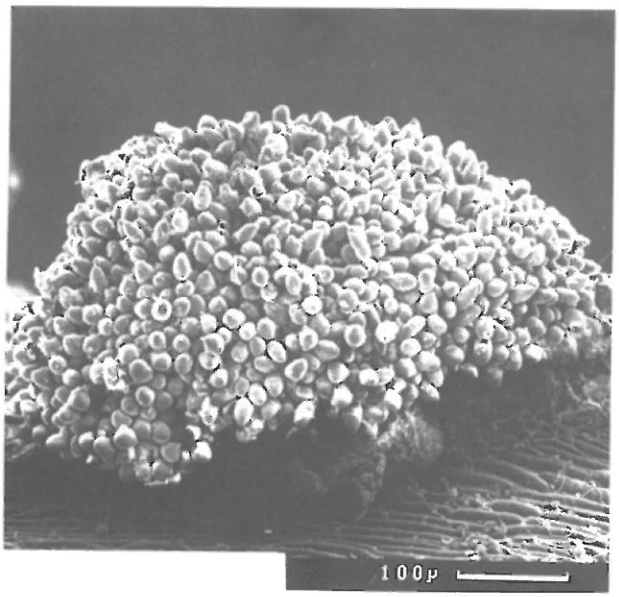
Species 7. *Gymnosporangium confusum*: aecia and aeciospores.

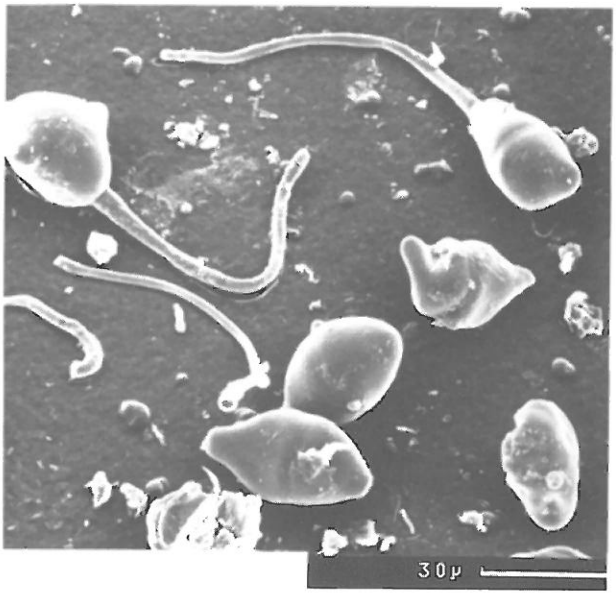




(See caption to photographs of telia and teliospores). Aeciospore surface: verruculose (WH).

Species 8 *Gymnosporangium cornutum*: telia and teliospores.



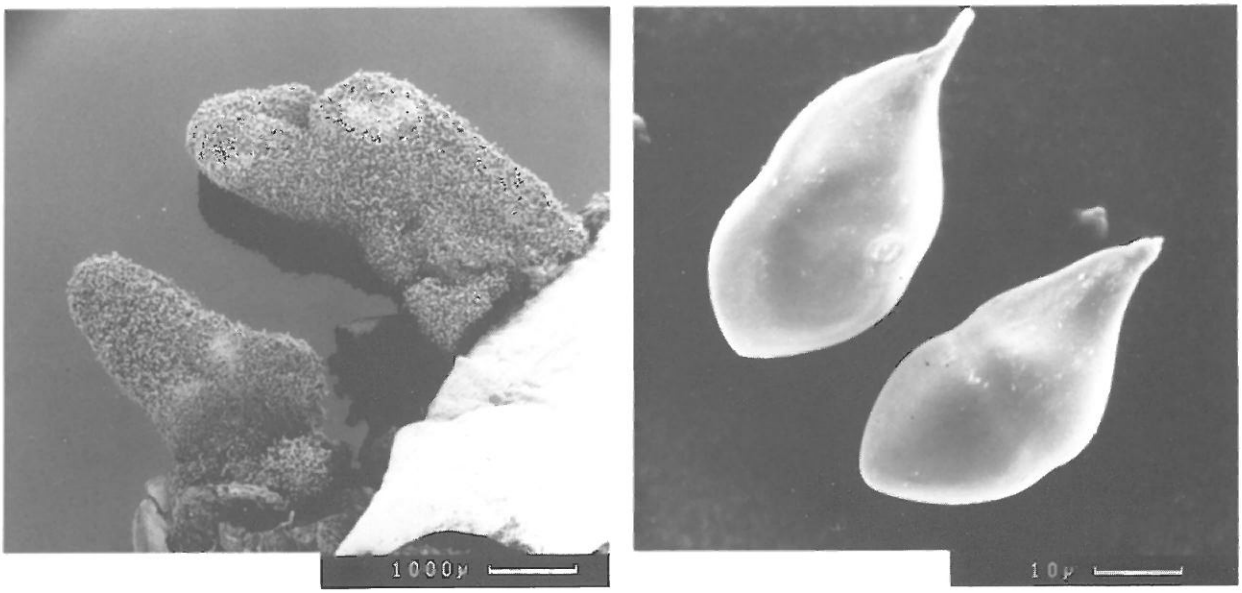


Yorks in B, 191 [A] on *Sorbus aucuparia*. [T] on *Juniperus communis*. Drawing of T in WH 121. Descriptions of A in EE 255 and the T on EE 150. Teliospore surface: presumably smooth.

Species 8. *Gymnosporangium cornutum*: aecia and aeciospores.

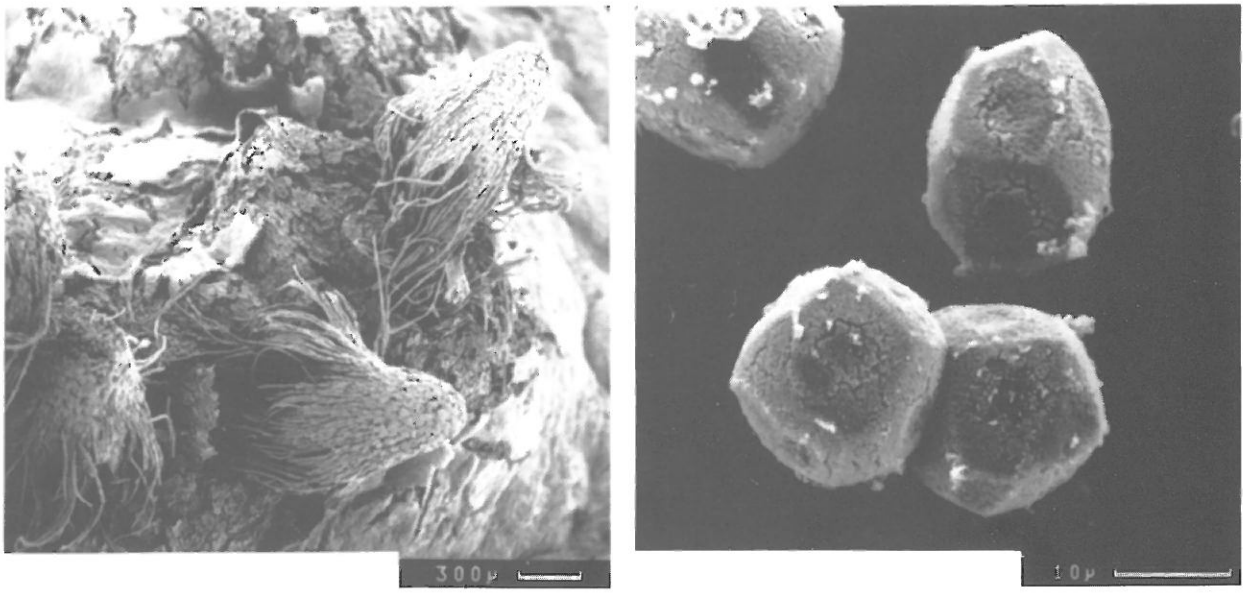
(See caption to photographs of telia and teliospores). Aeciospore surface: minutely verruculose (EE), finely verruculose (WH).

Species 9. *Gymnosporangium fuscum*: telia and teliospores.



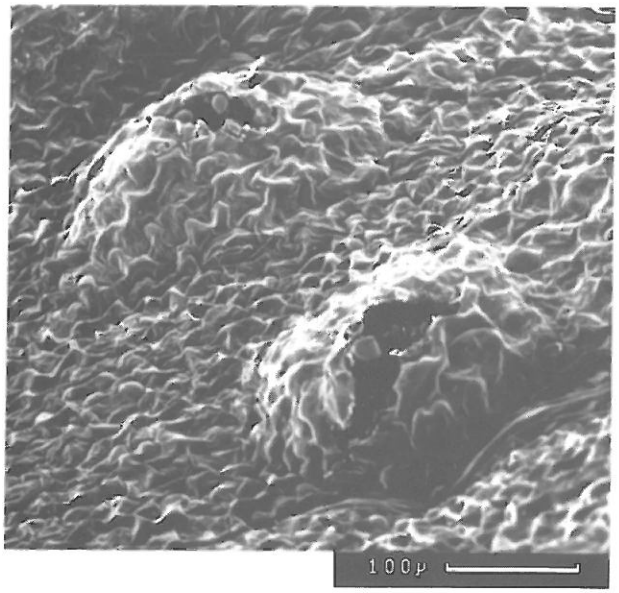
Yorks in B, 191. [A] on Pyrus spp. [T] on Juniperus spp. Drawing of T in WH 119 and of A and T in CMID 545. Teliospore surface: presumably smooth.

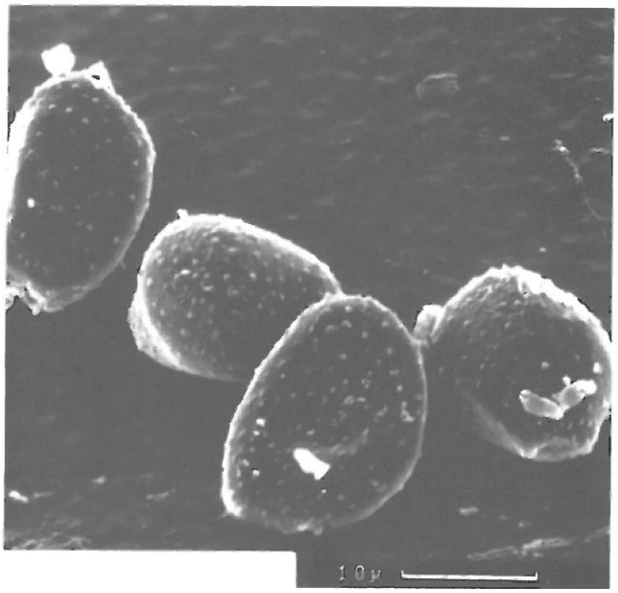
Species 9. *Gymnosporangium fuscum*: aecia and aeciospores.



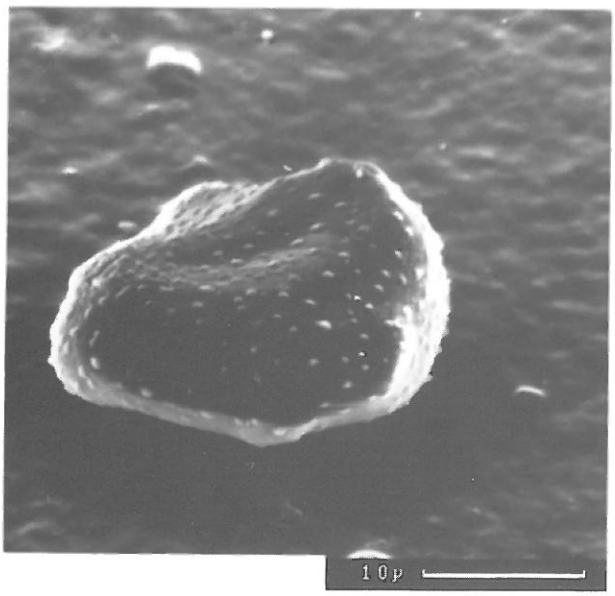
(See caption to photographs of telia and teliospores). Aeciospore surface: finely verruculose (WH), finely verrucose (CMID).

Species 11. *Hyalopsora polypodii*: uredinia and urediniospores.



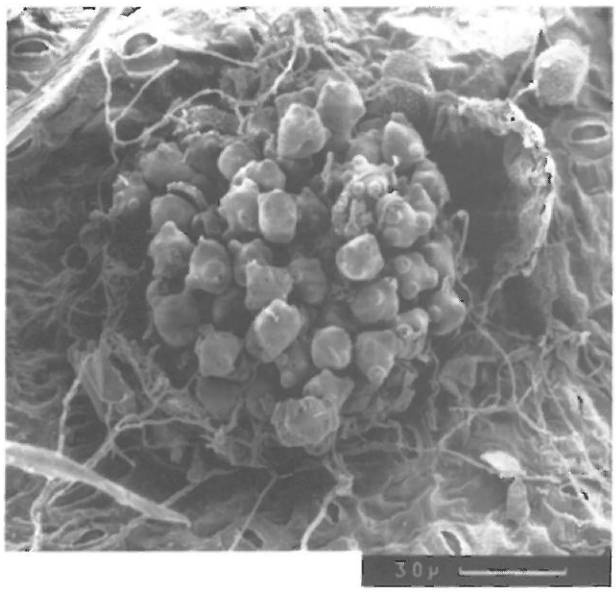


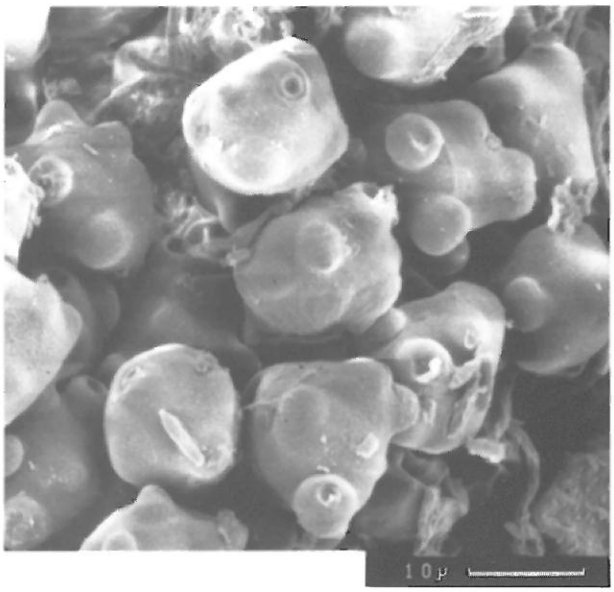
Yorks in B, 191. [U] on *Cystopteris fragilis*. Urediniospores are of two types – normal and thick-walled. Telia have not been seen in Britain, but consist of 2-4 cells in single epidermal cells. Drawing of U in WH 29, and EE Fig. 2085. Description in EE 562. Urediospore surface: faint, distant warts (WH).



Thickwalled "amphispore" of Hyalopsora polypodii found in uredinia with mainly normal urediniospores.

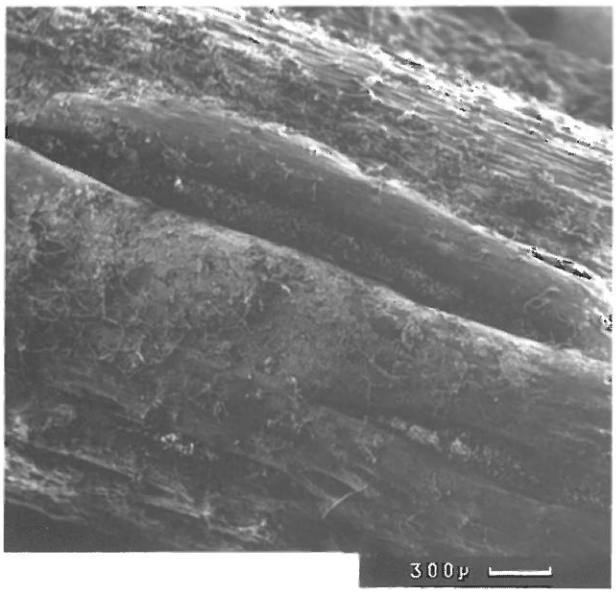
Species 12. *Kuehneola uredinis*: telia and teliospores.

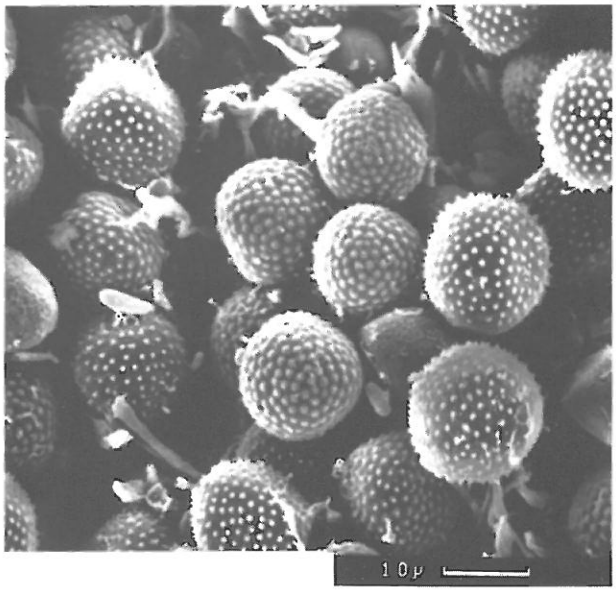




Yorks in B, 191 [AUT] on Rubus spp. Drawings of U and T in WH 108 and in CMID 202. EE Fig. 1045 has drawings of chains of T. descriptions in WH 108, CMID 202 and EE 231. Teliospore surface: smooth (WH), smooth but often bearing coronate projections or bumps at the top (in apical spores) or upper rim (in intercalary spores) (CMID).

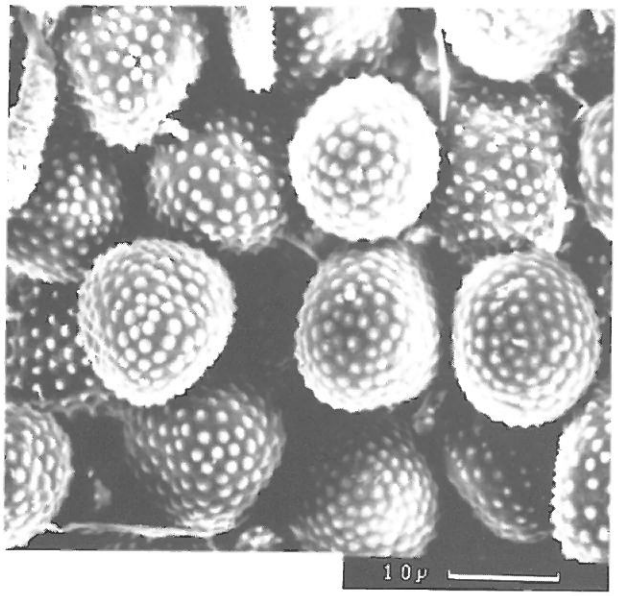
Species 12. *Kuehneola uredinis*: uredinia and urediniospores.





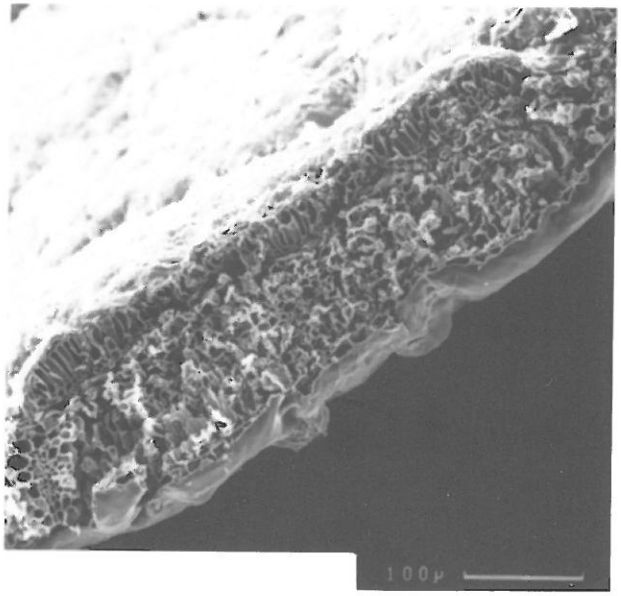
(See caption to photographs of telia and teliospores). Urediniospore surface: finely and closely verrucose-echinulate (WH), closely echinulate, the spines 1.5-2.5μm apart and 0.5-0.75μm high (CMID).

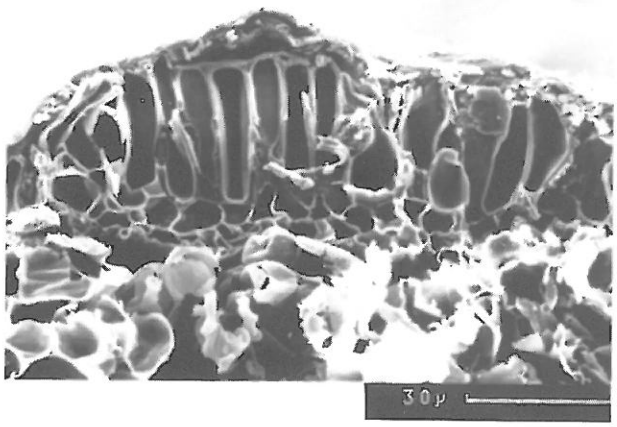
Species 12. *Kuehneola uredinis*: aecia and aeciospores.



(See caption to photographs of telia and teliospores). Aeciospore surface: closely verrucose (WH), like the urediniospores (CMID).

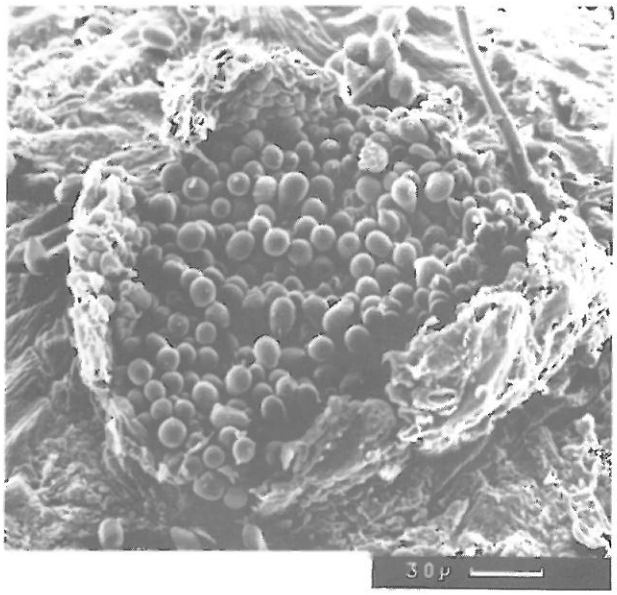
Species 13. *Melampsora allii-fragilis*: telia and teliospores.

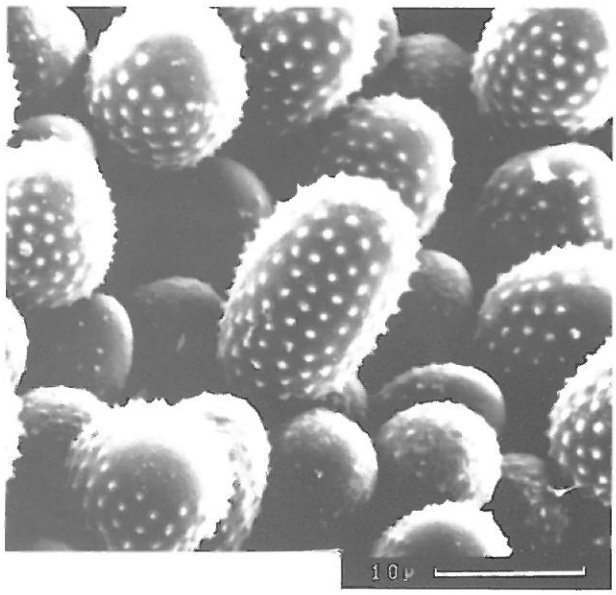




Yorks in B, 191 [U and T] on Salix spp. Descriptions only of AUT in WH 92 and EE 244. Telia subcuticular. Teliospore surface: presumably smooth.

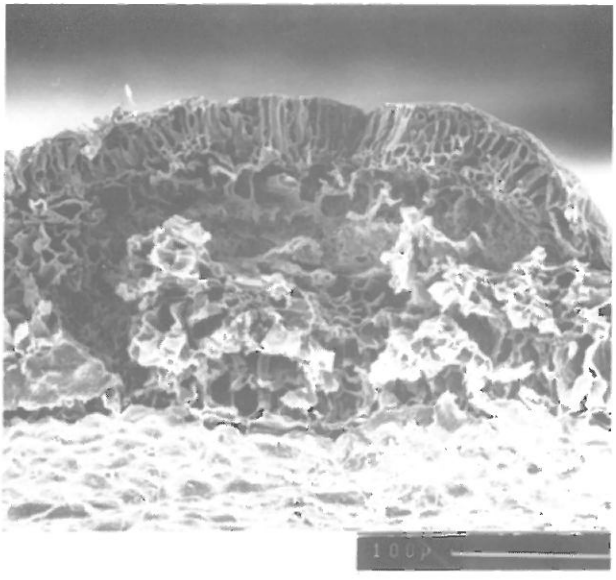
Species 13. *Melampsora allii-fragilis*: uredinia and urediniospores.

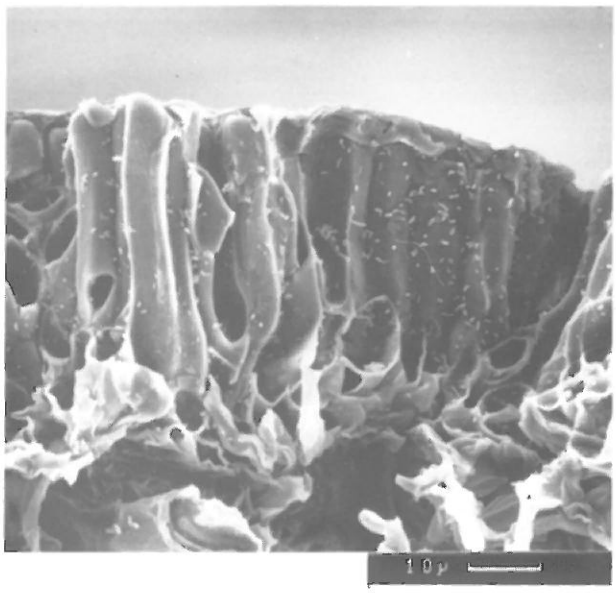




(See caption to photographs of telia and teliospores). Urediniospore surface: distantly echinulate, but smooth and somewhat thinner above (WH).

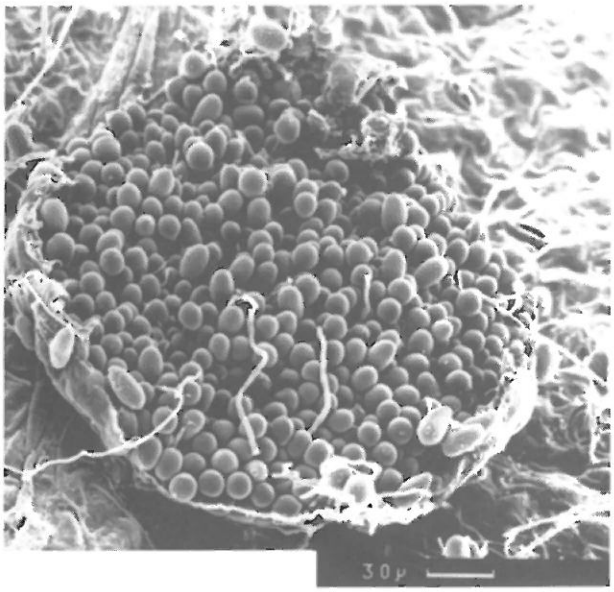
Species 14. *Melampsora allii-populina*: telia and teliospores.

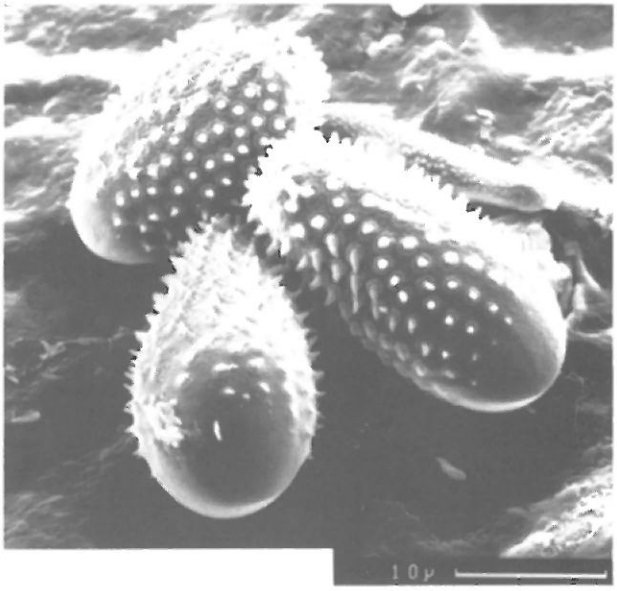




Yorks in B, 191 [U and T] on Populus spp. Drawings of U and T in WH 71, with descriptions of U and T in EE 189. The telia are subepidermal. Teliospore surface: presumably smooth.

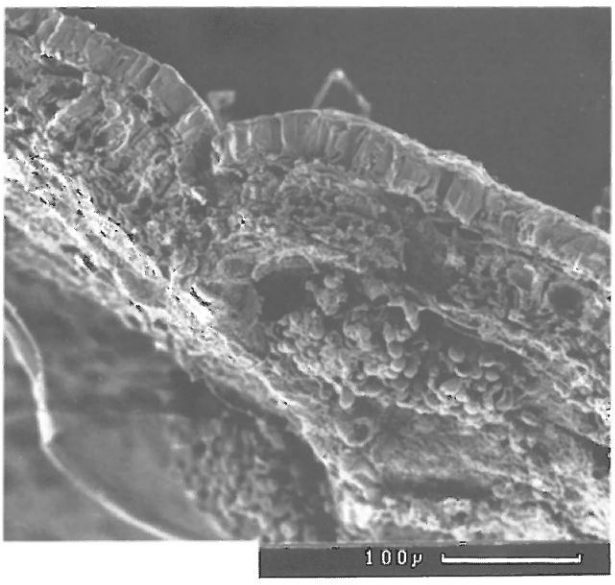
Species 14. *Melampsora allii-populina*: uredinia and urediniospores.

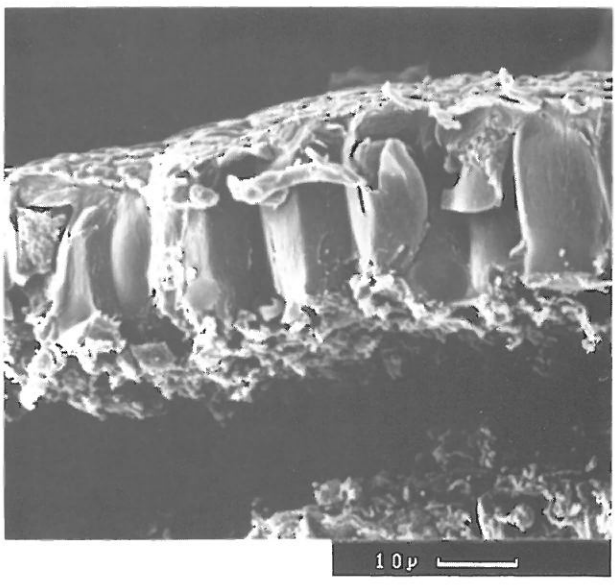




(See caption to photographs of telia and teliospores). Urediniospore surface: distantly echinulate, but smooth at apex (WH), echinulate except at apex (EE).

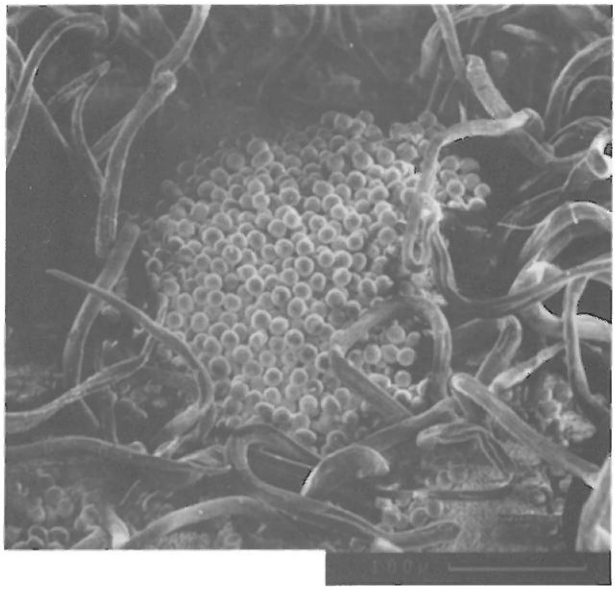
Species 15. *Melampsora capraearum*: telia and teliospores.

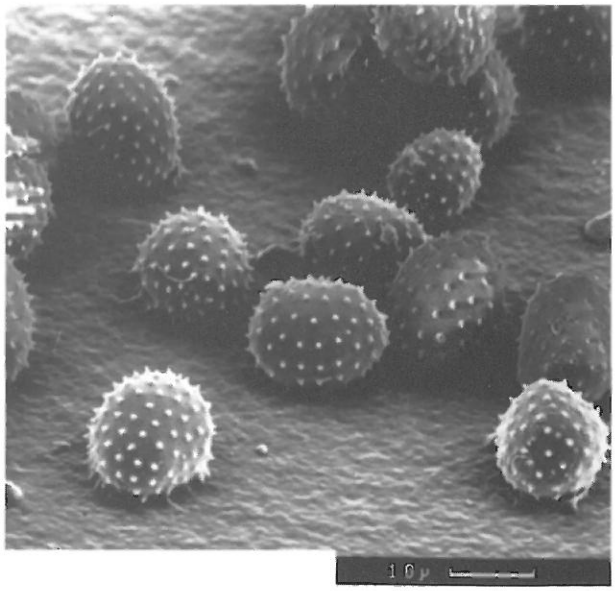




Yorks in B, 191. [A] on Larix spp. [U and T] on Salix spp. Drawings of U and T in WH 78. Descriptions of A in EE 154, with U on 244. The telia are subcuticular. Teliospore surface: presumably smooth.

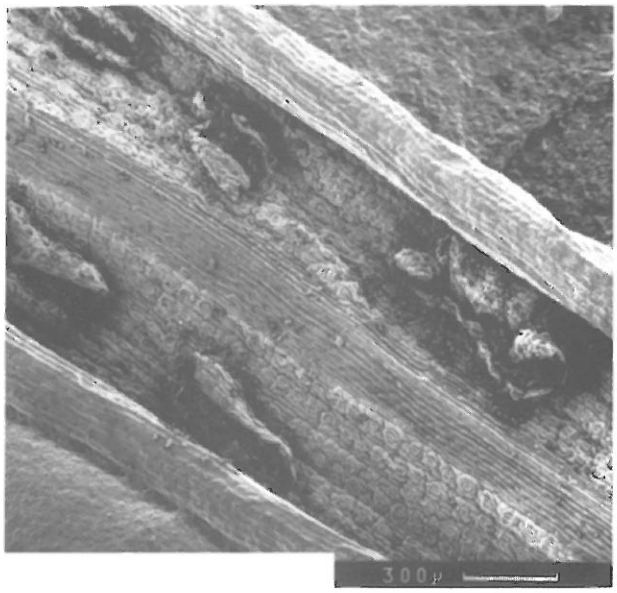
Species 15. *Melampsora capraearum*: uredinia and urediniospores..

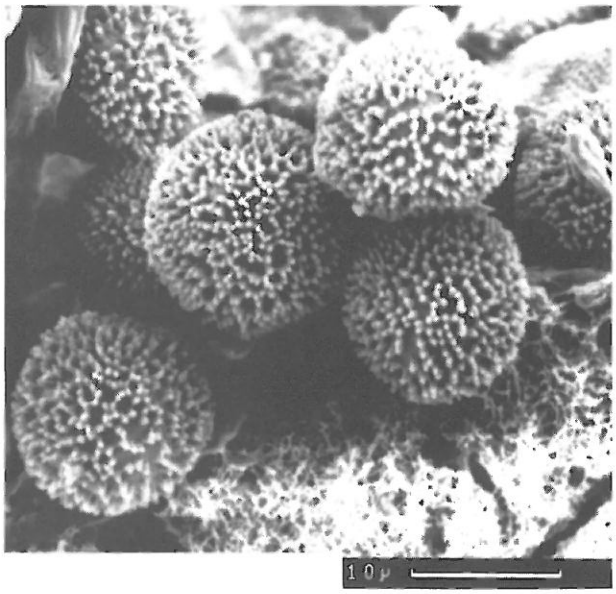




(See caption to photographs of telia and teliospores). Urediniospore surface: distantly echinulate, distance between warts 2-2.5μm (WH).

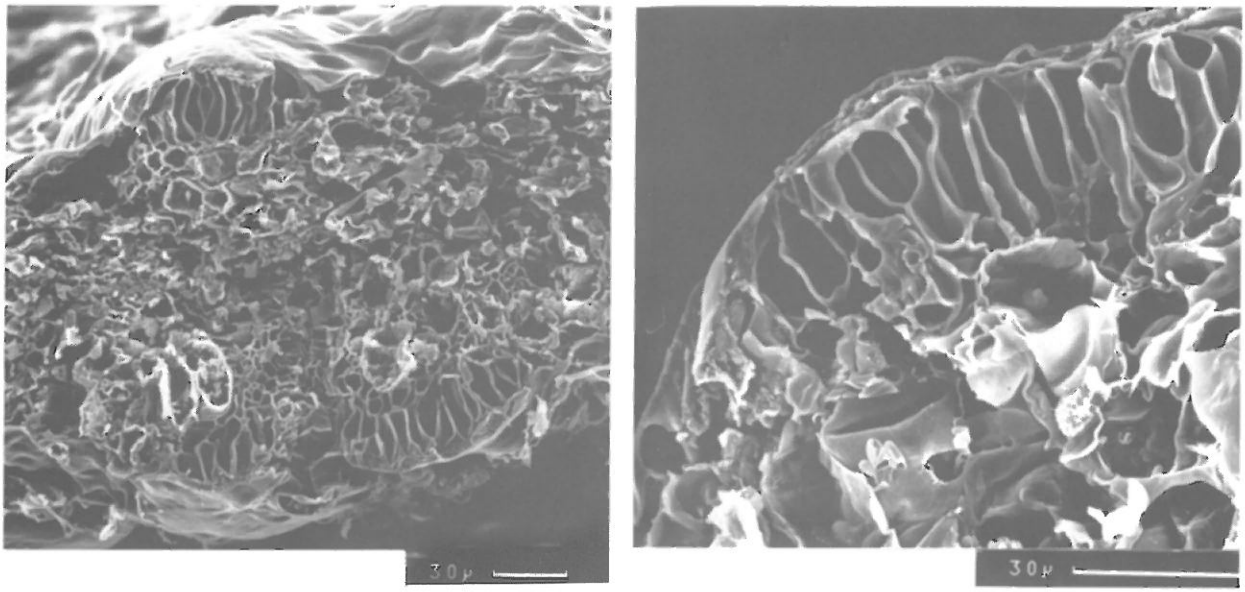
Species 15. *Melampsora capraearum*: aecia and aeciospores.





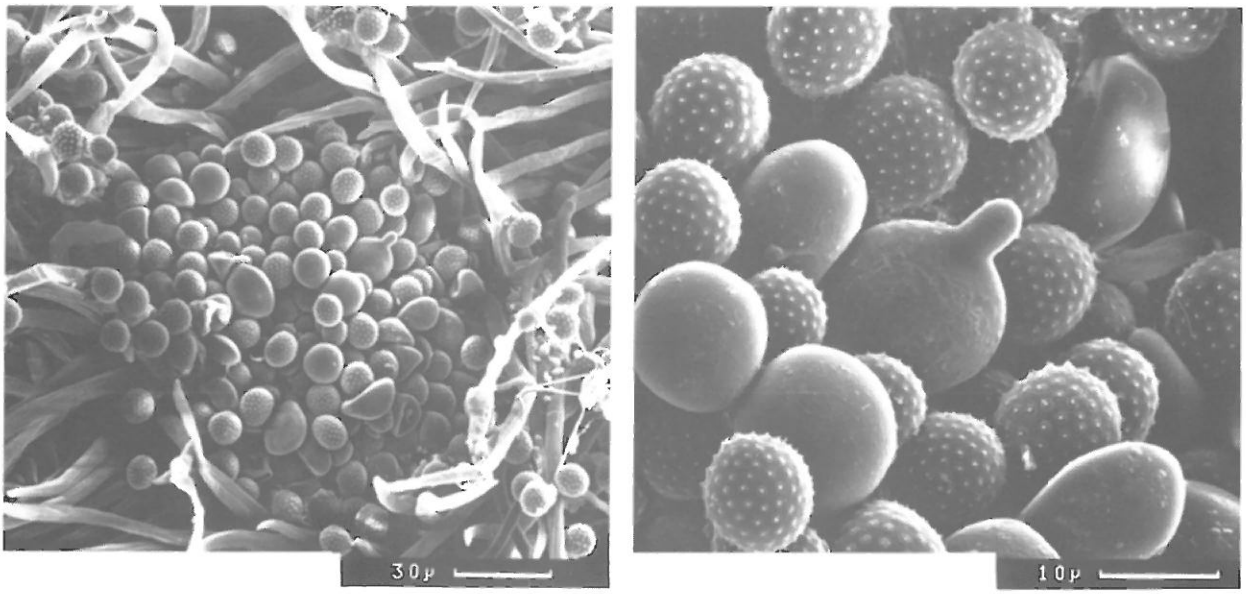
(See caption to photographs of telia and teliospores). Aeciospore surface: finely verrucose (WH), verruculose all over (EE).

Species 16. *Melampsora epitea* var. *epitea*: telia and teliospores.



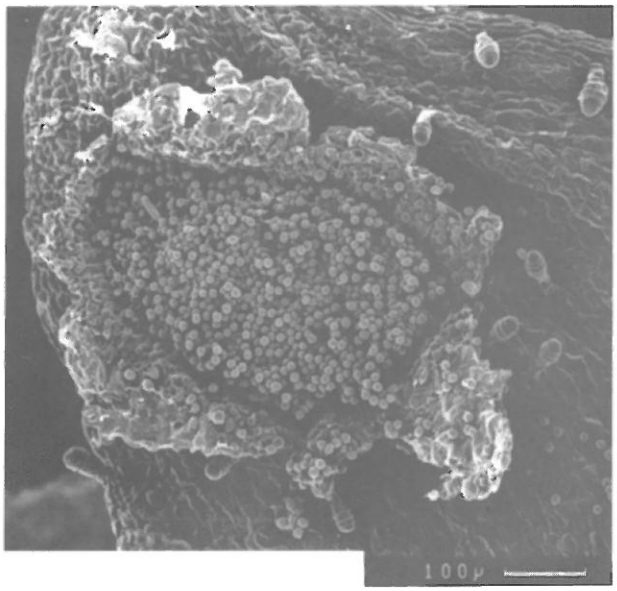
Yorks in B, 191. [A] e.g. on Larix spp., with [U and T] on Salix spp. Drawing of U and T (*M.epitea*) in WH 81. Descriptions of A on EE 154, with U and T on 224. The telia are subcuticular. Teliospore surface: smooth (EE).

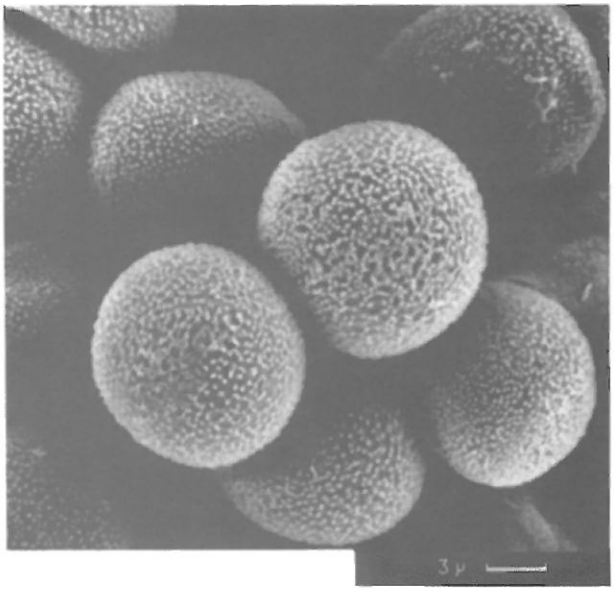
Species 16. *Melampsora epitea* var. *epitea*: uredinia and urediniospores.



(See caption to photographs of telia and teliospores). Urediniospore surface: aculeato-verrucose (WH), shortly echinulate (EE).

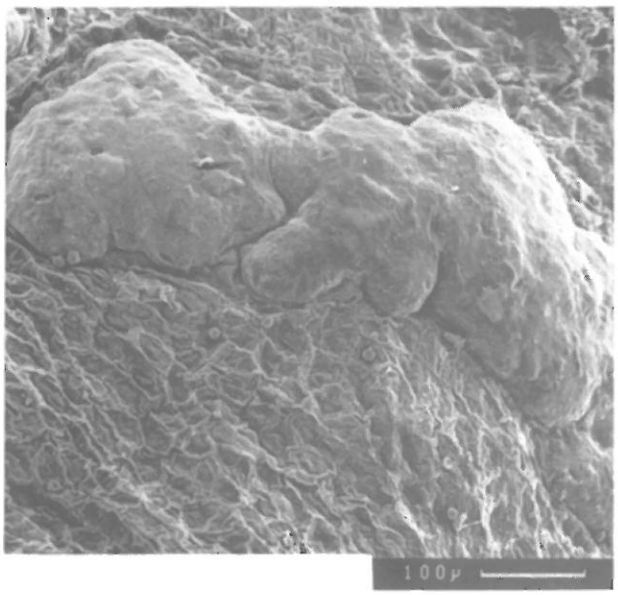
Species 16. *Melampsora epitea* var. *epitea*: aecia and aeciospores.

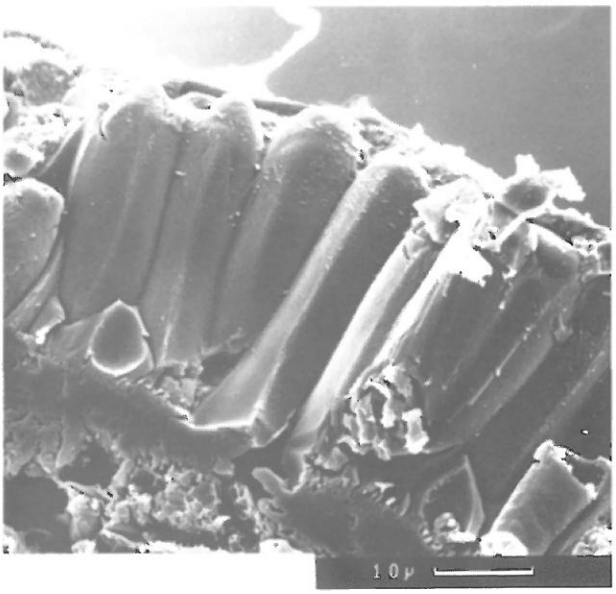




(See caption to photographs of telia and teliospores). Aeciospore surface: finely verrucose (WH).

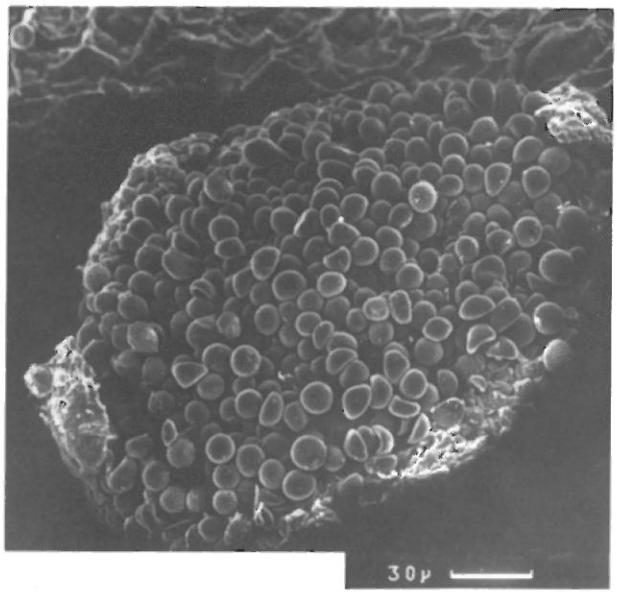
Species 17. *Melampsora euphorbiae*: telia and teliospores.

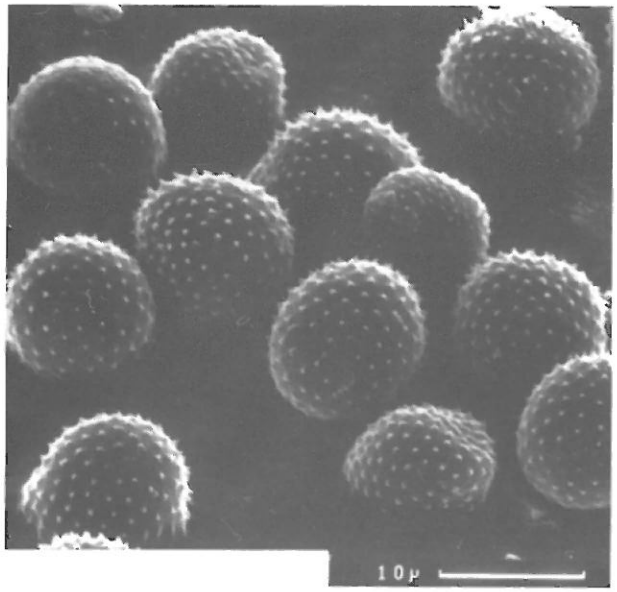




Yorks in B, 191 [UT] on Euphorbia spp. Drawing of U and T in WH 68. Description in EE 353. Teliospores subepidermal. Teliospore surface: presumably smooth.

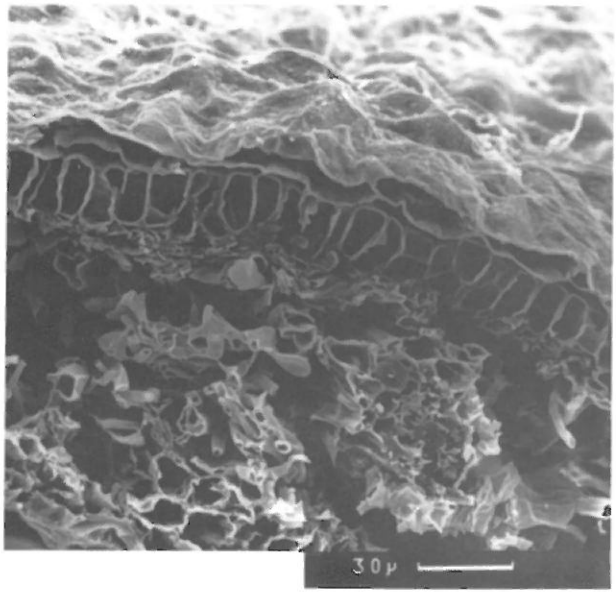
Species 17. *Melampsora euphorbiae*: uredinia and urediniospores.

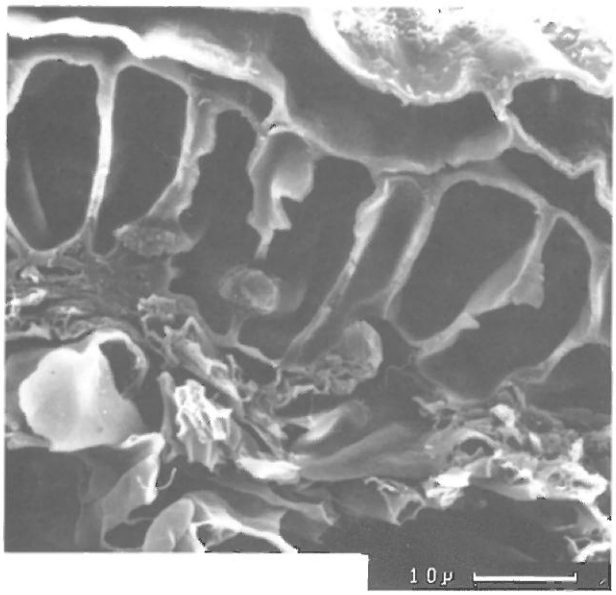




(See caption to photographs of telia and teliospores). Urediniospore surface: more or less densely echinulate (WH), echinulate (EE).

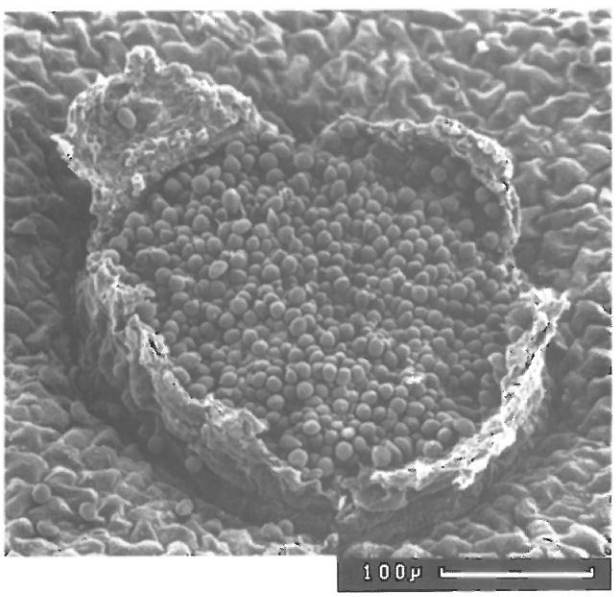
Species 18. *Melampsora hypericorum*: telia and teliospores.

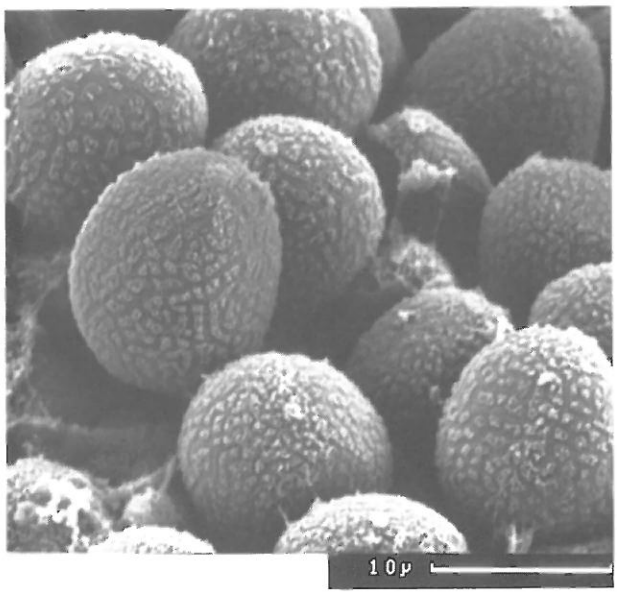




Yorks in B, 191. [AT] on Hypericum spp. Descriptions, only, in WH 70 and EE 371. Teliospore surface: presumably smooth. Teliospores subepidermal.

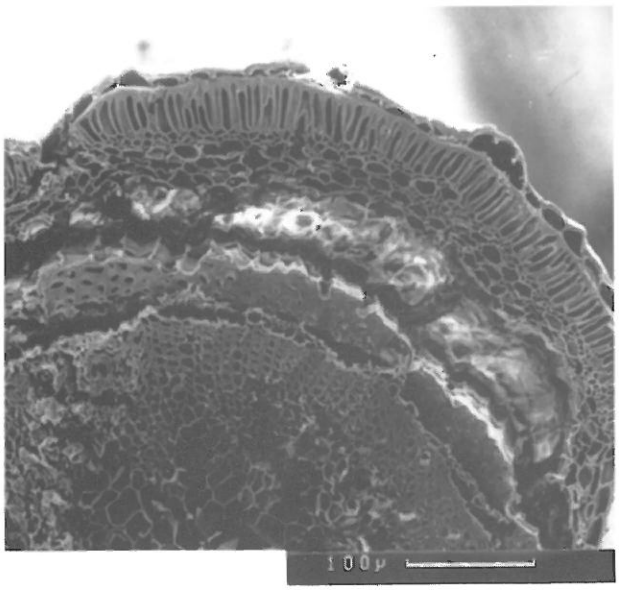
Species 18. *Melampsora hypericorum*: aecia and aeciospores.

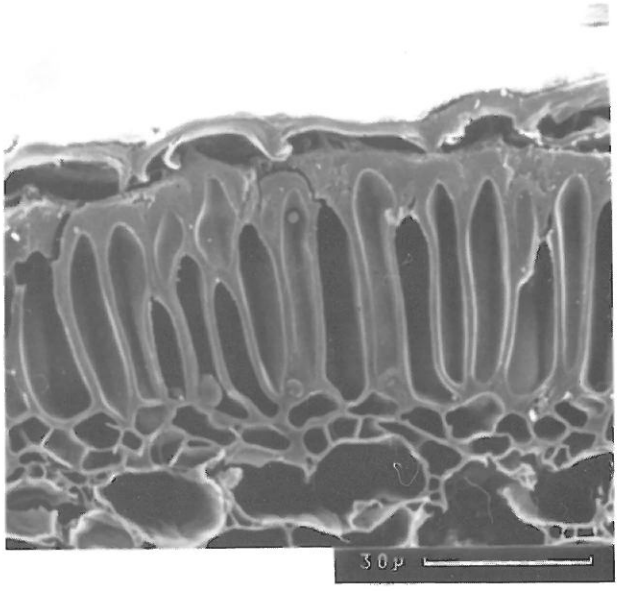




(See caption to photographs of telia and teliospores). Aeciospore surface: tesselate, warted (WH). Further investigation needed of patterns of warts on spore surfaces, which are apparently in groups of 1 to 5 on raised platforms (TFP).

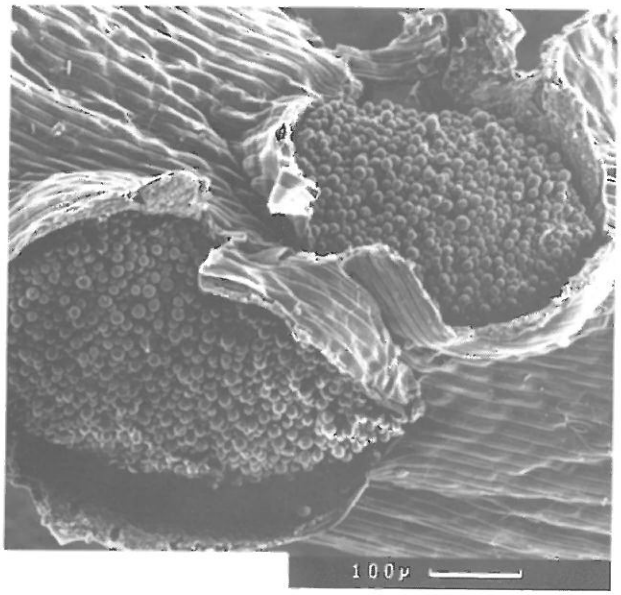
Species 19. *Melampsora lini* var. *lini*: telia and teliospores.

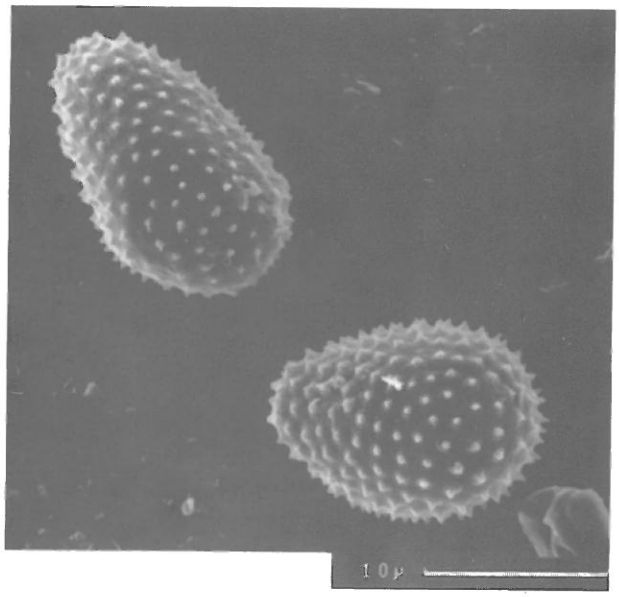




Yorks in B, 192. [UT] on *Linum catharticum*. Drawings on WH 64 (of *M. lini*) U and T. Descriptions of U and T on EE 380. Teliospore surface: presumably smooth.

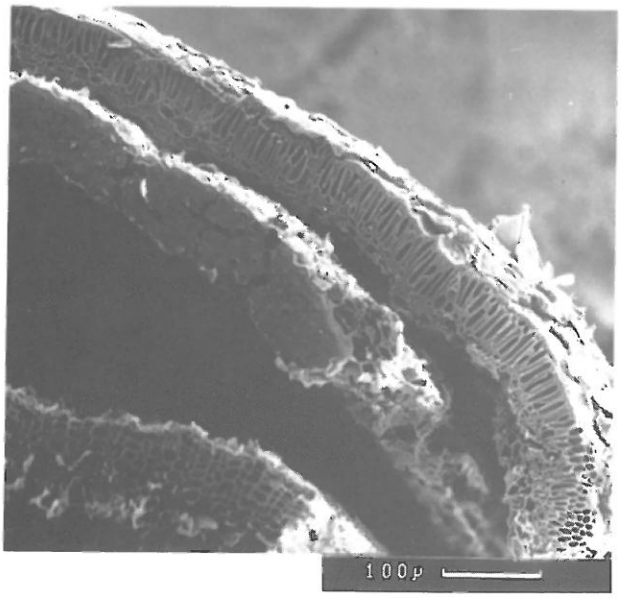
Species 19. *Melampsora lini* var. *lini*: uredinia and urediniospores.

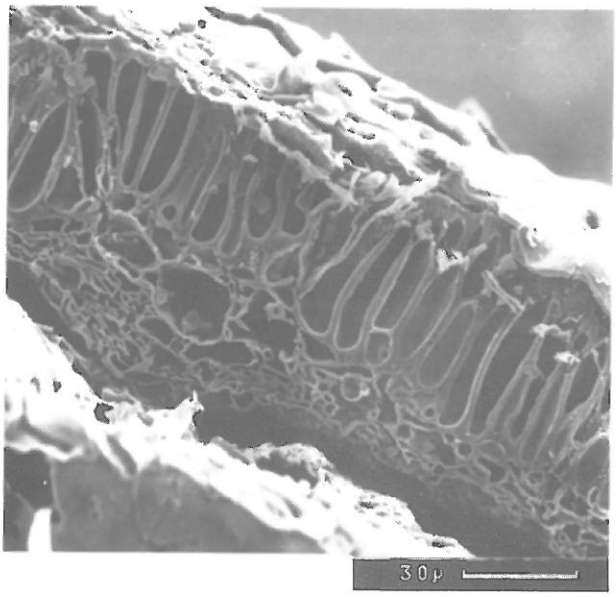




(See caption to photographs of telia and teliospores). Urediniospore surface: finely echinulate-verruculose (WH), shortly echinulate (EE).

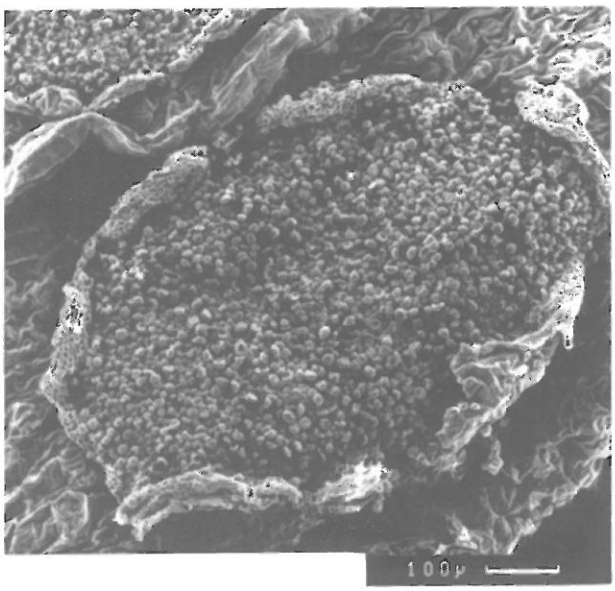
Species 19A. *Melampsora lini* var. *liniperda*: telia and teliospores.

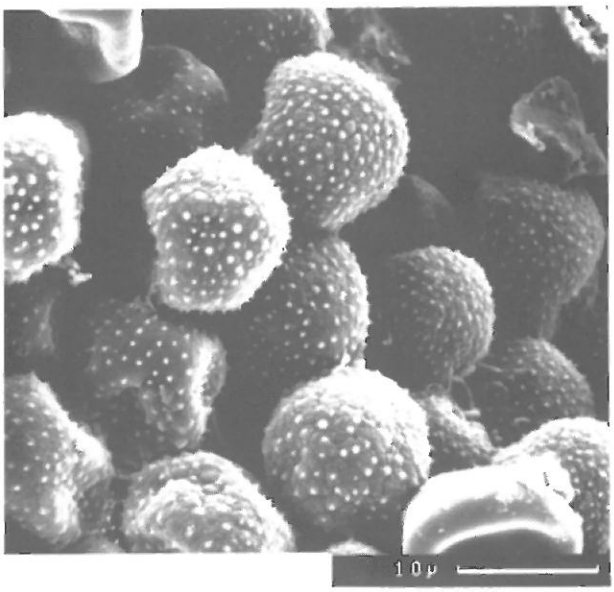




Yorks in B, 192. [AUT] on *Linum usitatissimum*. Drawings of U and T (of *M. lini*) on WH 64, with descriptions of A and T on EE 381. Telia subepidermal. Teliospore surface: presumably smooth.

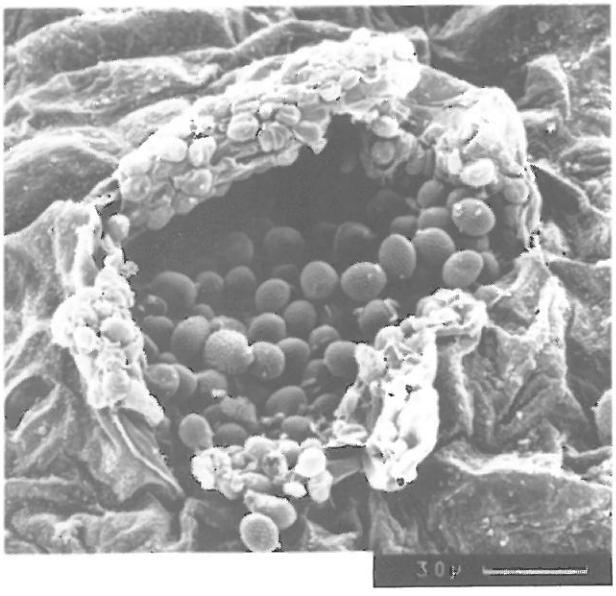
Species 19A. *Melampsora lini* var. *liniperda*: uredinia and urediniospores.

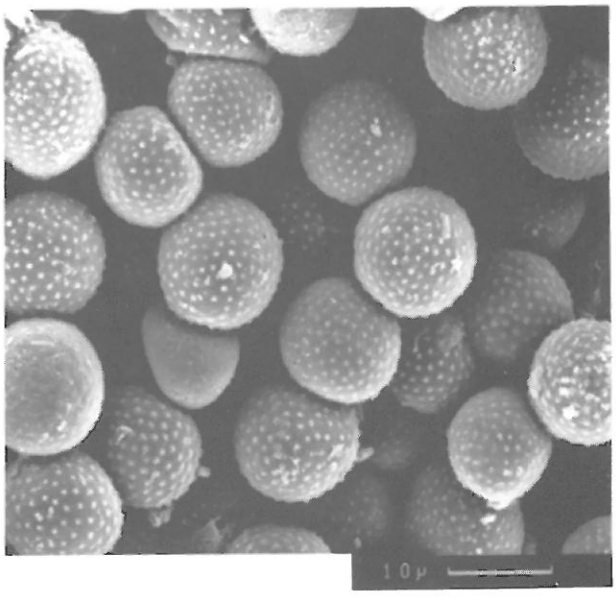




(See caption to photographs of telia and teliospores). Urediniospore surface: finely echinulate-verrucose (WH).

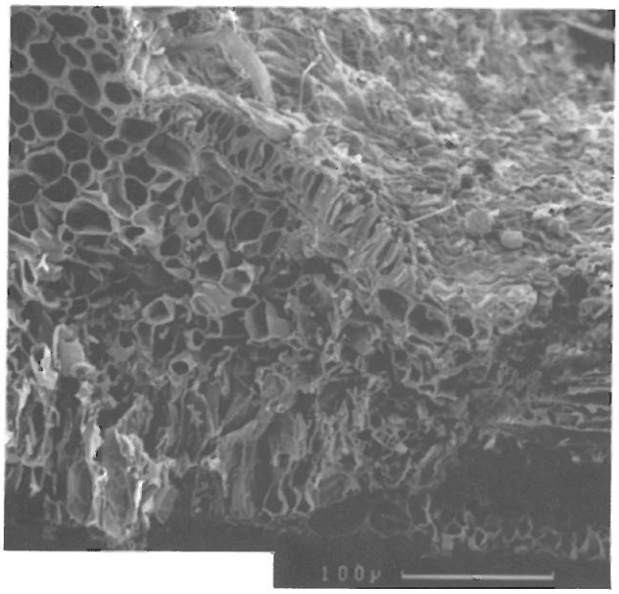
Species 19A. *Melampsora lini* var. *liniperda*: aecia and aeciospores.

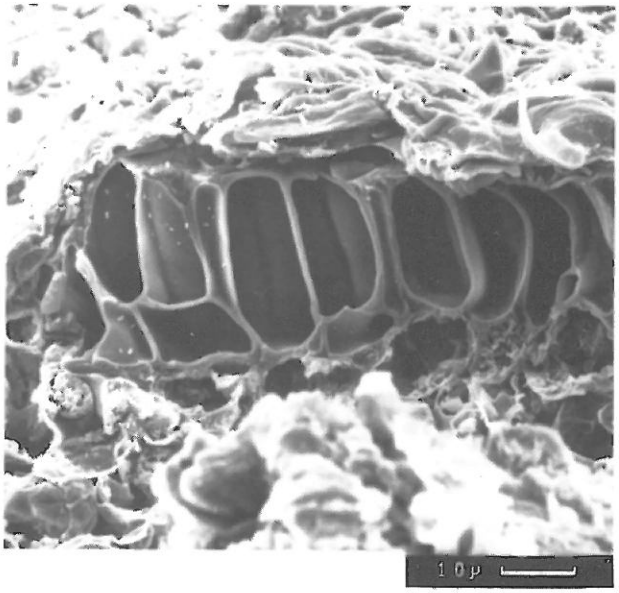




(See caption to photographs of telia and teliospores). Aeciospore surface: finely verruculose (WH).

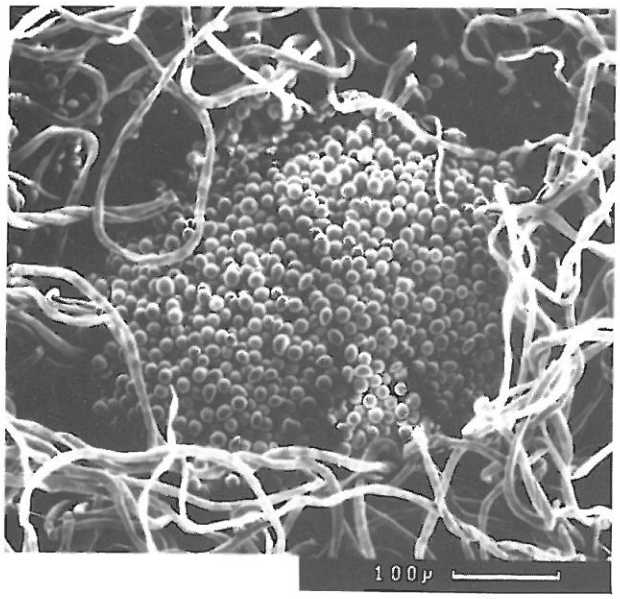
Species 20. *Melampsora populnea*: telia and teliospores.

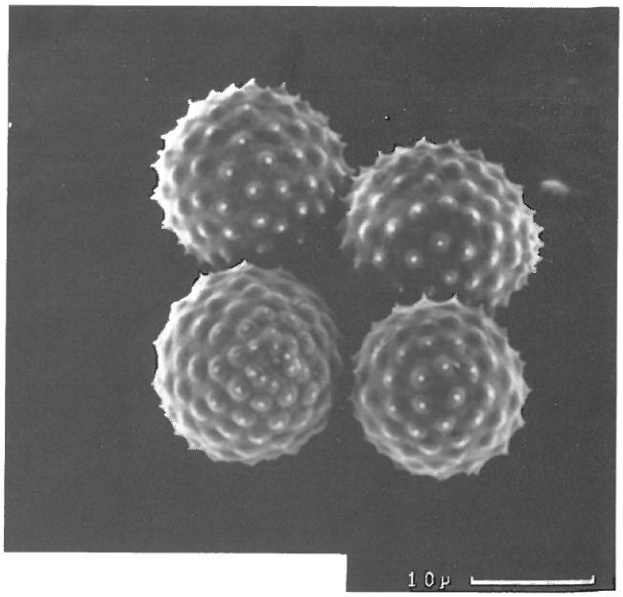




Yorks in B, 192. [A] e.g. on Mercurialis; [UT] on Populus spp. Drawing of U and T WH 75; Descriptions in EE (A) 181 and UT on 190. Teliospore surface: smooth (WH).

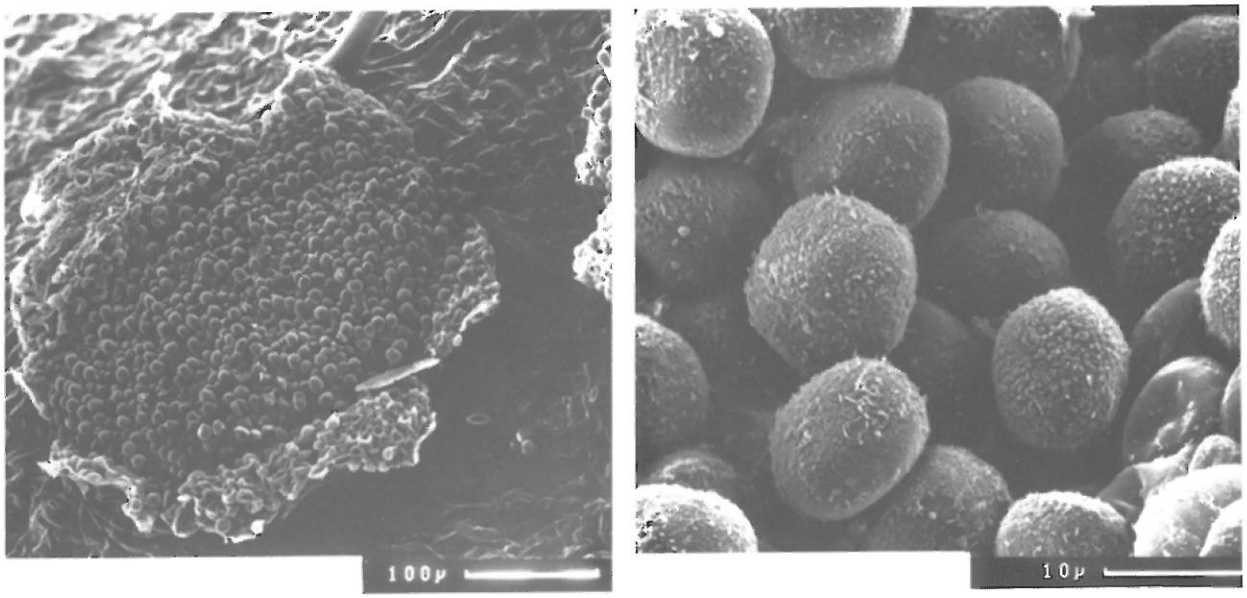
Species 20. *Melampsore populnea*: uredinia and urediniospores.





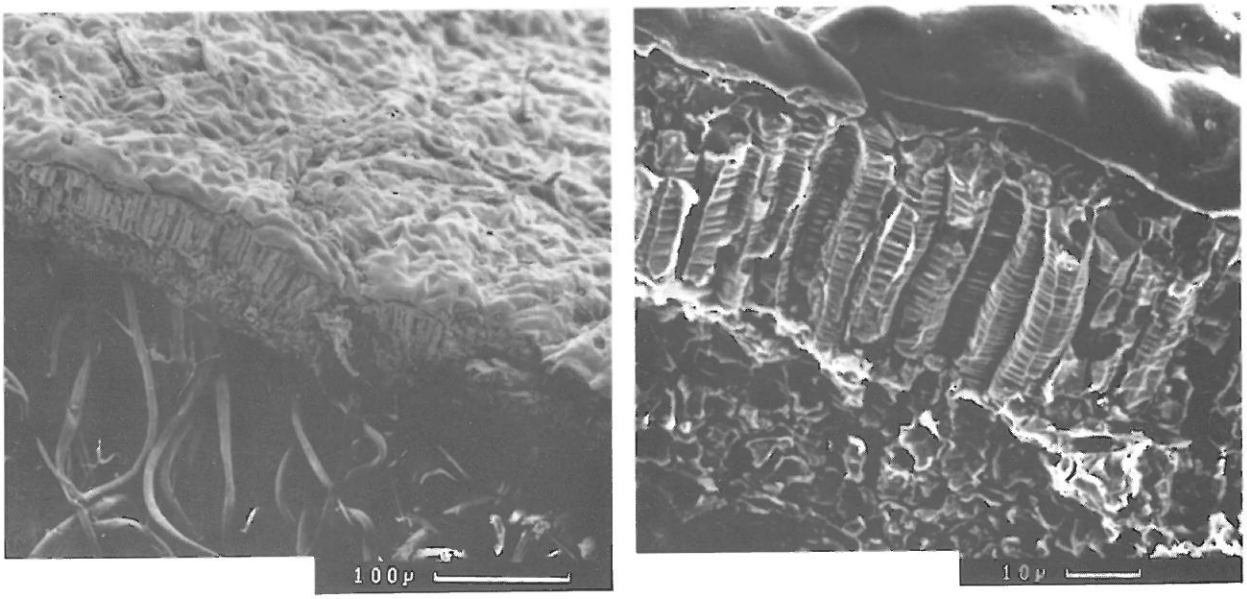
(See caption to photographs of telia and teliospores). Urediniospore surface: stout, rather distant spines about 2μm apart (WH), echinulate (EE).

Species 20. *Melampsora populnea*: aecia and aeciospores.



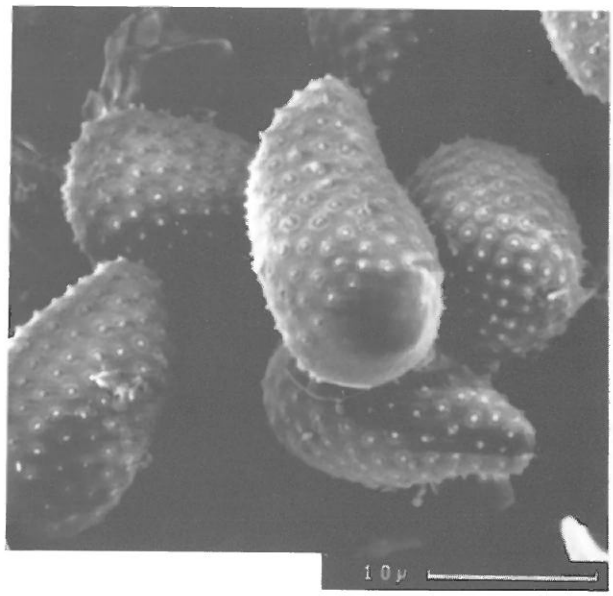
(See caption to photographs of telia and teliospores). Aeciospore surface: finely and densely verruculose (WH), minutely verruculose (EE).

Species 21. *Melampsora salicis-albae*: telia and teliospores.



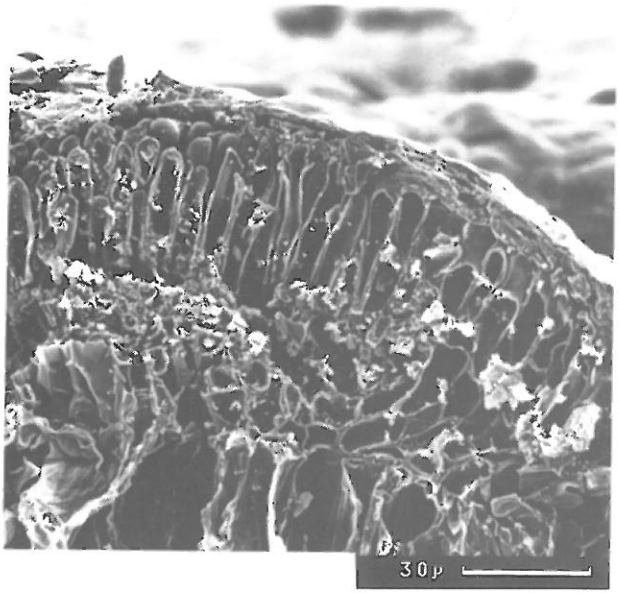
Yorks in B, 192. [UT] on *Salix alba*. Descriptions WH 91 and EE 244. Teliospore surface: presumably smooth. All teliospores examined by SEM have a curious wrinkled surface.

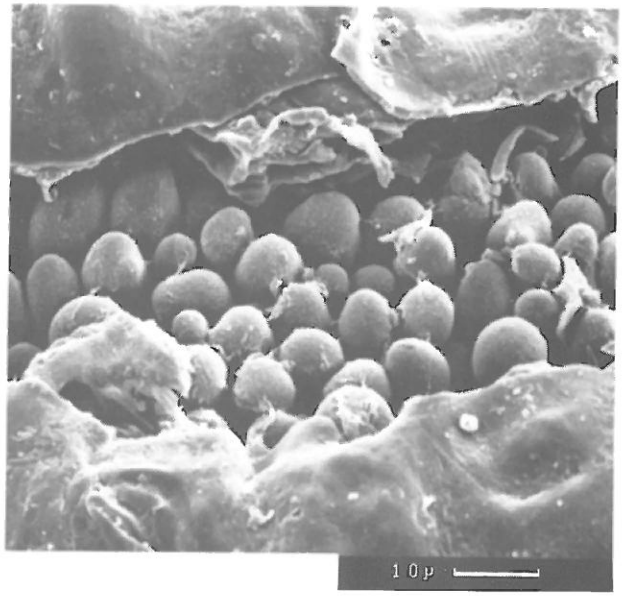
Species 21. *Melampsora salicis-albae*: uredinia and urediniospores.



(See caption to photographs of telia and teliospores). Urediniospore surface: smooth above, distinctly echinulate below (WH), smooth towards the apex (EE).

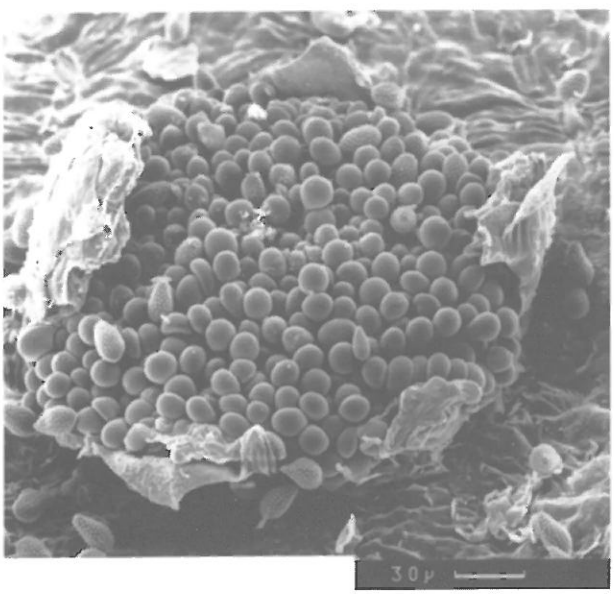
Species 22A. *Melampsora larici-populina*: telia and teliospores.

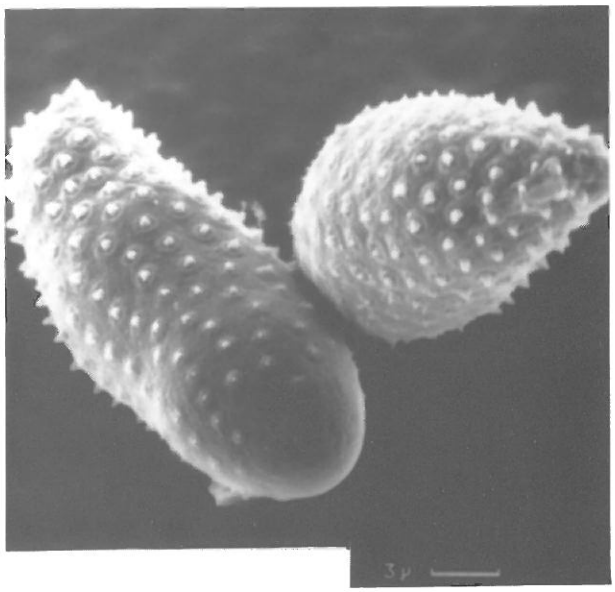




Yorks not in B; [UT] on Populus spp. WH73 with drawings of U and T. Descriptions in EE 154 and 190 (U and T). Subepidermal teliospores. A not found in Britain.

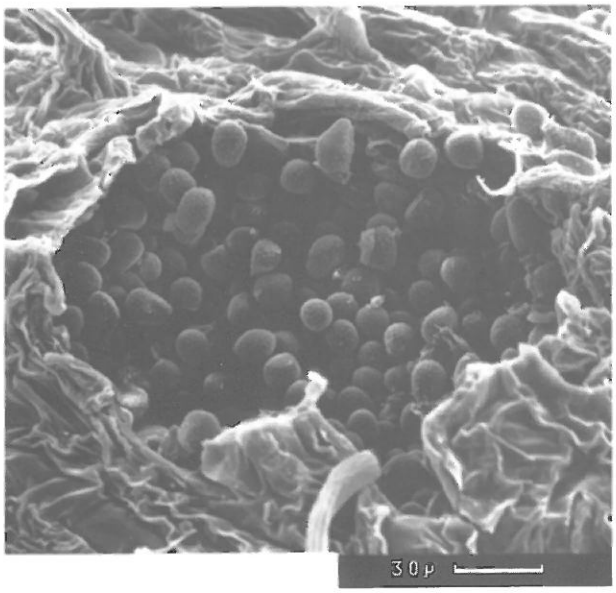
Species 22A. *Melampsora larici-populina*: uredinia and urediniospores.

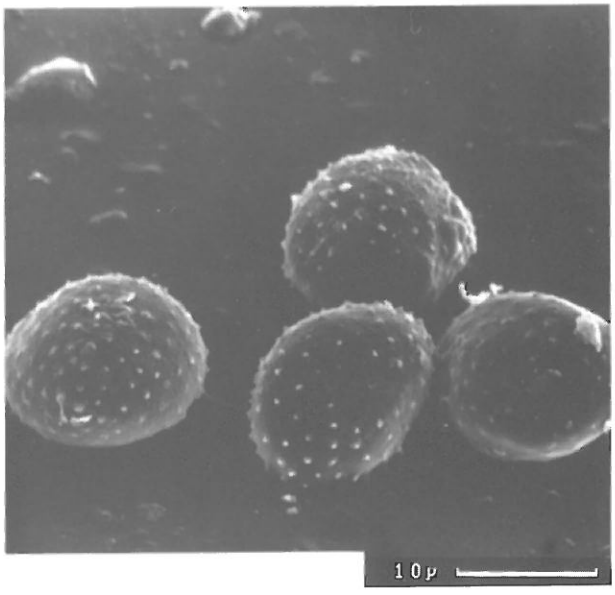




(See caption to photographs of telia and teliospores). (Urediniospore surface: Echinulate except at the smooth apex (WH, EE).

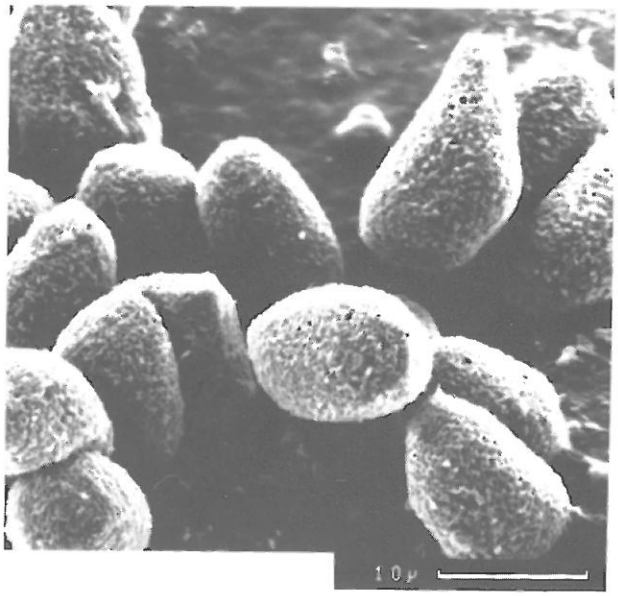
Species 23. *Melampsorella caryophyllacearum*: uredinia and urediniospores.





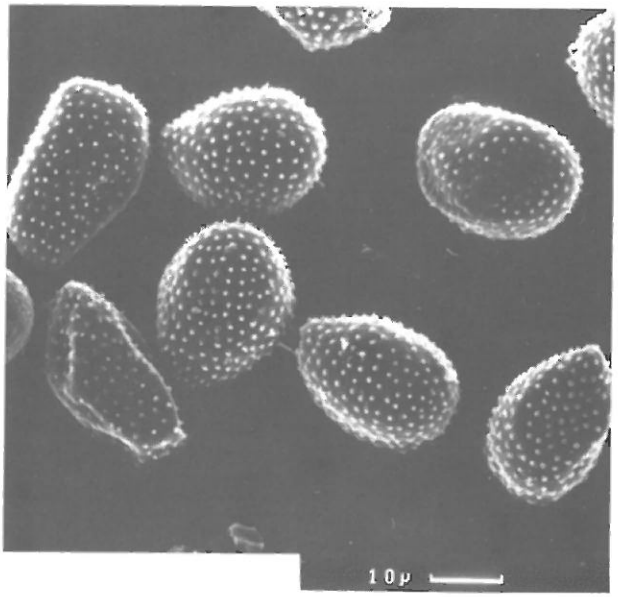
Yorks B 192 [A] on Abies spp; [UT] on, e.g. *Cerastium tomentosum*. WH43 has drawings of U only. EE 75 (A) and 329 (U and T). (Small intra-epidermal teliospores not suitable for SEM). Urediniospore surface sparsely echinulate (WH), sparingly echinulate (EE).

Species 23. *Melampsorella caryophyllacearum*: aecia and aeciospores.



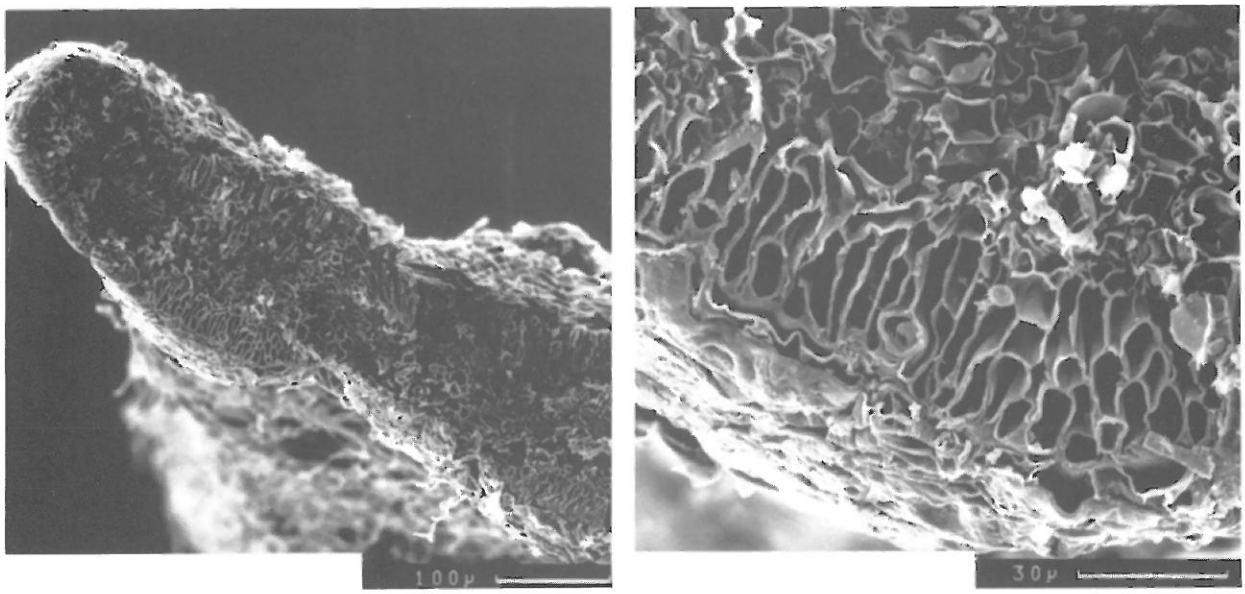
(See caption to photographs of uredinia and urediniospores). Aeciospore surface: verruculose (EE). Densely verruculose (WH).

Species 24. *Melampsorella symphyti*: uredinia and urediniospores.



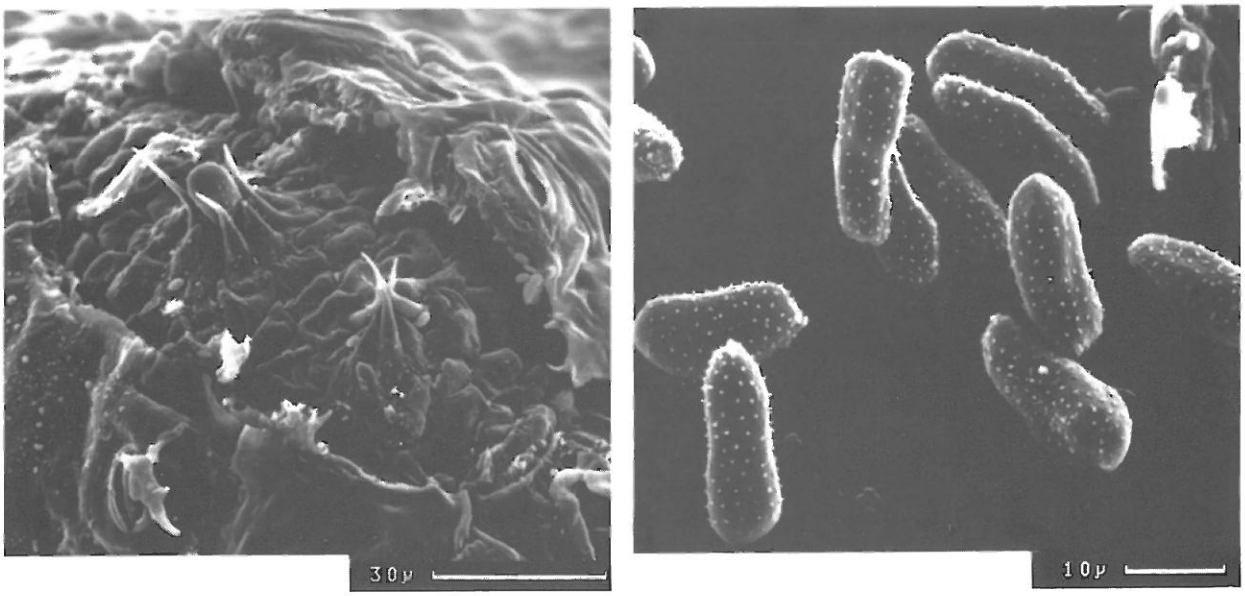
Yorks B 192 [UT] on Symphytum spp. WH46 has drawings of U only. Description in EE 431 (U and T). Teliospores 1-celled, within single epidermal cells and possibly seen only once. A not yet found in Britain. Urediniospore surface: sparsely and coarsely echinulate (EE).

Species 25. *Melampsoridium betulinum*: telia and teliospores.



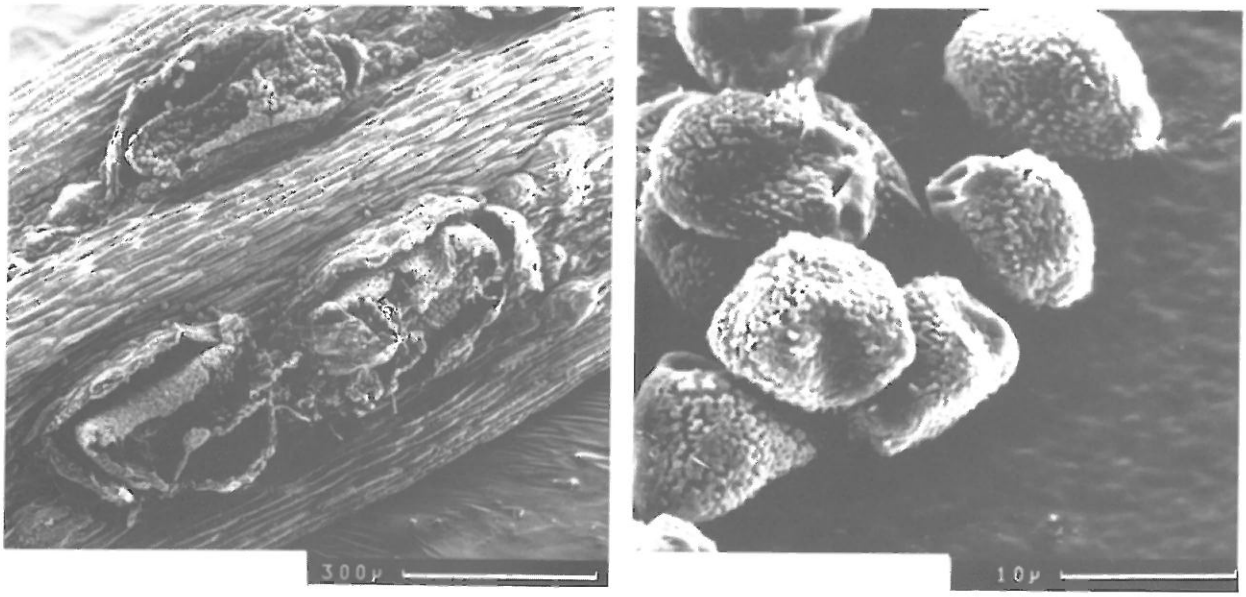
Yorks in B 192. [A] on Larix spp. [UT] on Betula spp. WH 49 has drawings of U and T. There are descriptions in EE 154 of (A) and 93 (U and T). Teliospore surface: smooth (WH and EE), subepidermal.

Species 25. *Melampsoridium betulinum*: uredinia and urediniospores.



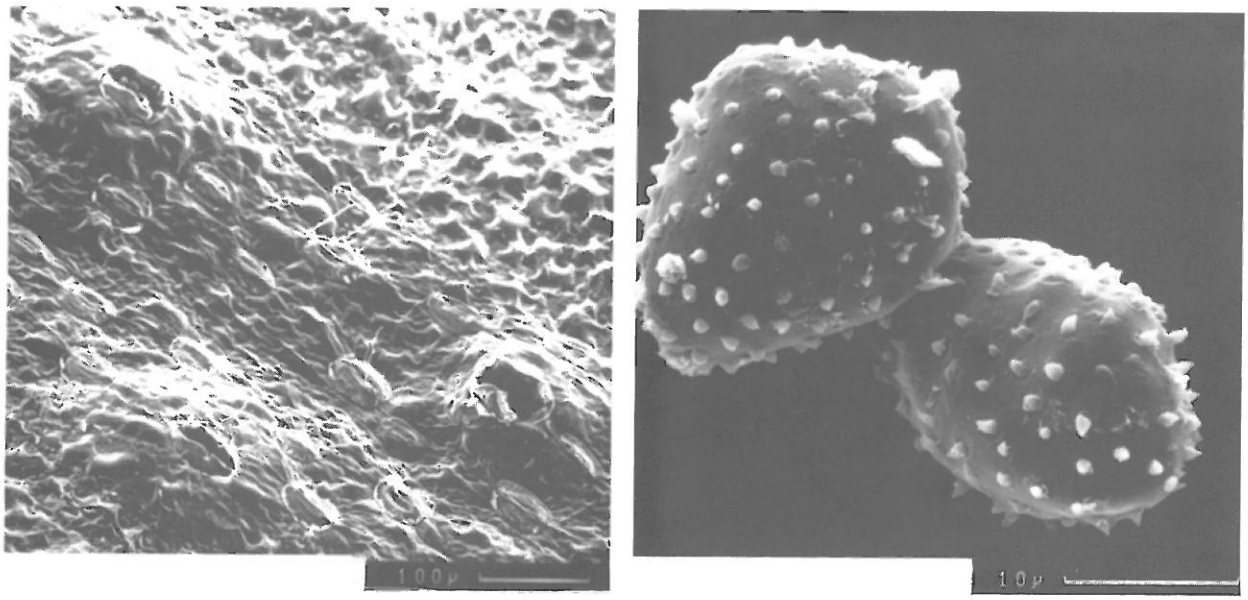
(See caption to photographs of telia and teliospores). Urediniospore surface: with distant spines but smooth at apex (WH), echinulate except near apex (EE).

Species 25. *Melampsoridium betulinum*: aecia and aeciospores.



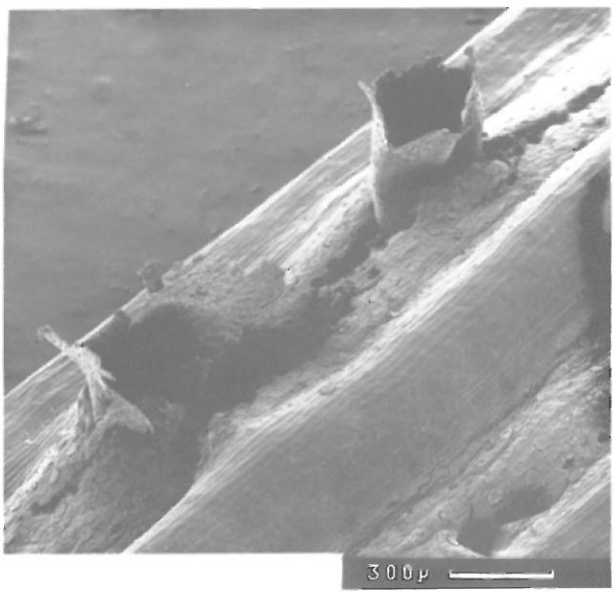
(See caption to photographs of telia and teliospores). Aeciospore surface: verruculose but with a small spot on one side (EE), finely and closely verrucose except a smooth (and slightly thinner) area on one side (WH).

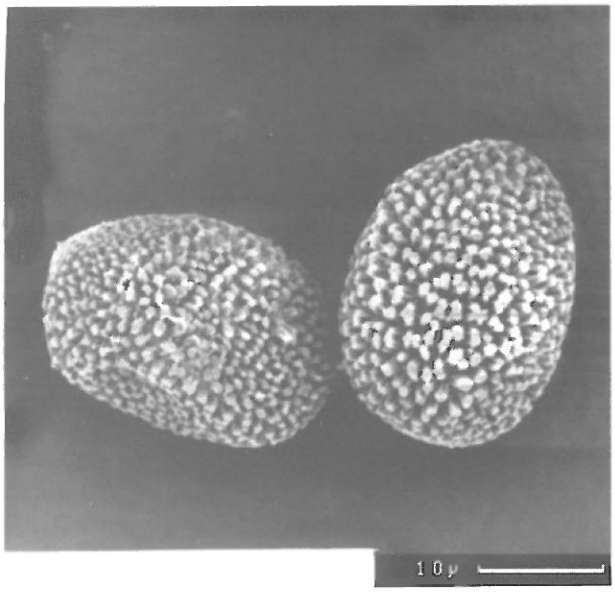
Species 26. *Milesina blechni*: uredinia and urediniospores.



Yorks B 192; [A] on Abies spp. [UT] on Blechnum spicant. WH18 has drawings of U, and EE has these in Fig. 2084. Descriptions are given in EE on p. 75 (A) and p. 562 (U and T) Urediniospore surface: with scattered rather coarse echinulations (WH), echinulate (EE).

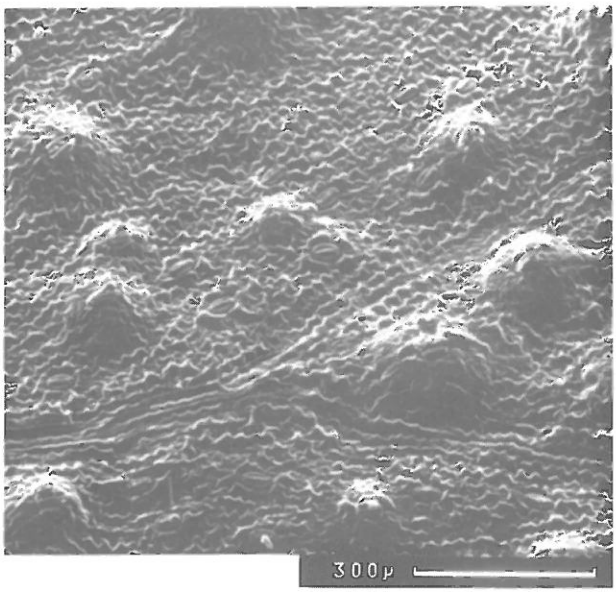
Species 26. *Milesina blechni:* aecia and aeciospores.

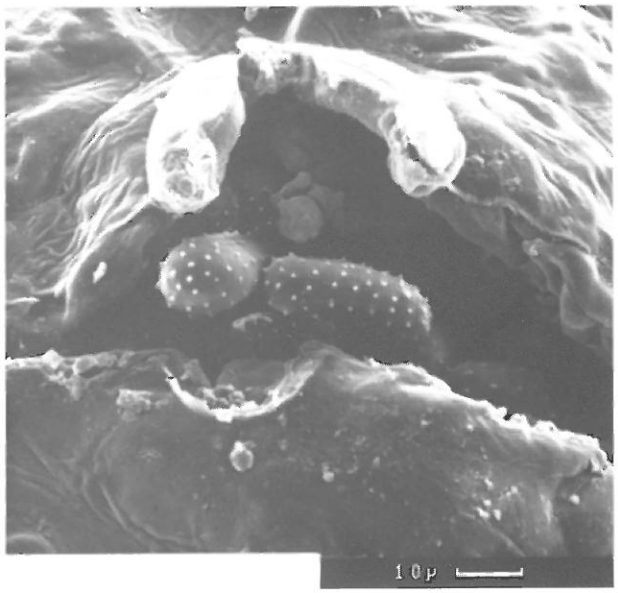




(See caption to photographs of uredinia and urediniospores). Aeciospore surface: densely and rather coarsely warted except on one side where the warts are minute (WH), verruculose with warts smaller on one side (EE).

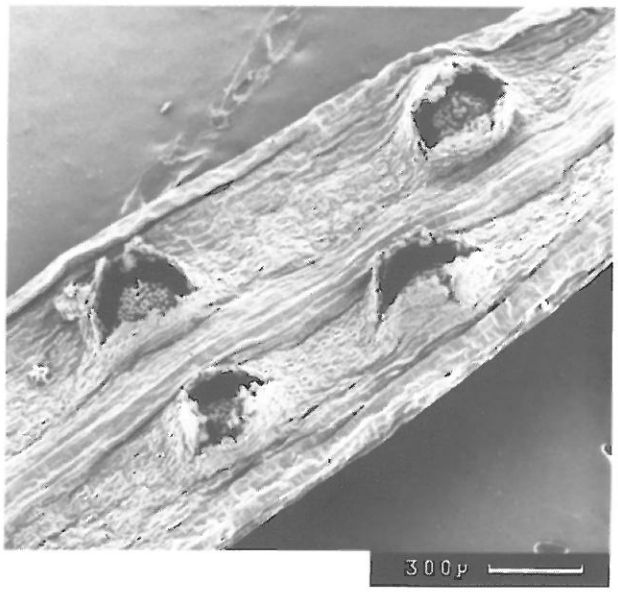
Species 27. *Milesina kriegeriana*: uredinia and urediniospores.

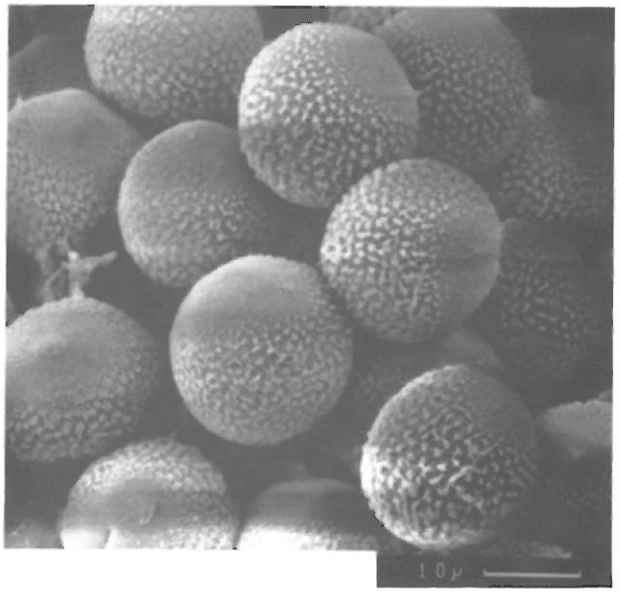




Yorks in B 192; [A] on Abies spp.; [UT] on Dryopteris spp. WH21 has drawings of U likewise EE Fig. 2086 has drawings of U and descriptions are given on p. 75 (A) and p. 563 (U and T). Teliospores intra-epidermal, 1 to 40, rounded shape often completely filling the epidermal cell. Urediniospore surface: echinulate (WH, EE).

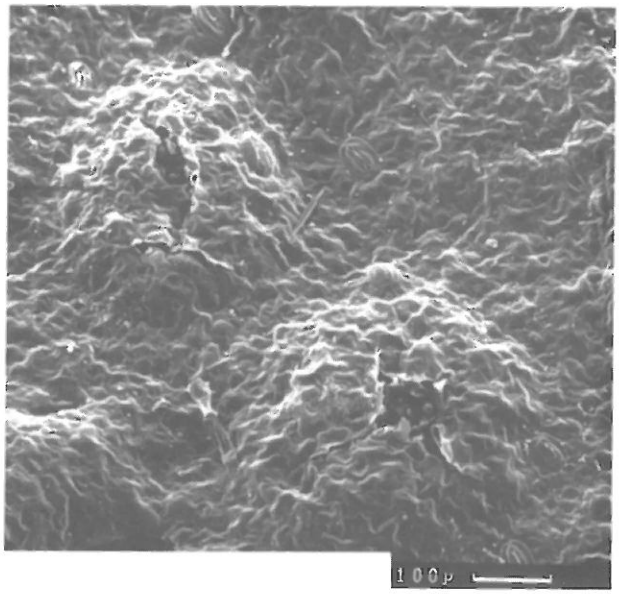
Species 27. *Milesina kriegeriana*: aecia and aeciospores.

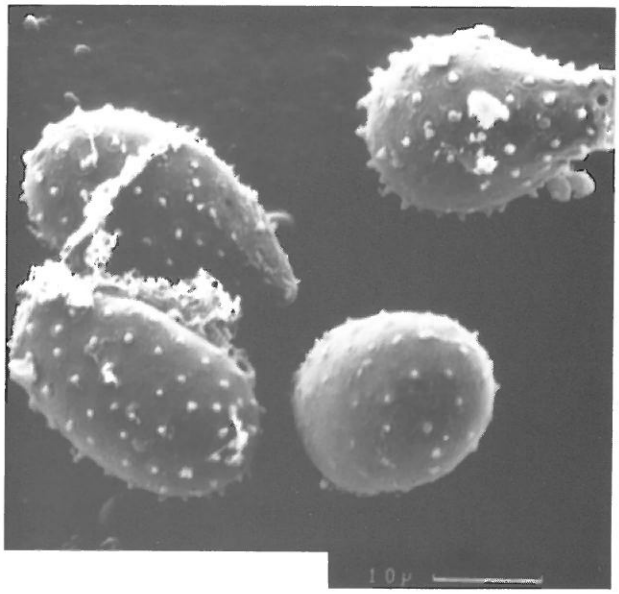




(See caption to photographs of uredinia and urediniospores). Aeciospore surface: finely warted (WH), minutely verruculose (EE).

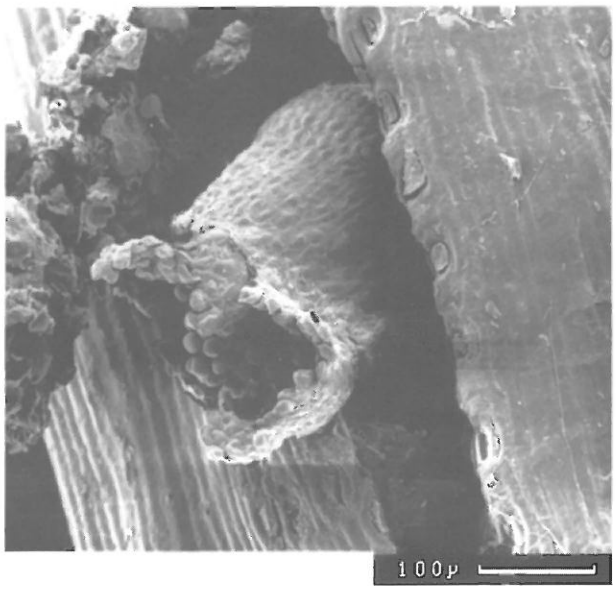
Species 27A. *Milesina scolopendrii*: uredinia and urediniospores.

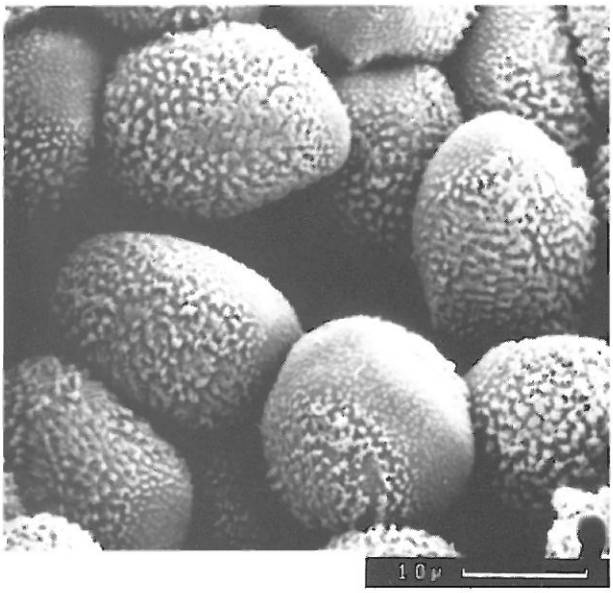




Not in B, first seen Yorkshire Naturalists Union Foray, Scarborough May 1988 (T.F. Hering). [A] on Abies spp. [UT] on *Phyllitis scolopendrium*. Drawing of U in WH 19 and EE Fig. 2098. Description in EE 566. Teliospores intra-epidermal, 1-40 celled. Teliospore surface: smooth (WH). Urediniospore surface: quite strongly and rather sparsely echinulate (WH), echinulate (EE).

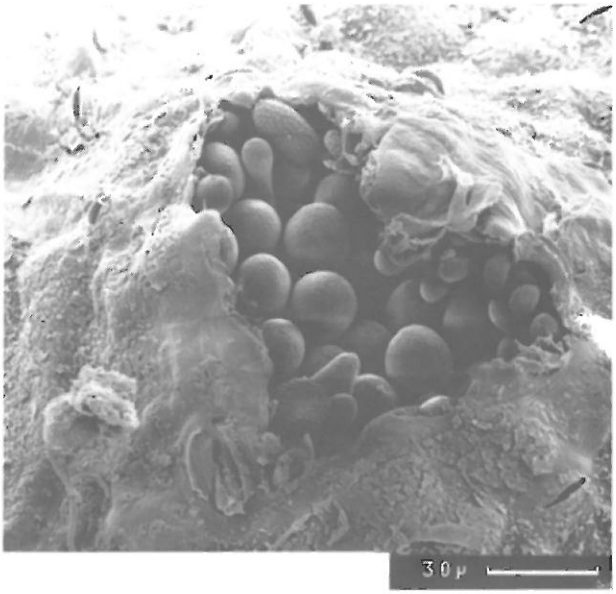
Species 27A. *Milesina scolopendrii*: aecia and aeciospores.

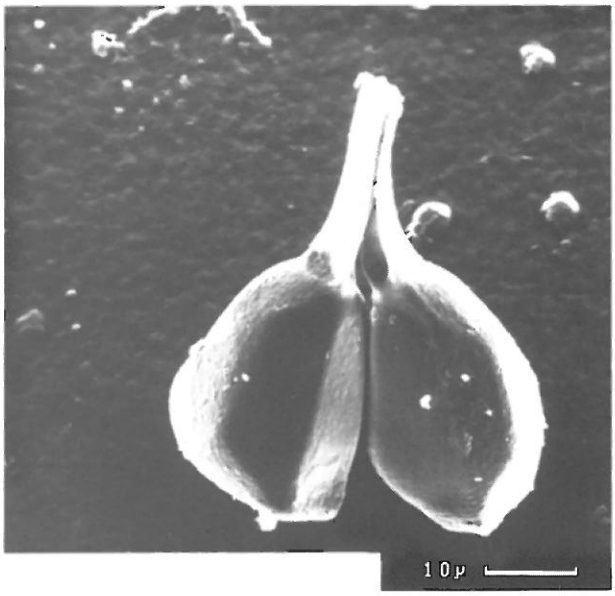




(See caption to photographs of uredinia and urediniospores). Aeciospore surface: very densely and rather coarsely verrucose with warts irregular in outline (WH).

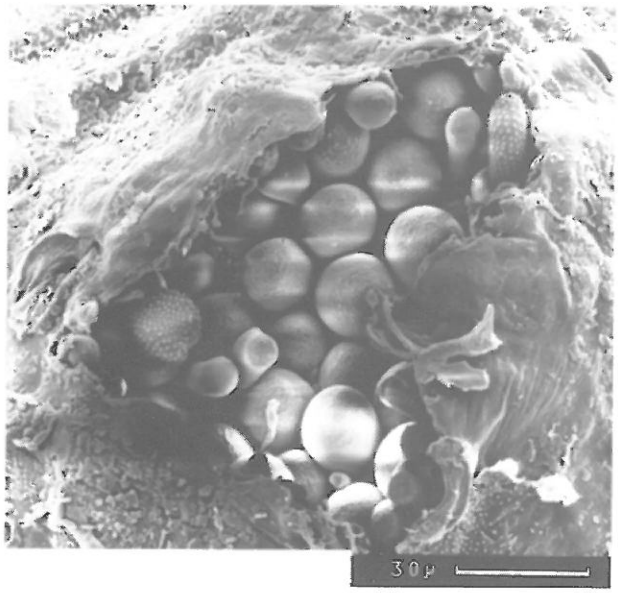
Species 28. *Miyagia pseudosphaeria*: telia and teliospores.

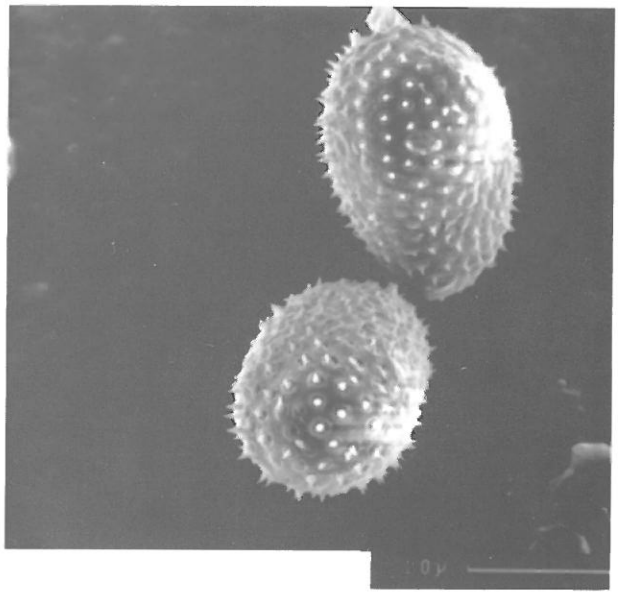




Yorks in B, 192. [UT] on Sonchus spp.; WH 298 has drawings of T (with one-celled mesospores) and thick walled paraphyses found in telia. Description EE428. Teliospore surface: smooth. A only produced artificially, on same host (WH, EE).

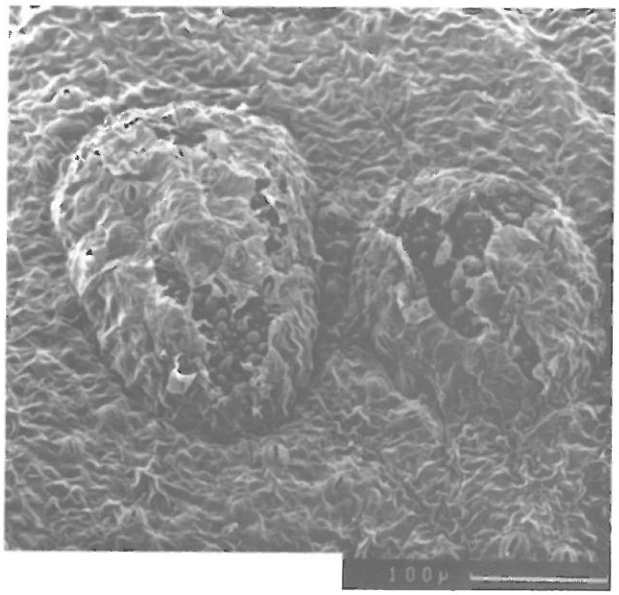
Species 28. *Miyagia pseudosphaeria*: uredinia and urediniospores.

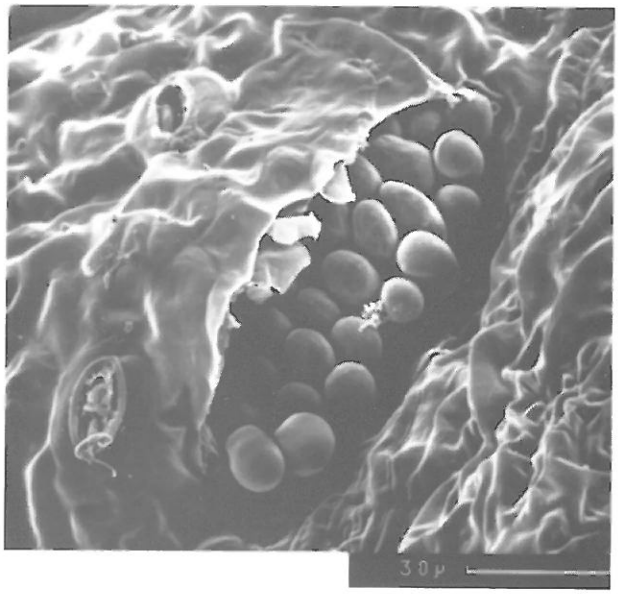




(See caption to photographs of telia and teliospores). Urediniospores surface: densely verrucose (WH), verruculose (EE).

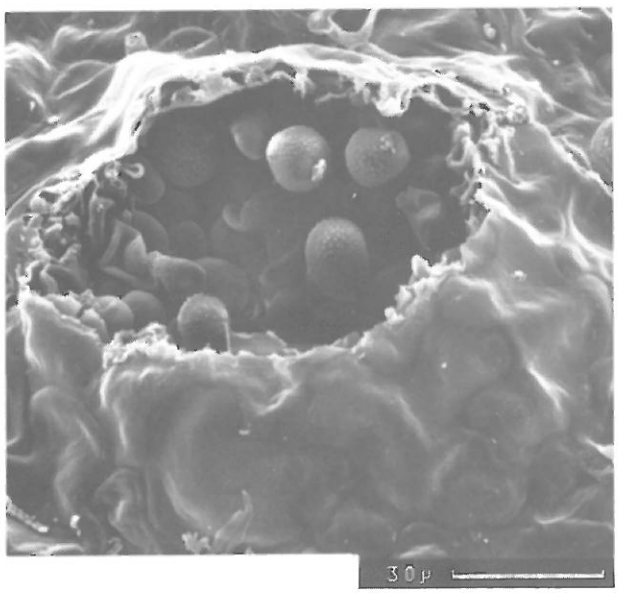
Species 29. *Ochropsora airae*: telia and teliospores.

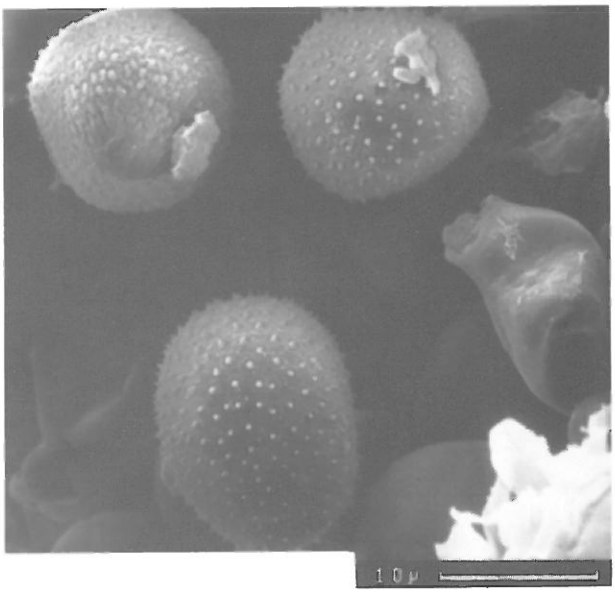




Yorks in B, 192, [A] on *Anemone nemorosa*; [UT] on *Sorbus aucuparia*; WH 11 has drawing of T. Description in EE 307 (A) and 255 (U and T). Teliospore surface: smooth (WH).

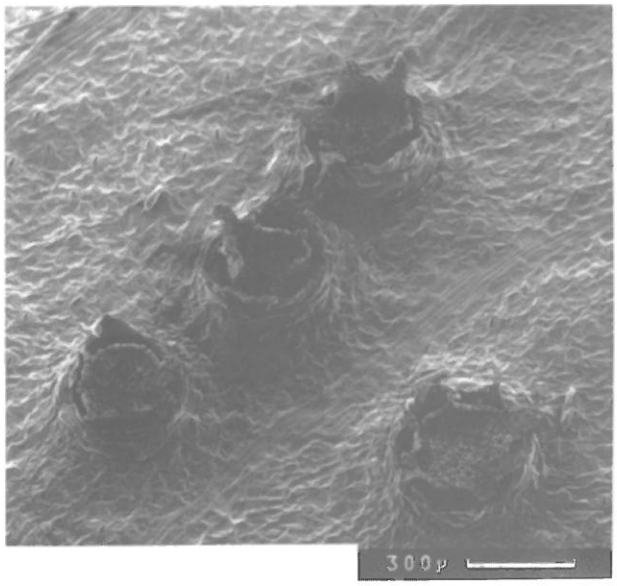
Species 29 *Ochropsora airae*: uredinia and urediniospores.

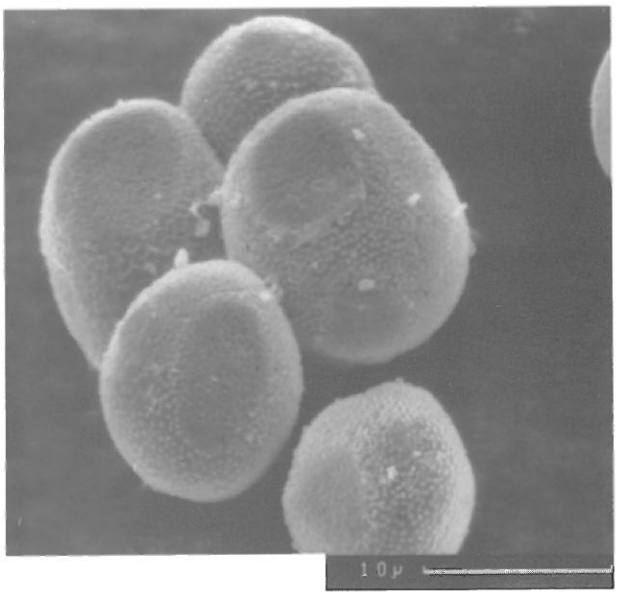




(See caption to photographs of telia and teliospores). Urediniospore surface: distantly verruculose or verruculose-echinulate (WH), verruculose (EE).

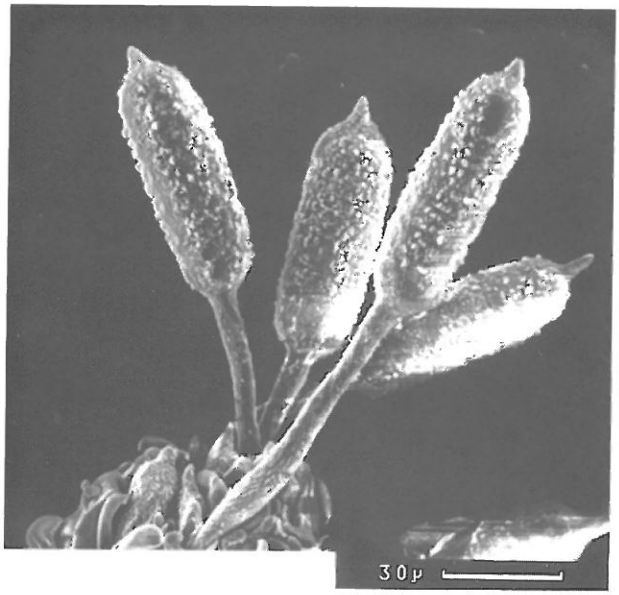
Species 29. *Ochropsora airae*: aecia and aeciospores.





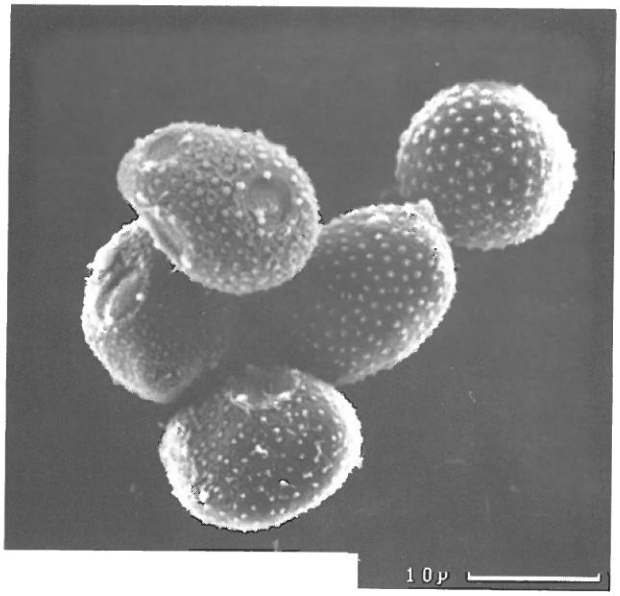
(See caption to photographs of telia and teliospores). Aeciospore surface: densely and delicately verruculose (WH), finely verruculose (EE).

Species 30. *Phragmidium bulbosum*: telia and teliospores.



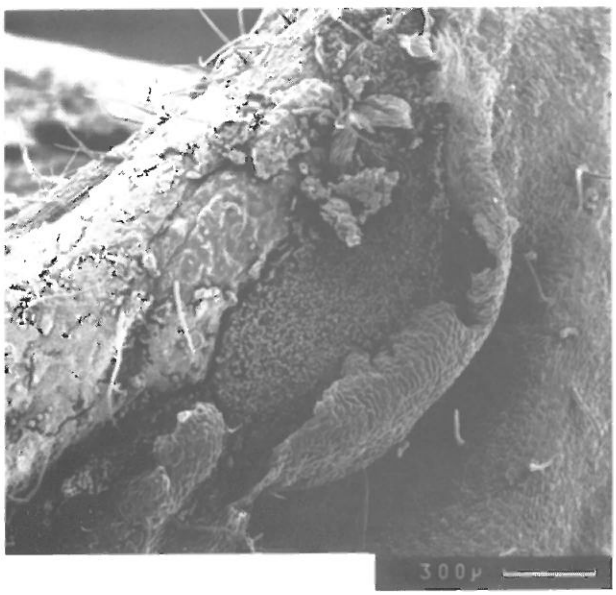
Yorks in B, 192. [AUT] on, e.g. *Rubus fruticosus*; WH95 has drawing of A, U, and T, EE Fig. 1046 is of U and T. (Description EE 231.) Drawings and description, A.U and T CMID 203. Teliospore surface: coarsely warted (WH), (CMID).

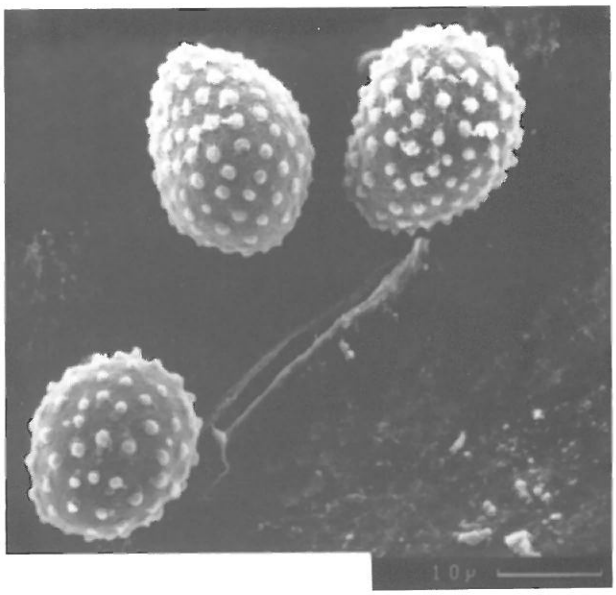
Species 30. *Phragmidium bulbosum*: uredinia and urediniospores.



(See caption to photographs of telia and teliospores). Urediniospore surface: sparingly and rather distantly echinulate (WH), echinulate, the spines 1.25 - 2μm apart and × *c*.0.5μm high, 1.25 - 2 μm thick (CMID).

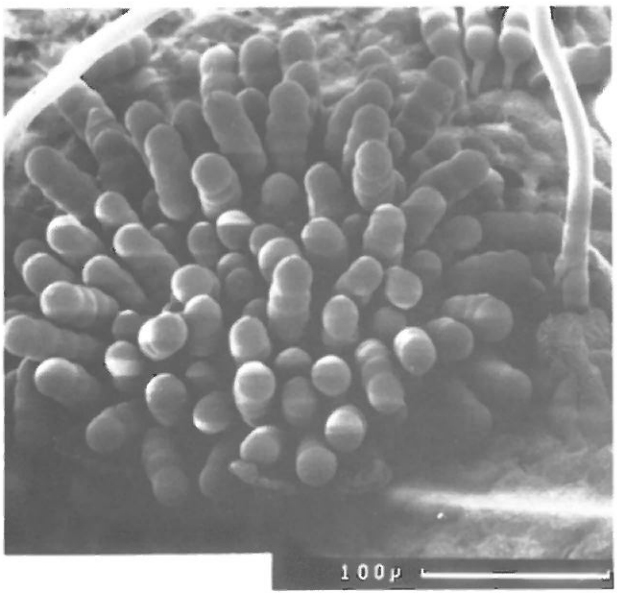
Species 30. *Phragmidium bulbosum*: aecia and aciospores.

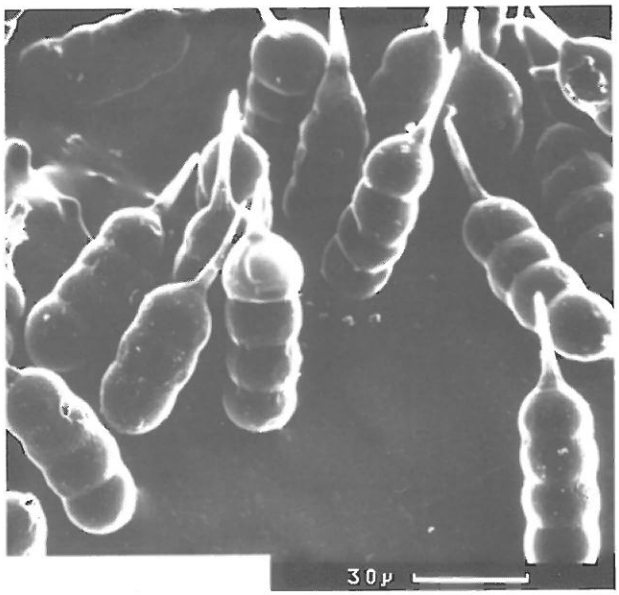




(See caption to photographs of telia and teliospores). Aeciospore surface: a few, rather large and irregular, flat, crowded warts (WH), coarsely verrucose with shallow warts up to 3μm diam. (CMID).

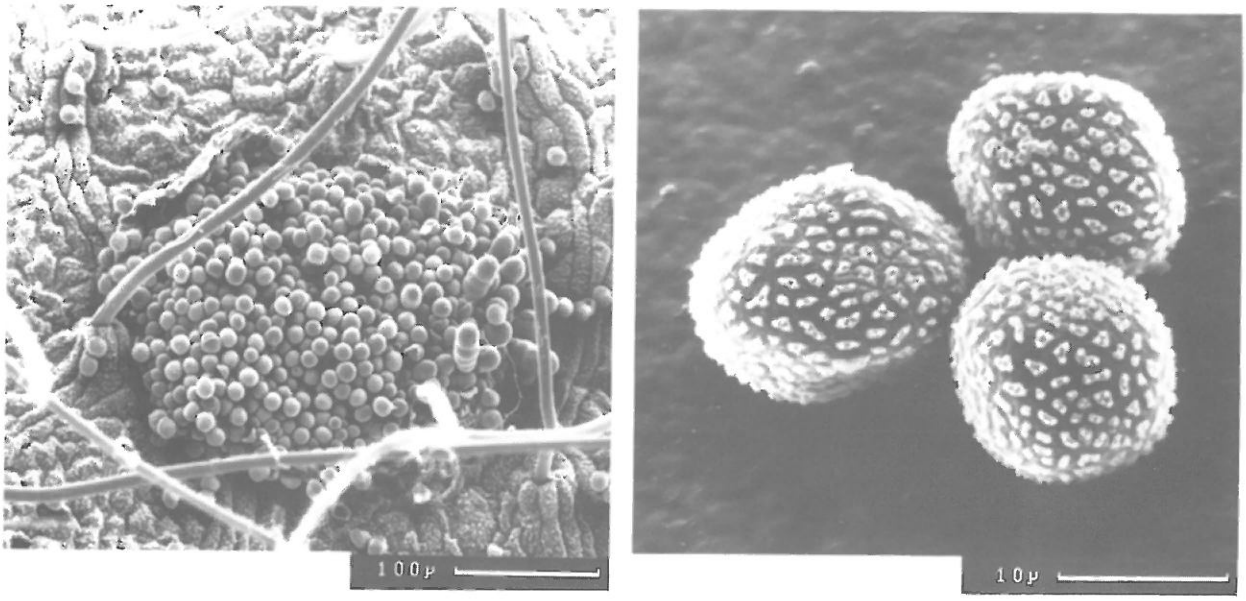
Species 31. *Phragmidium fragariae*: telia and teliospores.





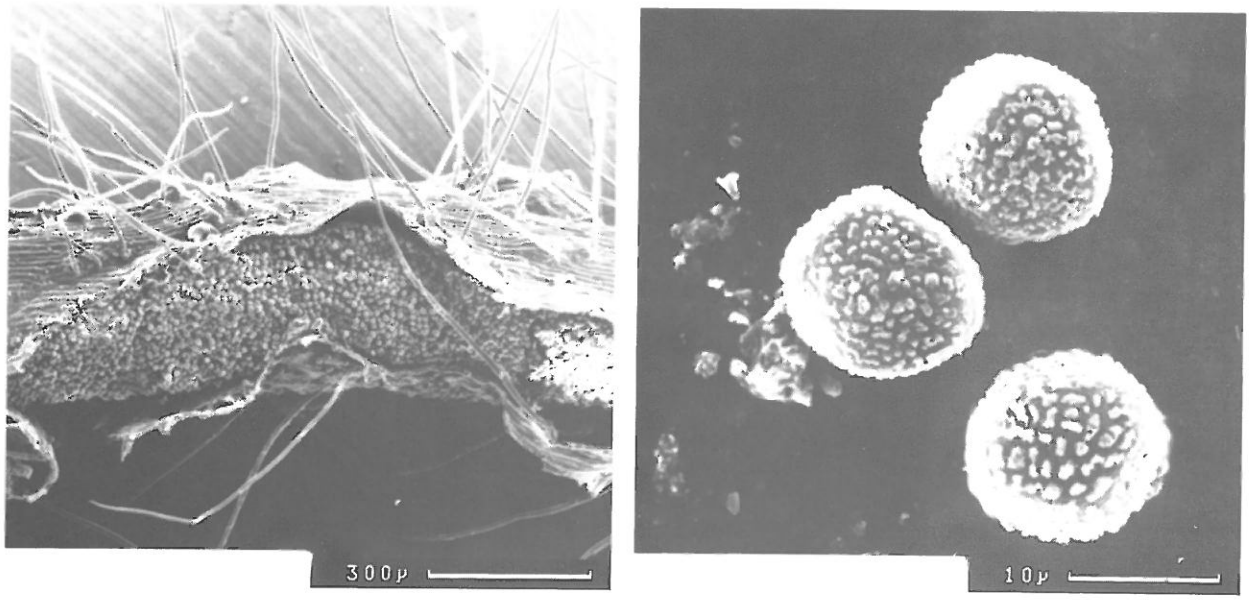
Yorks in B, 192. [AUT] on *Potentilla sterilis*. WH 100 has drawings of AU and T. EE has drawing of T and U in Fig. 1625, with descriptions on 406. Teliospore surface: generally quite smooth (WH).

Species 31. *Phragmidium fragariae*: uredinia and urediniospores.



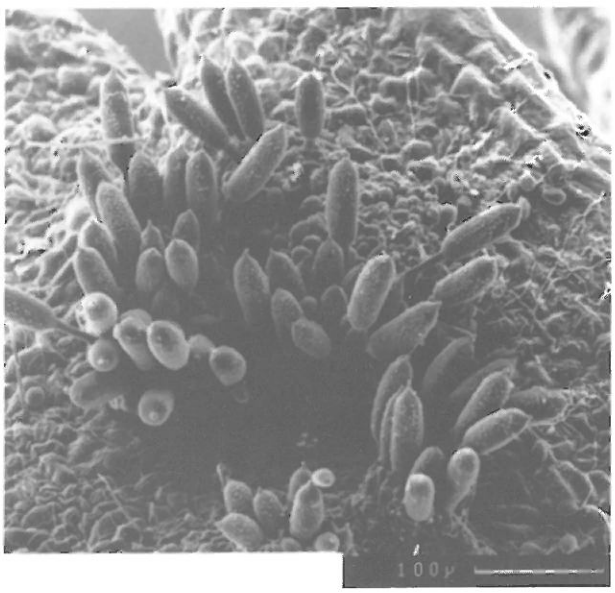
(See caption to photographs of telia and teliospores). Urediniospore surface: densely verrucose (WH), verrucose (EE).

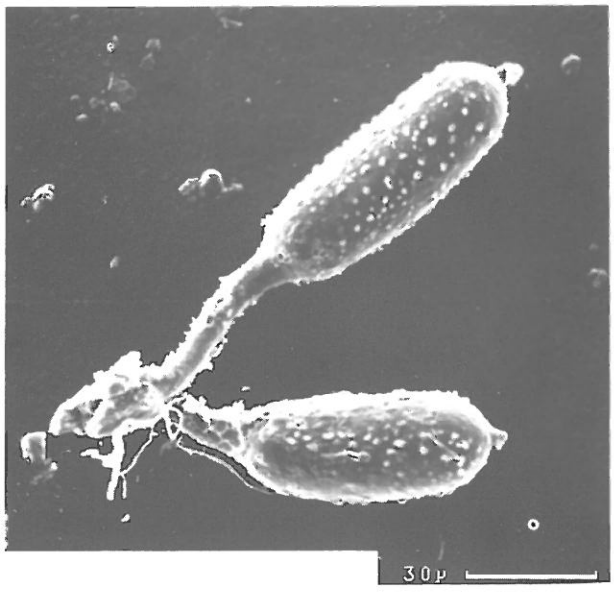
Species 31. *Phragmidium fragariae*: aecia and aeciospores.



(See caption to photographs of telia and teliospores). Aeciospore surface: densely verrucose (WH).

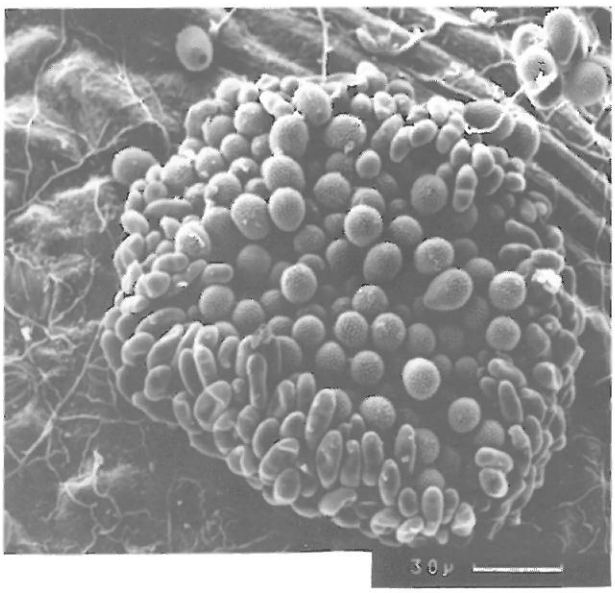
Species 32. *Phragmidium mucronatum*: telia and teliospores.

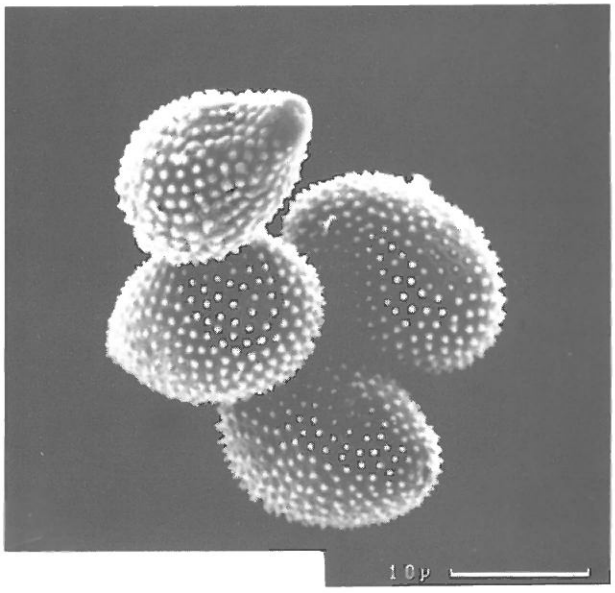




Yorks in B, 192. [AUT] on Rosa spp. WH 104 has drawings of A, U, and T. EE has drawings of U and T in Fig. 1032 and descriptions on 228. More drawings CMID 204. Teliospore surface: coarsely verrucose with almost hyaline tubercles (WH).

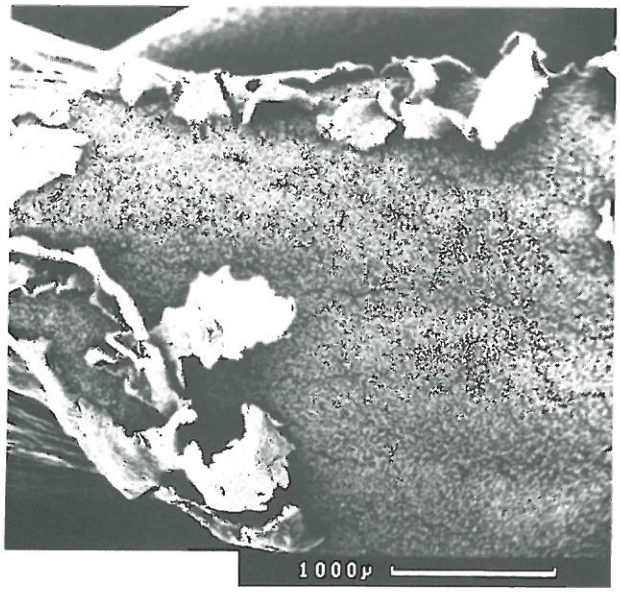
Species 32. *Phragmidium mucronatum*: uredinia and urediniospores.





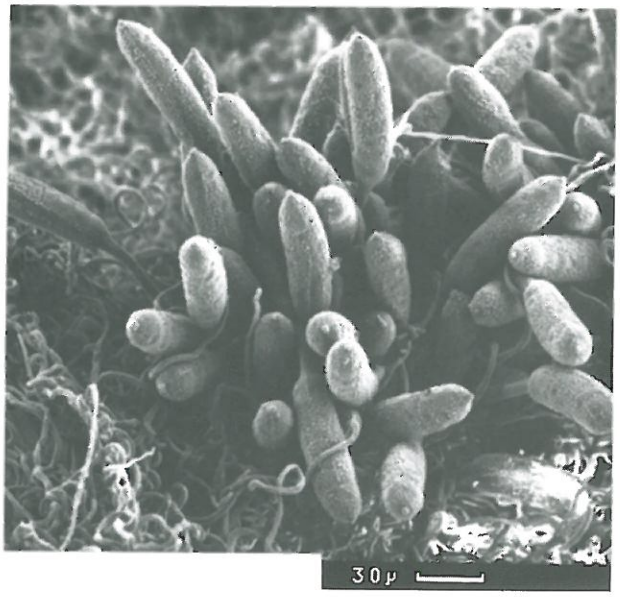
(See caption to photographs of telia and teliospores). Urediniospore surface: closely echinulate (WH), finely echinulate (EE), echinulate, the spines 1-2 μm apart × 0.5 μm high, 1.25- 2 μm thick (CMID).

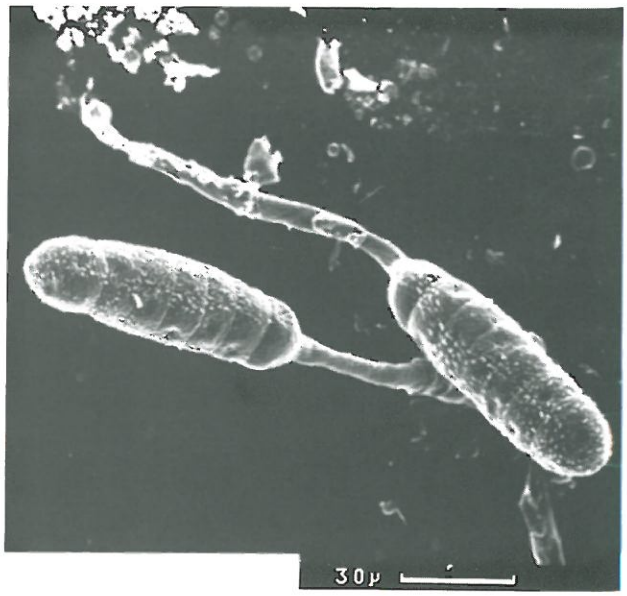
Species 32. *Phragmidium mucronatum*: aecia and aeciospores.



(See caption to photographs of telia and teliospore). Aeciospore surface: finely and distantly verruculose-echinulate (WH), echinulate, the spines 2-3 μm apart and x 0.5 μm high, 1.25 μm thick (CMID).

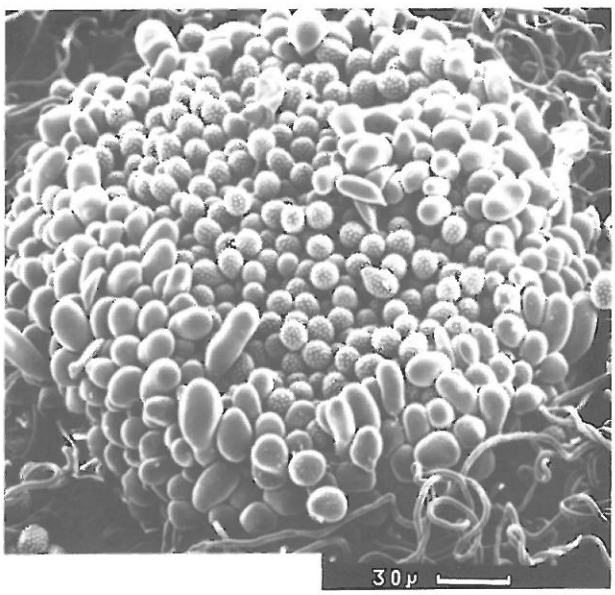
Species 33. *Phragmidium rubi-idaei*: telia and teliospores.

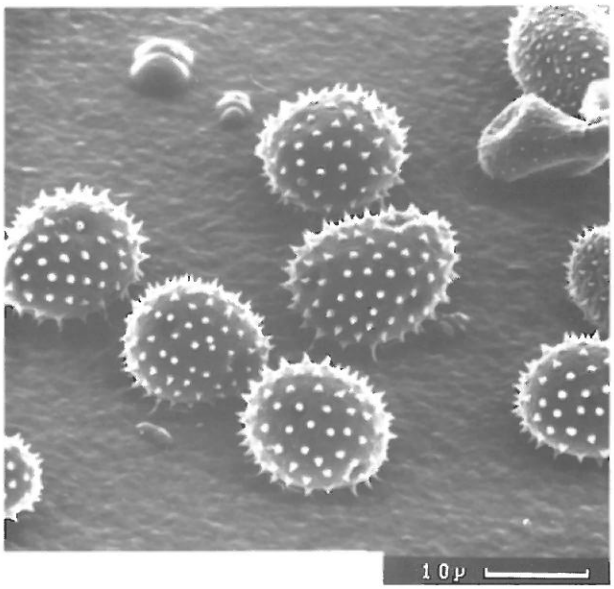




Yorks in B, 192. [AUT] on *Rubus idaeus*. WH 96 has drawing of T only. EE has a drawing of T in Fig. 1047 with description on 231. CMID No. 207 has drawing of AU and T. Teliospore surface: coarsely verrucose (WH), coarsely warted (CMID).

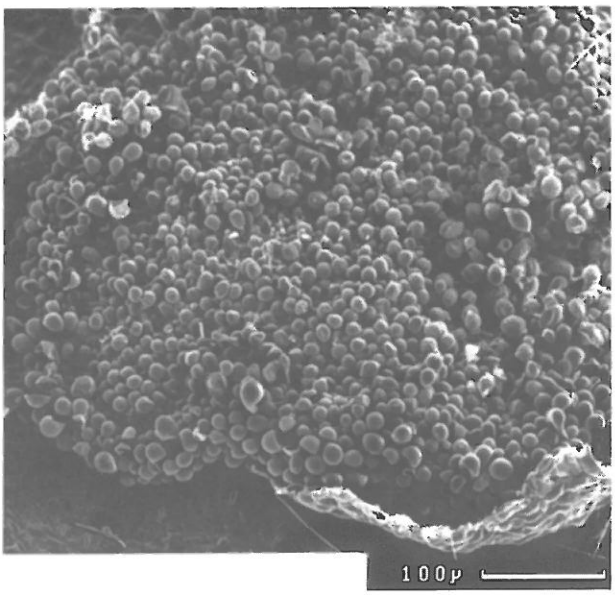
Species 33. *Phragmidium rubi-idaei*: uredinia and urediniospores.

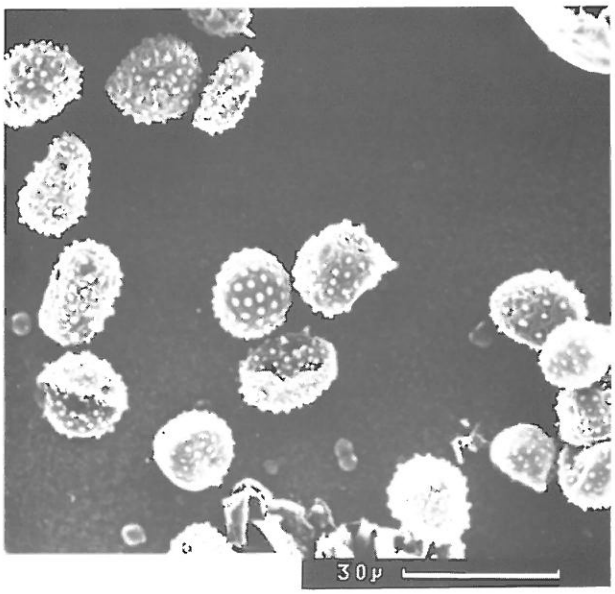




(See caption to photographs of telia and teliospores). Urediniospore surface: sparsely echinulate (WH), echinulate, the spines 2-3.5 μm apart × 0.5 -1 μm high, 1.25-1.5 μm thick (CMID).

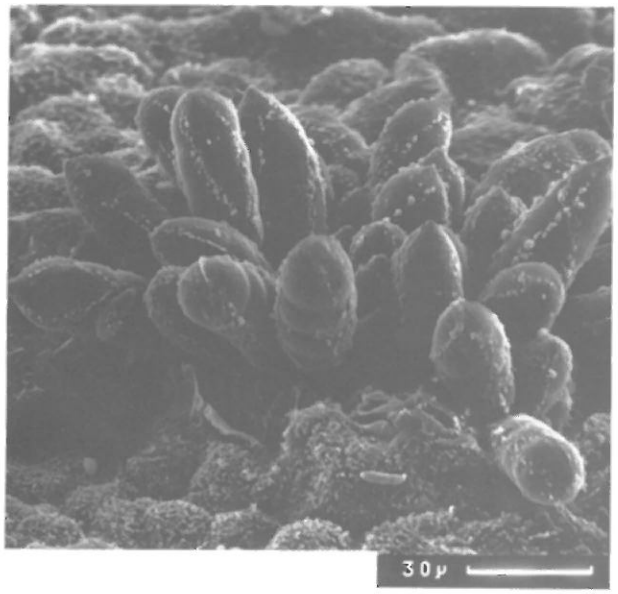
Species 33. *Phragmidium rubi-idaei*: aecia and aeciospores.

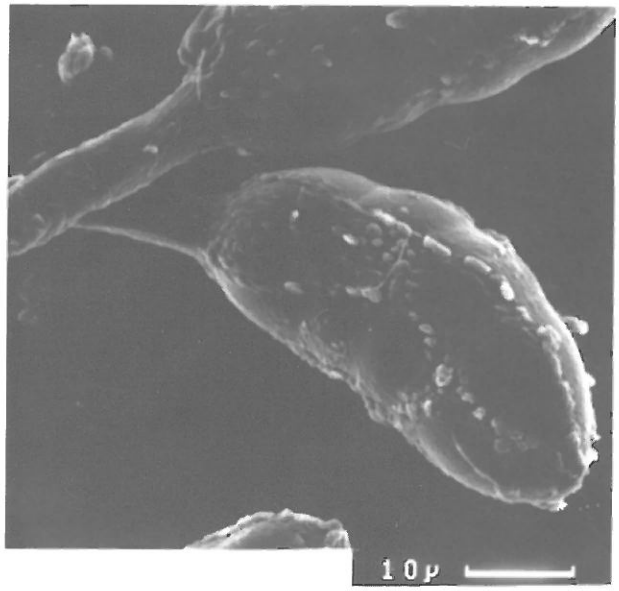




(See caption to photographs of telia and teliospores). Aeciospore surface: sparsely echinulate (WH), (CMID) spines 3 - 5 μm apart × 1 - 1.5 μm high, uneven (CMID).

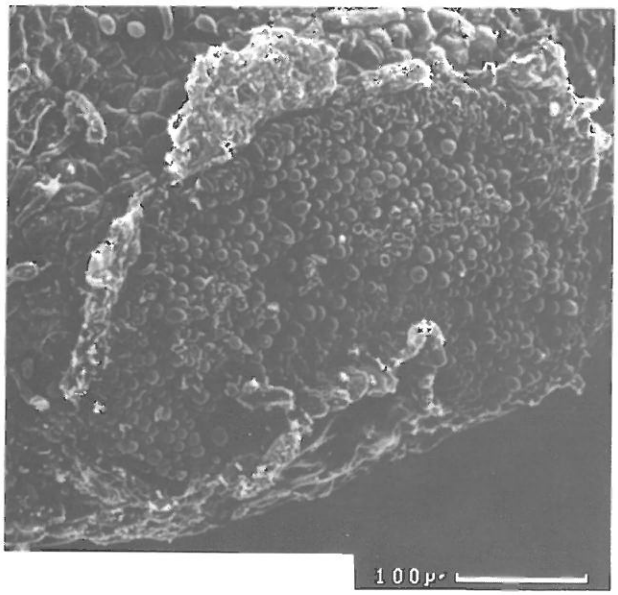
Species 34. *Phragmidium sanguisorbae*: telia and teliospores.

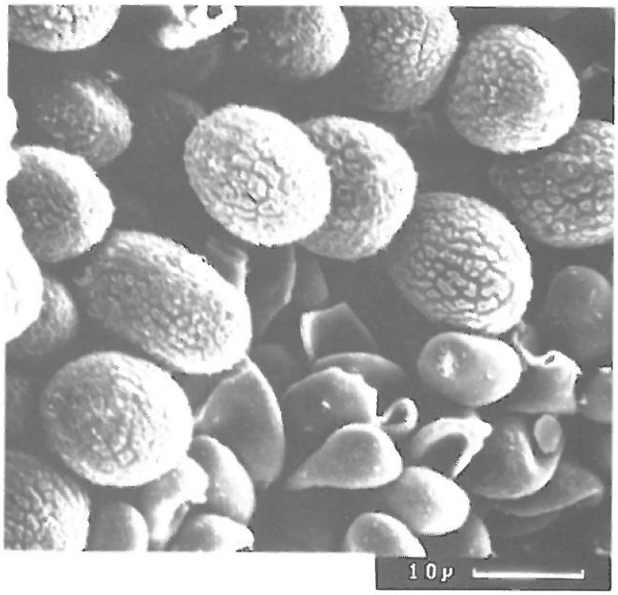




Yorks in B, 192. [AUT] on, e.g. *Poterium sanguisorba*. WH 102 has drawings of T and U and there is a description in EE 407. Teliospore surface: minute scattered warts (WH).

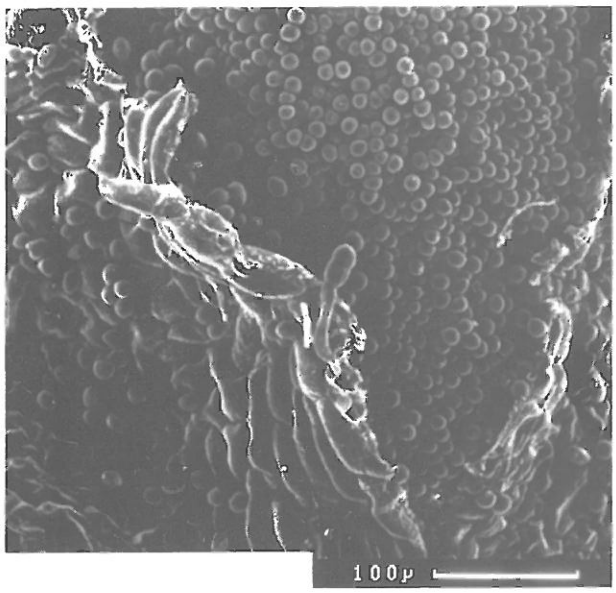
Species 34. *Phragmidium sanguisorbae* uredinia and urediniospores.





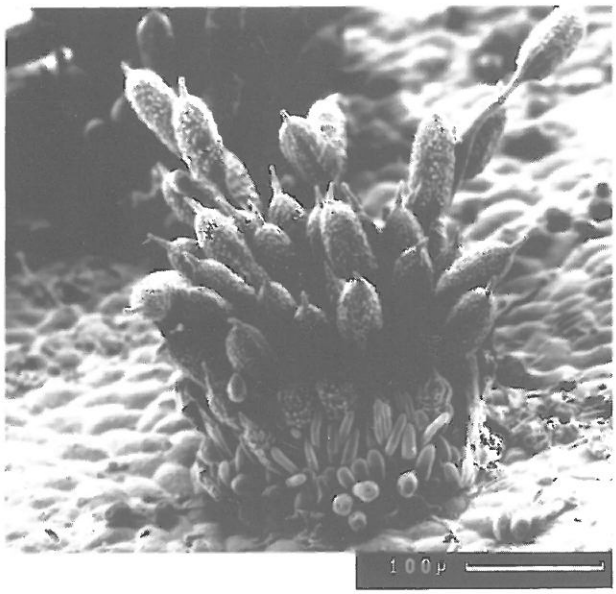
(See caption to photographs of telia and teliospores). Urediniospore surface: echinulate (WH). Examination of many specimens has failed to reveal an echinulate surface on urediniospores.

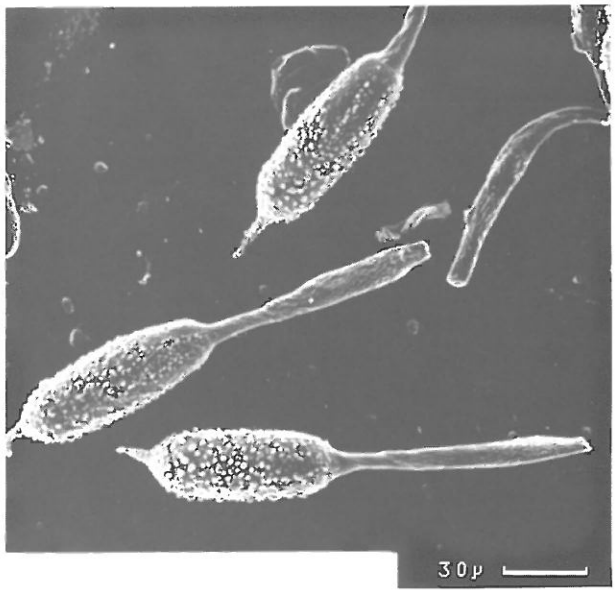
Species 34. *Phragmidium sanguisorbae*: aecia and aeciospores.



(See caption to photographs of telia and teliospores). Aeciospore surface: densely verrucose.

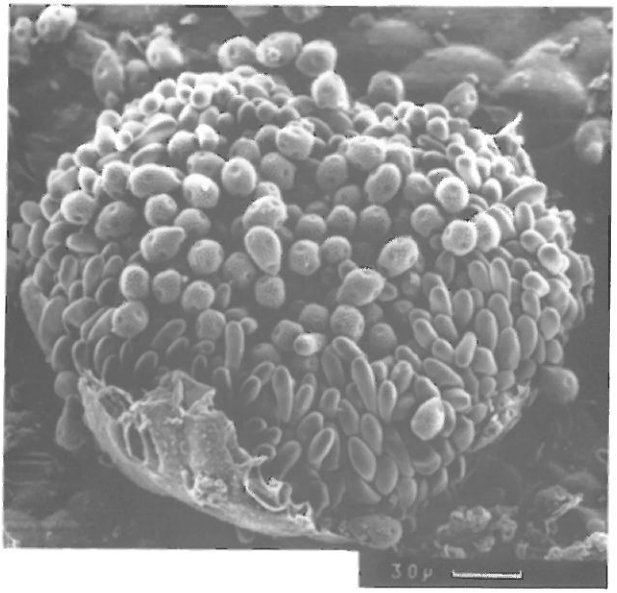
Species 35. *Phragmidium tuberculatum*: telia and teliospores.

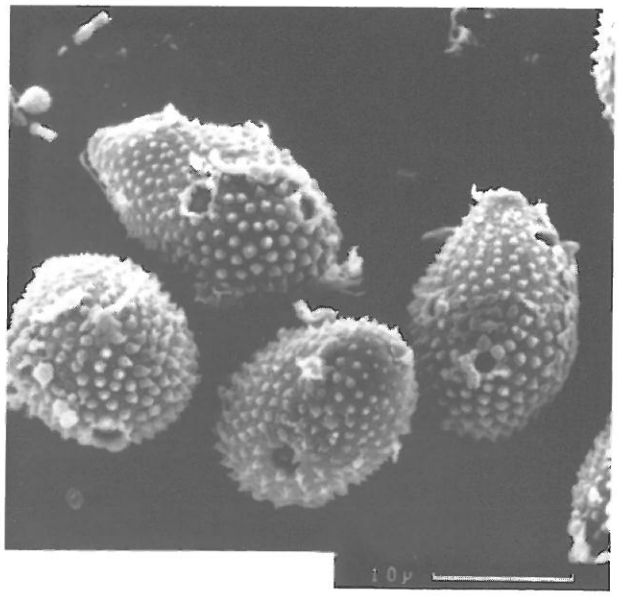




Yorks B 193; [AUT] on Rosa spp. WH has drawing of A, U and T on 106, EE has drawings of these in Fig. 1033 with a description on p. 228. Likewise there are drawings and descriptions in CMID 208. Teliospore surface: verrucose (WH), coarsely warted (CMID).

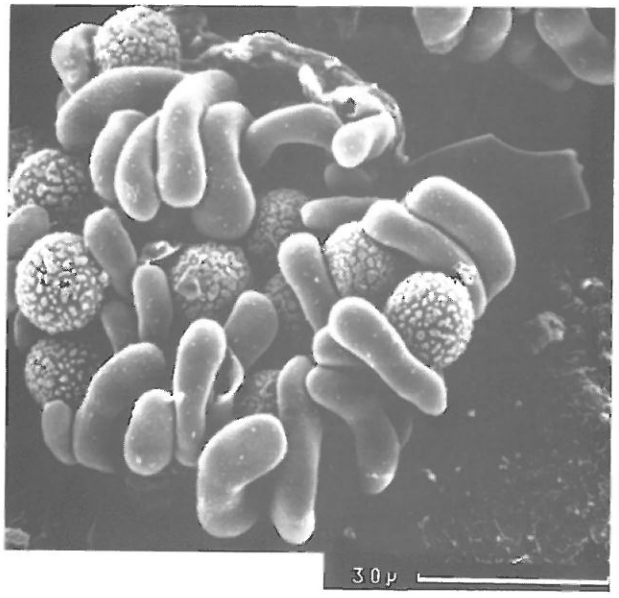
Species 35. *Phragmidium tuberculatum*: uredinia and urediniospores.

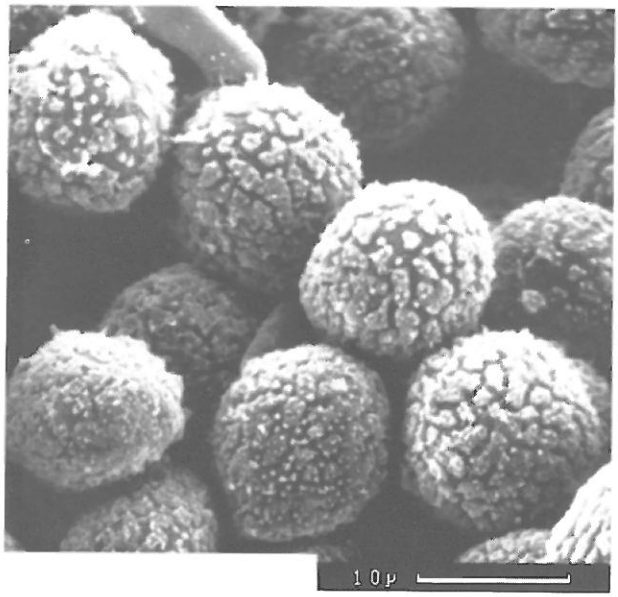




(See caption to photographs of telia and teliospores). Urediniospore surface: verrucose-echinulate (WH), coarsely echinulate (EE), echinulate, the spines 1-1.75 μm apart × 0.5μm high (CMID).

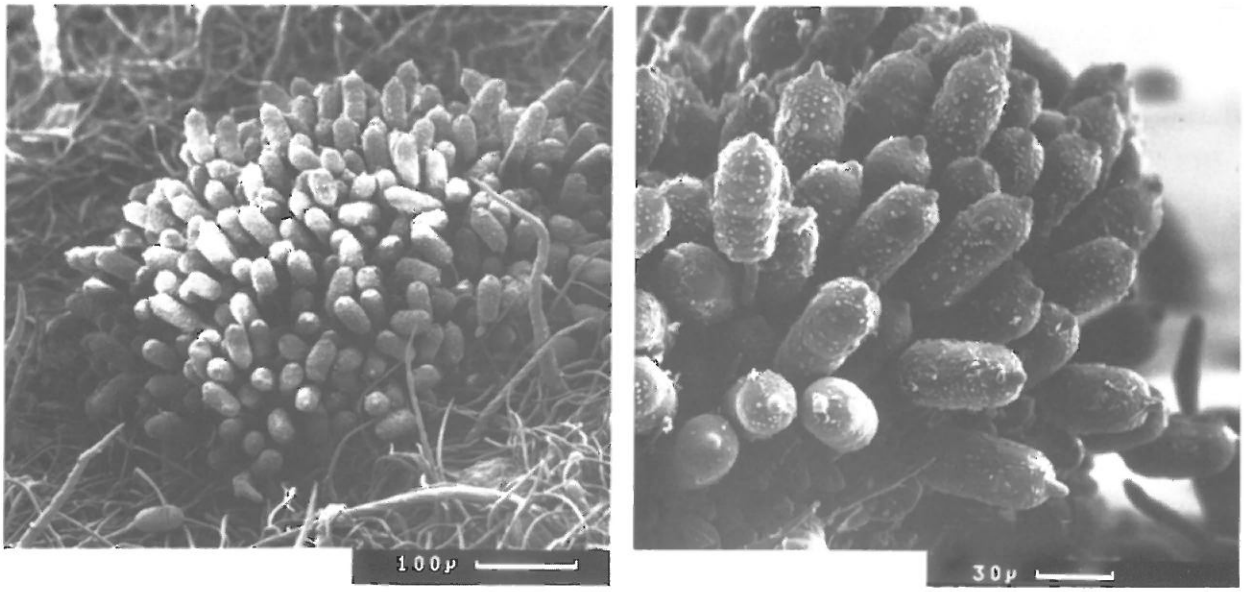
Species 35. *Phragmidium tuberculatum*: aecia and aeciospores.





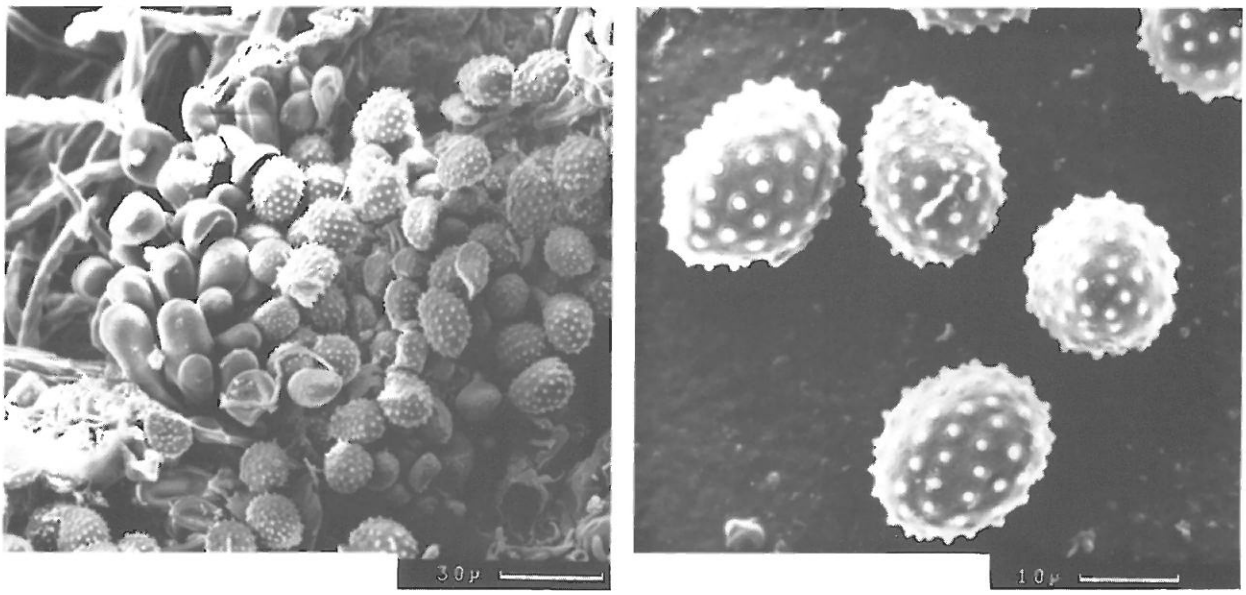
(See caption to photographs of telia and teliospores). Aeciospore surface: densely verrucose (WH), verrucose with short warts 1-2 μm diam. and 2-3μm apart (CMID).

Species 36. *Phragmidium violaceum*: telia and teliospores.



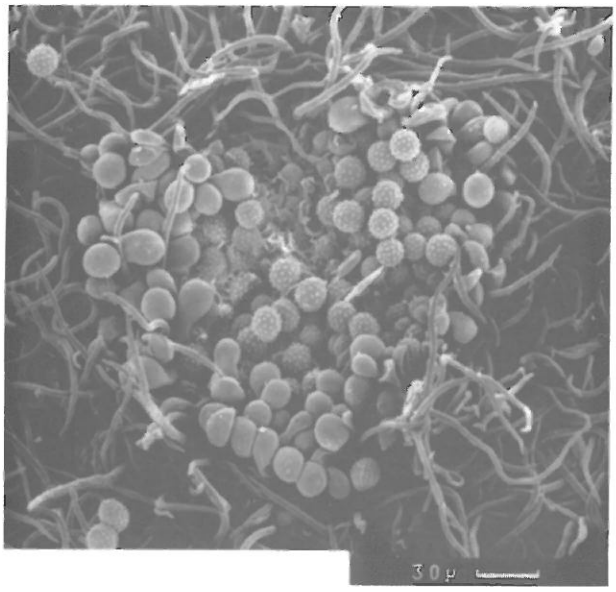
Yorks in B, 193. [AUT] on, e.g. *Rubus fruticosus* agg. WH98 has drawings of A U and T; There are T drawings in Fig. 1048 EE, with a description on 232. CMID 209 has drawings of AU and T. Teliospore surface: covered by numerous hyaline warts (WH),, coarsely warted (CMID).

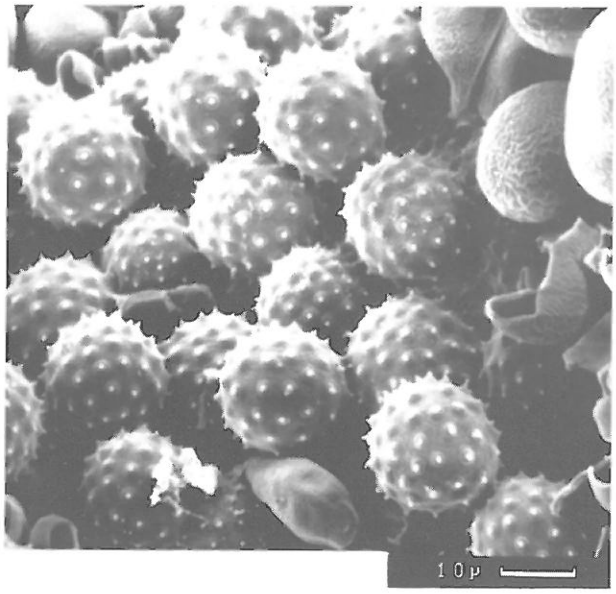
Species 36. *Phragmidium violaceum*: uredinia and urediniospores.



(See caption to photographs of telia and teliospores). Urediniospore surface; distantly and strongly aculeate - verrucose (WH), echinulate, the spines 3-5μm apart × 0.75-1μm high (CMID).

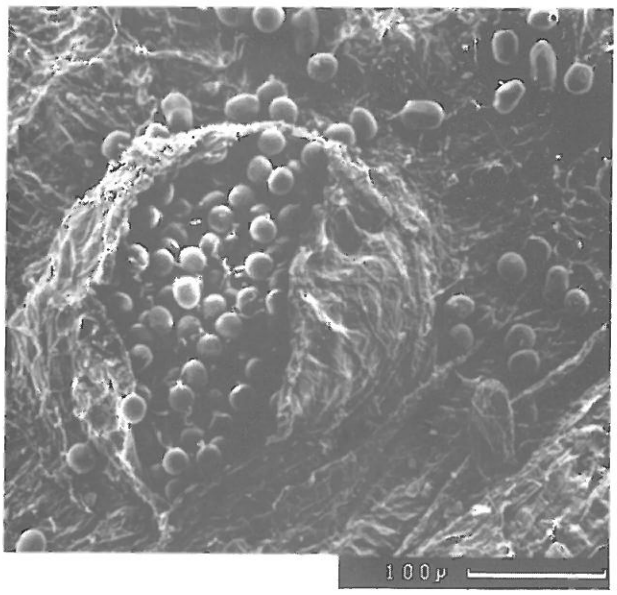
Species 36. *Phragmidium violaceum*: aecia and aeciospores.

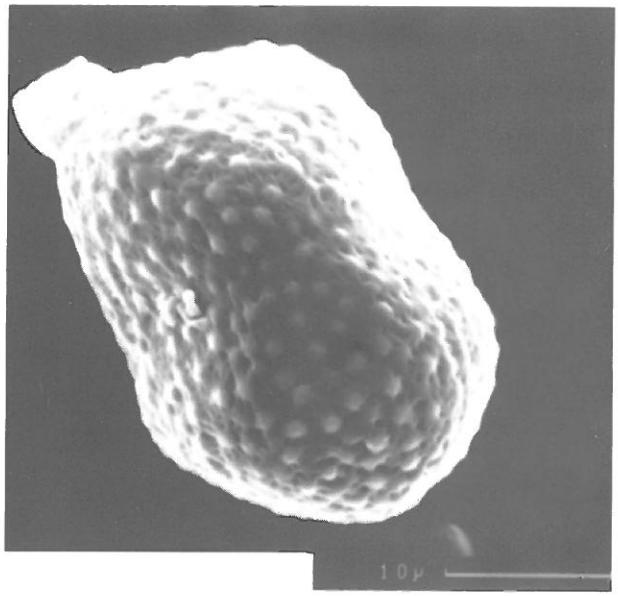




(See caption to photographs of telia and teliospores). Aeciospore surface: distantly and strongly aculeate - verrucose, spines about 4-5 μm apart (WH), echinulate, the spines 2.5-5μm apart × 1-1.5μm high (CMID).

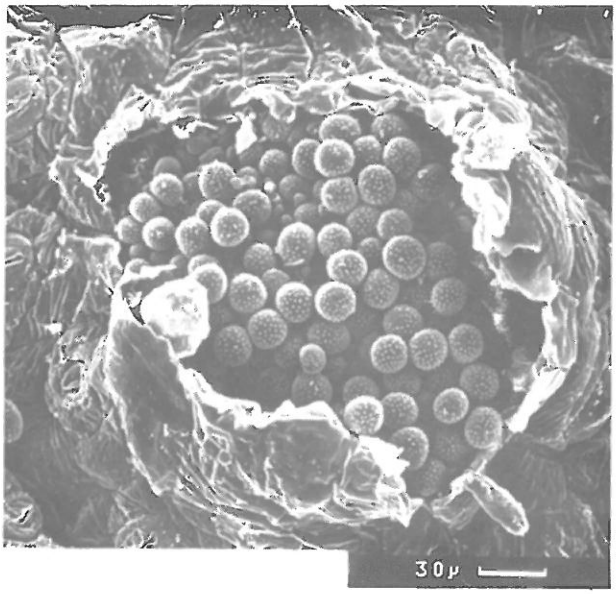
Species 37. *Puccina acetosae*: telia and teliospore.

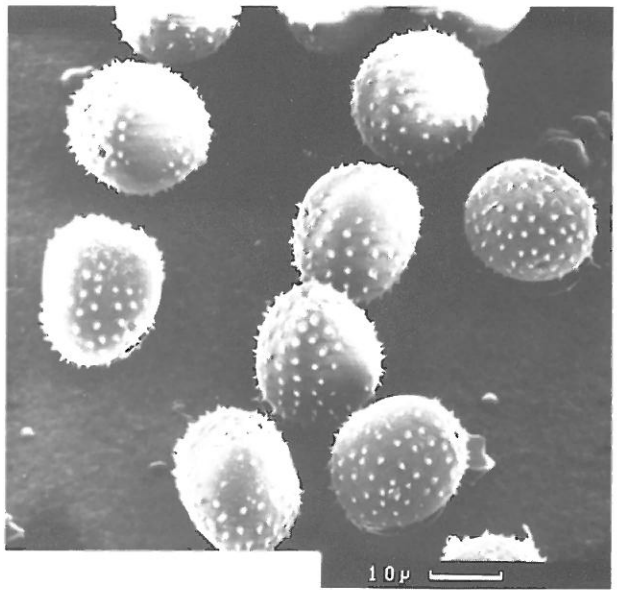




Yorks in B, 193. [UT] on *Rumex acetosella*; [U] only on *Rumex acetosa*. WH 159 has drawings of U and T. Description EE 414. Teliospore surface: delicately verruculose (WH), verruculose (EE).

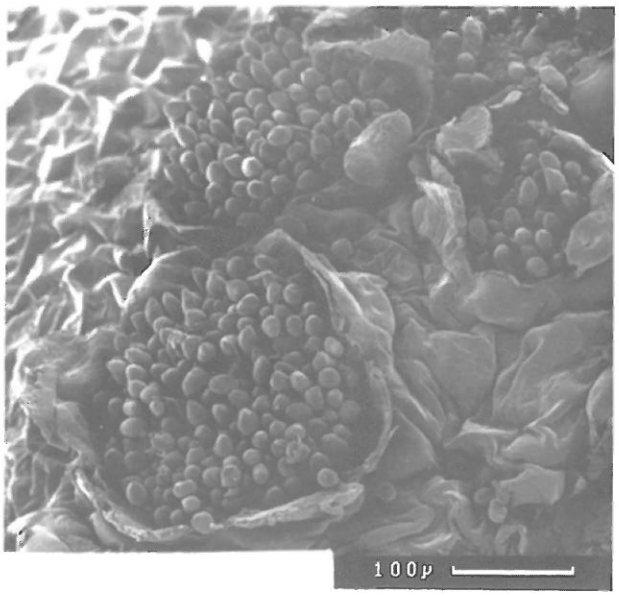
Species 37. *Puccinia acetosae*: uredinia and urediniospores.

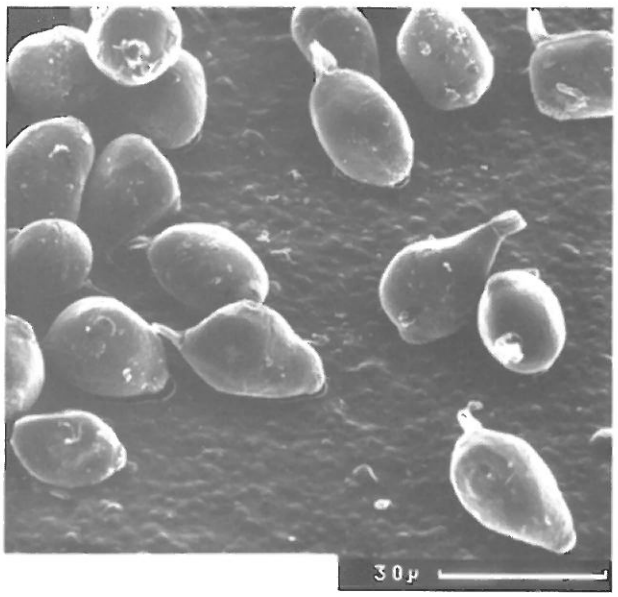




(See caption to photographs of telia and teliospores). Urediniospore surface: sparsely echinulate with colourless spines 2-3.5μm apart (WH), only a few spaced-out spines (EE).

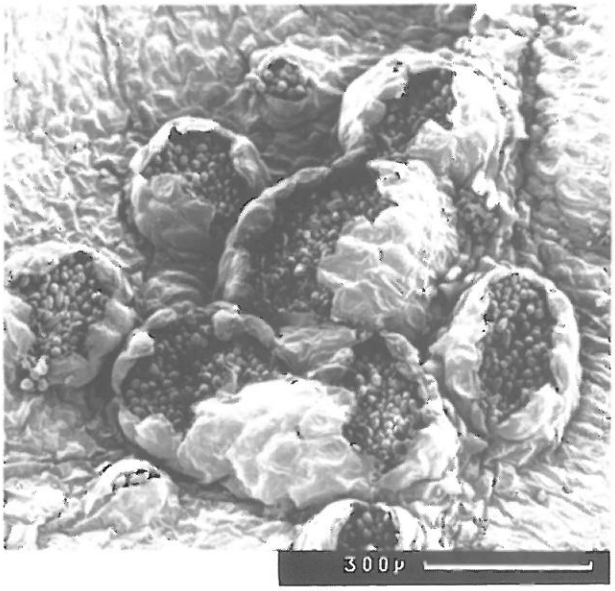
Species 38. *Puccinia adoxae:* telia and teliospores.

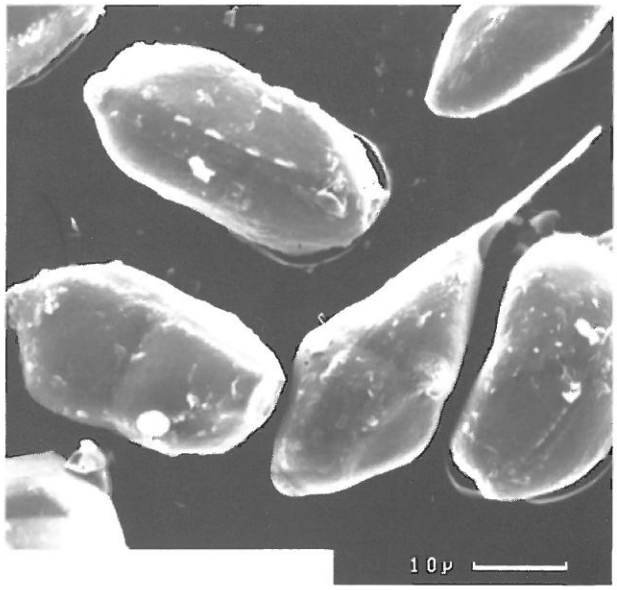




Yorks in B, 193 [T] on *Adoxa moschatellina;* WH has drawing of T on 186; EE also has drawing of T in Fig. 1326, with description on 301. Teliospore surface: smooth (WH).

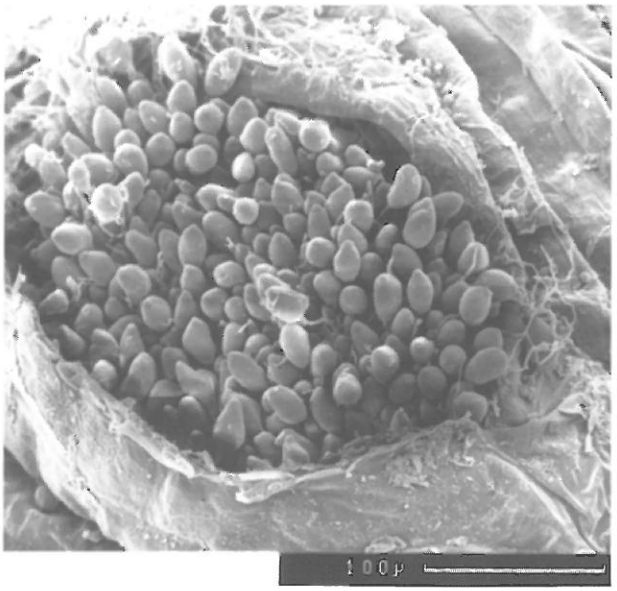
Species 39. *Puccinia aegopodii*: telia and teliospores.

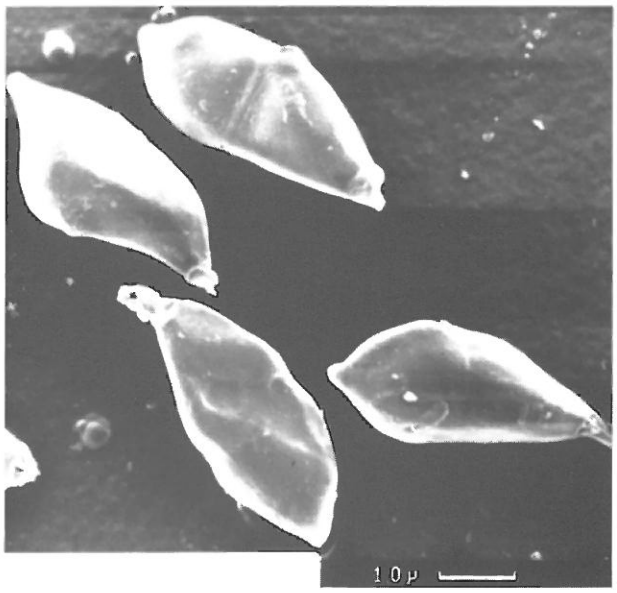




Yorks in B, 193. [T] on *Aegopodium podograria*; WH 144 has drawings of T. Description EE 301. Teliospore surface: smooth (WH).

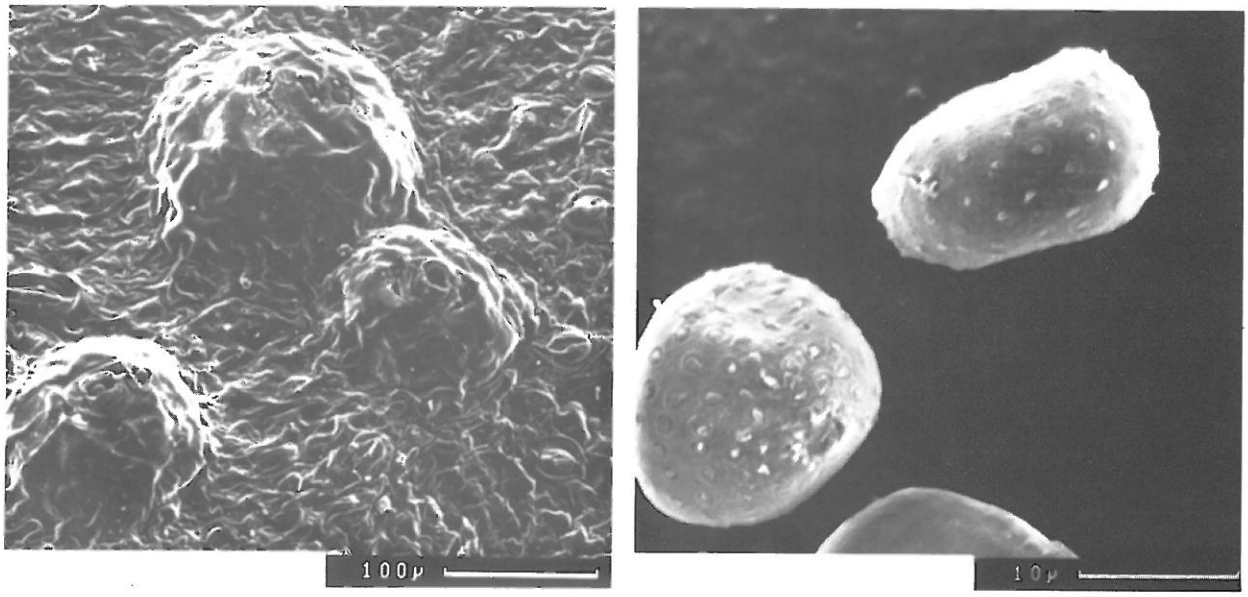
Species 40. *Puccinia albescens*: telia and teliospores.





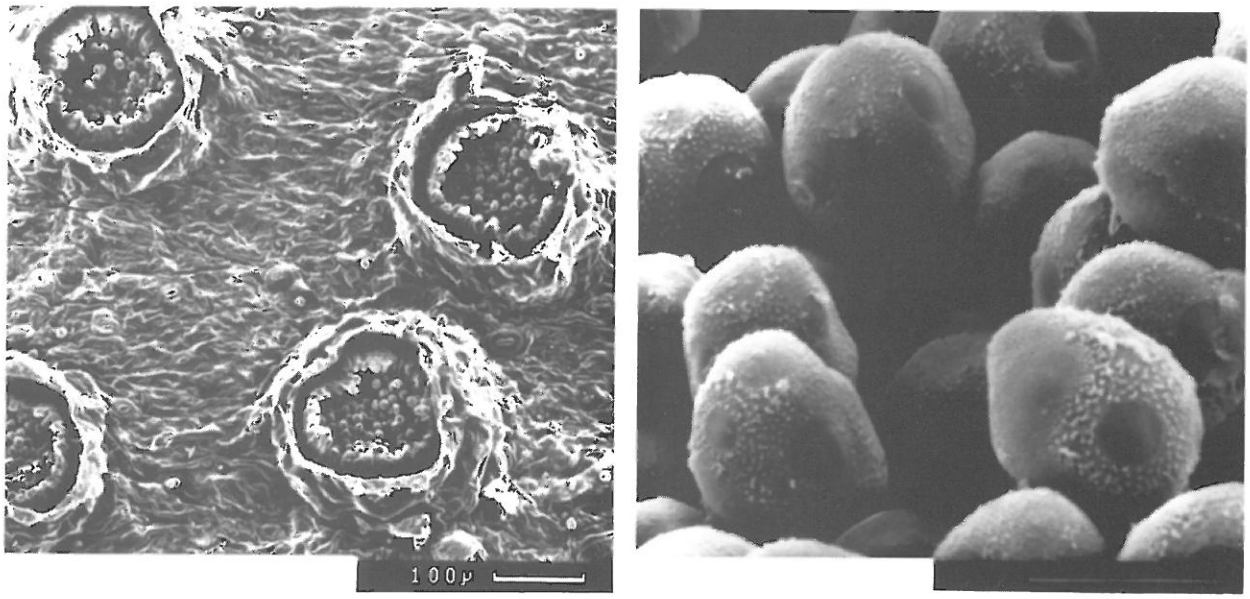
Yorks in B, 193. [AUT] on *Adoxa moschatellina*; WH 188 has drawing of U and T. description EE 301. Teliospore surface: smooth (WH).

Species 40. *Puccinia albescens*: uredinia and urediniospores.



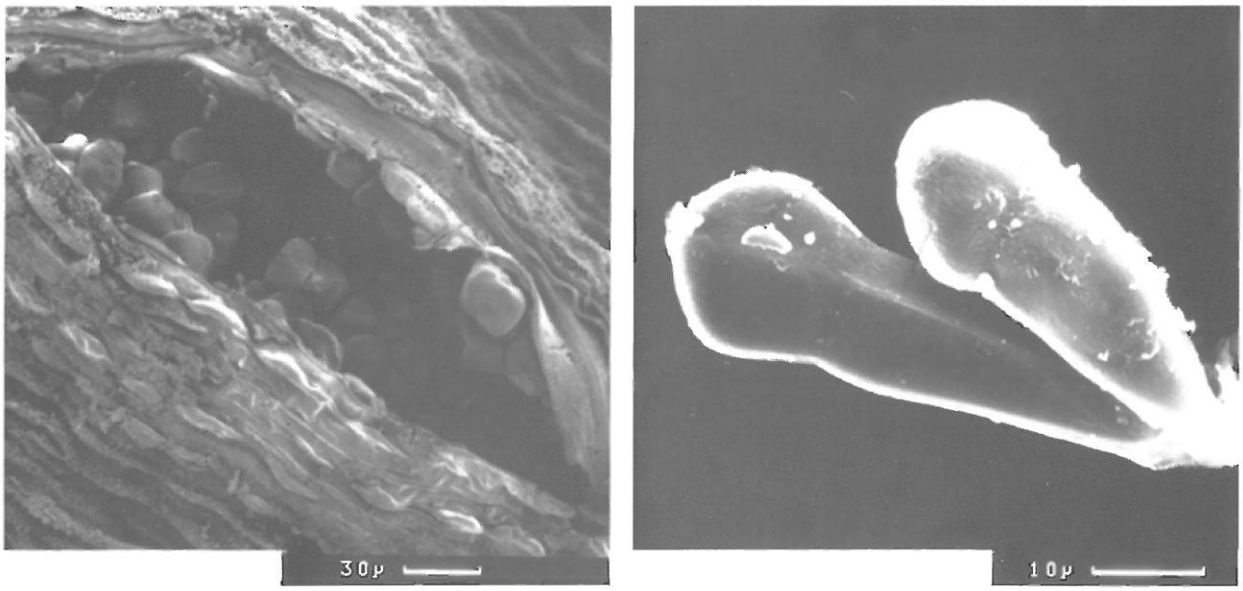
(See caption to photographs of telia and teliospores). Urediniospore surface: echinulate (WH).

Species 40. *Puccinia albescens*: aecia and aeciospores.



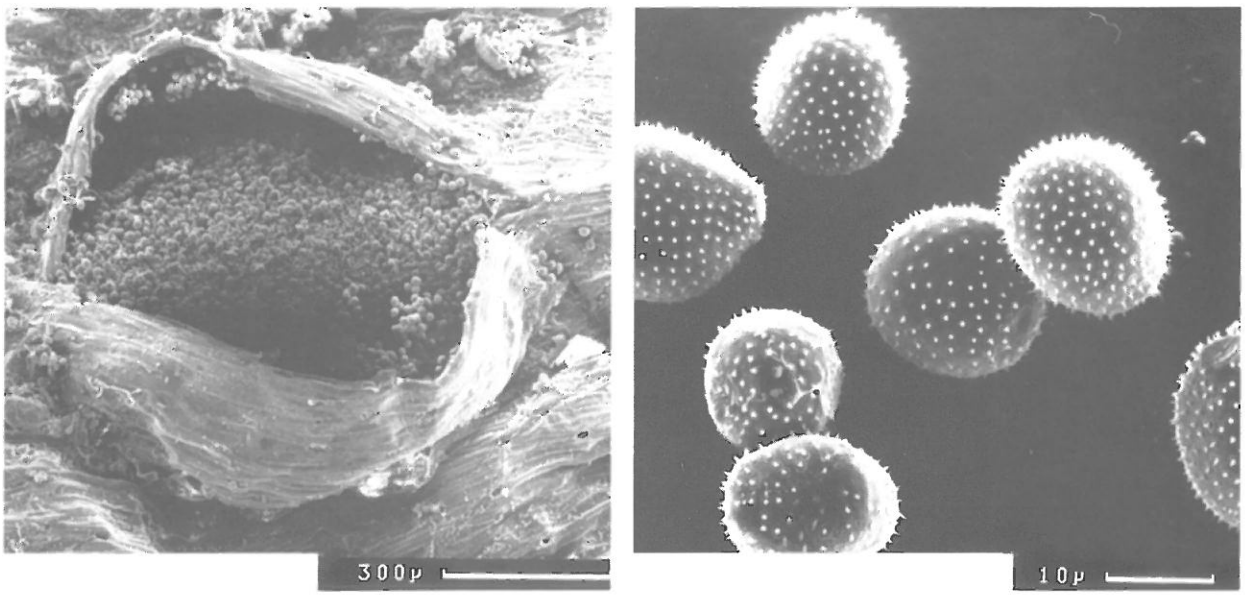
(See caption to photographs of telia and teliospores). Aeciospore surface: finely warted (WH).

Species 41. *Puccinia allii*: telia and teliospores.



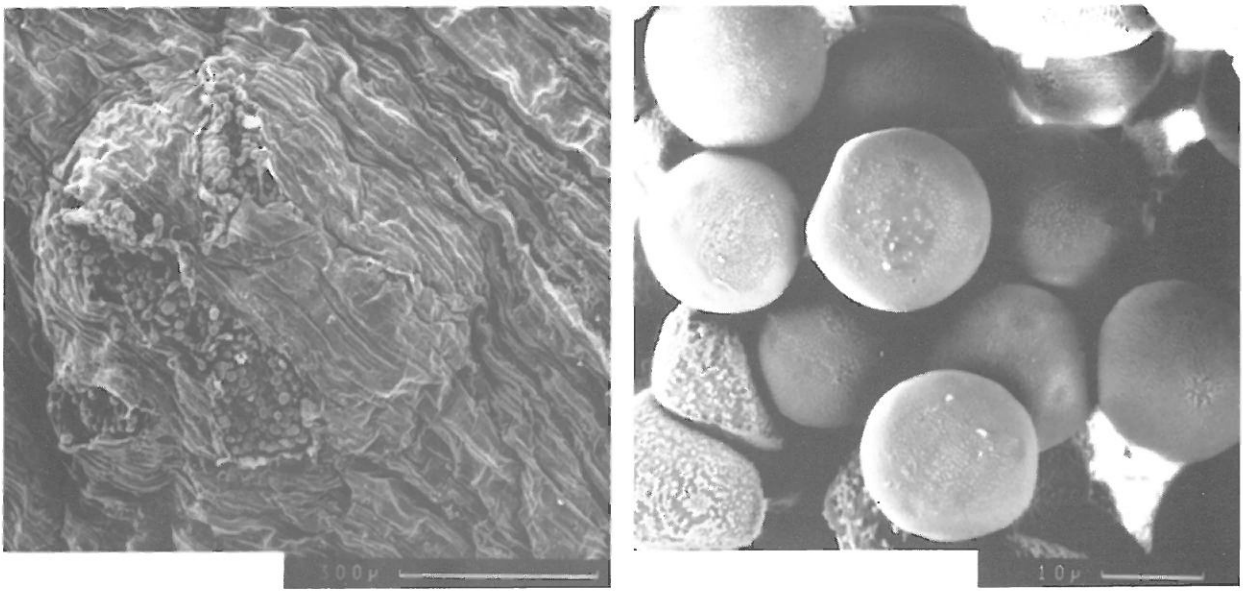
Yorks in B, 193. [AUT] on Allium spp; WH 217 has UT - the drawings include a mesospore or one-celled teliospore - and CMID 52 has light microscope photographs of U and T. There are descriptions in EE 303. Teliospore surface: smooth (WH), (CMID).

Species 41. *Puccinia allii*: uredinia and urediniospores.



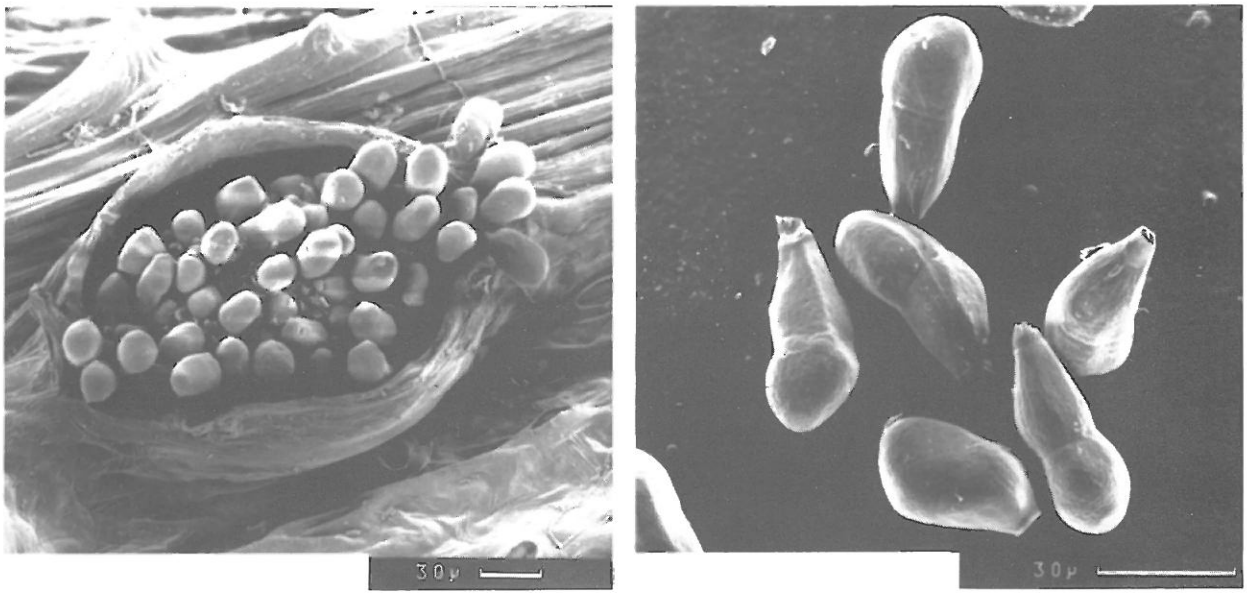
(See caption to photographs of telia and teliospores). Urediniospore surface: very delicately echinulate (WH), finely echinulate (EE), echinulate (CMID).

Species 41. *Puccinia allii*: aecia and aeciospores.



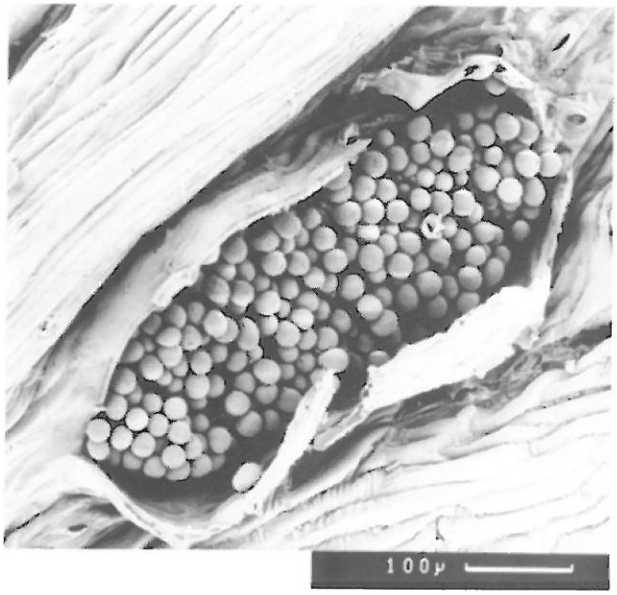
(See caption to photographs of telia and teliospores). Aeciospore surface: verruculose (WH).

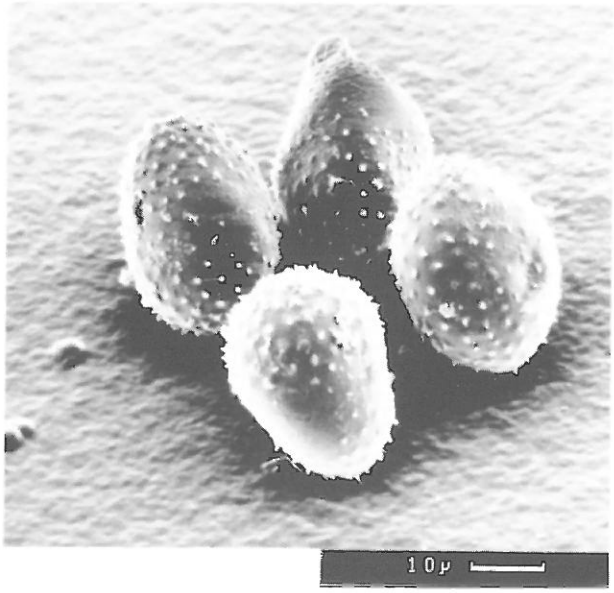
Species 42. *Puccinia angelicae*: telia and teliospores.



Yorks in B, 193. [AUT] on, e.g. *Angelica sylvestris*. Drawings of U and T in WH 145. description EE 308. Teliospore surface: smooth, though not mentioned in WH or EE.

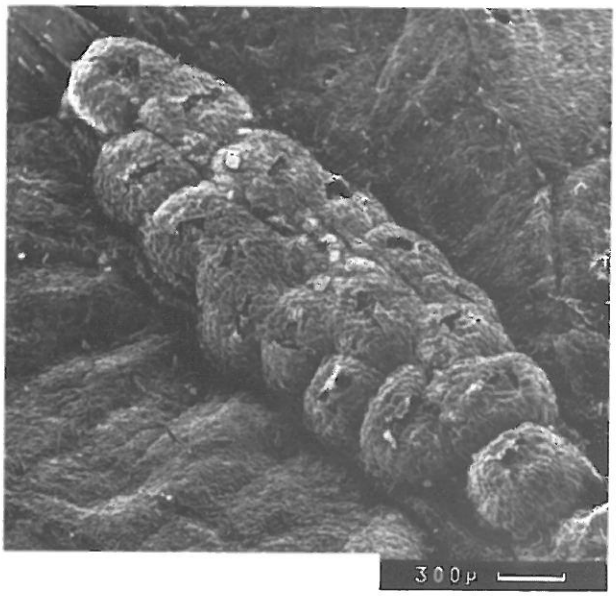
Species 42. *Puccinia angelicae*: uredinia and urediniospores.

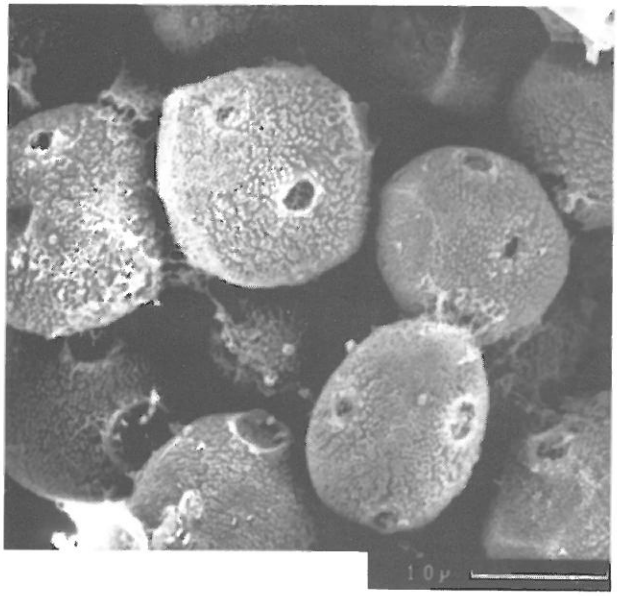




(See caption to photographs of telia and teliospores). Urediniospore surface: regularly and distantly echinulate, distance between spines 3 - 3.5 μm (WH), echinulate (EE).

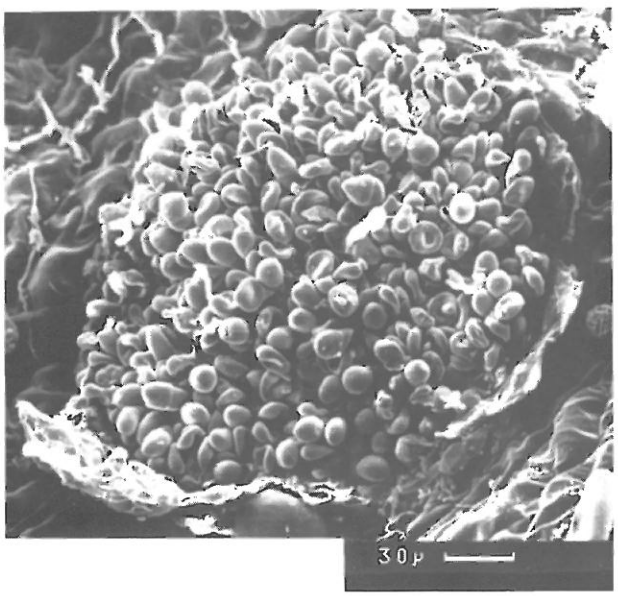
Species 42. *Puccinia angelicae*: aecia and aeciospores.

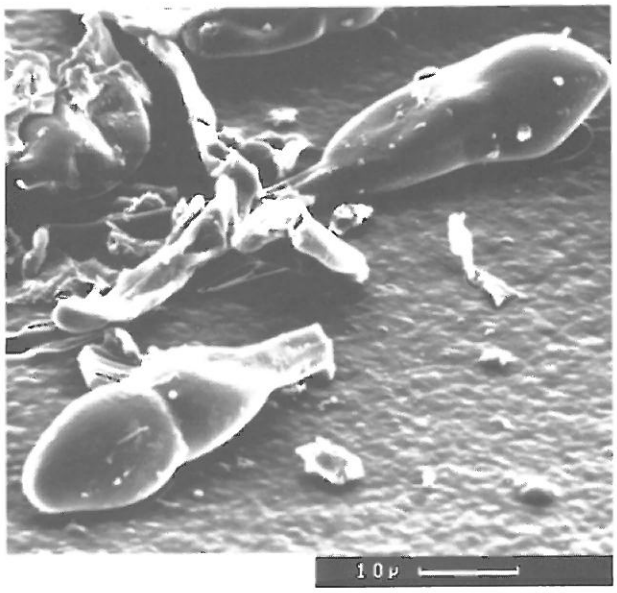




(See caption to photographs of telia and teliospores). Aeciospore surface: delicately verruculose (WH).

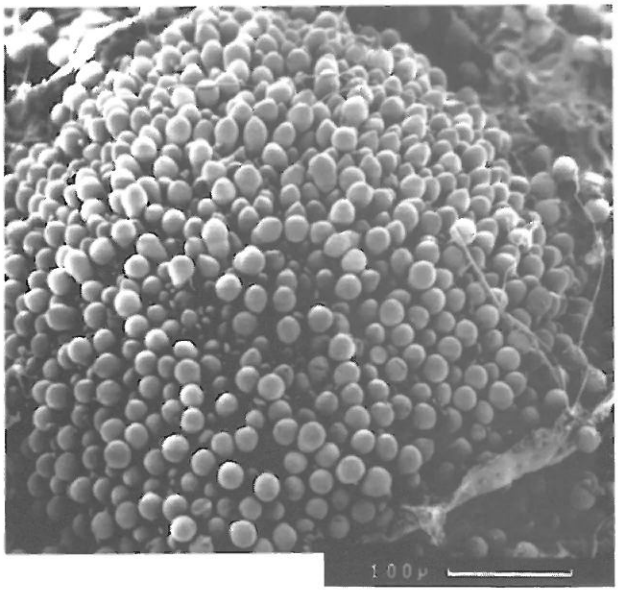
Species 43. *Puccinia annularis*: telia and teliospores.

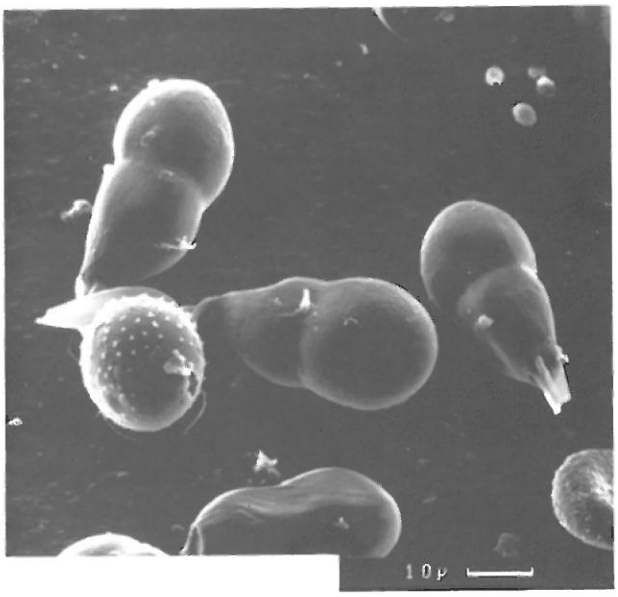




Yorks in B, 193. [T] on *Teucrium scorodonia*. Drawing of T in WH 177. Descriptions in EE, 433. Teliospore surface: smooth (WH, EE).

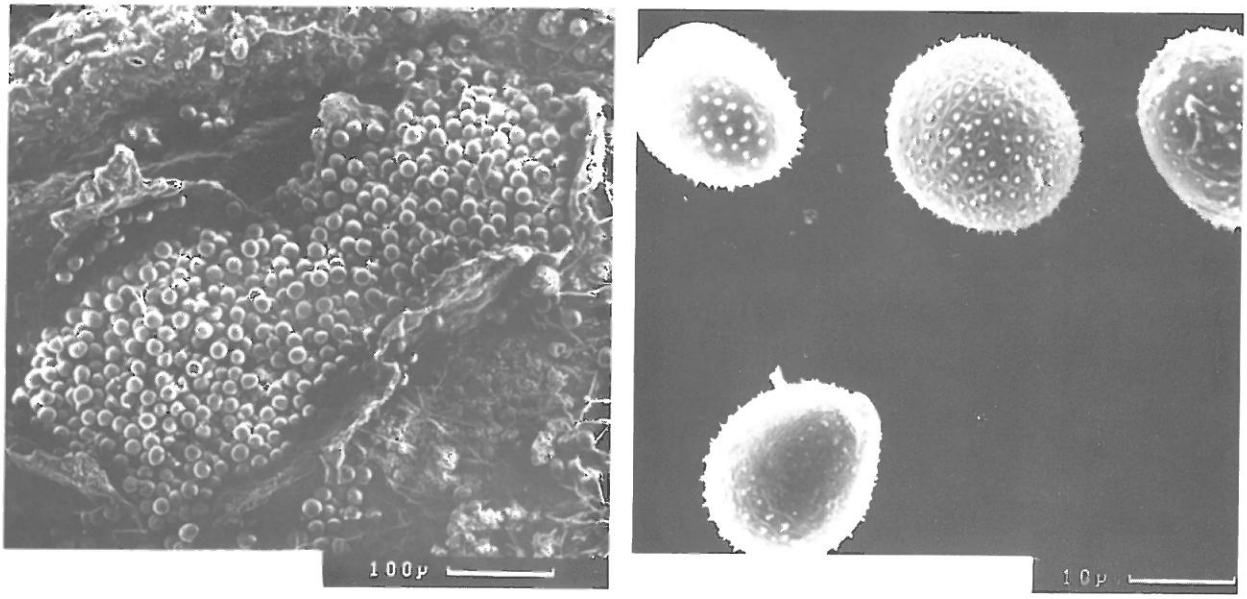
Species 44. *Puccinia antirrhini*: telia and teliospores.





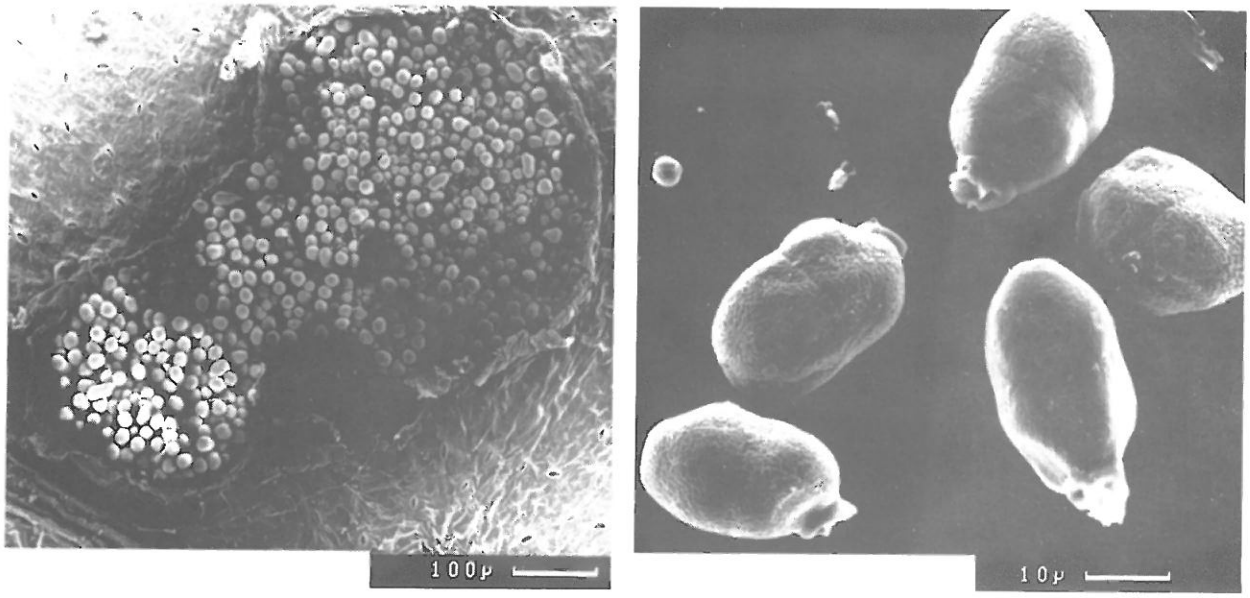
Yorks in B, 193. [UT] on Antirrhinum spp. Drawing of U and T in WH, 173, and in CMID 262. Description in EE, 310. Teliospore surface: smooth (WH, CMID).

Species 44. *Puccinia antirrhini*: uredinia and urediniospores.



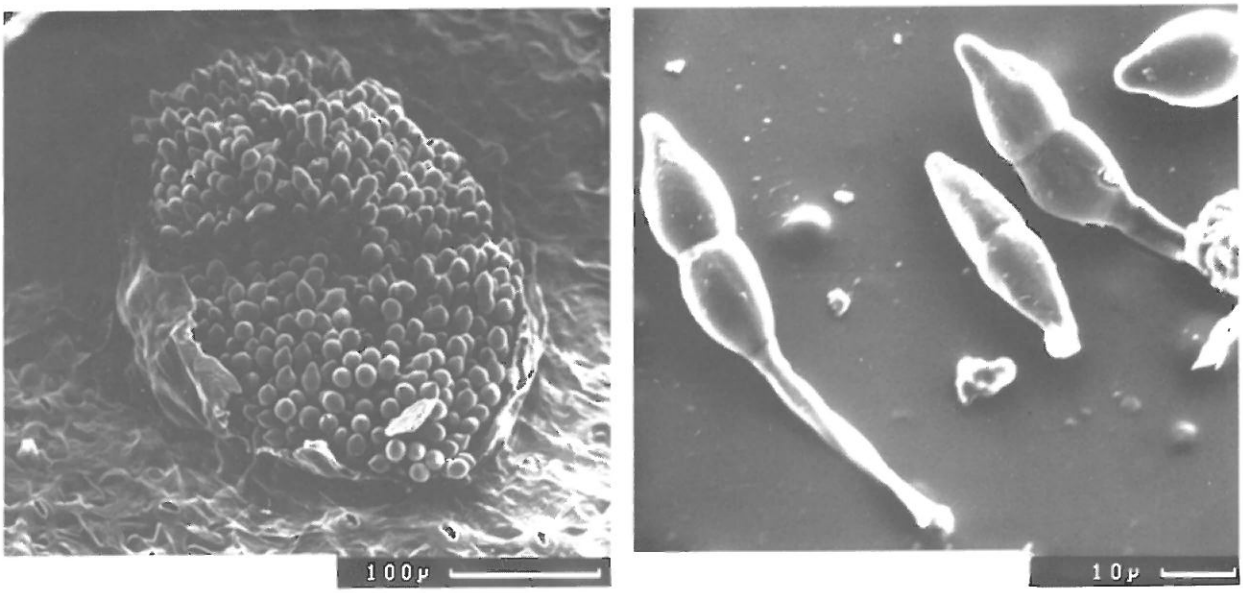
(See caption for telia and teliospores). Urediniospore surface: shortly echinulate (WH), echinulate (EE, CMID).

Species 45. *Puccinia apii*: telia and teliospores.



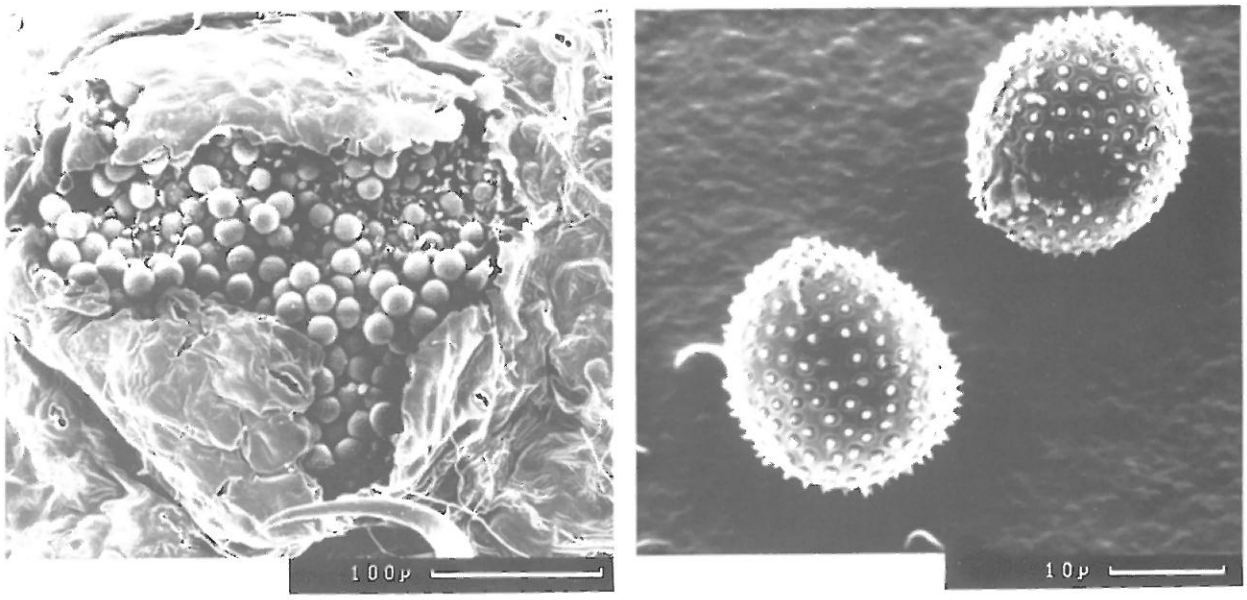
Yorks in B, 193. [AUT] on *Apium graveolens*. Drawings of U and T in WH, 146, and photographs of these in CMID 284. Description EE 311. Teliospore surface: smooth (WH, EE, CMID). No specimens of U and A. This rust has not been found for perhaps 100 years.

Species 46. *Puccinia arenariae*: telia and teliospores.



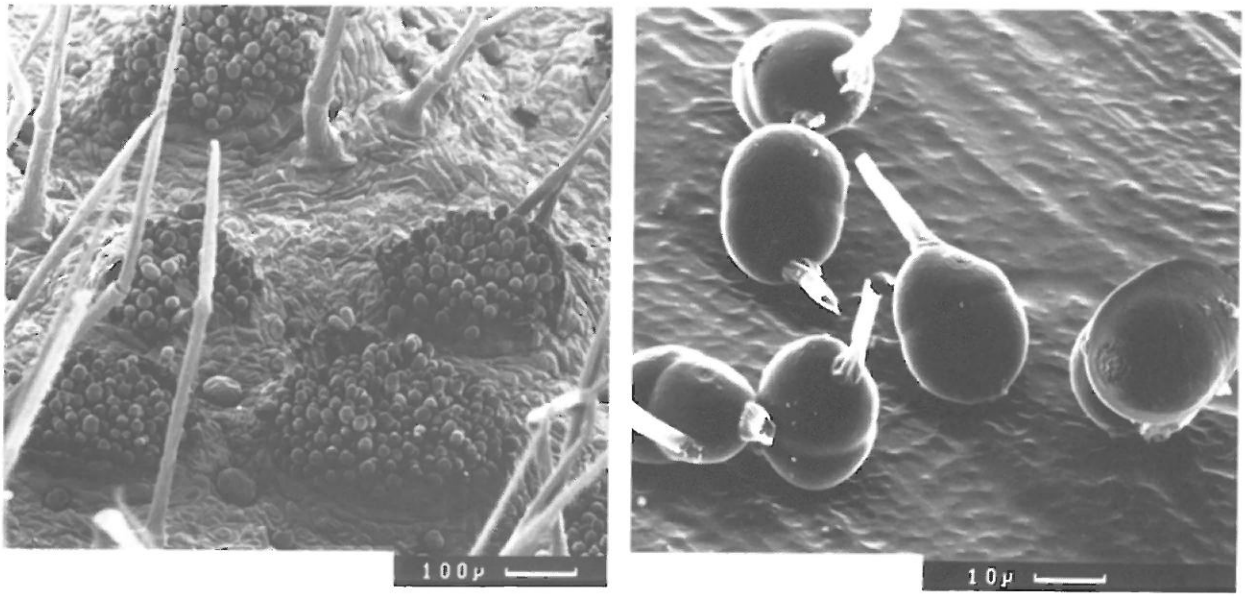
Yorks in B, 193. [T] on, e.g. Silene spp. T (germinating) drawn in WH 127, EE Fig 1366. Teliospore surface: smooth (WH).

Species 47. *Puccinia behenis*: uredinia and urediniospores.



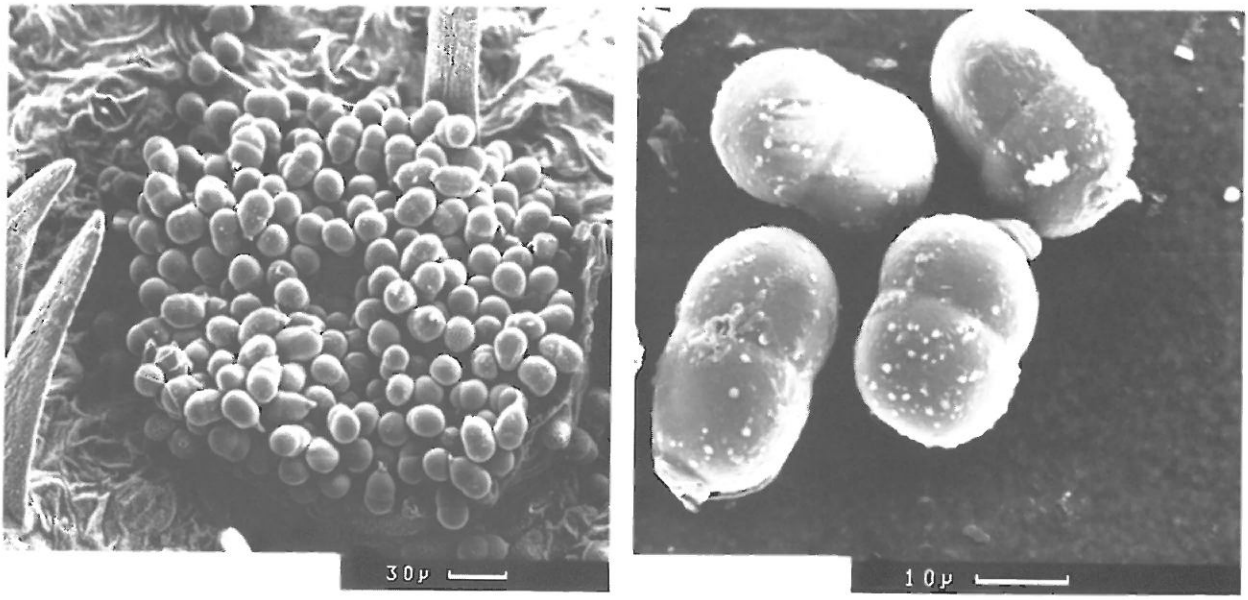
Yorks in B, 193. [UT] on Silene spp. Drawing of U in WH, 131. Description in EE, 422. Urediniospore surface: echinulate (WH, EE).

Species 48. *Puccinia betonicae*: telia and teliospores.



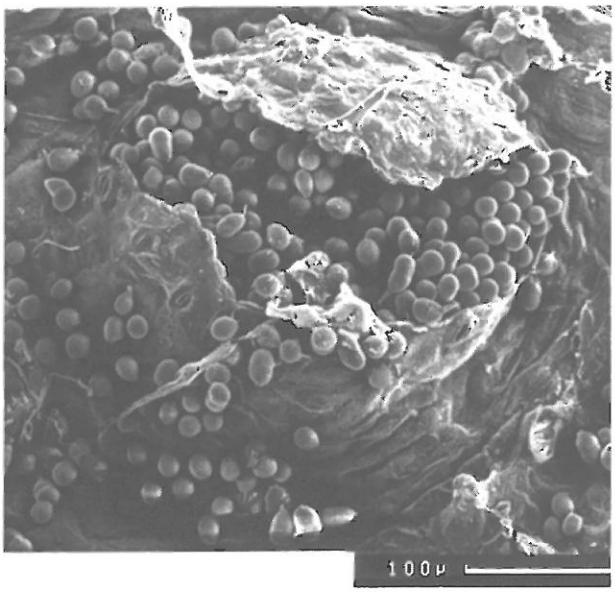
Yorks in B, 193. [T] on *Stachys officinalis*. Drawing of T in WH 177. Description in EE, 319. Teliospore surface: smooth (WH, EE).

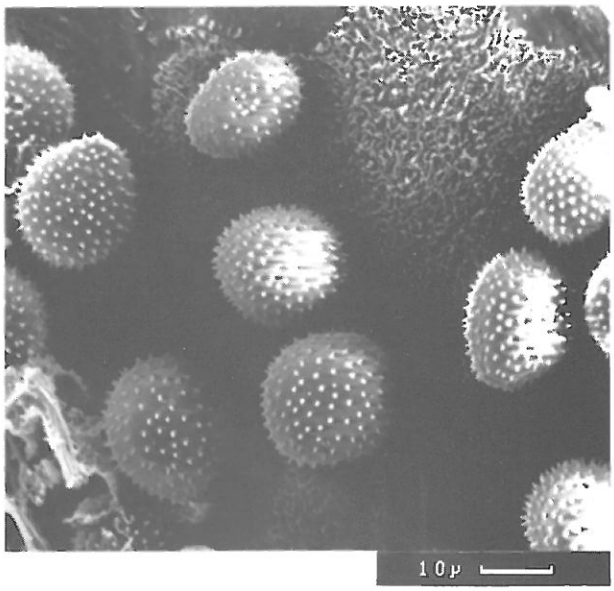
Species 49. *Puccinia bistortae*: telia and teliospores.



Yorks in B, 193. [A] e.g. on *Conopodium majus,* [UT] on Polygonum spp. Drawings of T and U in WH 160. Descriptions EE 308 (A) and 403 (UT). Teliospore surface: smooth or finely verrucose in a few longitudinal lines (WH), often finely verrucose (EE).

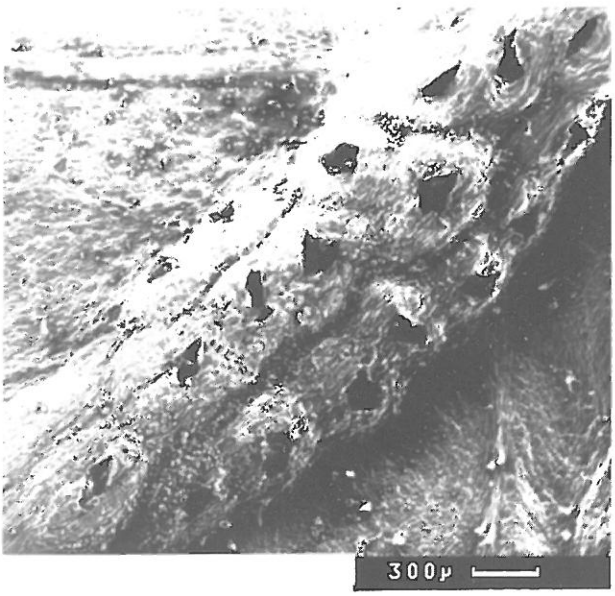
Species 49. *Puccinia bistortae*: uredinia and urediniospores.

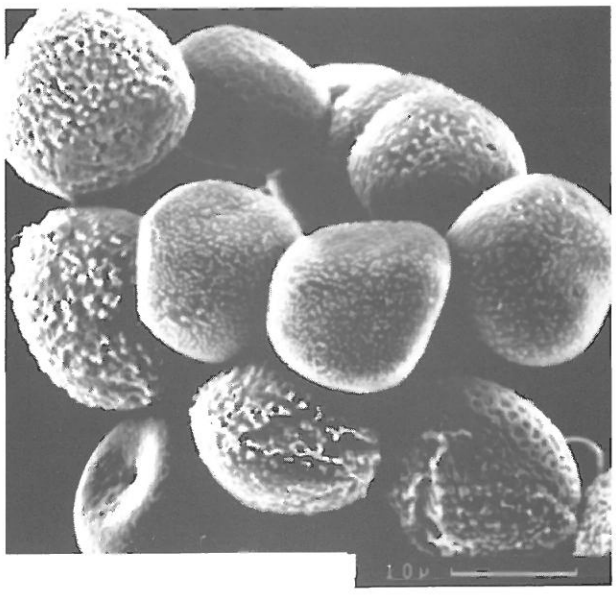




(See caption to photographs of telia and teliospores). Urediniospore surface: finely echinulate (WH), shortly echinulate (EE).

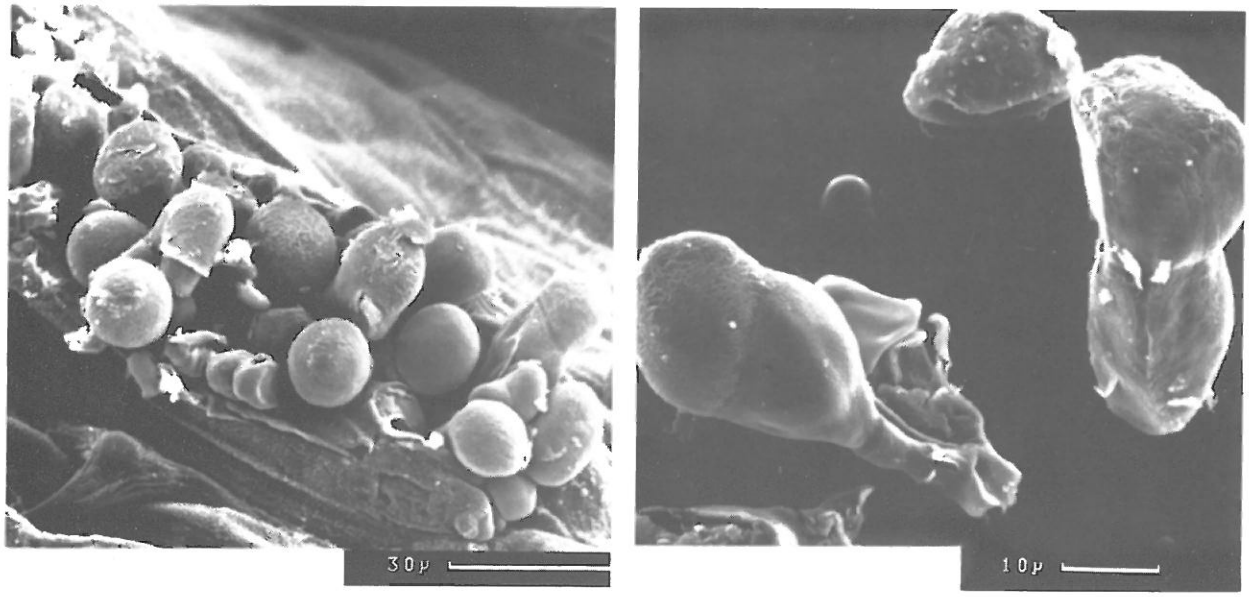
Species 49. *Puccinia bistortae*: aecia and aeciospores.





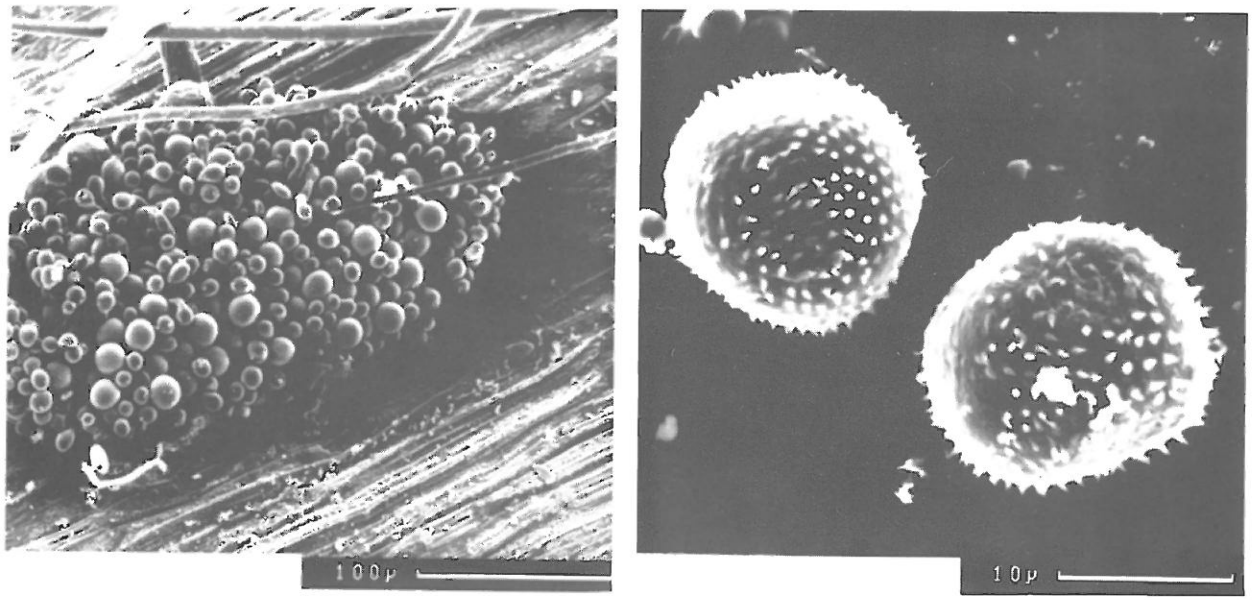
(See caption to photographs of telia and teliospores). Aeciospore surface: verruculose (WH).

Species 50. *Puccinia brachypodii* var. *arrhenatheri*: telia and teliospores



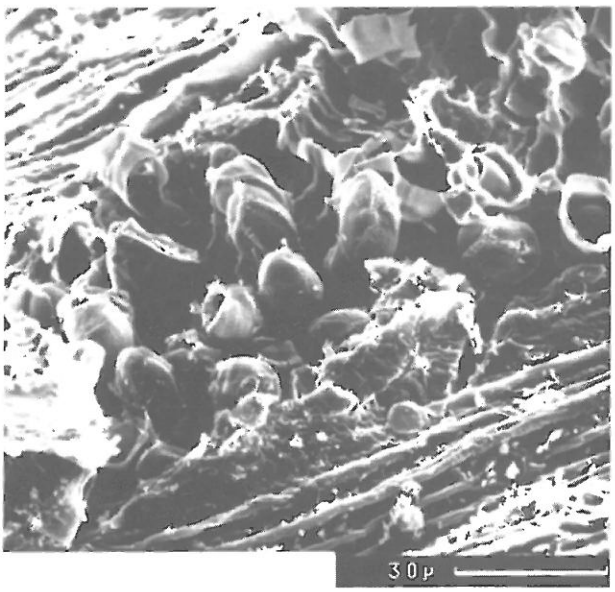
Yorks in B, 197 (as *Puccinia poae - nemoralis*). [UT] on Arrhenatherum elatius. Drawing of U and T in EE Fig. 1844. Description in WH 489 (additions and corrections) and in EE 482. Teliospore surface: presumably smooth (WH 272).

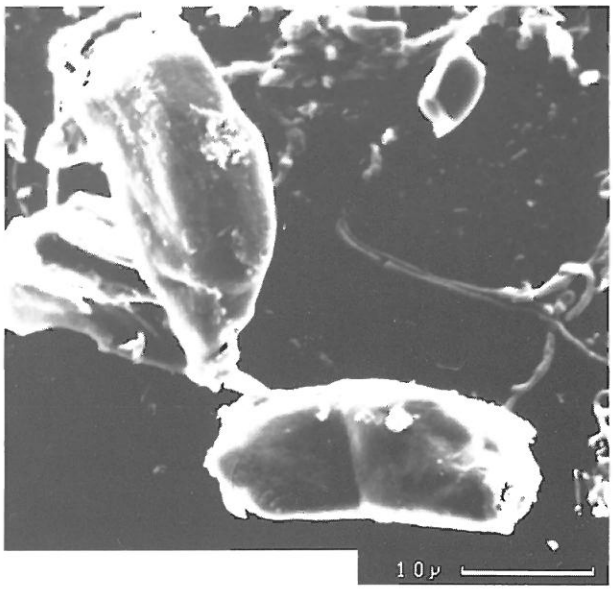
Species 50. *Puccinia brachypodii* var. *arrhenatheri*: uredinia and urediniospores.



(See caption to photographs of telia and teliospores). Urediniospores surface: minutely verruculose (EE).

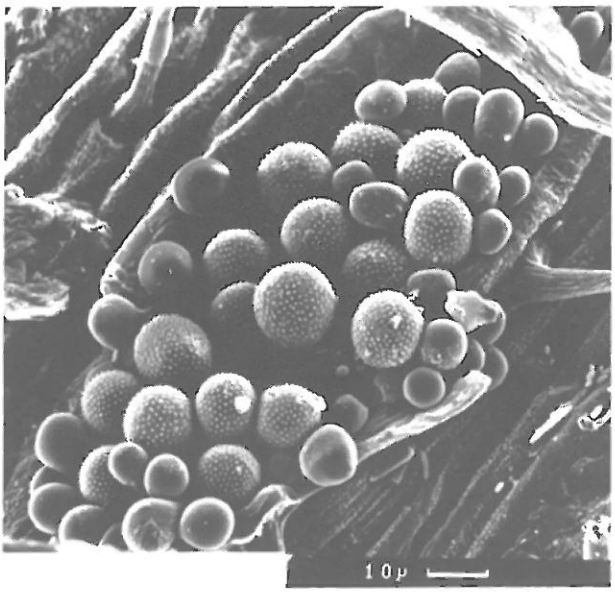
Species 50A. *Puccinia brachypodii* var. *brachypodii*: telia and teliospores.

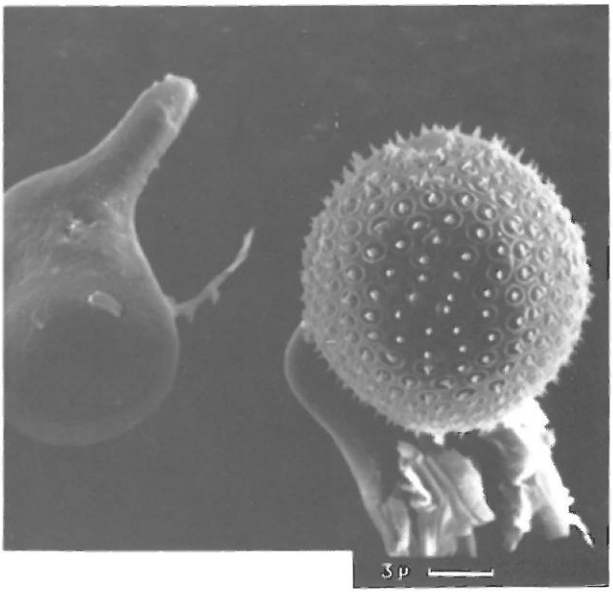




Yorks in B, 194 (as *Puccinia brachypodii*). [UT] on Brachypodium spp. Drawing of U and T in WH 250 (*P. brachypodii*). See also WH 489 (additions and corrections). Descriptions of U and T in EE 486. Teliospore surface: smooth (WH).

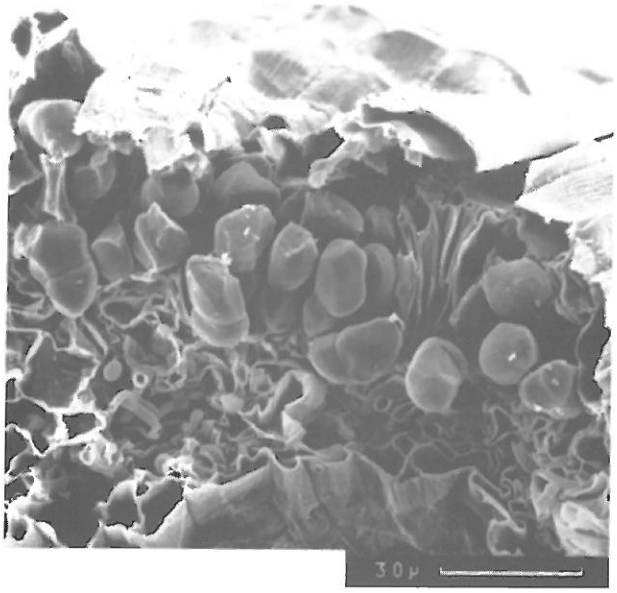
Species 50A. *Puccinia brachypodii* var. *brachypodii*: uredinia and urediniospores.





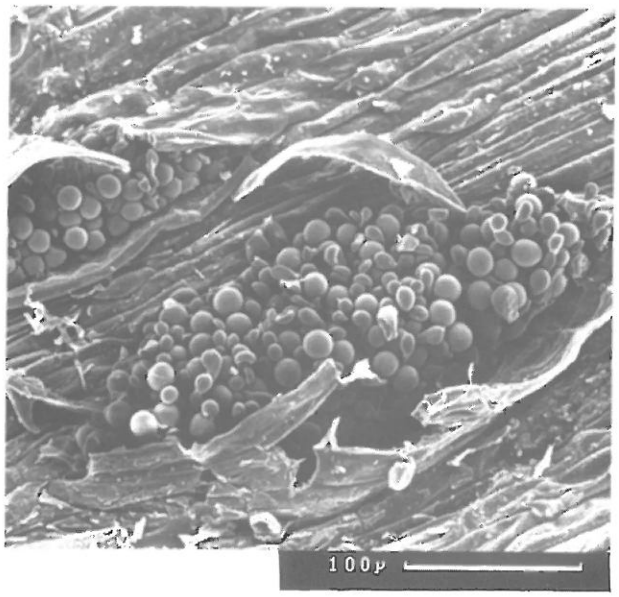
(See caption to photographs of telia and teliospores). Urediniospore surface: delicately verruculose (WH), finely verruculose (EE).

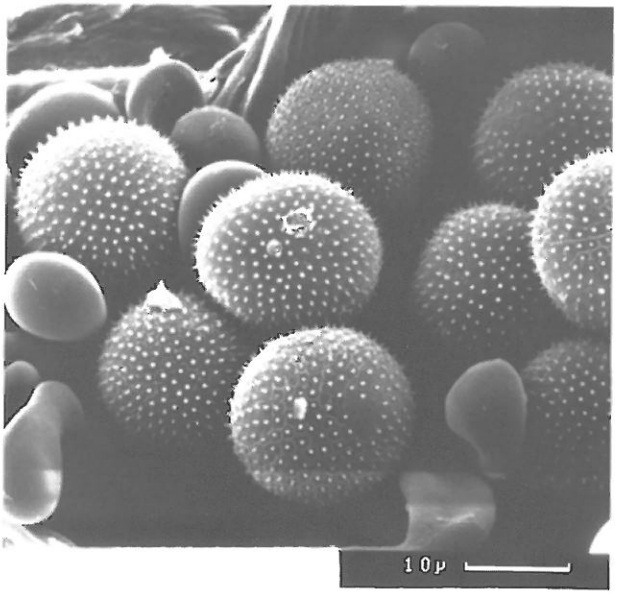
Species 50B. *Puccinia brachypodii* var.*poae-nemoralis*: telia and teliospores



Yorks in B, 197 (as *Puccinia poae-nemoralis*). [UT] on, e.g. *Poa nemoralis*. Drawing of U and T in WH 271 (*P. poae-nemoralis*). See also WH 489 (additions and corrections). Descriptions of U and T in EE451. Teliospore surface: smooth (WH).

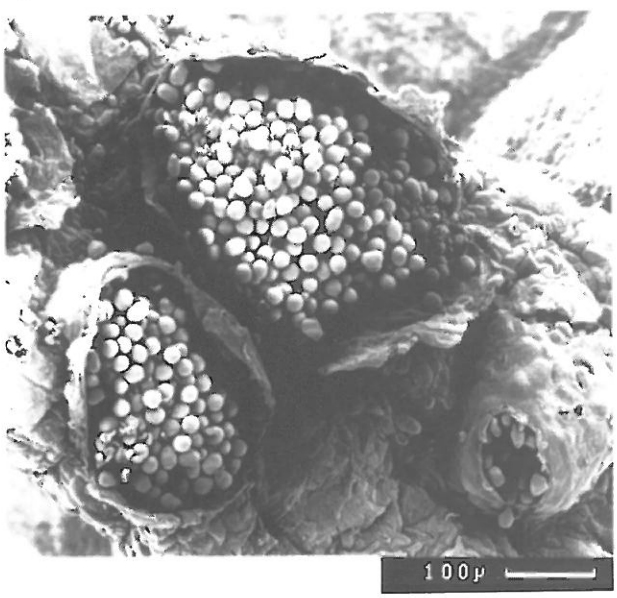
Species 50B *Puccinia brachypodii* var. *poae-nemoralis*: uredinia and urediniospores.

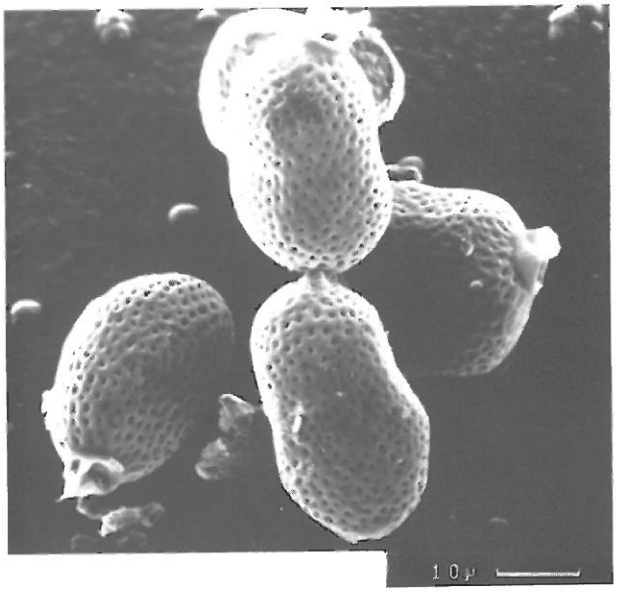




(See caption to photographs of telia and teliospores). Urediniospore surface: densely and minutely verruculose (WH).

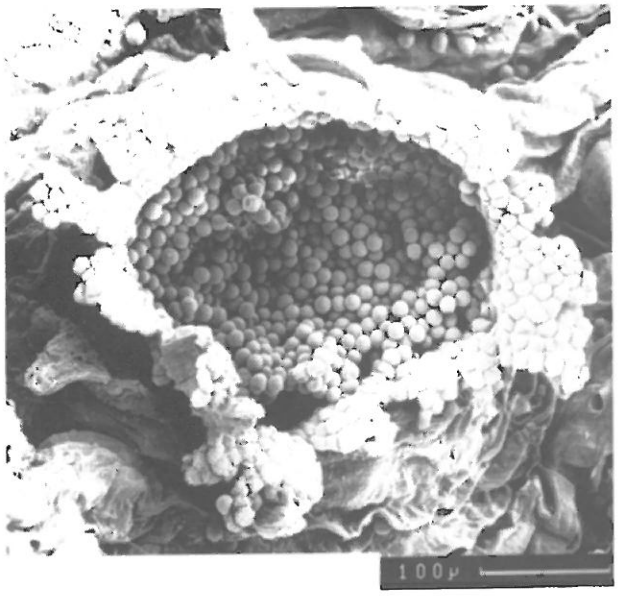
Species 51 *Puccinia bulbocastani*: telia and teliospores.

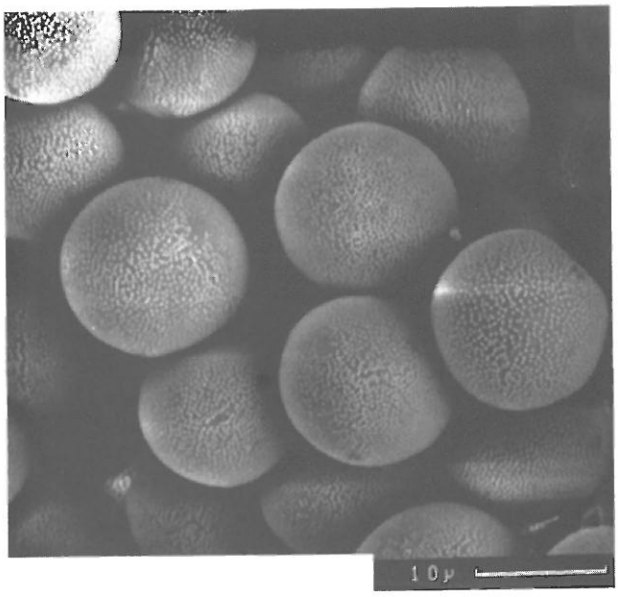




Yorks in B, 194. [AT] on *Bunium bulbocastanum*. Descriptions only WH 147 and EE 322. Teliospore surface: presumably smooth.

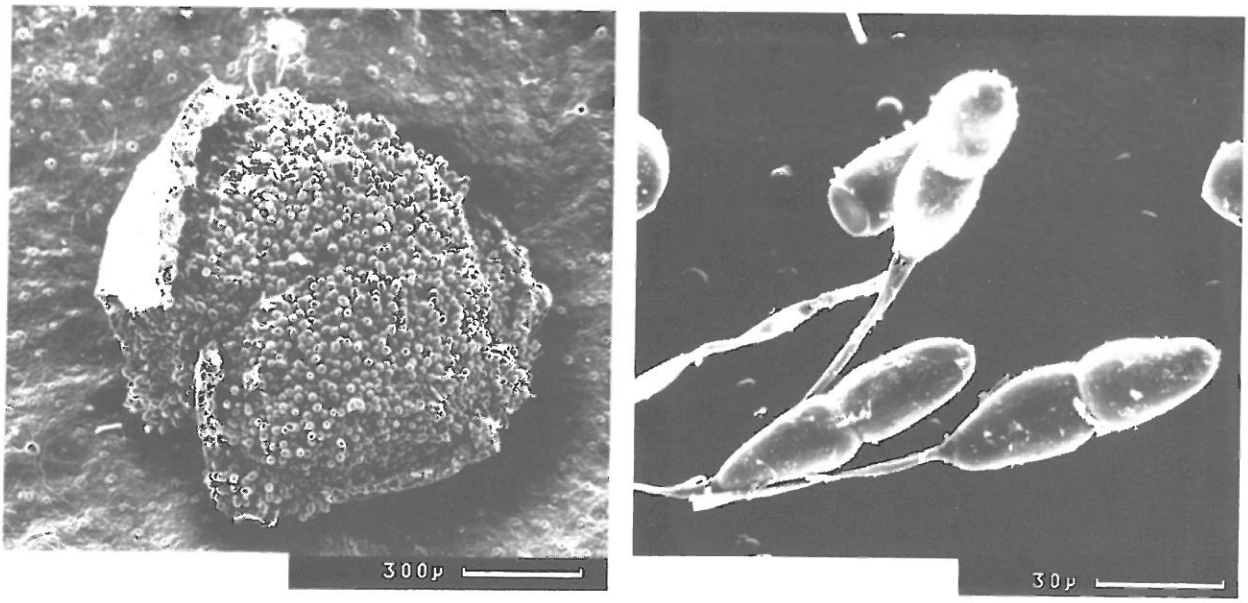
Species 51. *Puccinia bulbocastani*: aecia and aeciospores.





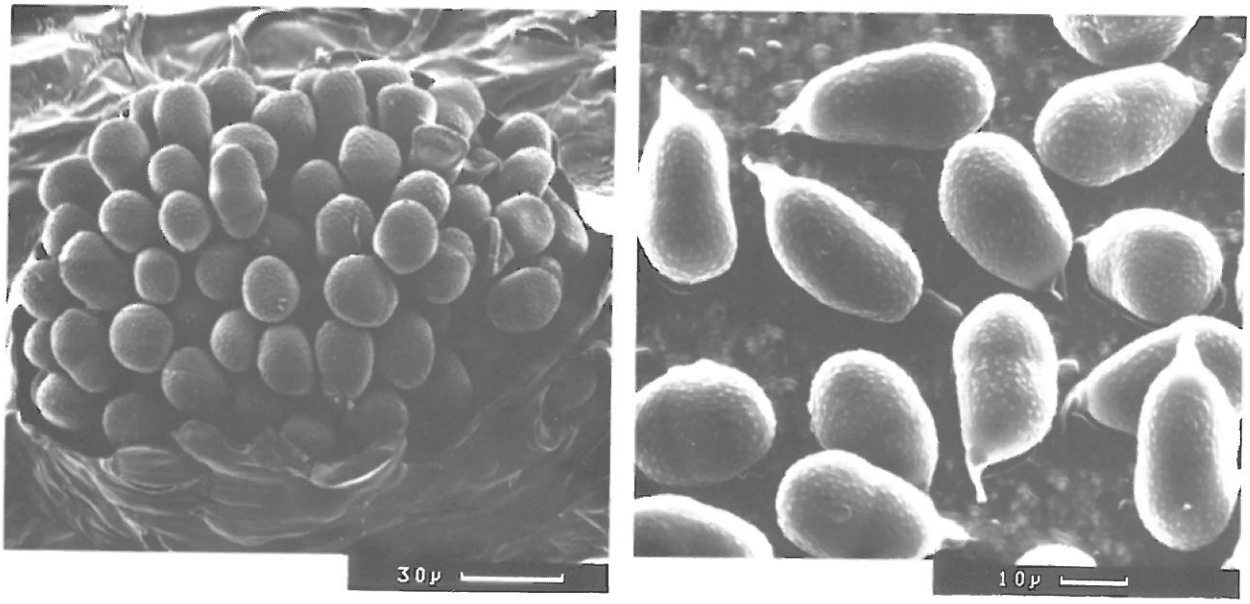
(See caption to photographs of telia and teliospores). Aeciospores surface: delicately veruculose (WH).

Species 52. *Puccinia buxi*: telia and teliospores.



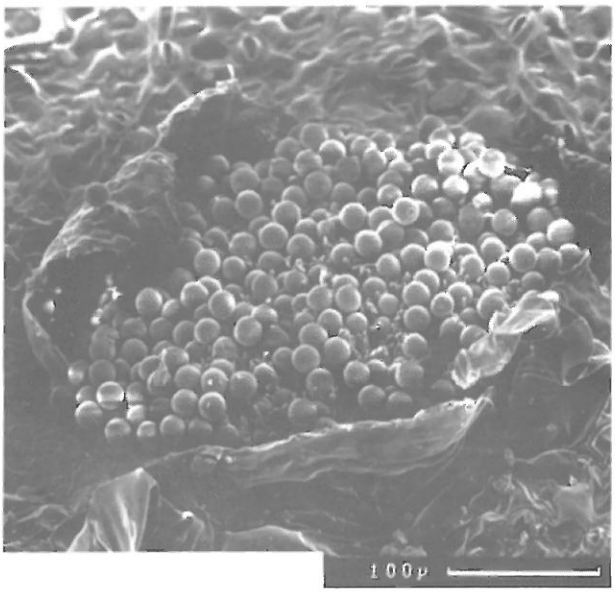
Yorks in B, 194. [T] on *Buxus sempervirens*. Drawing of T in WH 135 and description in EE, 100. Teliospore surface: smooth (WH, EE).

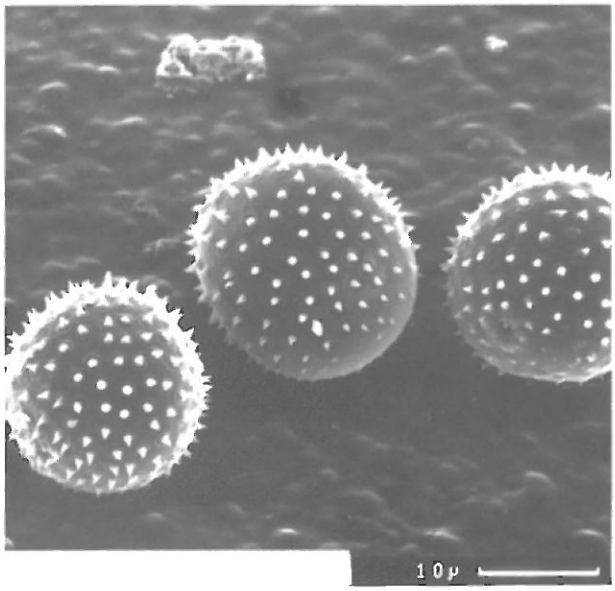
Species 53. *Puccinia calcitrapae*: telia and teliospores.



Yorks in B, 194. [UT] e.g. on Centaurea spp. Drawing of U and T in WH 191. Description EE 327. Teliospore surface: faintly verruculose (WH), slightly verruculose EE.

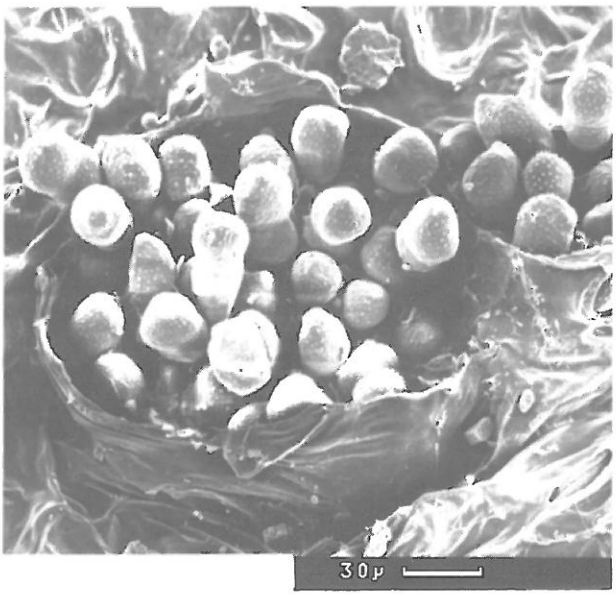
Species 53. *Puccinia calcitrapae*: uredinia and urediniospores.

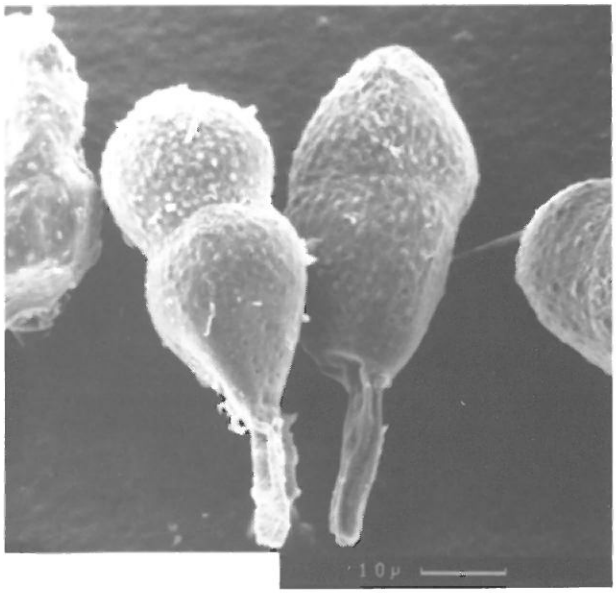




(See caption to photographs of telia and teliospores). Urediniospore surface: resembles aecidiospores (WH), echinulate (EE).

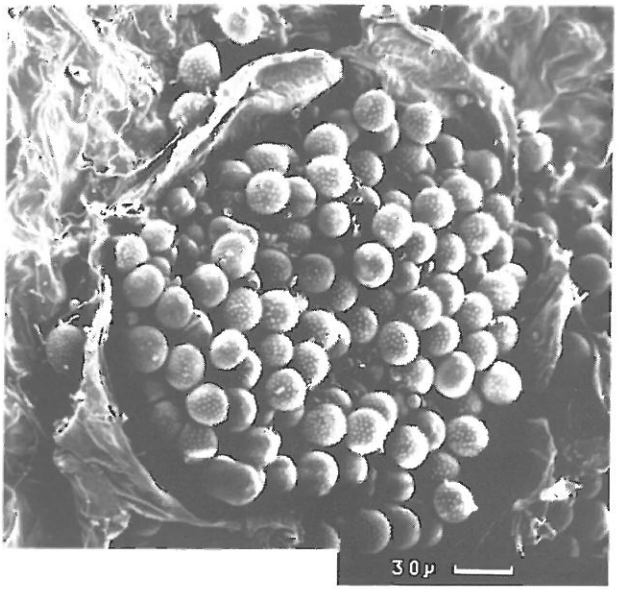
Species 54. *Puccinia calthae*: telia and teliospores.

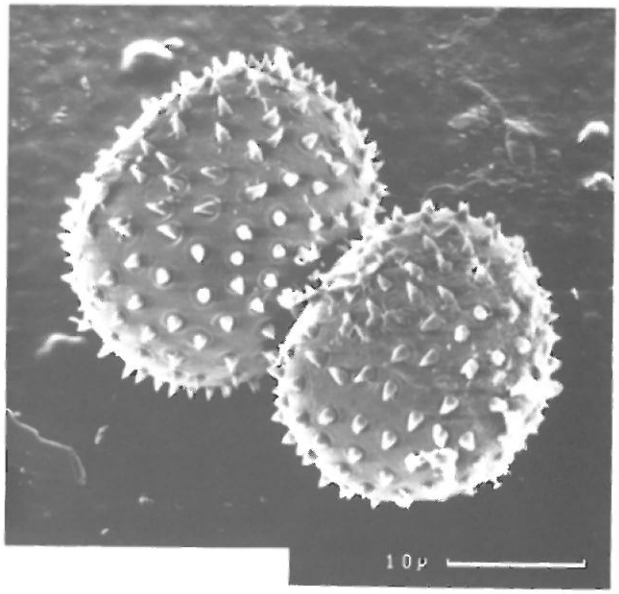




Yorks in B, 194. [AUT] on *Caltha palustris*. Drawings of U and T in WH 123. Description EE 324. Teliospore surface: smooth (WH, EE).

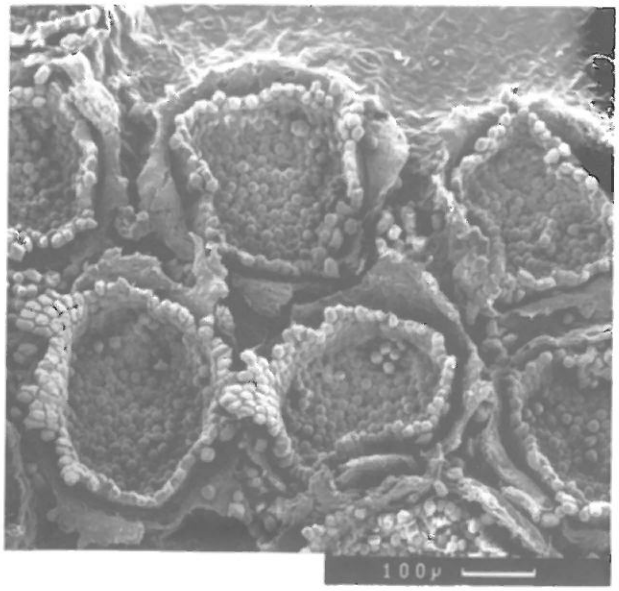
Species 54. *Puccinia calthae*: uredinia and urediniospores.

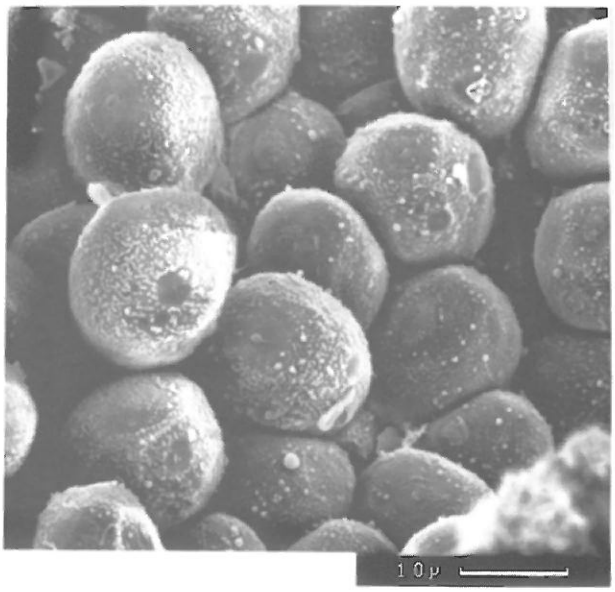




(See caption to photographs of telia and teliospores). Urediniospore surface: echinulate (WH).

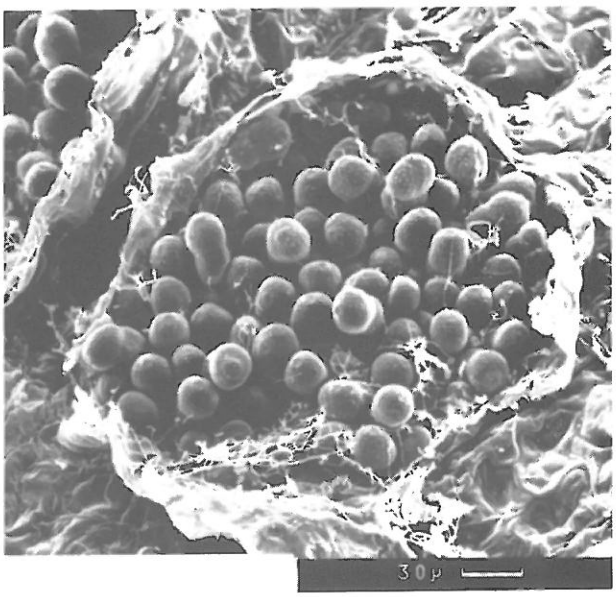
Species 54. *Puccinia calthae*: aecia and aeciospores.

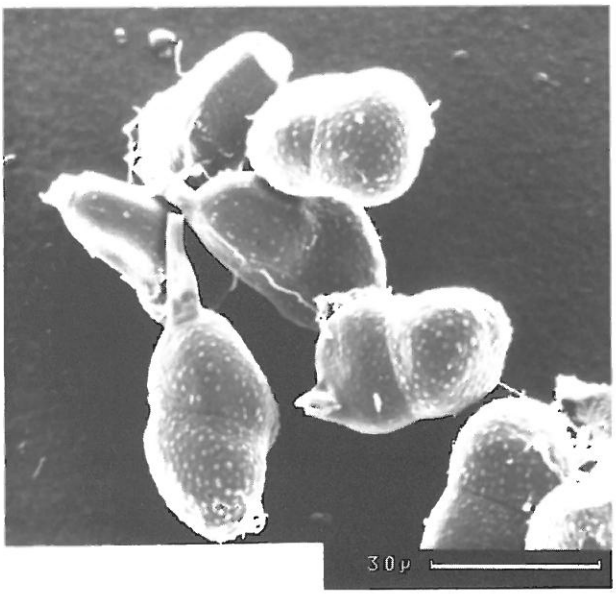




(See caption to photographs of telia and teliospores). Aeciospore surface: finely verrucose (WH).

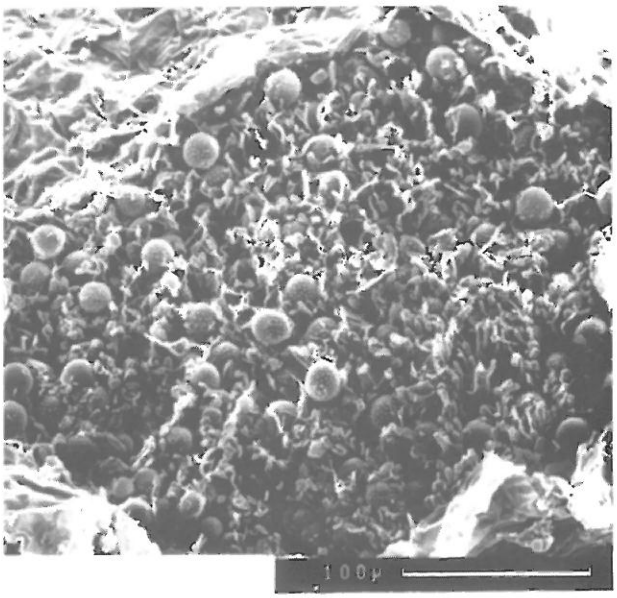
Species 55. *Puccinia calthicola*: telia and teliospores.

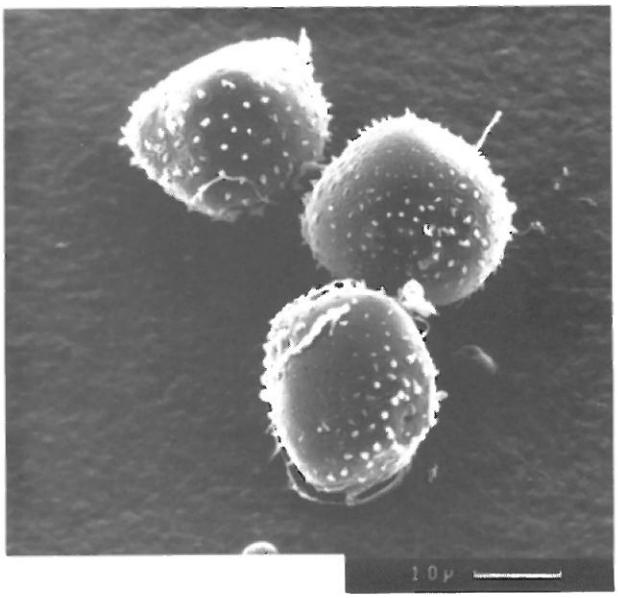




Yorks in B, 194. [AUT] on *Caltha palustris*. Drawing U and T on WH 124, and EE Fig. 1402 shows T. Description in EE 324. Teliospore surface: delicately verruculose (WH), partially verruculose (EE).

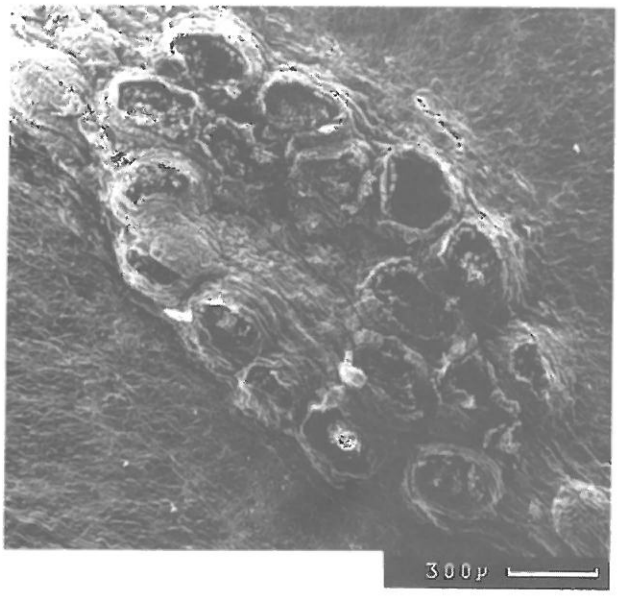
Species 55. *Puccinia calthicola*: uredinia and urediniospores.

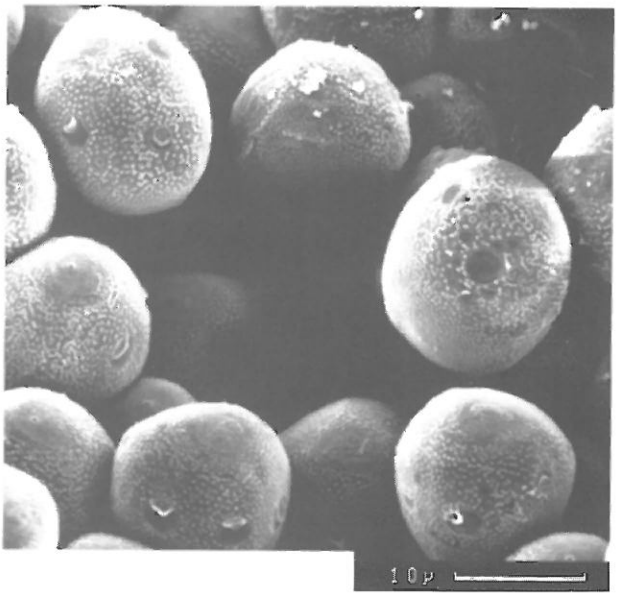




(See caption to photographs of telia and teliospores). Urediniospores surface: echinulate (WH).

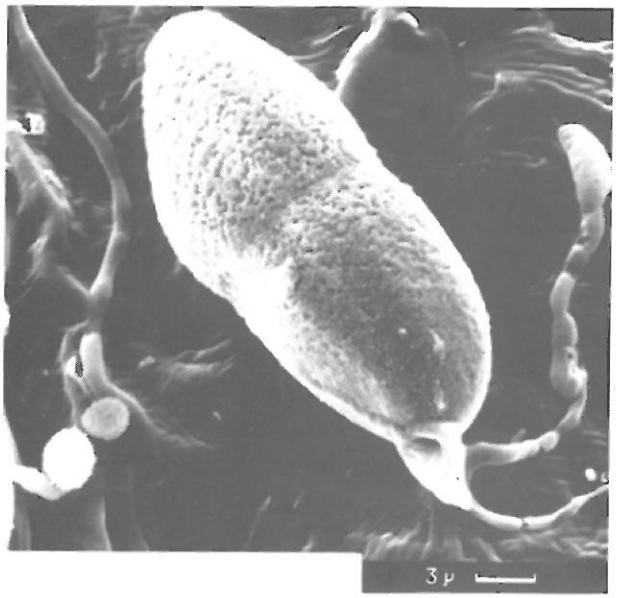
Species 55. *Puccinia calthicola*: aecia and aeciospores.





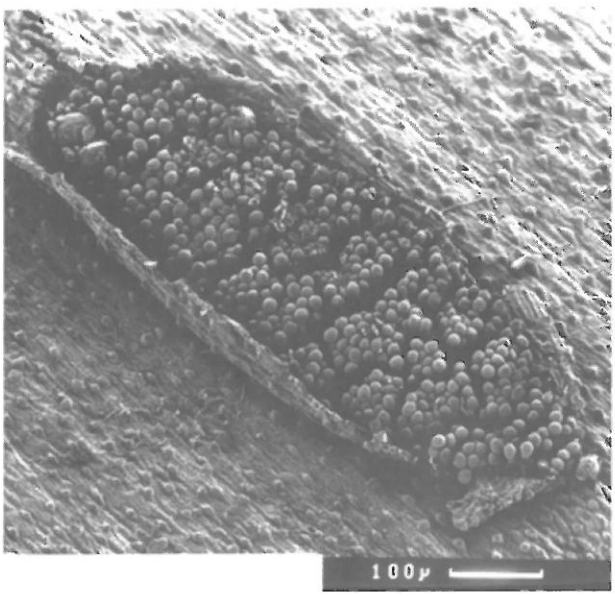
(See caption to photographs of telia and teliospores). Aeciospore surface: finely verruculose (WH).

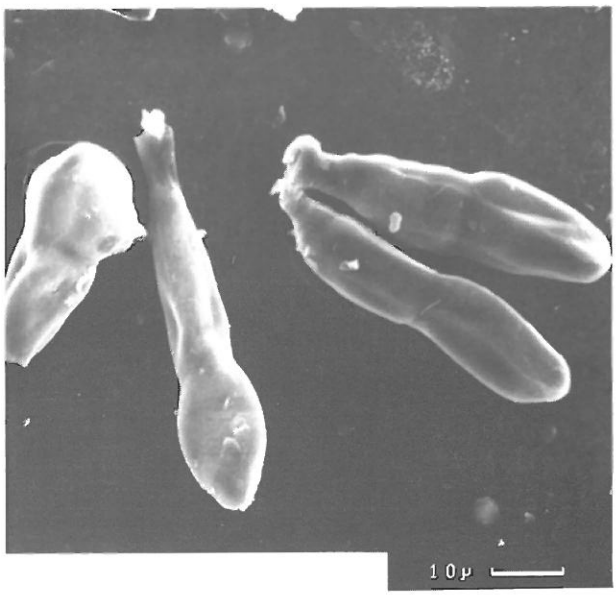
Species 56. *Puccinia campanulae*: teliospore.



Yorks in B, 194. [T] e.g. on Campanula spp. WH 182 has a drawing of T. Description EE 325. teliospore surface: finely verruculose (WH). (Only isolated teliospores found on all herbarium specimens examined).

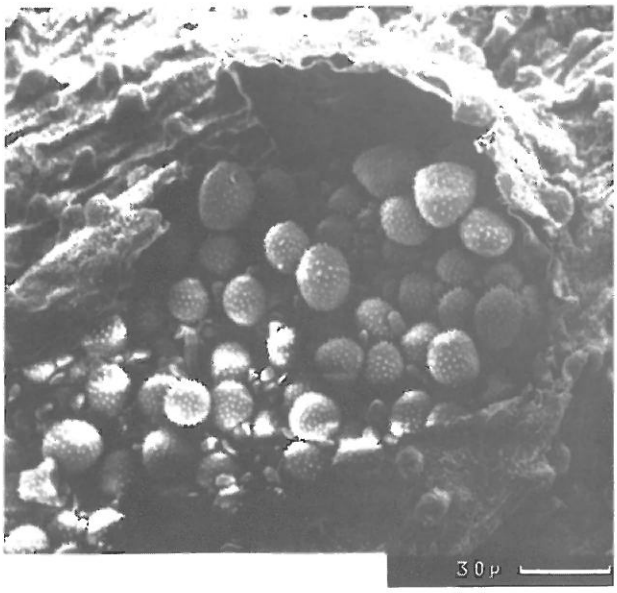
Species 57. *Puccinia caricina* var. *caricina*: telia and teliospores.

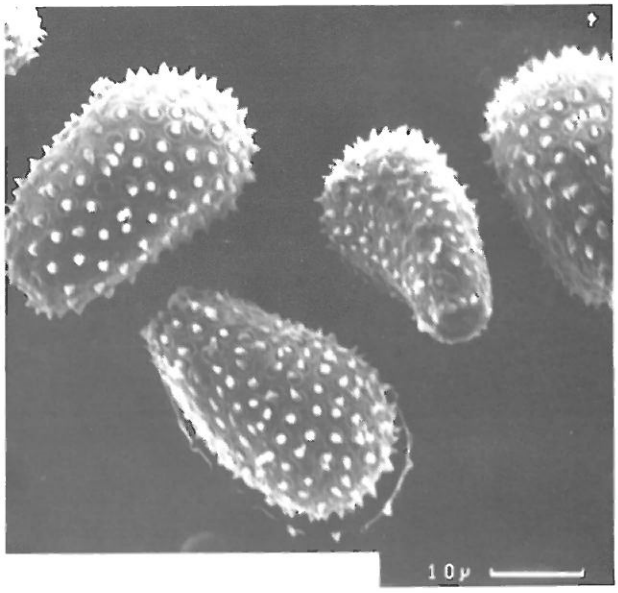




Yorks in B, 194. [A] on e.g. Urtica spp; [UT] on Carex spp. Drawing of var. *urticae-hirtae* WH 232 (T and U). Description EE 225, 440(A) and 521. Teliospore surface: smooth (WH).

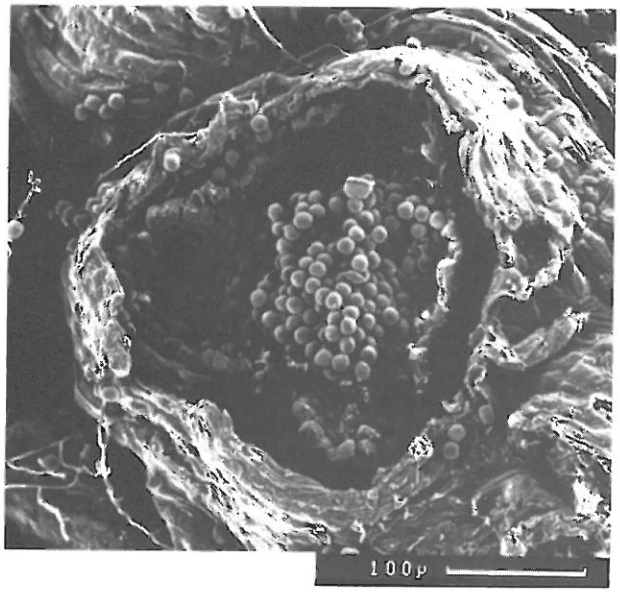
Species 57. *Puccinia caricina* var.*caricina*: uredinia and urediniospores.

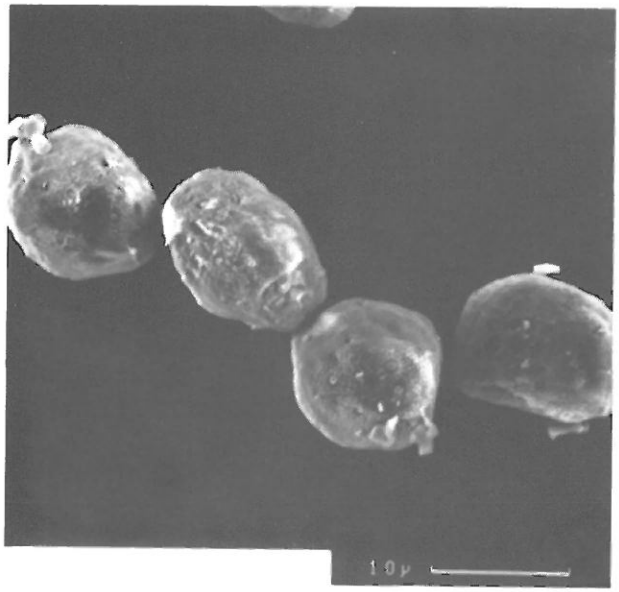




(See caption to photographs of telia and teliospores). Urediniospore surface: echinulate (WH).

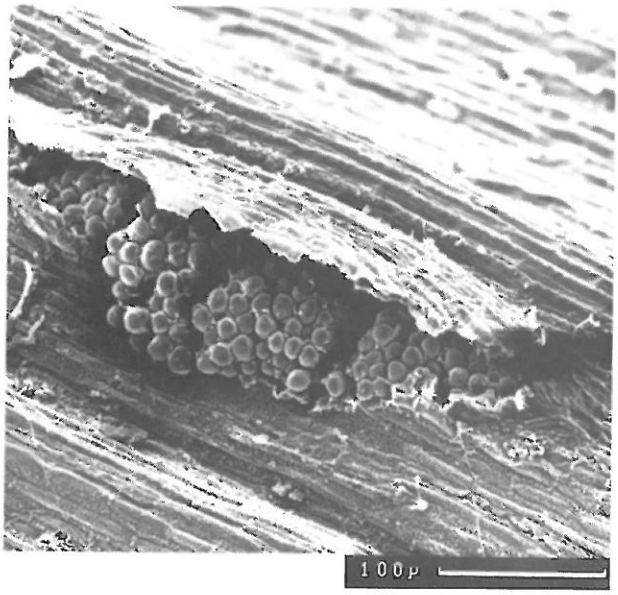
Species 57. *Puccinia caricina* var. *caricina*: aecia and aeciospores.

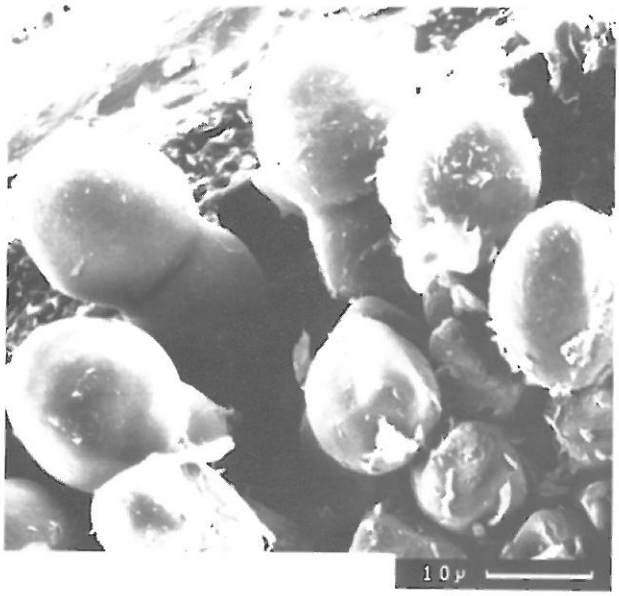




(See caption to photographs of telia and teliospores). Aeciospore surface: verruculose (WH, EE)

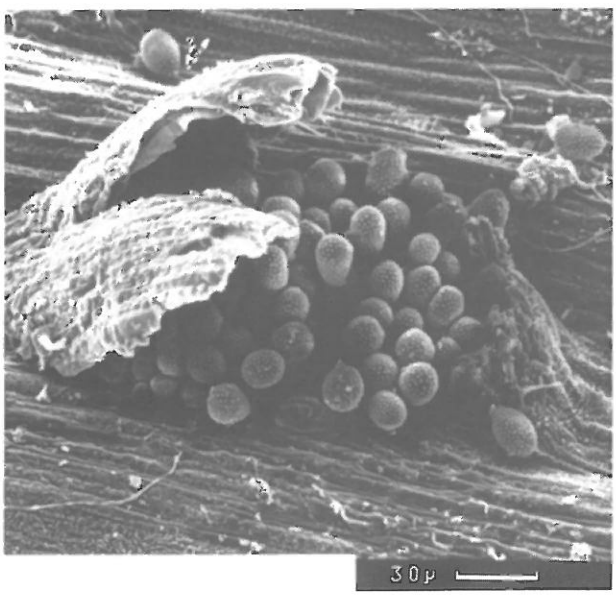
Species 57A. *Puccinia caricina* var. *pringsheimiana*: telia and teliospores.

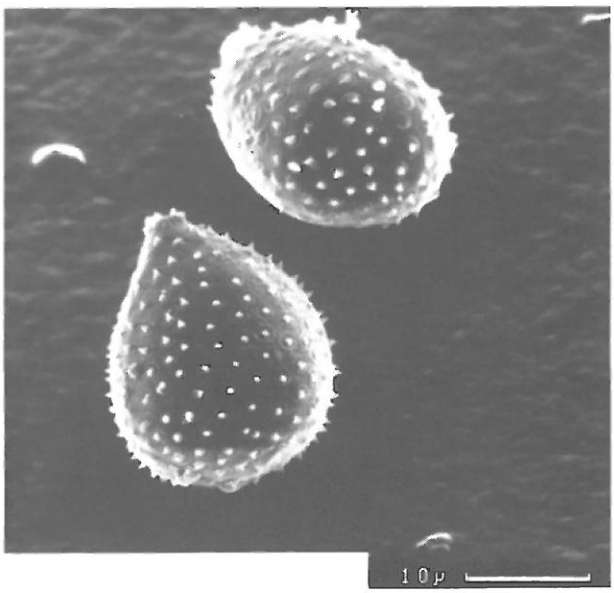




Yorks in B, 194; [A] on, e.g. *Ribes uva-crispa* [UT] on, e.g. *Carex nigra*. Descriptions WH 236 and EE 521. (See species 57). Teliospore surface: presumably smooth.

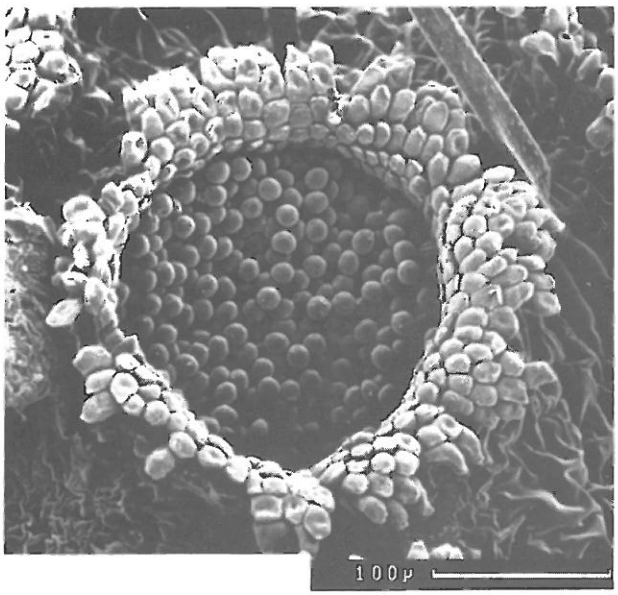
Species 57A. *Puccinia caricina* var. *pringsheimiana*: uredinia and urediniospores.

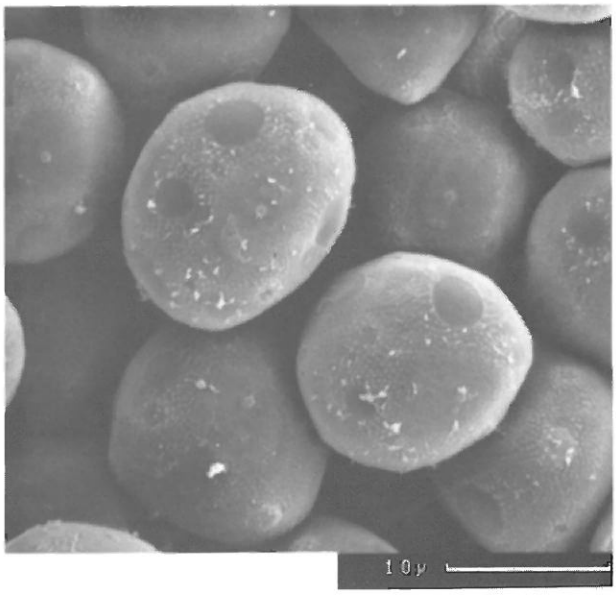




(See caption to photographs of telia and teliospores). Urediniospore surface: presumably echinulate as 57.

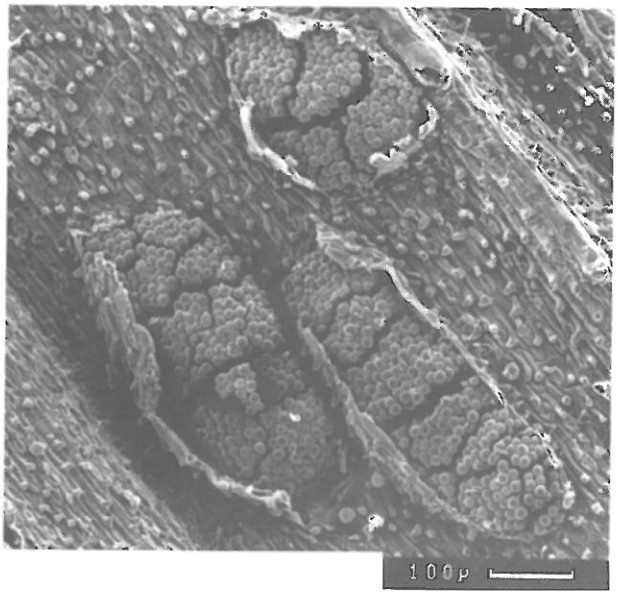
Species 57A. *Puccinia caricina* var. *pringsheimiana*: aecia and aeciospores

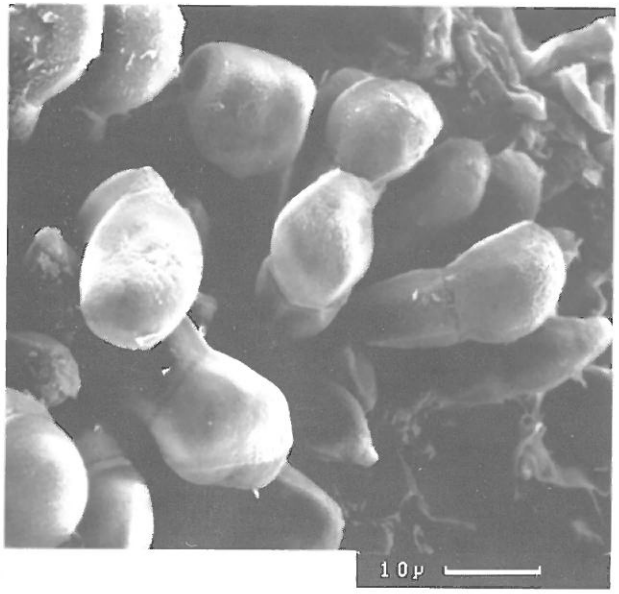




(See caption to photographs of telia and teliospores). Aeciospore surface: presumably verruculose as 57.

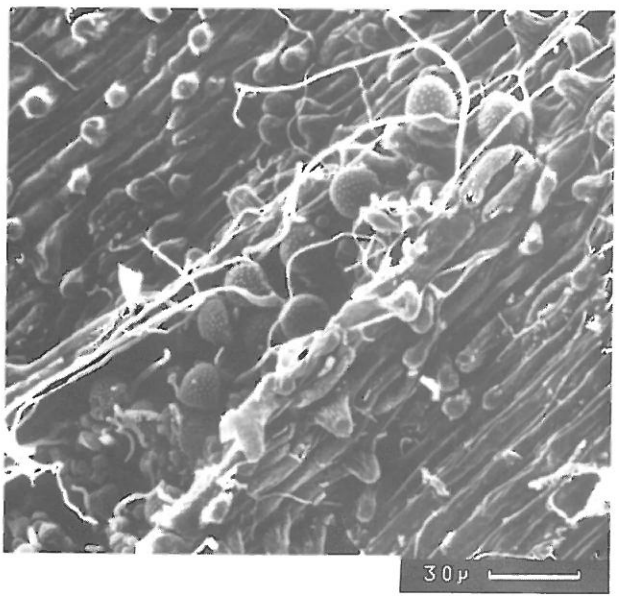
Species 57B. *Puccinia caricina* var. *uliginosa*: telia and teliospores.

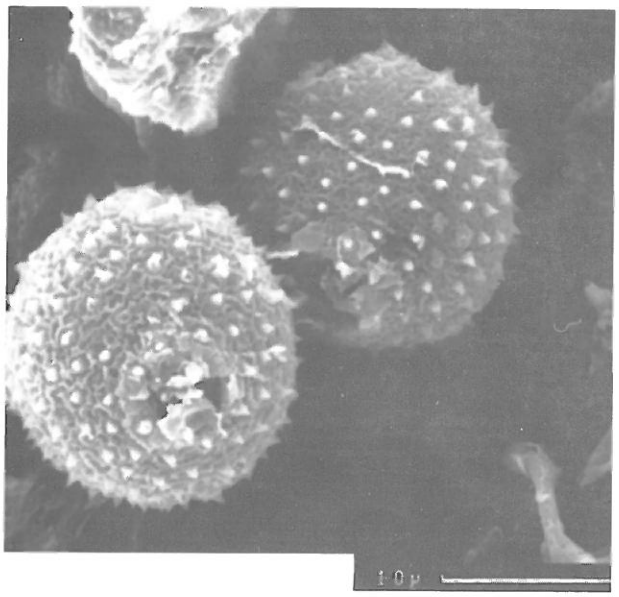




Yorks in B, 194 [A] on *Parnassia palustris*; [UT] on *Carex nigra*. Descriptions WH 237 and in EE, 396 and 521. (See species 57) Teliospore surface: presumably smooth as 57.

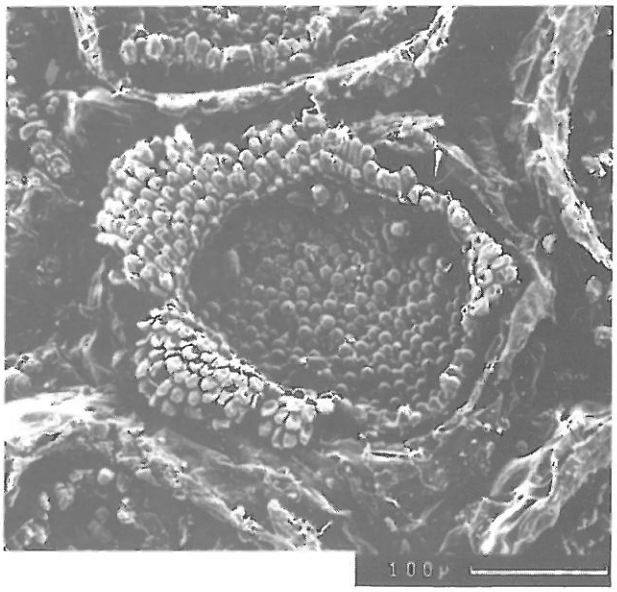
Species 57B. *Puccinia caricina* var. *uliginosa*: uredinia and urediniospores.

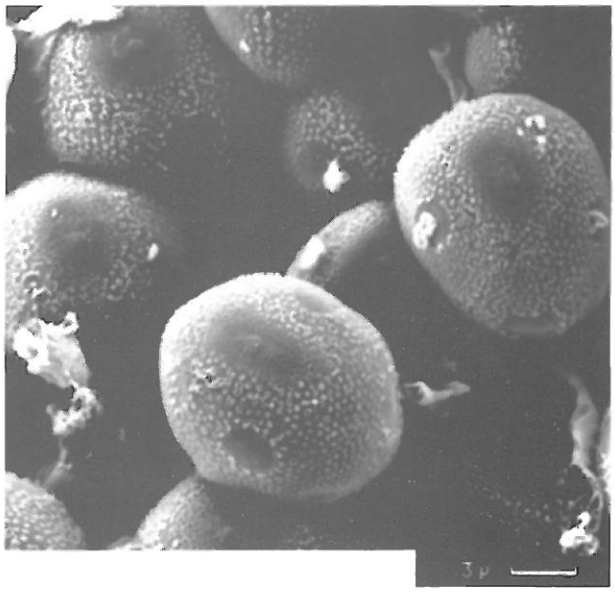




(See caption to photographs of telia and teliospores). Urediniospore surface: presumably echinulate as 57.

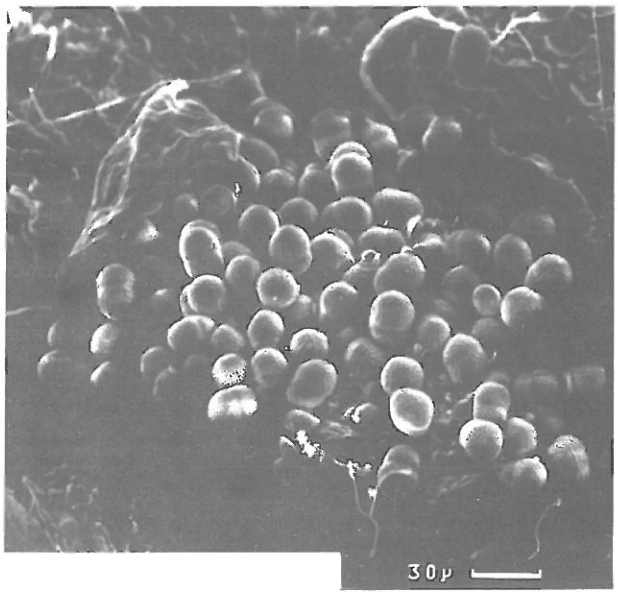
Species 57B. *Puccinia caricina* var. *uliginosa*: aecia and aeciospores.

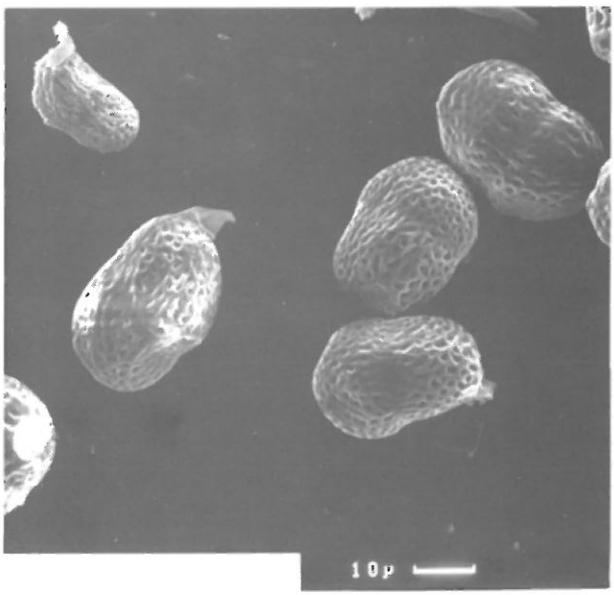




(See caption to photographs of telia and teliospores). Aeciospore surface: presumably verruculose as 57.

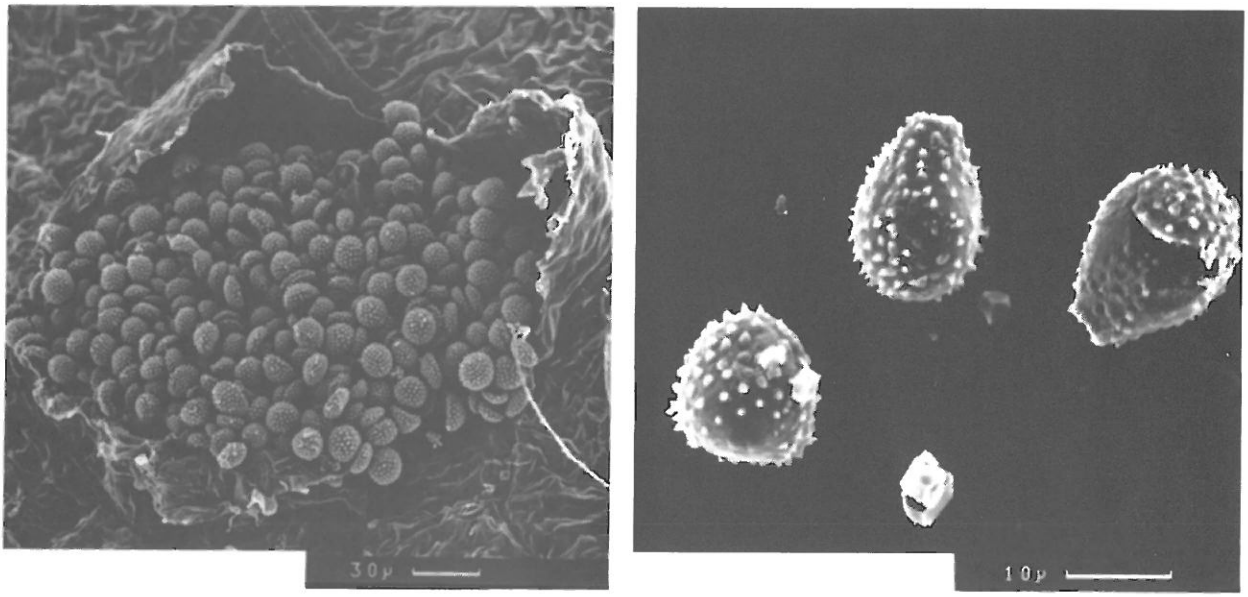
Species 58. *Puccinia chaerophylli*: telia and teliospores.





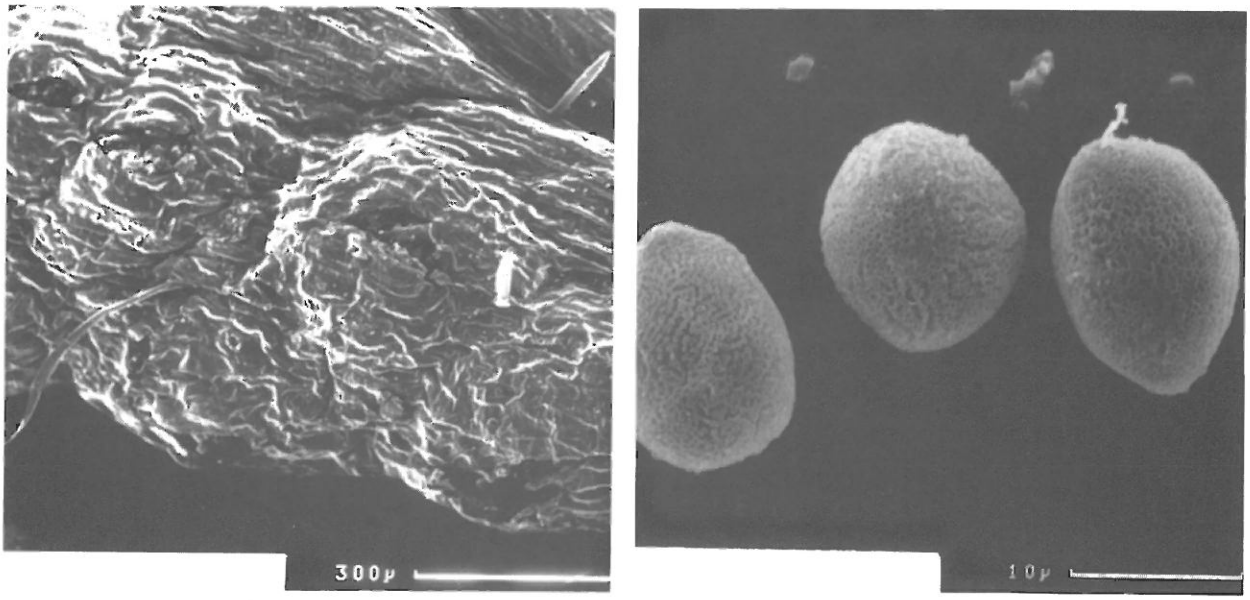
Yorks in B, 194. [AUT] e.g. on *Myrrhis odorata*. Drawings of UT in WH 148 and in Fig. 1354 (EE). Description in EE 309. Teliospore surface: reticulate.

Species 58. *Puccinia chaerophylli*: uredinia and urediniospores.



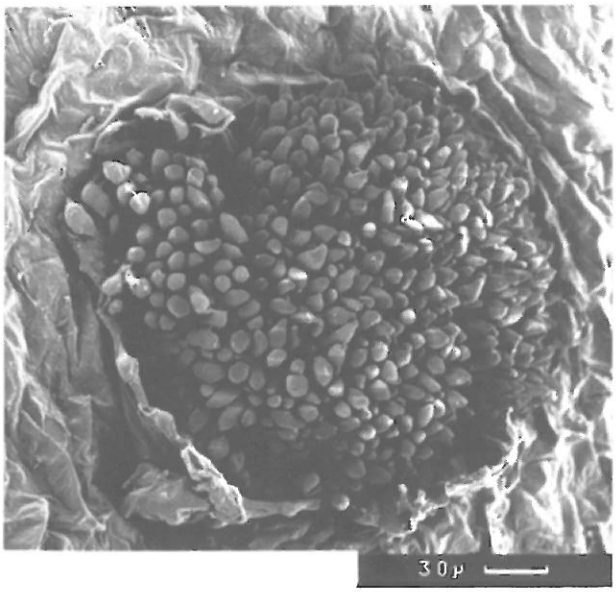
(See caption to photographs of telia and teliospores). Urediniospore surface echinulate (WH).

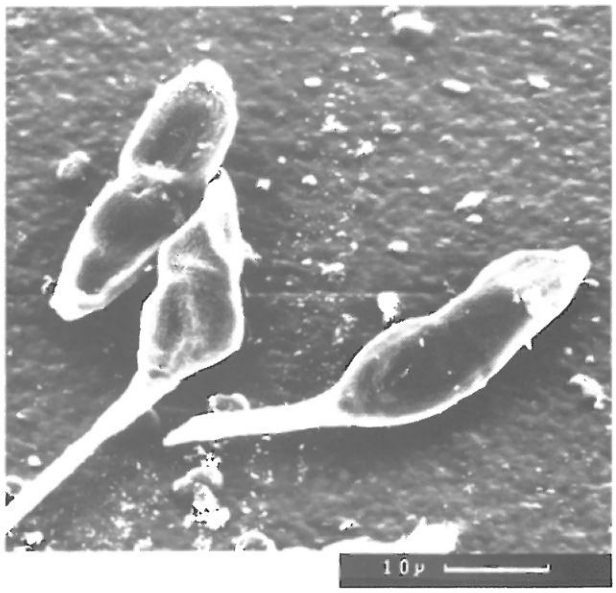
Species 58. *Puccinia chaerophylli*: aecia and aecidiospores



(See caption to photographs of telia and teliospores). Aecidiospore surface: verruculose (WH).

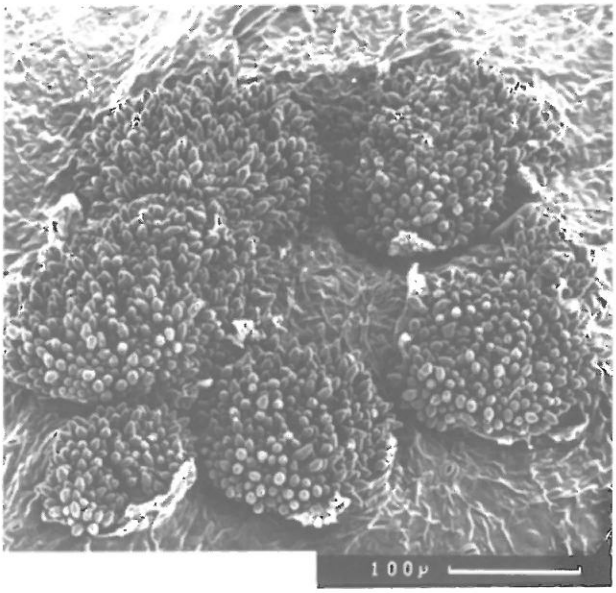
Species 59. *Puccinia chrysosplenii*: telia and teliospores

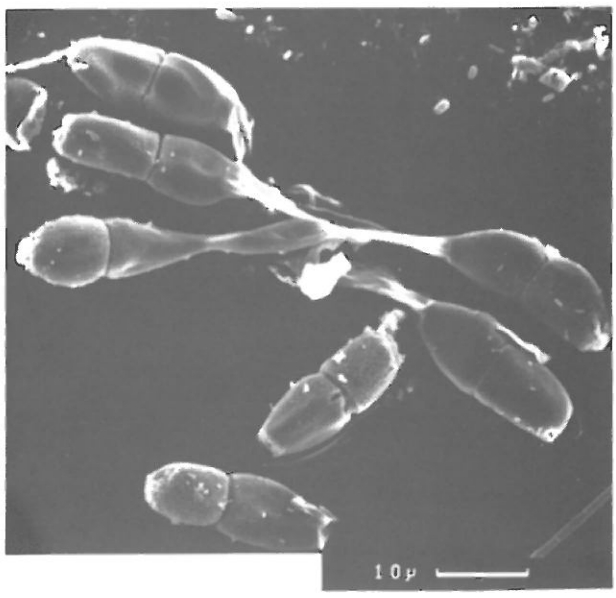




Yorks in B, 194. [T] on Chrysosplenium spp. Drawings of T in WH 137 and EE Fig. 1430. Description EE 333. Teliospore surface: may be smooth as in WH, type (a) or with very faint, rather irregular longitudinal ridges, type (b), which apparently occur in different sori (WH). All specimens examined by SEM were essentially smooth.

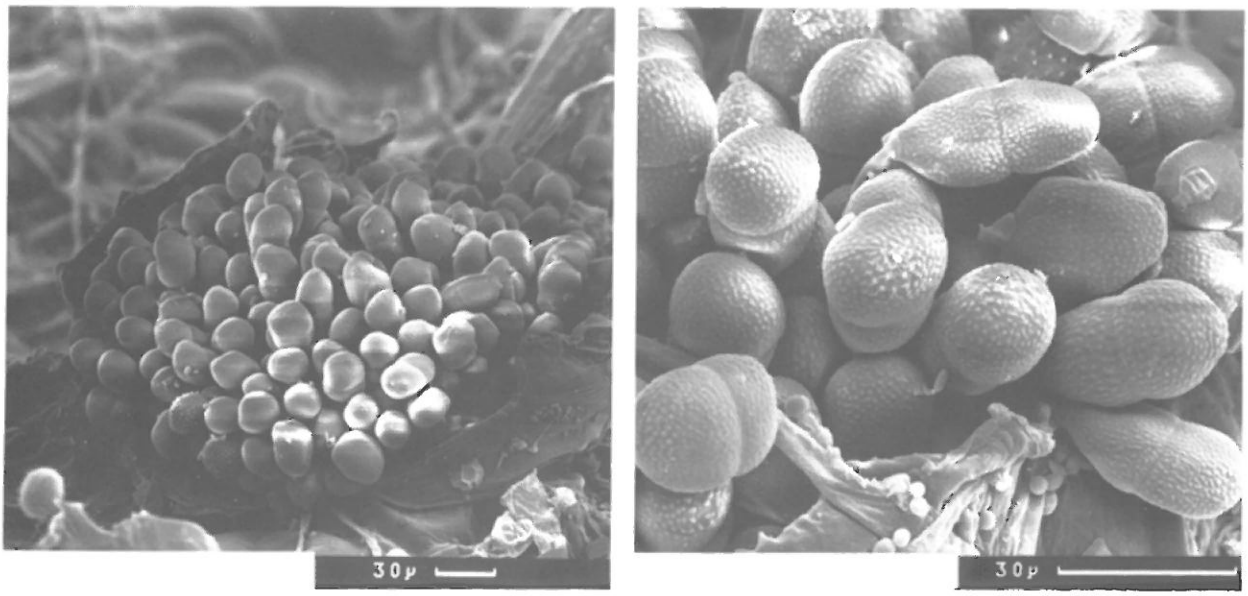
Species 60. *Puccinia circaeae*: telia and teliospores.





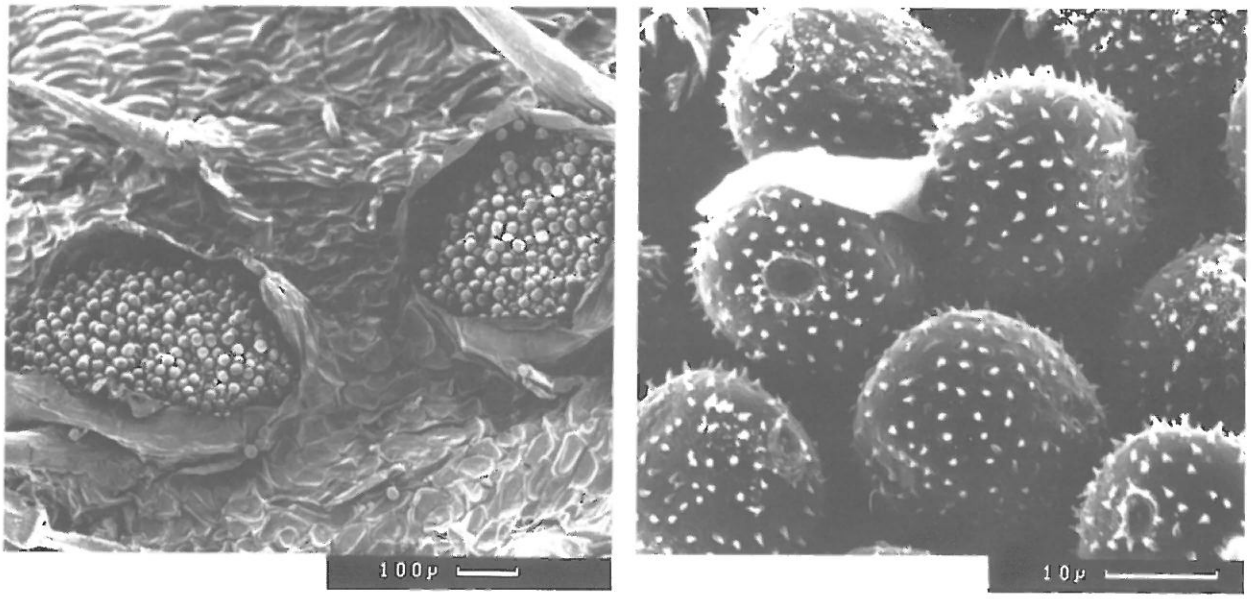
Yorks in B, 194 [T] on spp. of Circaea. Drawing of T inWH 141. Description in EE, 334. Teliospore surface: smooth (WH, EE).

Species 61. *Puccinia cnici*: telia and teliospores.



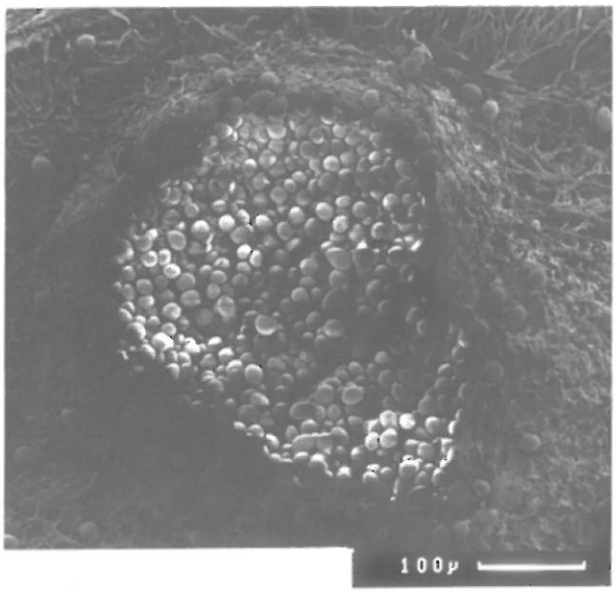
Yorks in B, 194. [AUT] on Cirsium spp. Drawings of U and T in WH 196; description EE 335. Teliospore surface: wall finely verrucose (WH), smooth to minutely verrucose (EE).

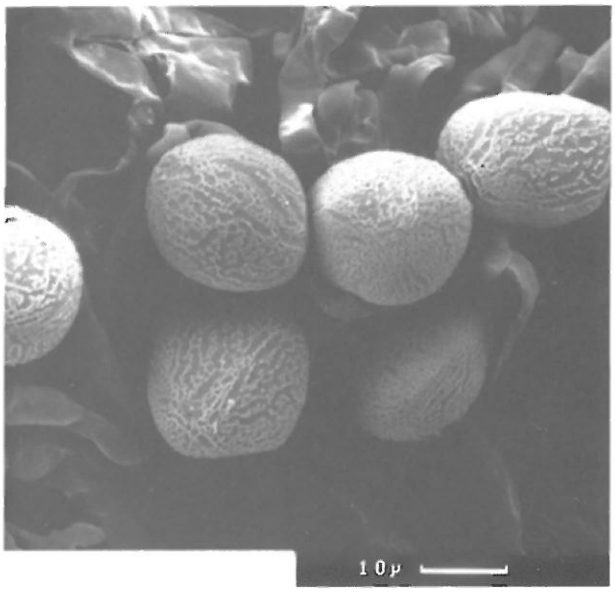
Species 61. *Puccinia cnici*: uredinia and urediniospores.



(See caption to photographs of telia and teliospores). Urediniospore surface: echinulate (WH, EE).

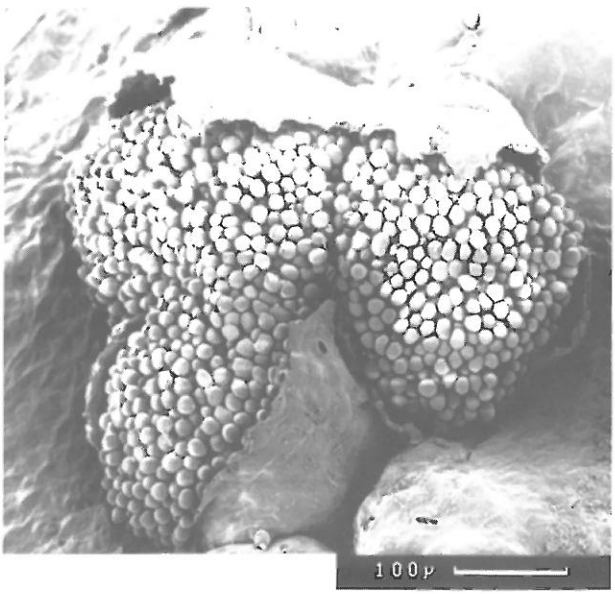
Species 61. *Puccinia cnici*: aecia and aeciospores.





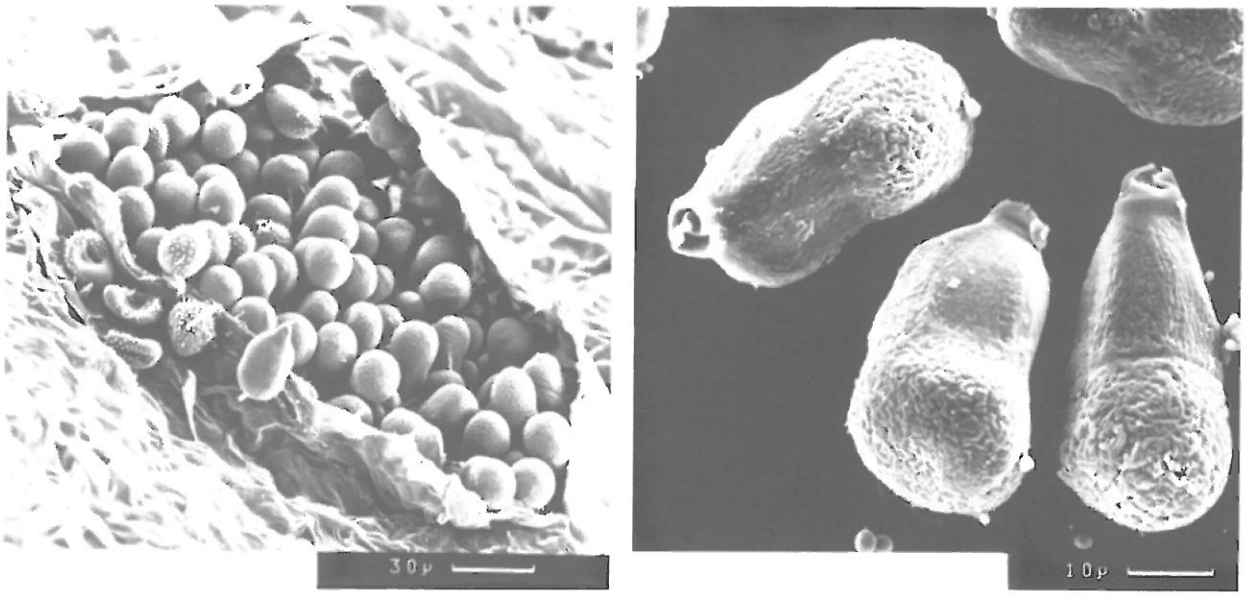
(See caption to photographs of telia and teliospores). Aeciospore surface: verruculose (WH).

Species 62. *Puccinia cnici-oleracei*: telia and teliospores.



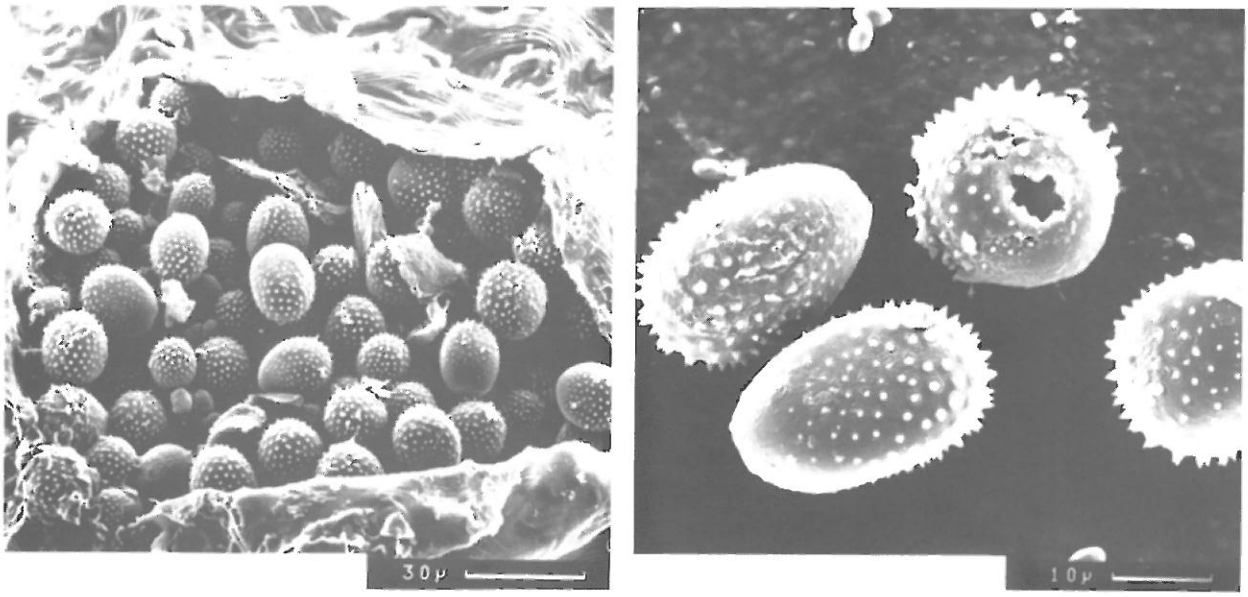
Yorks in B, 194 [T] e.g. on *Achillea millefolium*. Drawing of T in WH, 197, and EE Fig. 1322. Description EE 300. Teliospore surface: smooth (WH).

Species 63. *Puccinia conii*: telia and teliospores.



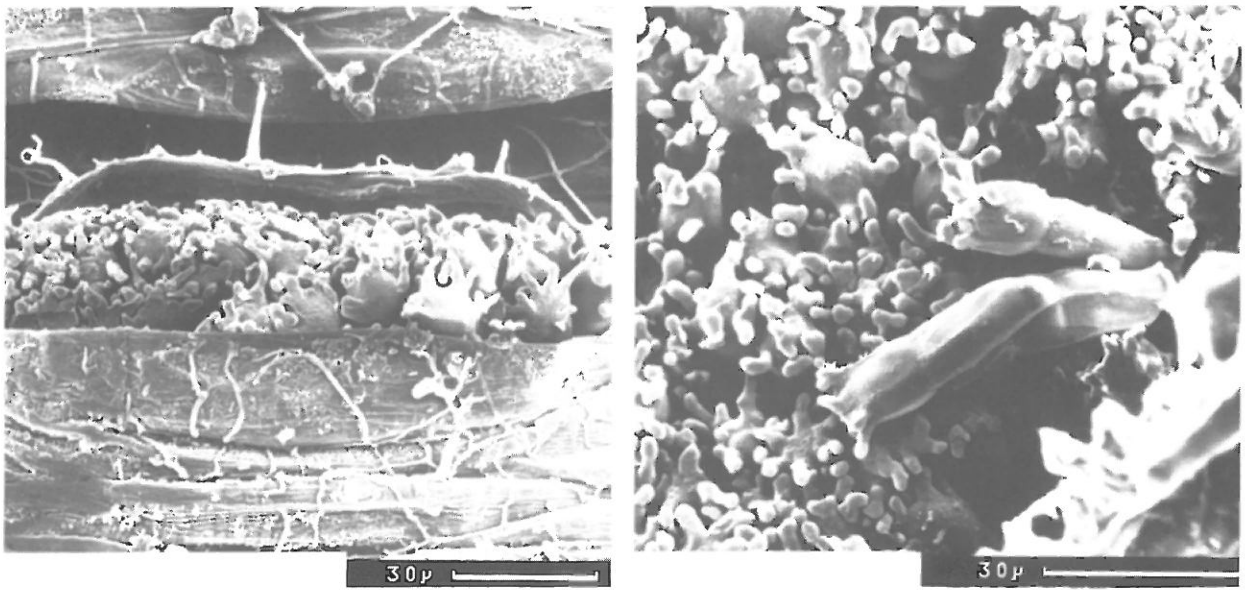
Yorks in B, 194. [UT] on *Conium maculatum*. Drawing of U and T in WH 150. description EE 338. Teliospore surface: nearly or quite smooth (WH), smooth (EE).

Species 63. *Puccinia conii*: uredinia and urediniospores.



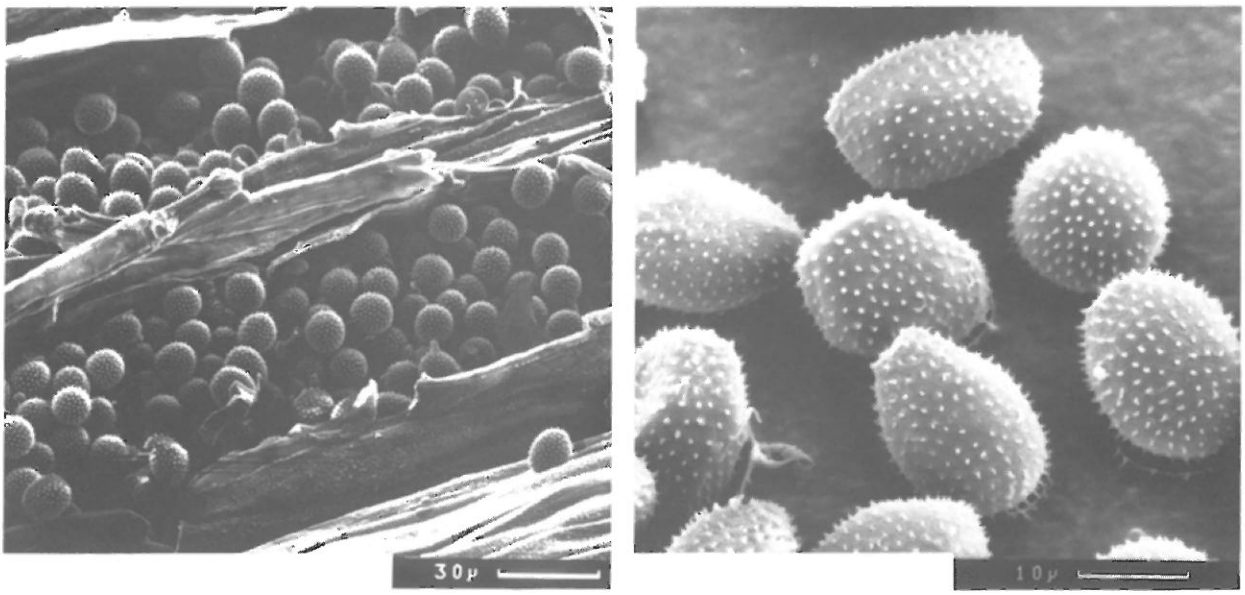
(See caption to photographs of telia and teliospores). Urediniospore surface: echinulate in the upper part only (WH), top half echinulate and lower half smooth (EE).

Species 64. *Puccinia coronata:* telia and teliospores.



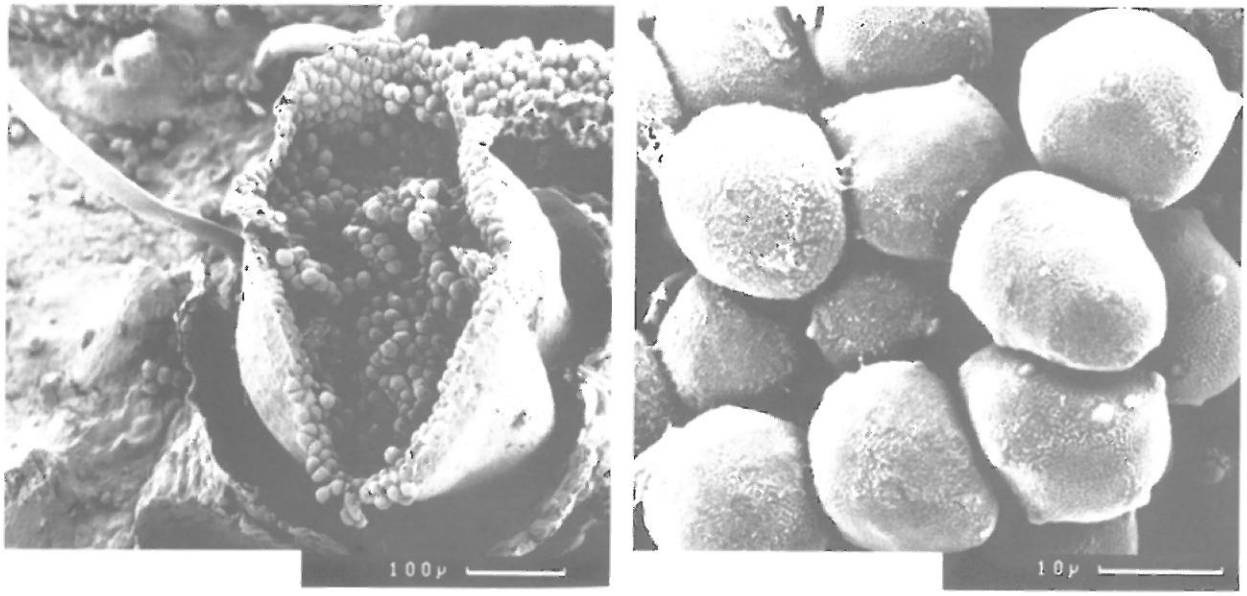
Yorks in B, 194. [A] on, e.g. *Frangula alnus* [UT] on, e.g. *Avena sativa*. Drawings of U and T in WH, 251 and EE Fig. 1731. Description (A) EE 220 and 451 (UT). Teliospore surface: smooth (WH), as are the remarkable apical projections.

Species 64. *Puccinia coronata*: uredinia and urediniospores.



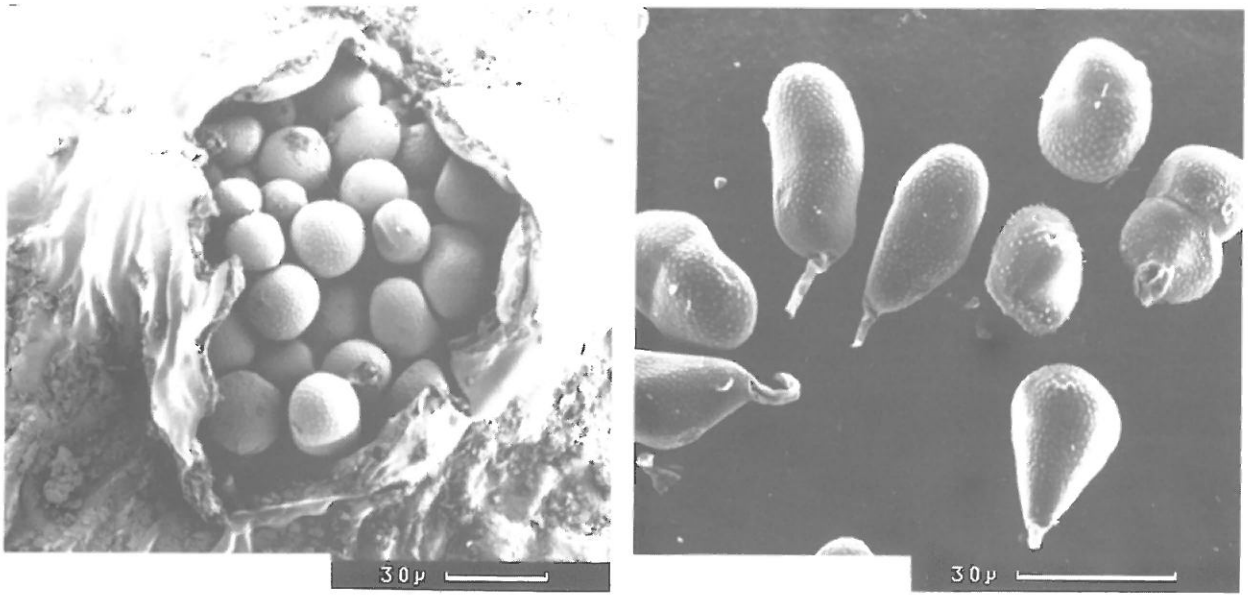
(See caption to photographs of telia and teliospores). Urediniospore surface: finely echinulate (WH, EE).

Species 64. *Puccinia coronata*: aecia and aeciospores.



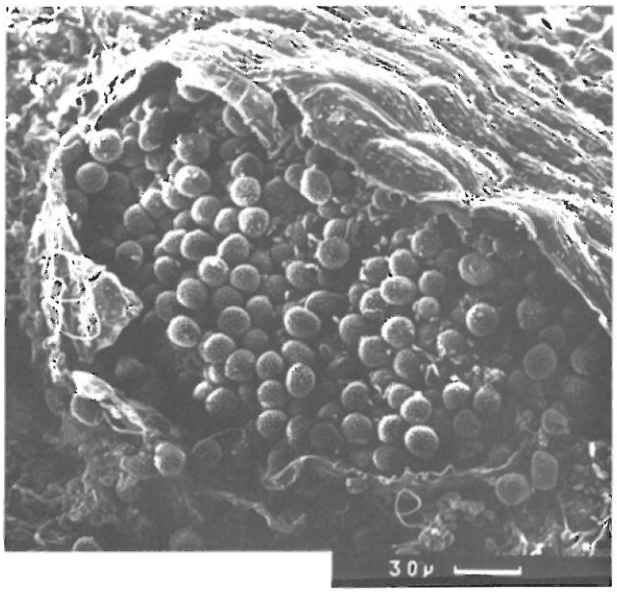
(See caption to photograph of telia and teliospores). Aeciospore surface: very finely verruculose (WH), finely verruculose (EE).

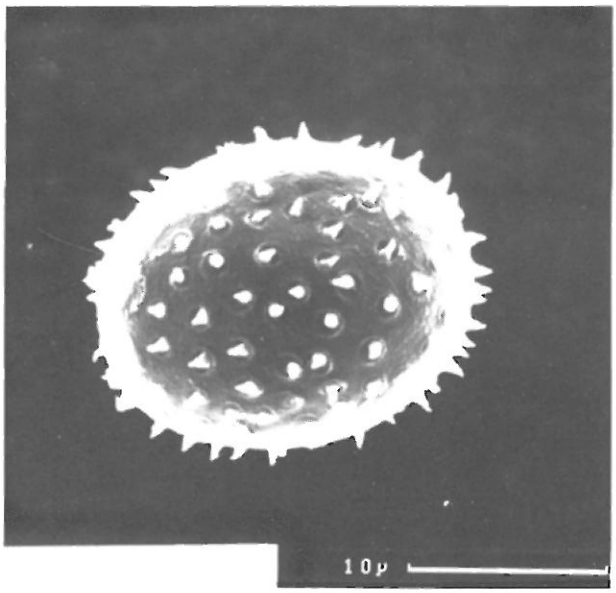
Species 65. *Puccinia crepidicola*: telia and teliospores.



Yorks in B, 195. On Crepis spp., [UT]. Drawing of U and T in WH 200. Description in EE 339. Surface of teliospore: finely verrucose (WH), minutely verrucose (EE).

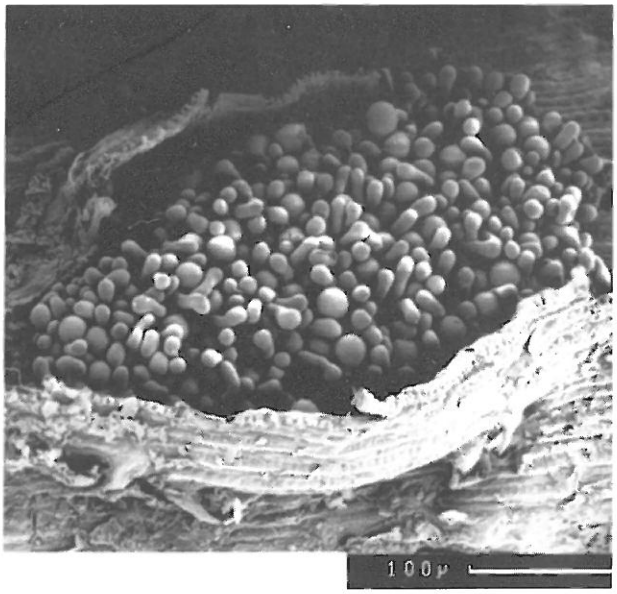
Species 65. *Puccinia crepidicola*: uredinia and urediniospores.

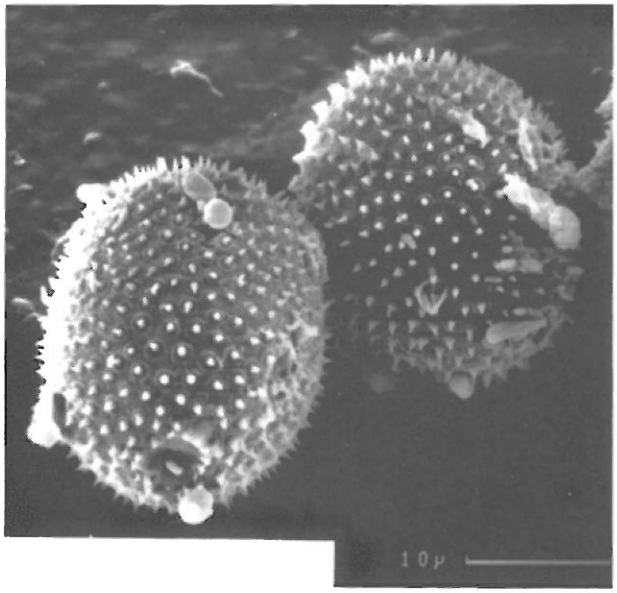




(See caption to photographs of telia and teliospores). Urediniospore surface: echinulate (WH), minutely echinulate (EE).

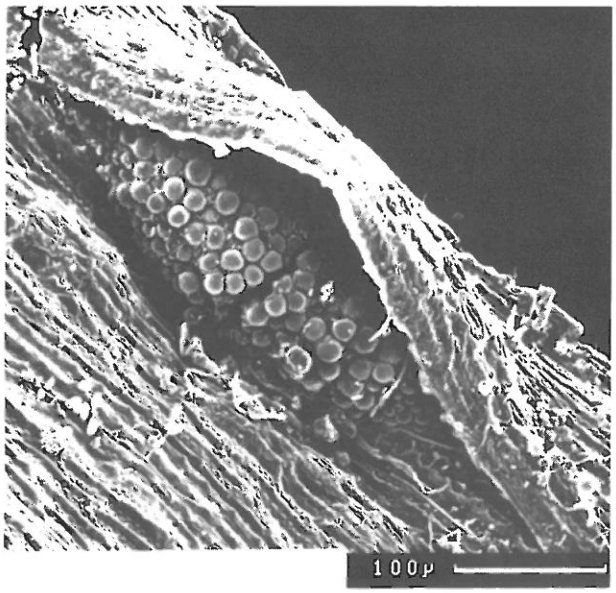
Species 66. *Puccinia deschampsiae*: uredinia and urediniospores.





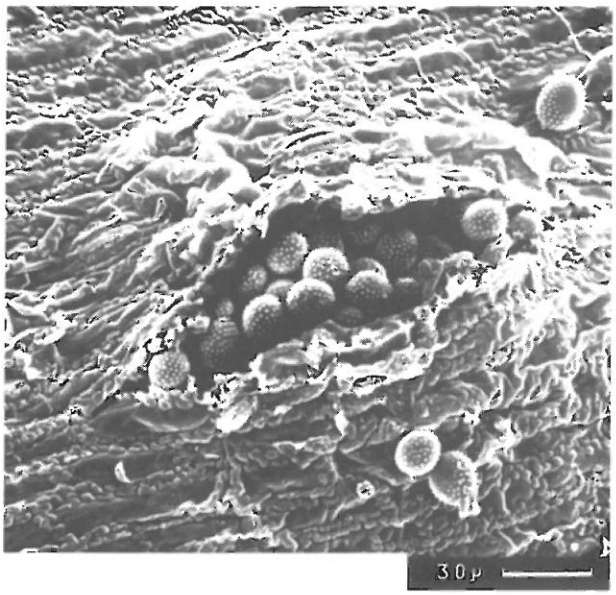
Yorks in B, 195. [U] on *Deschampsia caespitosa*. Drawing of U (and of T - the latter not yet found in Britain) in WH 255. Description EE 492. Urediniospore surface: densely or shortly echinulate or echinulate-verrucose (WH), shortly echinulate (EE).

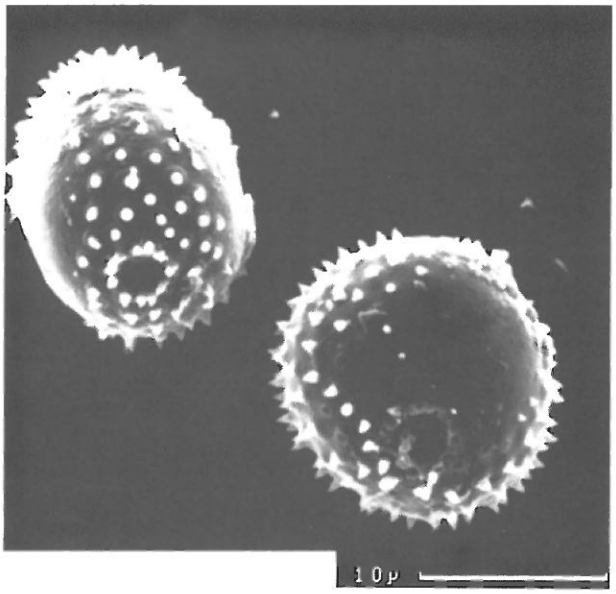
Species 67. *Puccinia dioicae* var. *schoeleriana*: telia and teliospores.



Yorks in B, 195 (as *P.dioicae*). [A] on *Senecio jacobaea;* [UT] on *Carex arenaria. P. dioicae* has been sub-divided into 5 vars. see WH241-3. Drawings of U and T (as *P.dioicae*) WH241. Teliospore surface: smooth (WH).

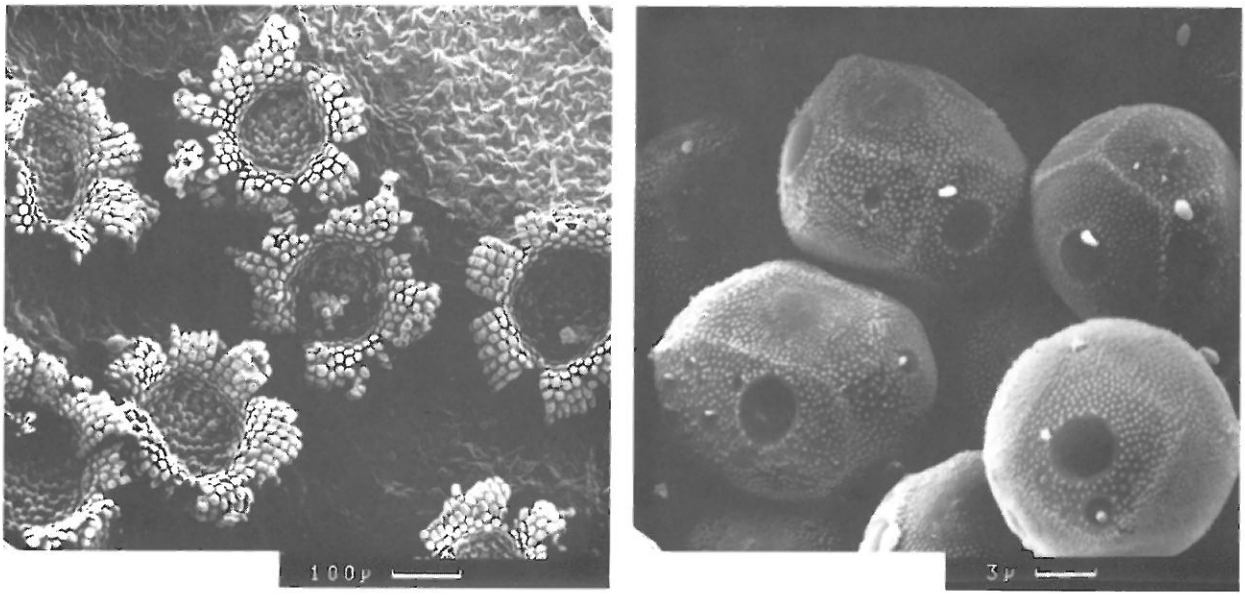
Species 67. *Puccinia dioicae* var. *schoeleriana*: uredinia and urediniospores





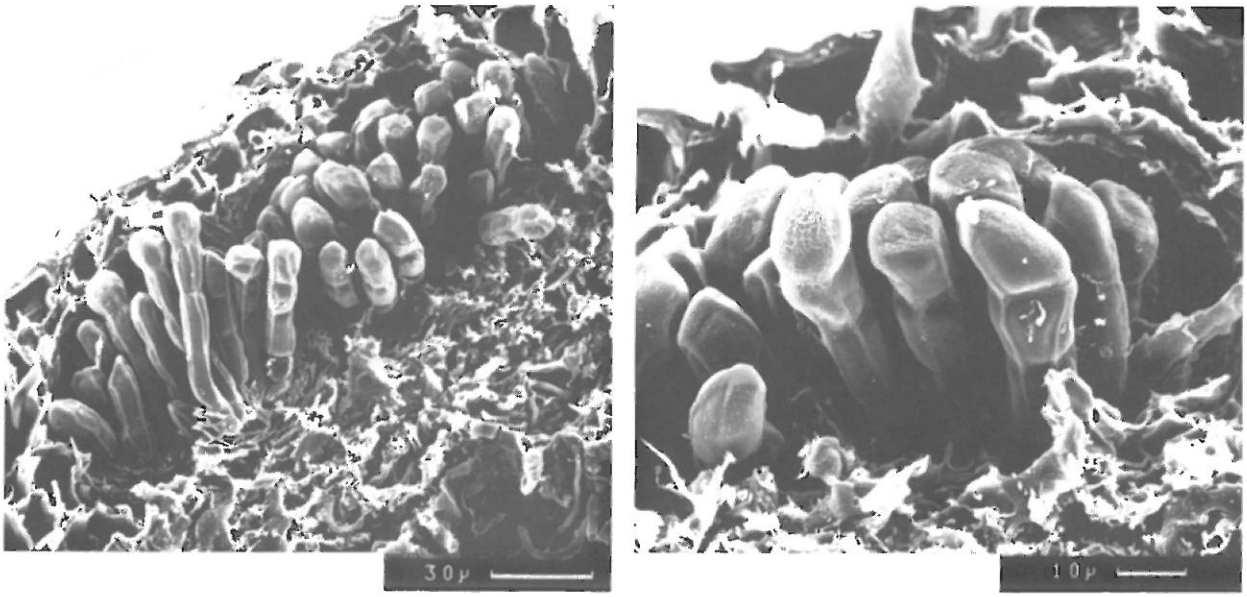
(See caption to photographs of telia and teliospores). Urediniospore surface: almost smooth (WH).

Species 67. *Puccinia dioicae* var. *schloeriana*: aecia and aeciospores



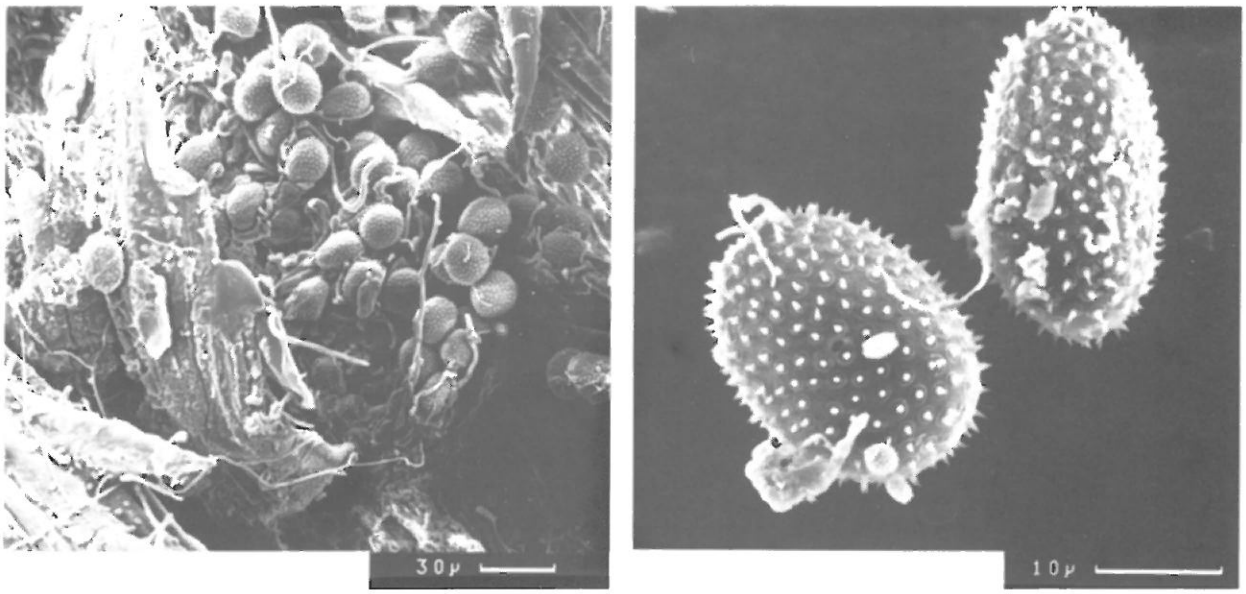
(See caption to photographs of telia and teliospores). Aeciospore surface: finely verruculose (WH).

Species 68. *Puccinia elymi*: telia and teliospores.



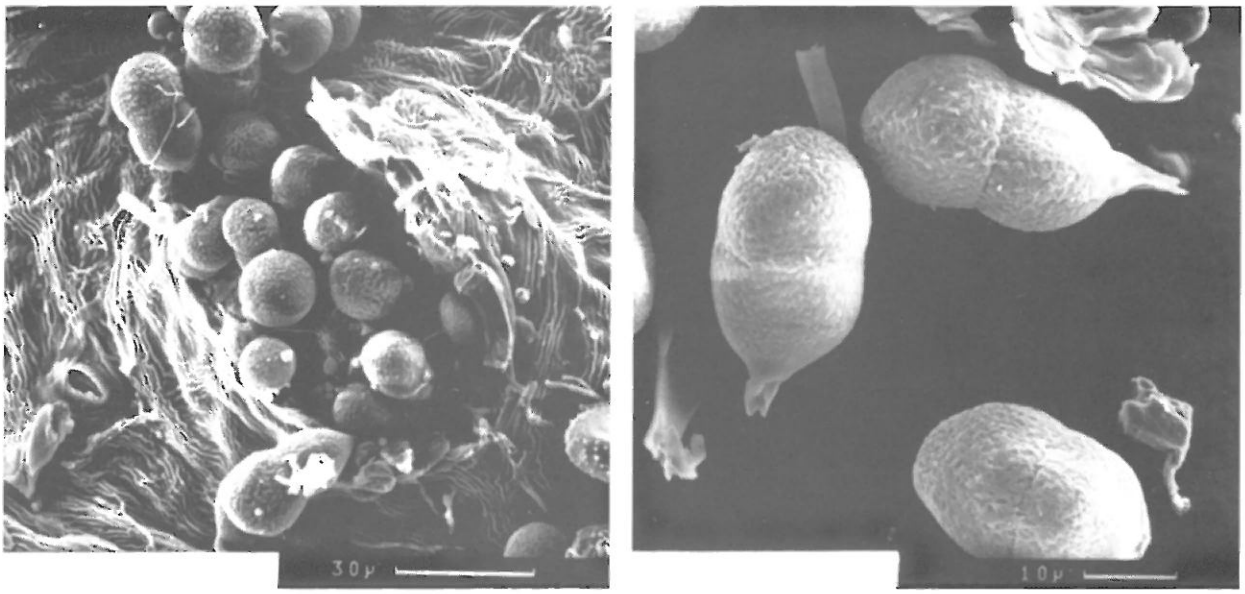
Yorks in B, 195. [UT] e.g. on *Elymus arenarius*. Drawings of T in WH 256. Description EE 495. Teliospore surface: smooth in WH drawing, no description of it in WH or EE.

Species 68. *Puccinia elymi*: uredinia and urediniospores.



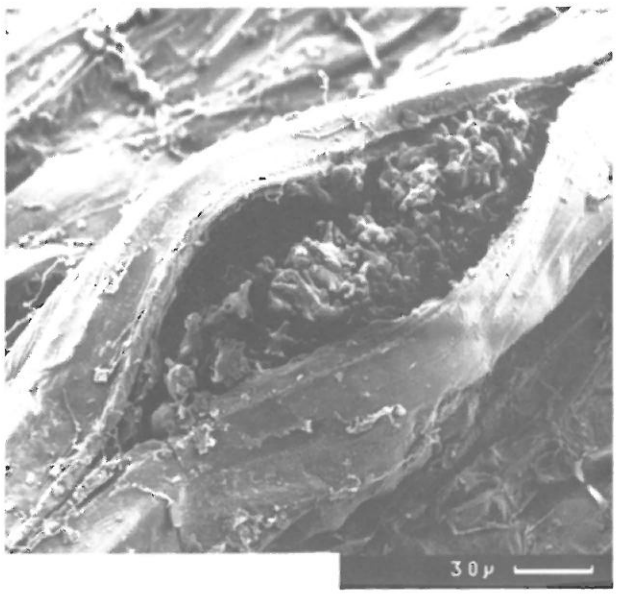
(See caption to photographs of telia and teliospores). Urediniospore surface: not in WH, EE.

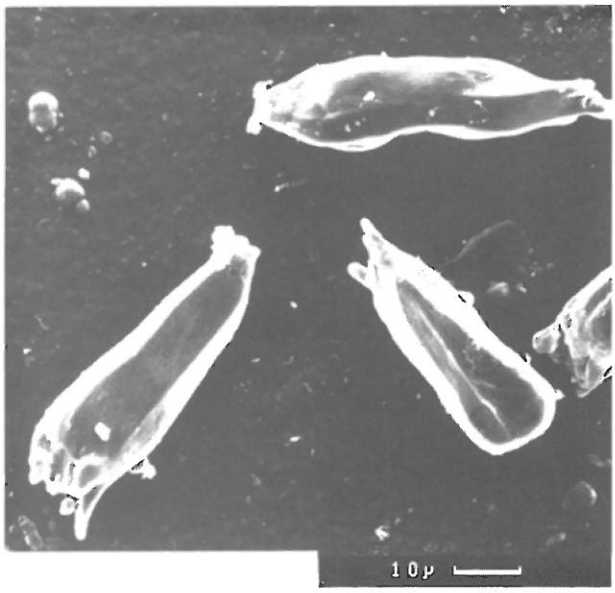
Species 69. *Puccinia epilobii*: telia and teliospores.



Yorks in B, 195. [T] on Epilobium spp. Drawing of T in WH 142. Description EE 346. Teliospore surface: minutely verrucose (WH), minutely verruculose (EE).

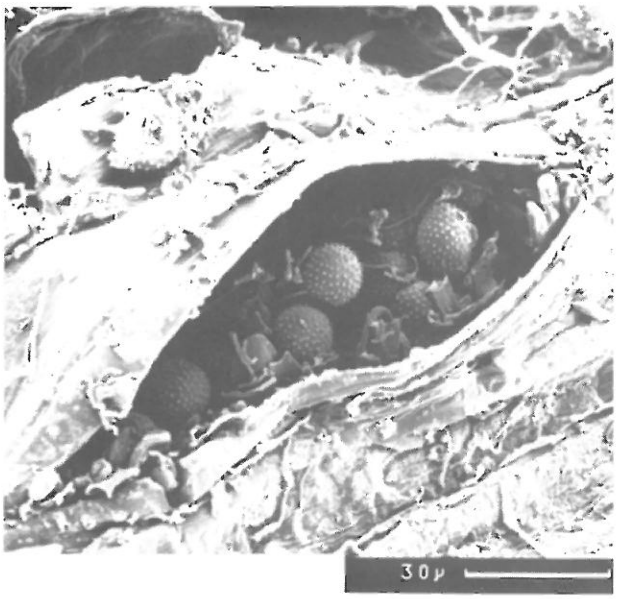
Species 70. *Puccinia festucae*: telia and teliospores.

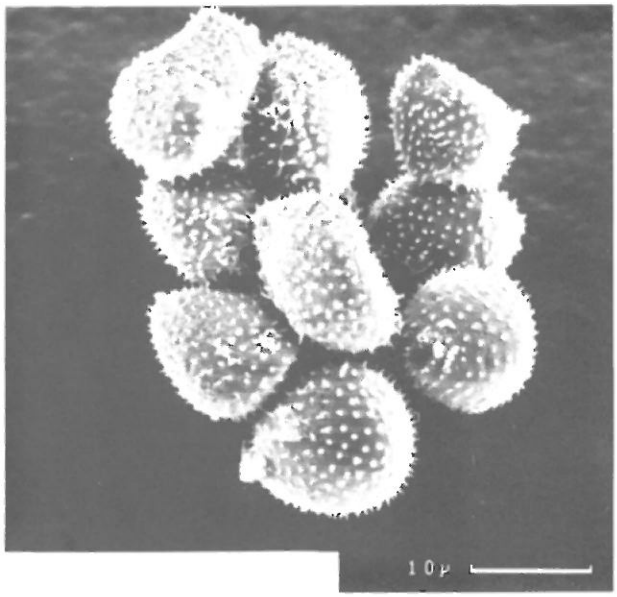




Yorks in B, 195 [A[on *Lonicera periclymenum* [UT] on Festuca spp. Drawing of U and T in WH, 258. Description in EE 159 (A) and 496 (UT). Teliospore surface: smooth (WH).

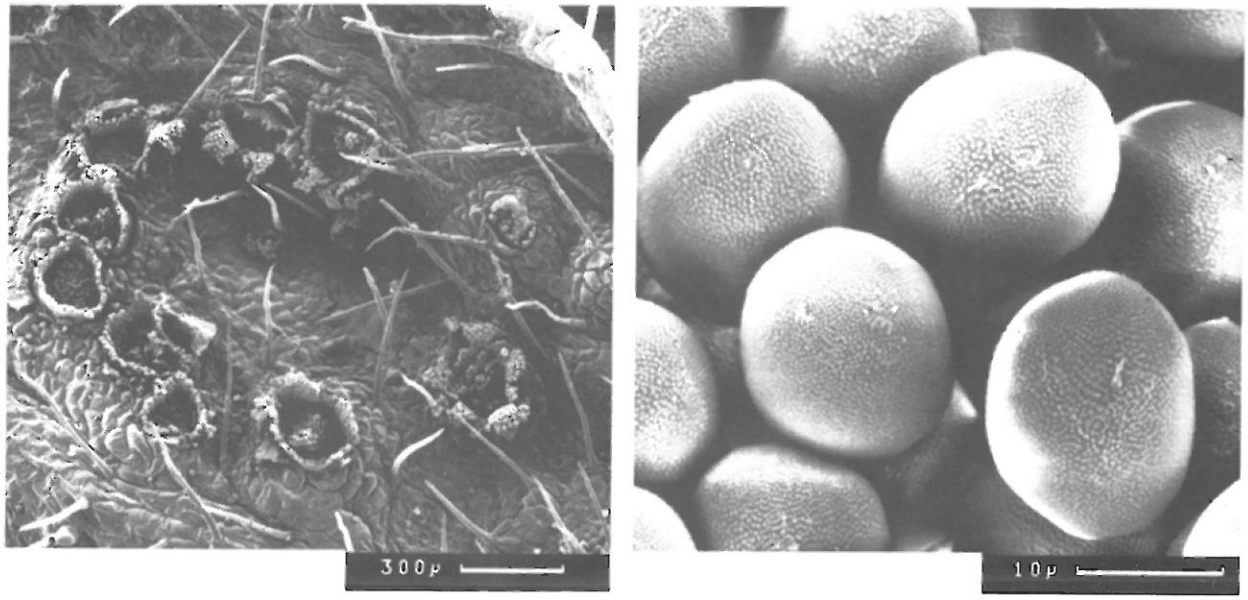
Species 70. *Puccinia festucae*: uredinia and urediniospores.





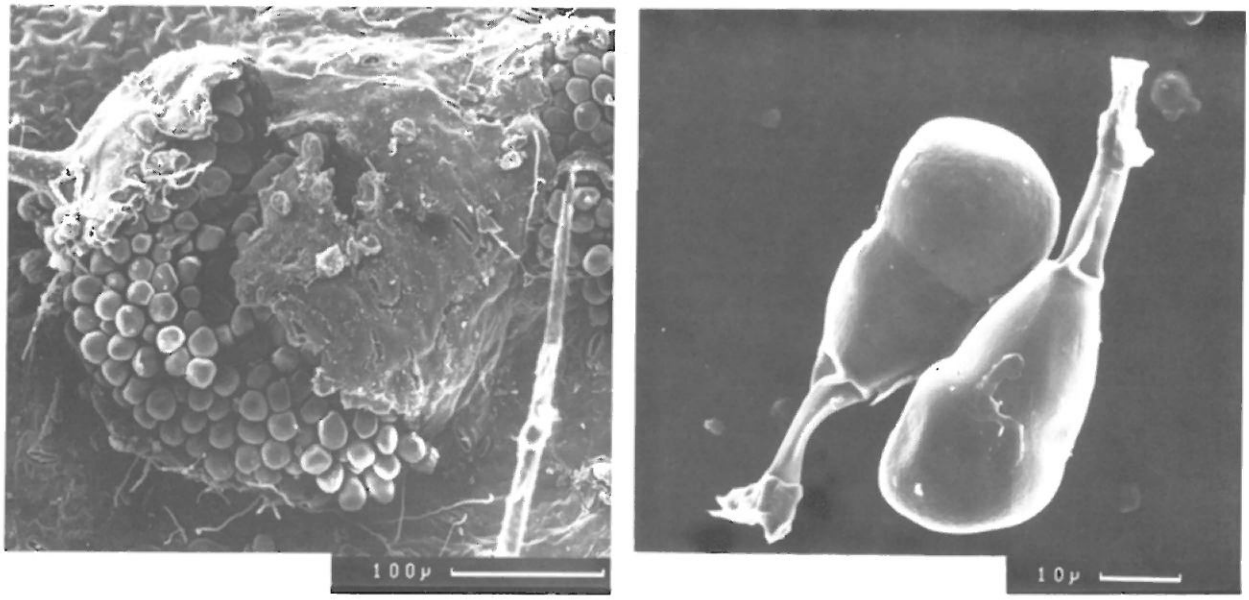
(See caption for photographs of telia and teliospores). Urediniospore surface: echinulate with spines 2-3 μm apart (WH), minutely echinulate (EE).

Species 70. *Puccinia festucae*: aecia and aecidiospores.



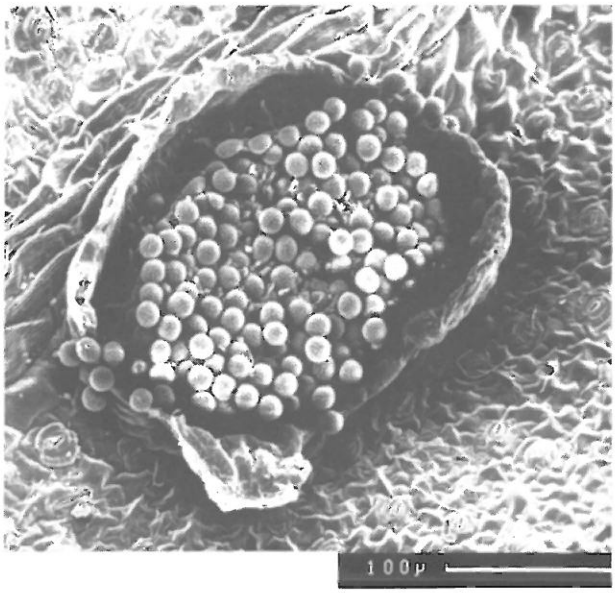
(See caption for photographs of telia and teliospores). Aeciospore surface: tesselate, in surface view finely warted (WH).

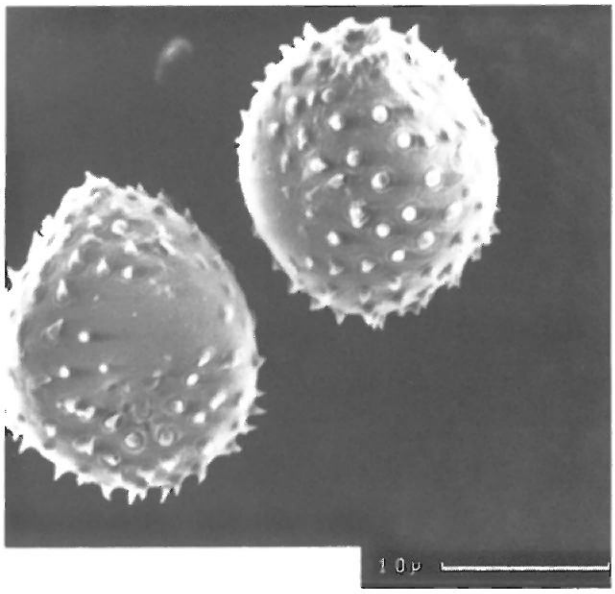
Species 71. *Puccinia galii-cruciatae*: telia and teliospores.



Yorks in B, 195. [AUT] on *Galium cruciata*. Drawing of U and T in WH 183, Description EE, 360, Teliospore surface: smooth (WH).

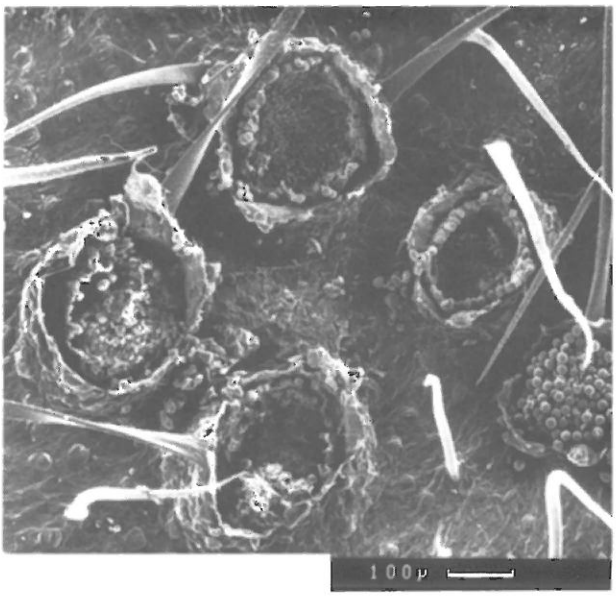
Species 71. *Puccinia galli-cruciatae*: uredinia and urediniospores.

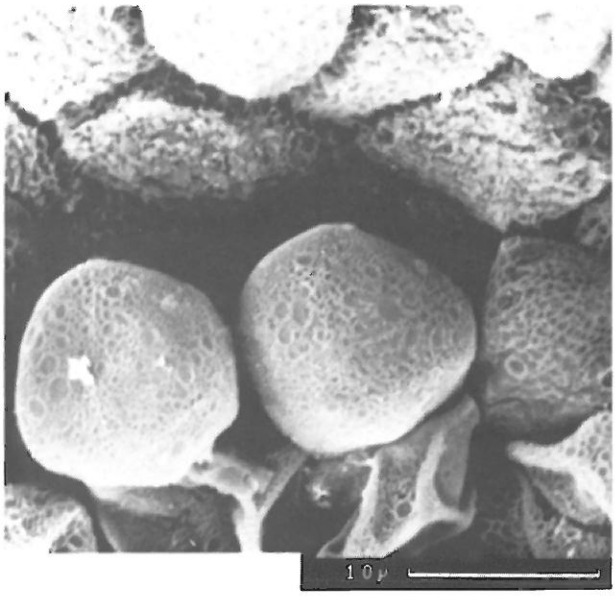




(See caption to photographs of telia and teliospores). Urediniospore surface: distinctly echinulate (WH), similar to aeciospores (EE).

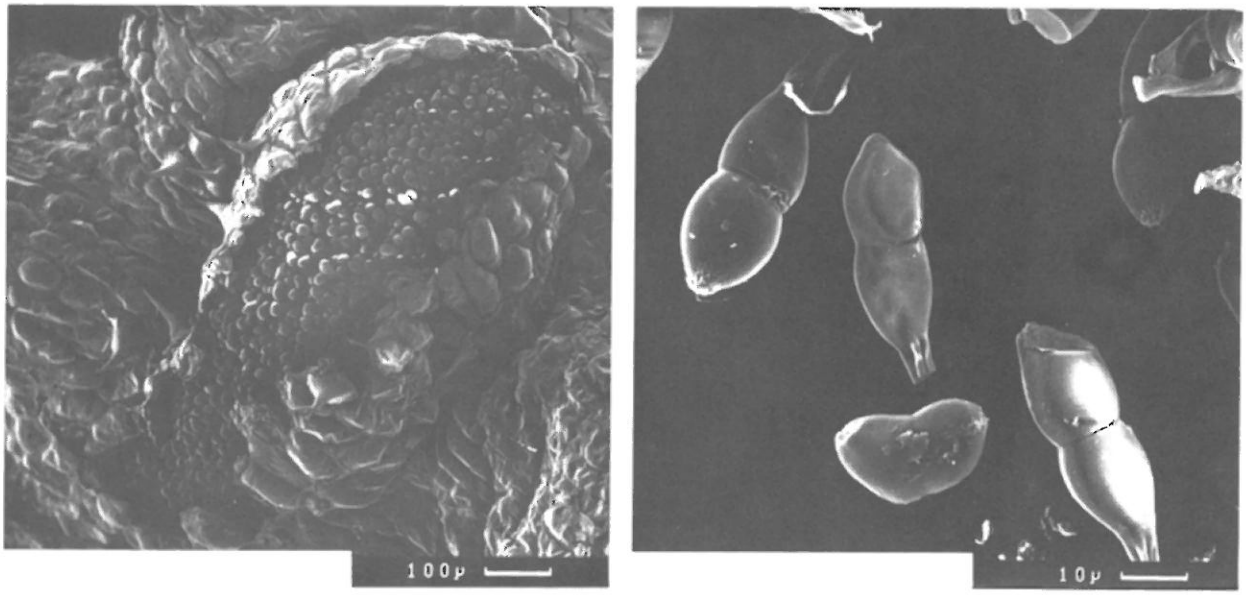
Species 71. *Puccinia galli-cruciatae*: aecia and aeciospores.





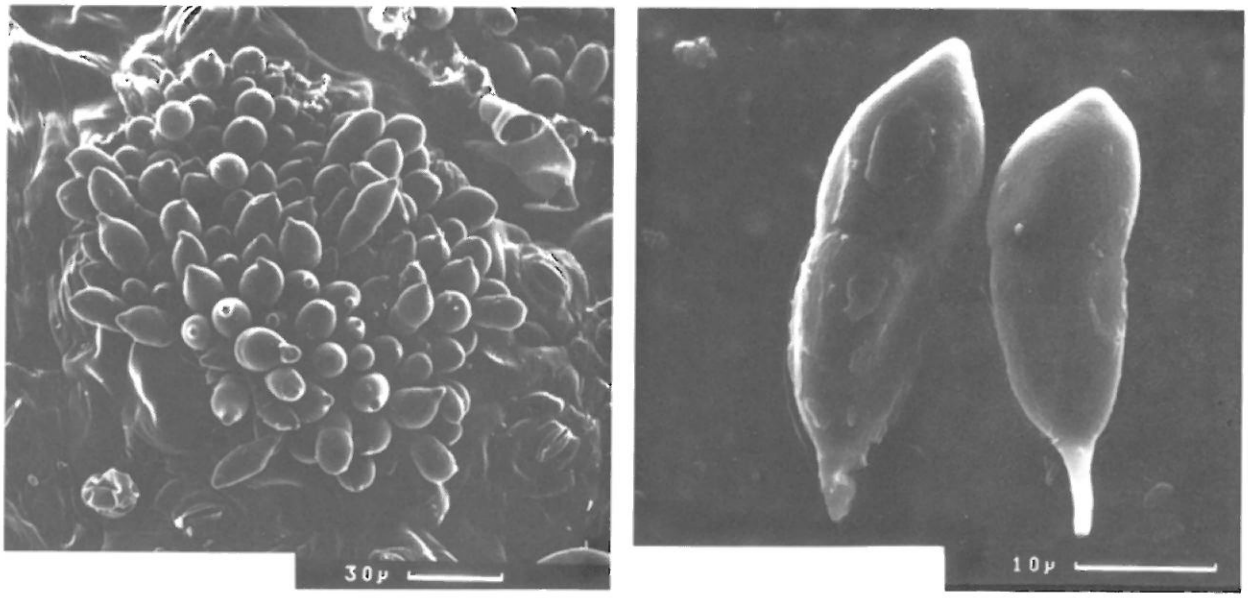
(See caption to photographs of telia and teliospores). Aeciospore surface: similar to uredospores (WH), echinulate (EE).

Species 72. *Puccinia galli-verni*: telia and teliospores.



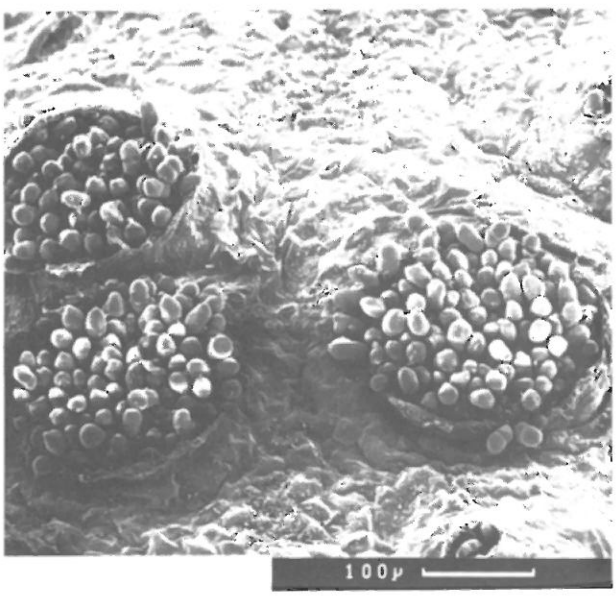
Yorks in B, 195. [T] on Galium spp.
Drawing of in WH, 186. Description in EE, 360. Teliospore surface: smooth (WH).

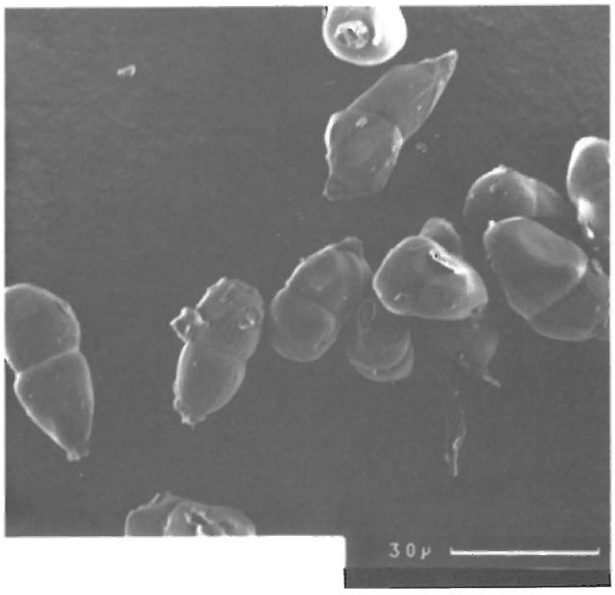
Species 73. *Puccinia glechomatis*: telia and teliospores



Yorks in B, 195. [T] on *Nepeta hederacea*. Drawing of T in WH, 178; description in EE 365.
Teliospore surface: smooth.

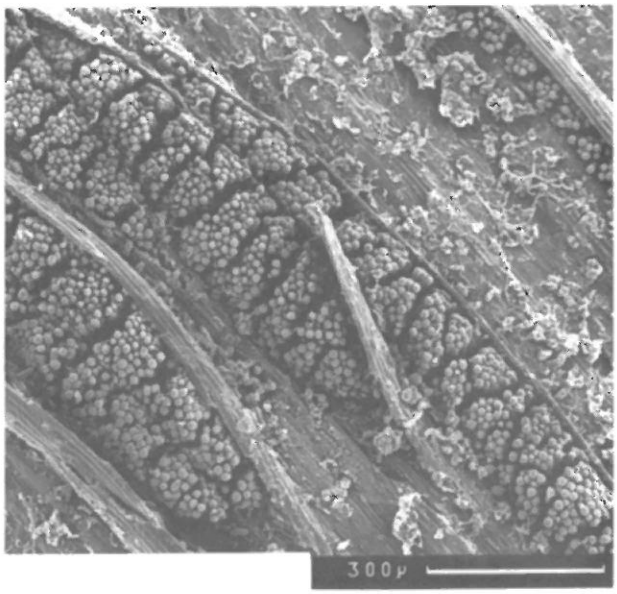
Species 74. *Puccinia glomerata*: telia and teliospores.

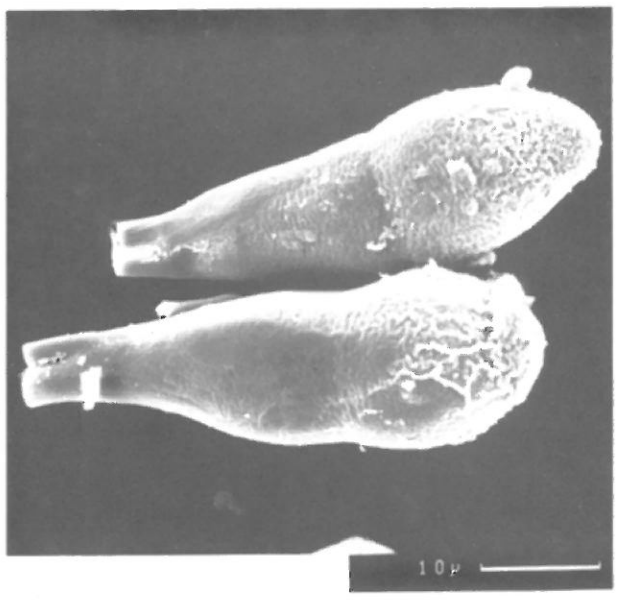




Yorks in B, 195. [T] on, e.g. *Senecio jacobea*. Drawing of T in WH, 202; description in EE 420. Teliospore surface: smooth (WH).

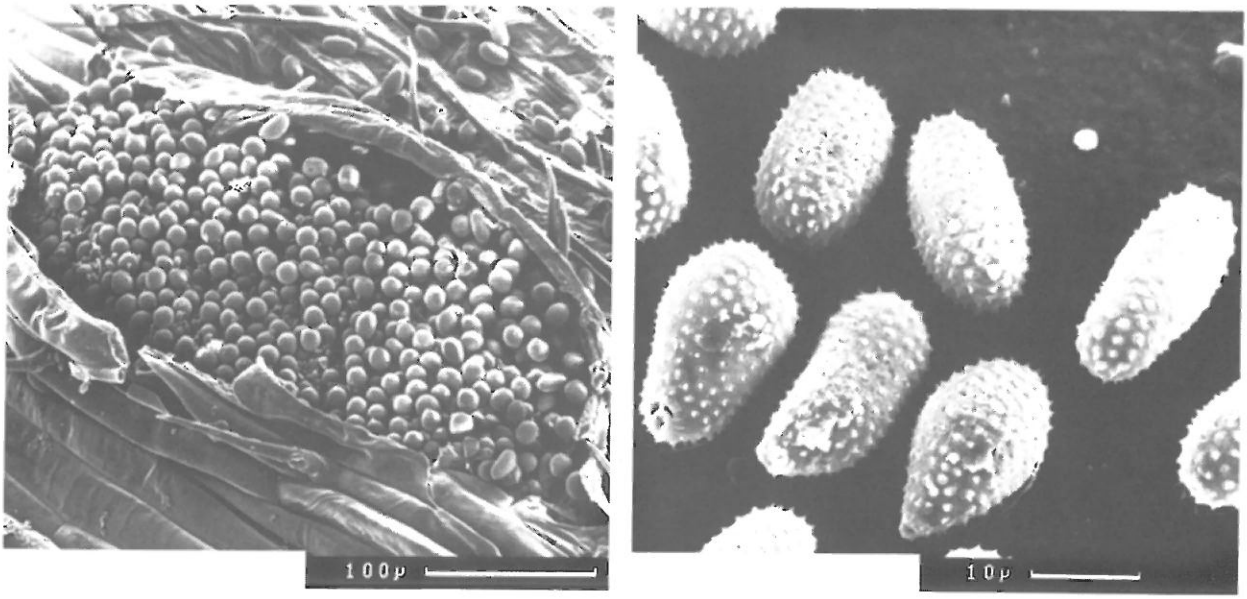
Species 75. *Puccinia graminis*: telia and teliospores.





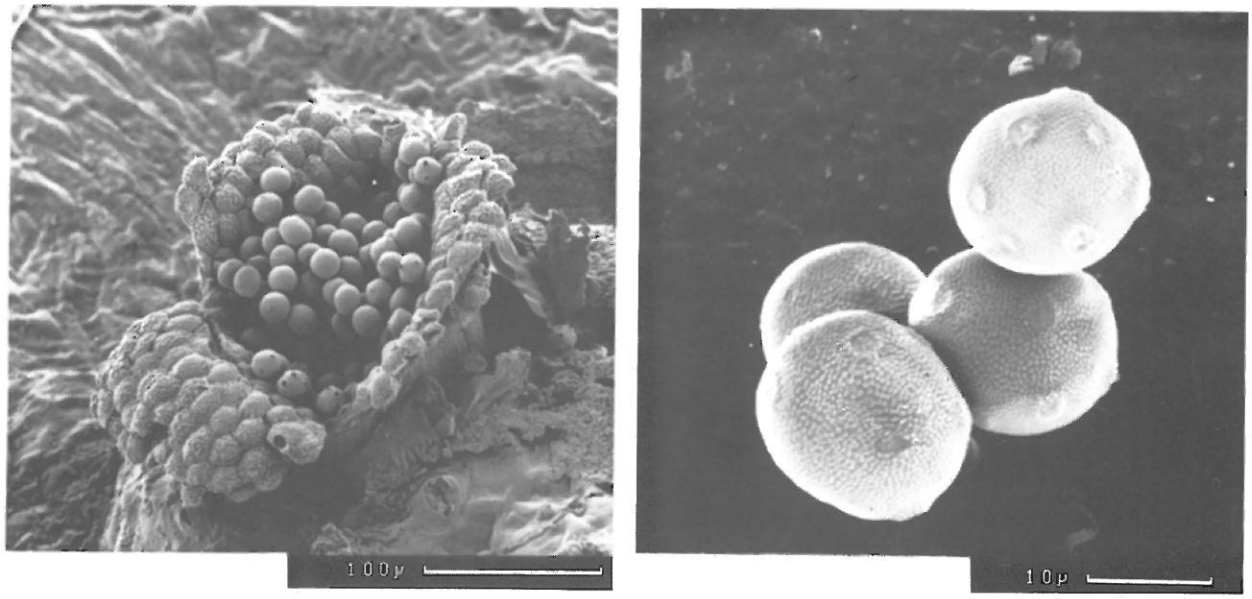
Yorks in B, 195 [A] e.g. on *Berberis vulgaris*. [UT] e.g. on *Triticum aestivum*, Drawing of U and T in WH, 260 and in EE, Fig. 1732. Description EE 452. Teliospore surface: smooth (WH).

Species 75. *Puccinia graminis*: uredinia and urediniospores.



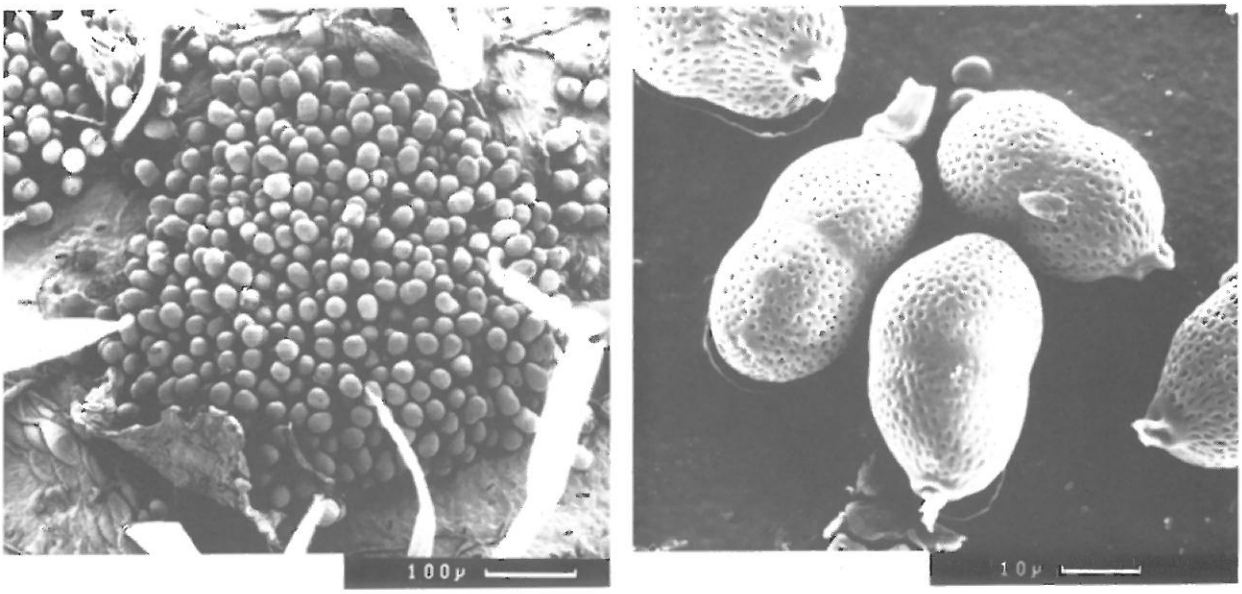
(See caption to photographs of telia and teliospores). Urediniospore surface: echinulate (WH).

Species 75. *Puccinia graminis*: aecia and aeciospores.



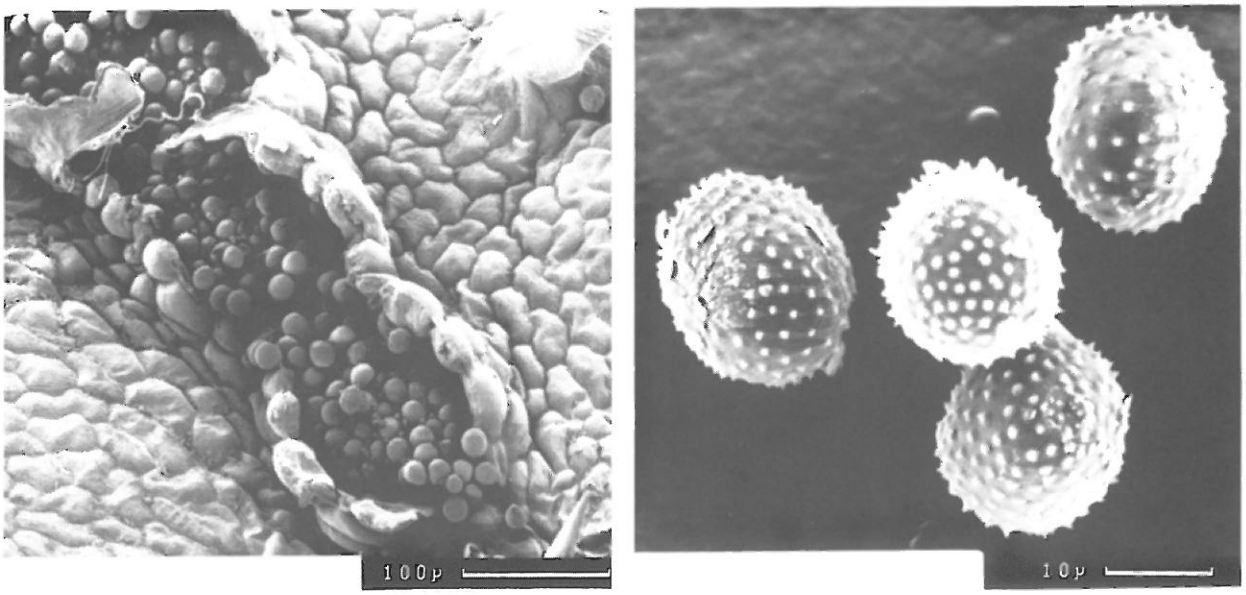
(See caption to photographs of telia and teliospores). Aeciospore surface: smooth or very finely verruculose (WH).

Species 76. *Puccinia heraclei*: telia and teliospores.



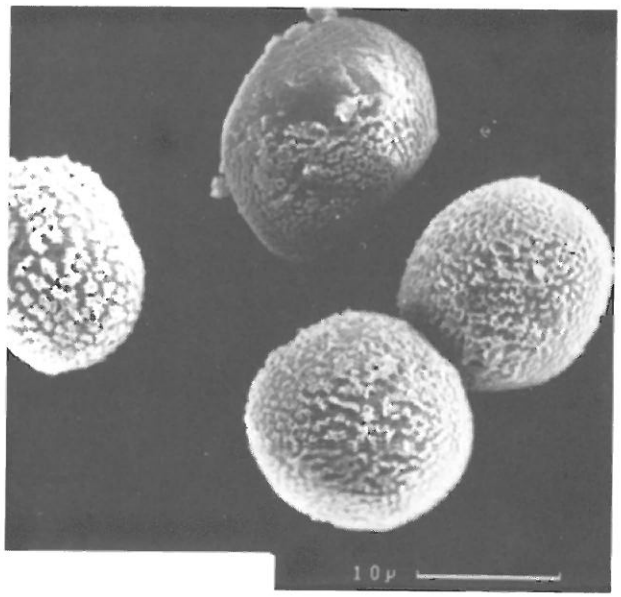
Yorks in B, 196. [AUT] on *Heracleum sphondylium*. Drawing of T in WH, 151. Description EE 367.
Teliospore surface: wall finely reticulate, areolae round, 1μm in diameter.

Species 76. *Puccinia heraclei*: uredinia and urediniospores.



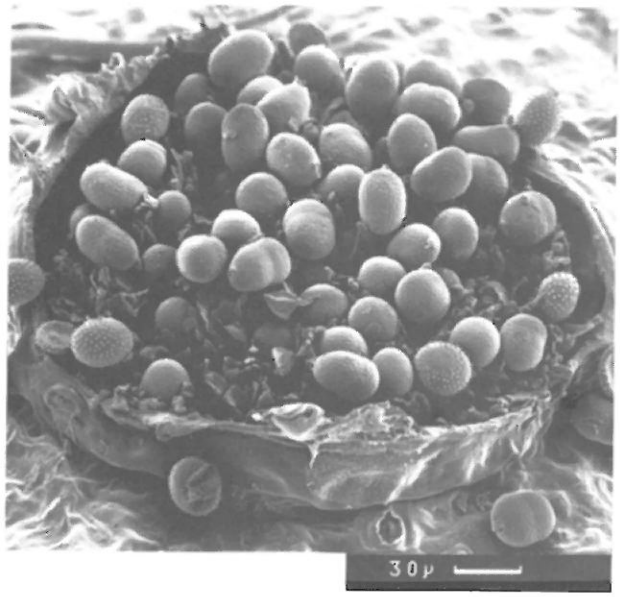
(See caption to photograph of telia and teliospores). Urediniospore surface: coarsely echinulate (WH), echinulate (EE).

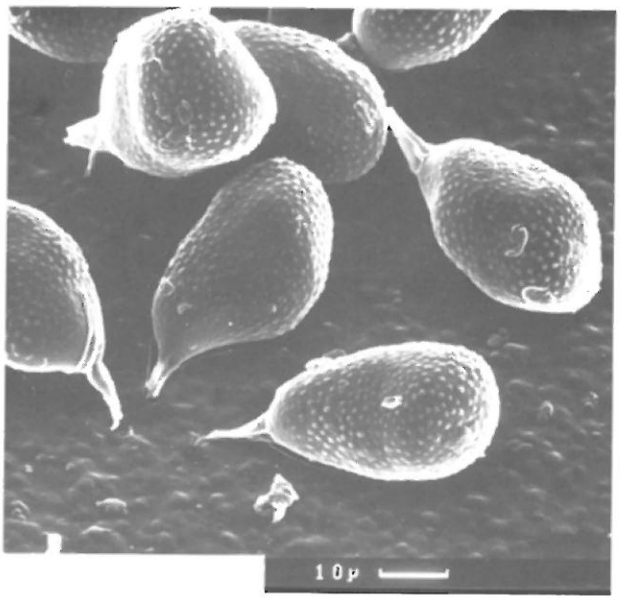
Species 76. *Puccinia heraclei*: aecia and aeciospores.



(See caption to photograph of telia and teliospores). Aeciospore surface: delicately verruculose (WH).

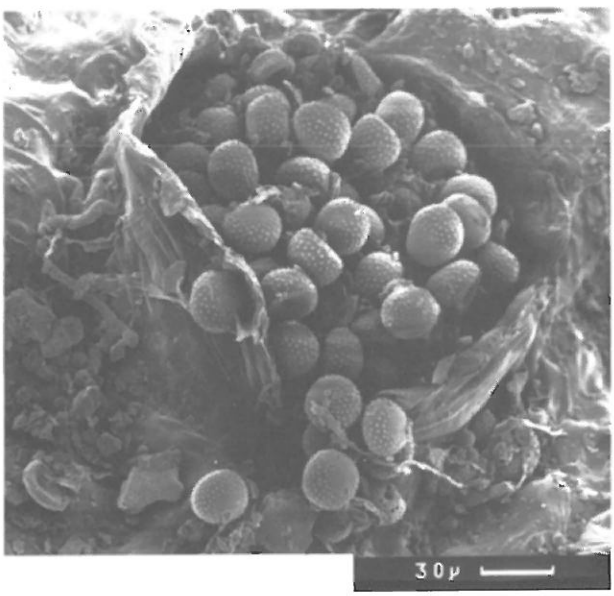
Species 77. *Puccinia hieracii* var.*hieracii*: telia and teliospores.

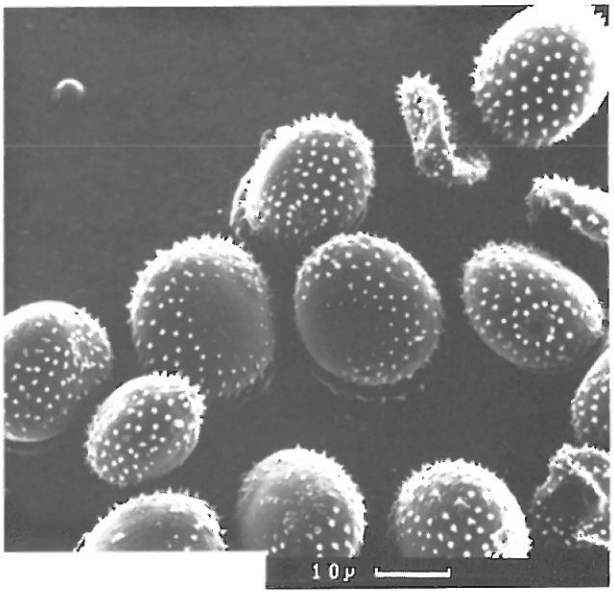




Yorks in B, 196. [AUT] e.g. *Centaurea nigra*. Drawing of U and T in WH 203. Description EE 369. (Aeciospores resemble the urediniospores). Teliospore surface: finely verrucose (WH).

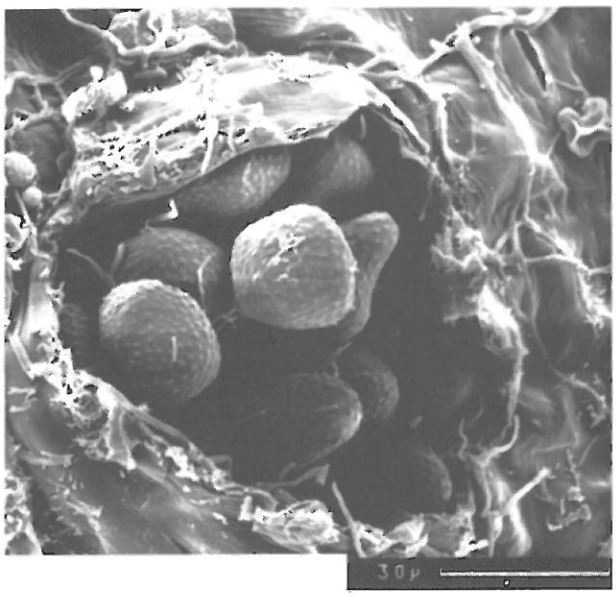
Species 77. *Puccinia hieracii* var. *hieracii*: uredinia and urediniospores.

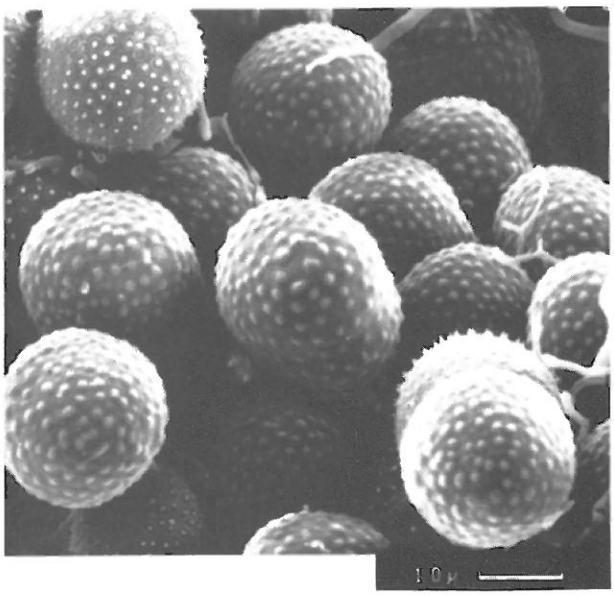




(See caption to photographs of telia and teliospores). Urediniospore surface: echinulate (WH, EE).

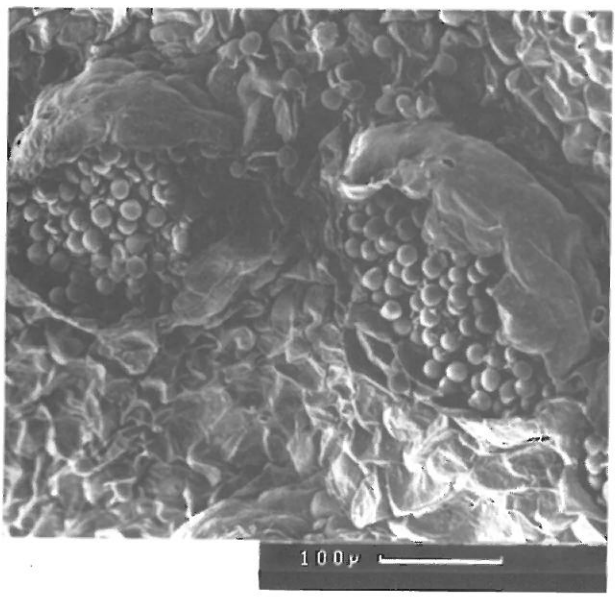
Species 77A. *Puccinia hieracii* var. *hypochoeridis*: telia and teliospores.

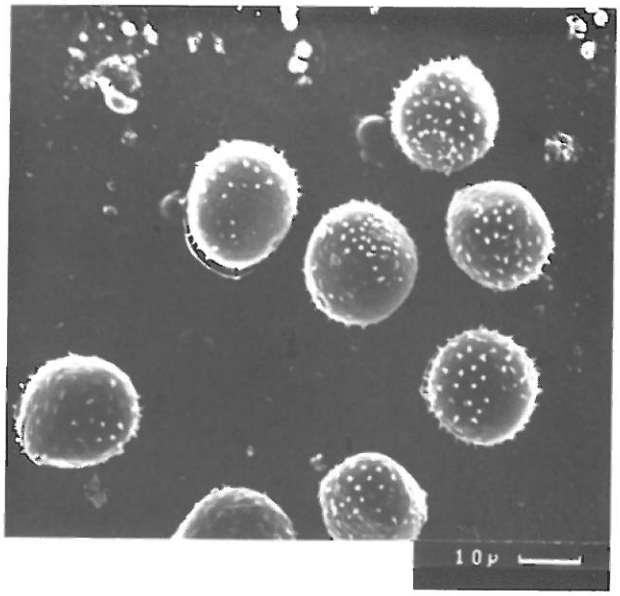




Yorks in B, 196. [AUT] on Hypochoeris spp. Drawing of U in WH, 206. Description EE, 372. Teliospore surface: finely verrucose, see species 77.

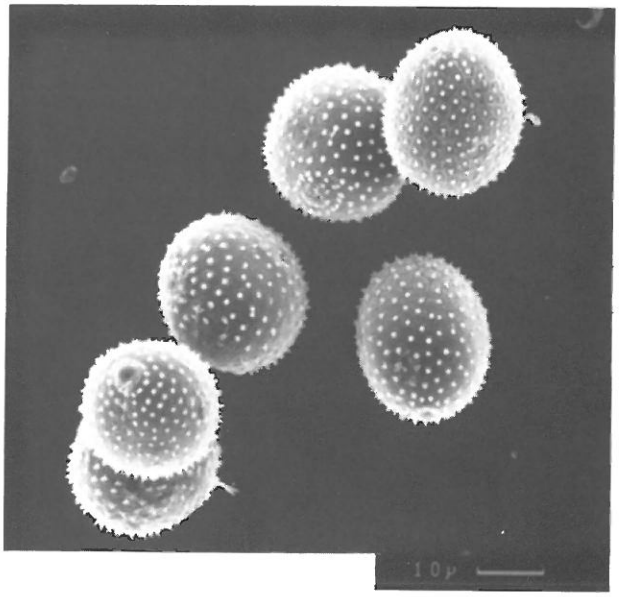
Species 77A. *Puccinia hieracii* var *hypochoeridis*: uredinia and urediniospores.





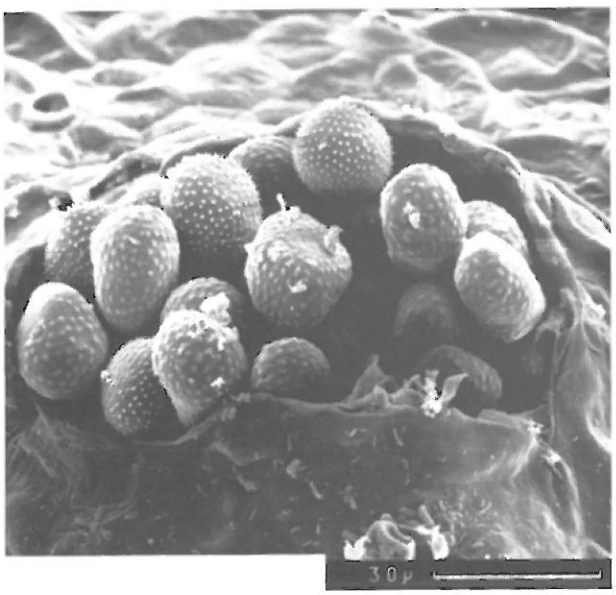
(See caption to photographs of telia and teliospores). Urediniospores surface: echinulate (WH, *P. hieracii*).

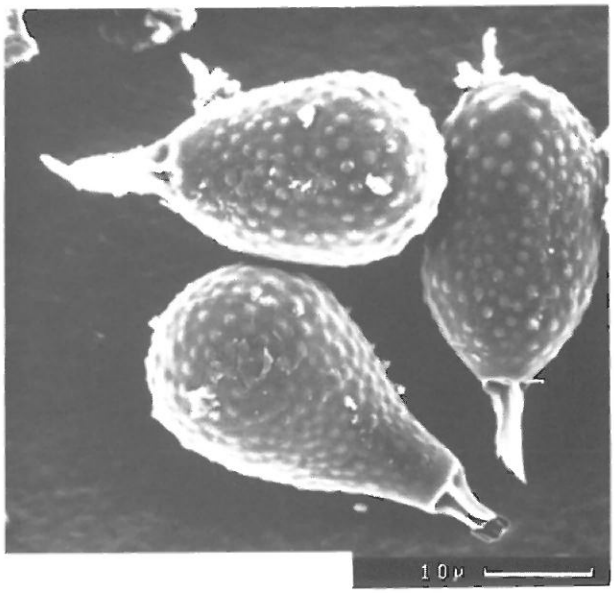
Species 77A. *Puccinia hieracii* var. *hypochoeridis*: aecia.



(See caption to photographs of telia and teliospores). Aeciospore surface: resemble uredospores (WH, *P. hieracii*).

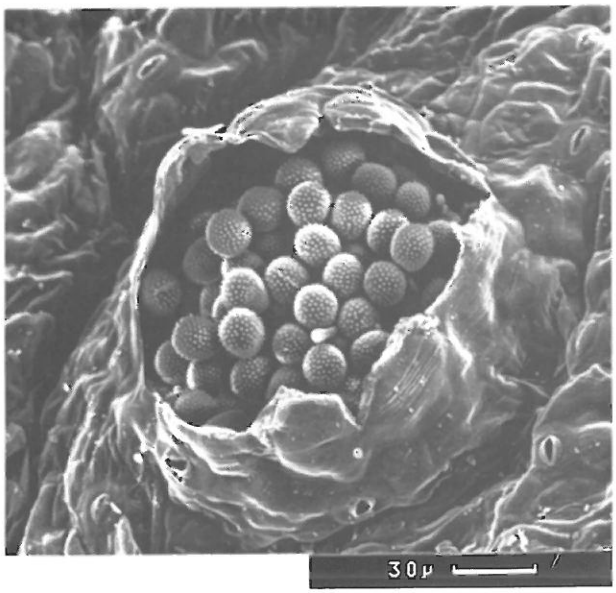
Species 77B. *Puccinia hieracii* var. *piloselloidarum*: telia and teliospores .

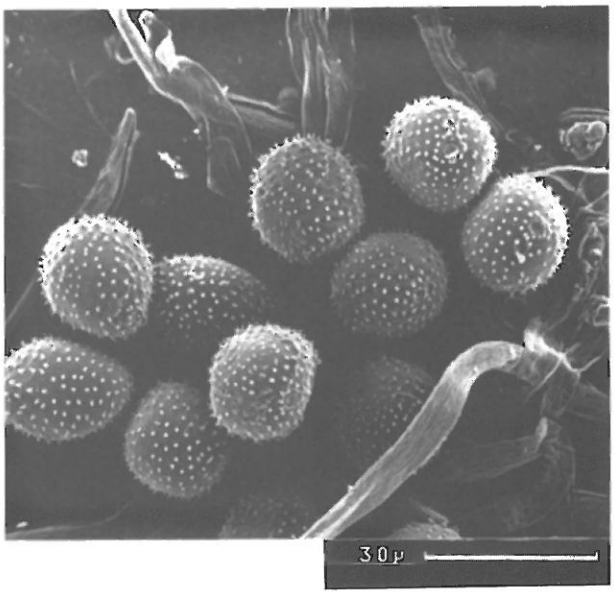




See caption for telia and teliospores of *P. hieracii* var. *hieracii* (77). Occurs only on *Hieracium pilosella*.

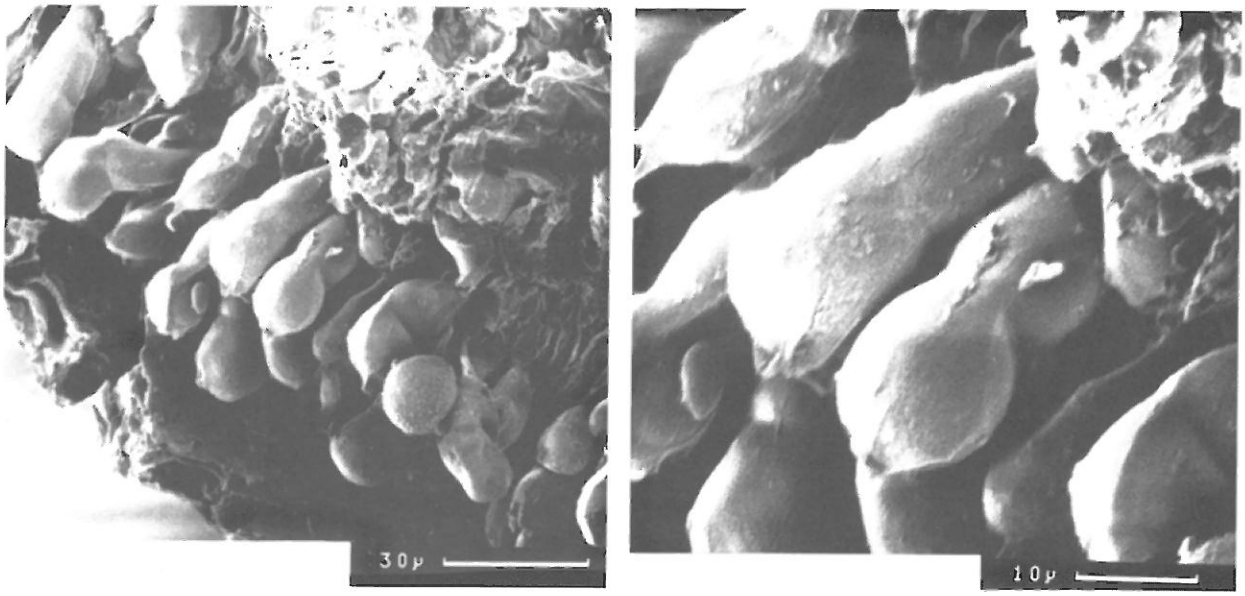
Species 77B. *Puccinia hieracii* var. *piloselloidarum*: uredinia and urediniospores.





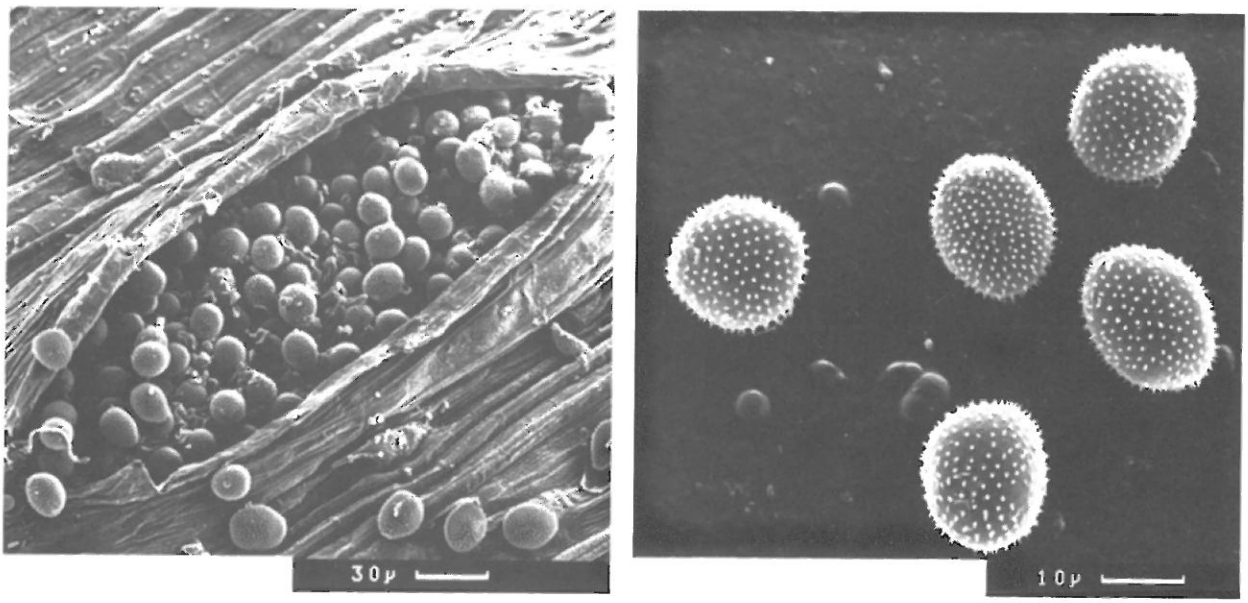
See caption for telia and teliospores of *P. hieracii* var. *hieracii* (77). Occurs only on *Hieracium pilosella*. Urediniospore surface: presumably echinulate as 77.

Species 78. *Puccinia hordei*: telia and teliospores.



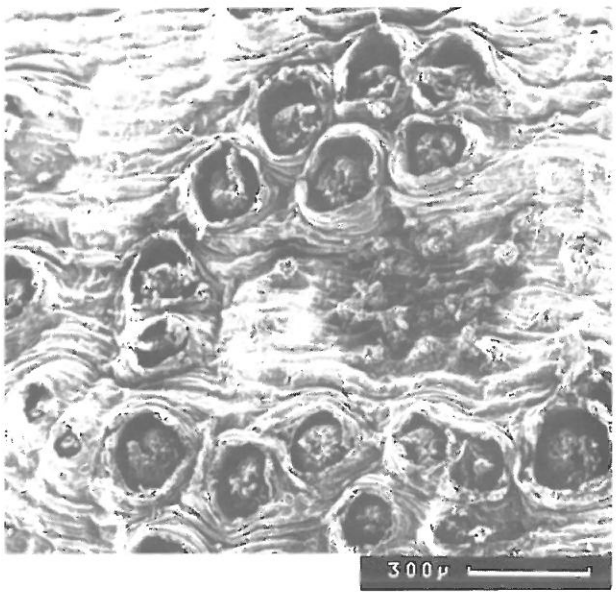
Yorks in B, 196. [A] on Ornithogalum spp. [UT] on Hordeum spp. Drawing of T in WH 264. description EE 501. Teliospore surface: smooth (WH, EE).

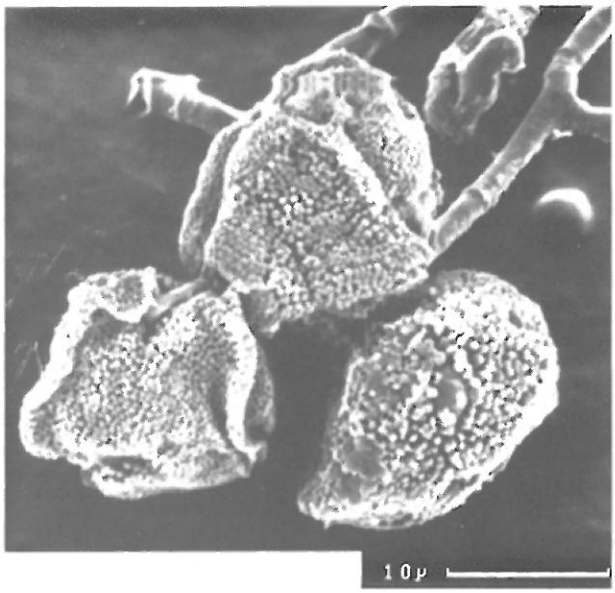
Species 78. *Puccinia hordei*: uredinia and uredinospores.



(See caption for photographs of telia and teliospores). Urediniospore surface: echinulate (WH, EE).

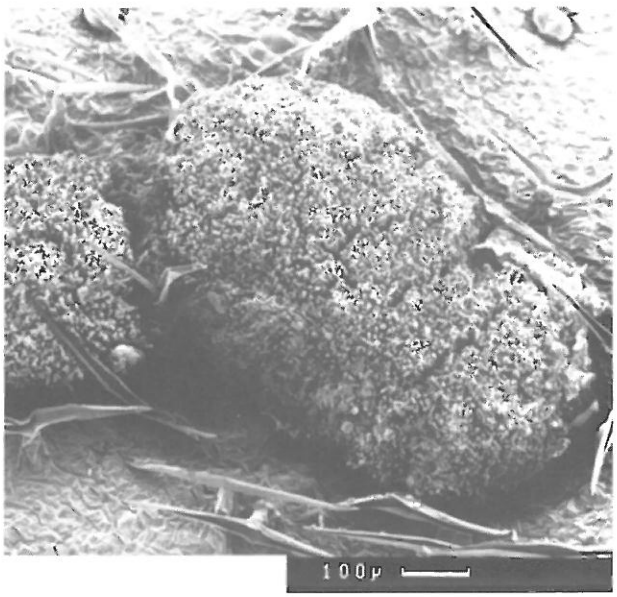
Species 78. *Puccinia hordei*: aecia and aeciospores.

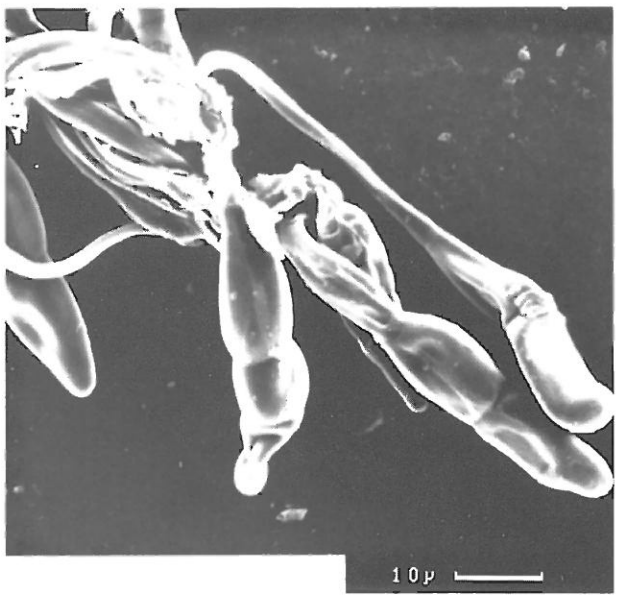




(See caption to photographs of telia and teliospores). Aeciospore surface: minutely verrucose (WH).

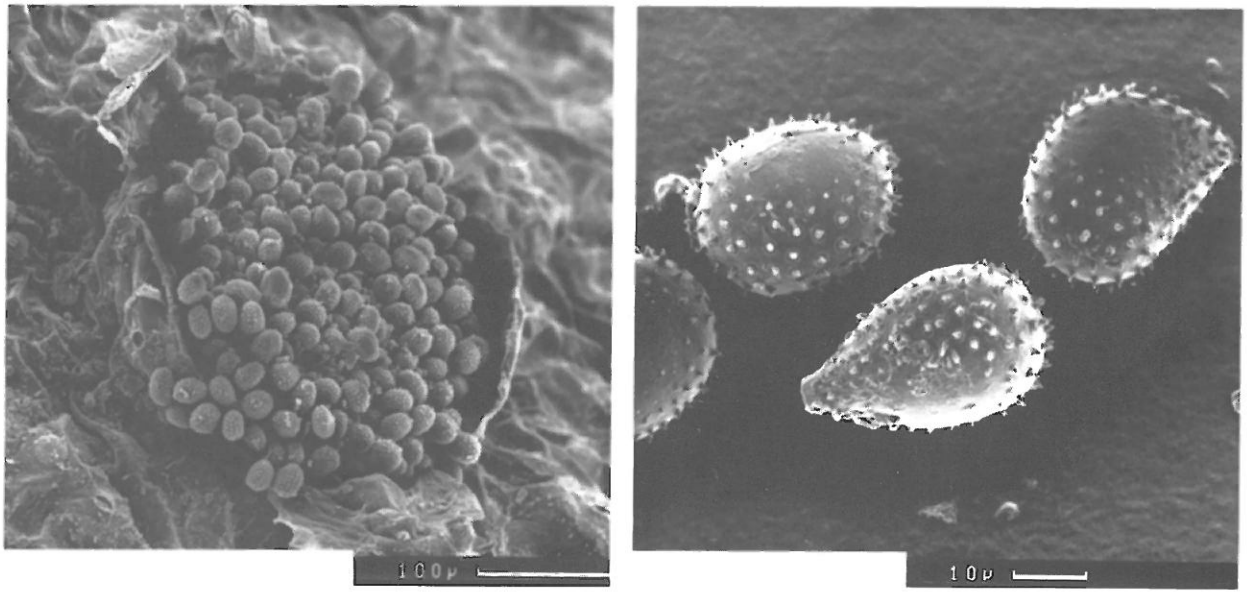
Species 78A. *Puccinia horiana*: telia and teliospores.





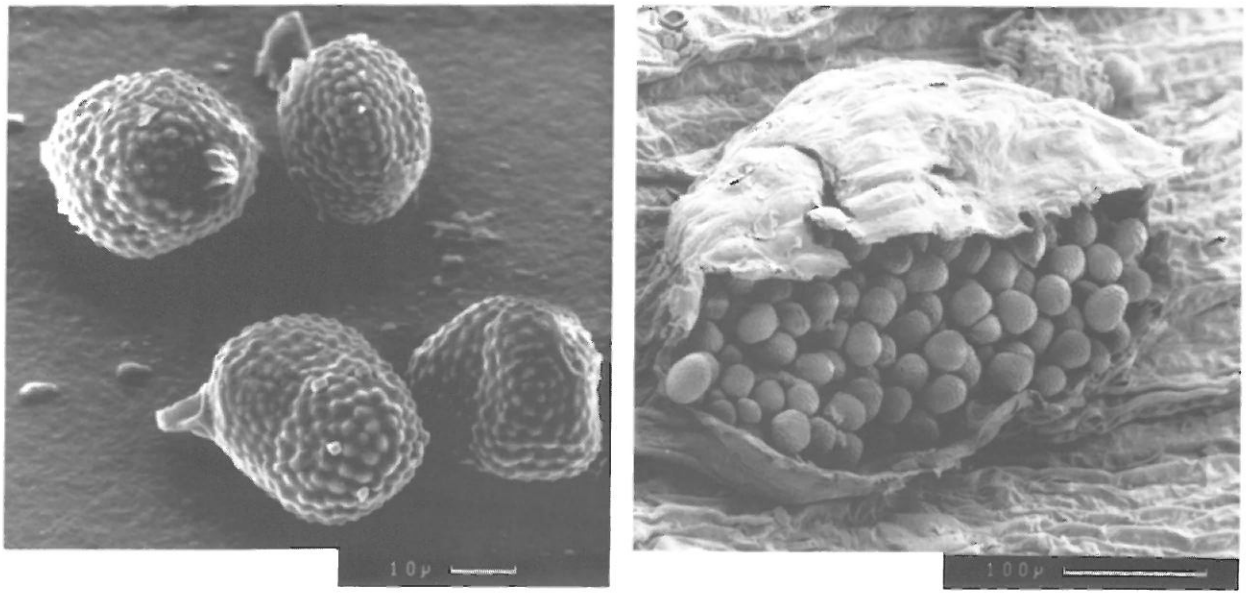
Yorks not in B, [T] on Chrysanthemum spp. Description in WH 368, EE 331. Drawings of T in CMID 176. Teliospore surface: presumably smooth.

Species 79. *Puccinia hydrocotyles*: uredinia and urediniospores.



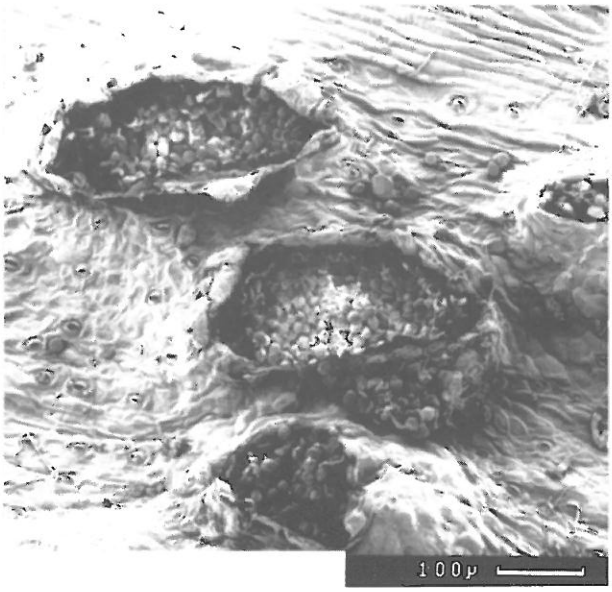
Yorks in B 196. [U] on *Hydrocotyle vulgaris*. Drawing of U in WH 151. Description EE 371. Urediniospore surface: echinulate (WH, EE).

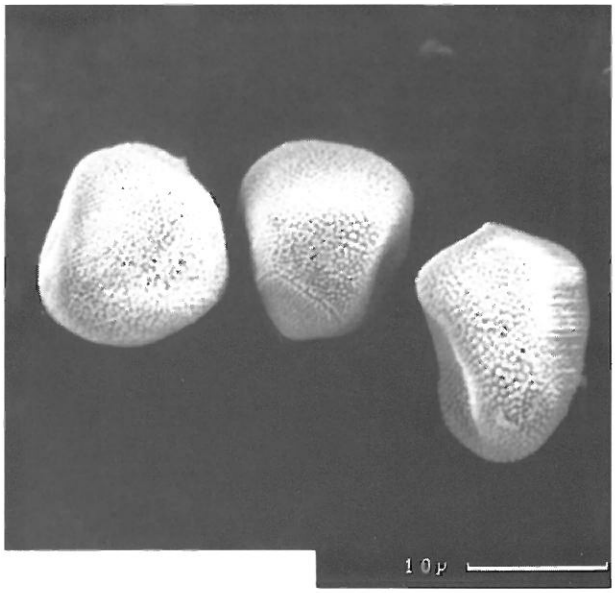
Species 80. *Puccinia hysterium*: telia and teliospores.



Yorks in B, 196. [AT] on *Tragopogon pratensis*. Drawings of T in WH 207. Description EE 435. Faintly echinulate urediniospores reported in telia. Teliospore surface: tuberculate (WH, EE).

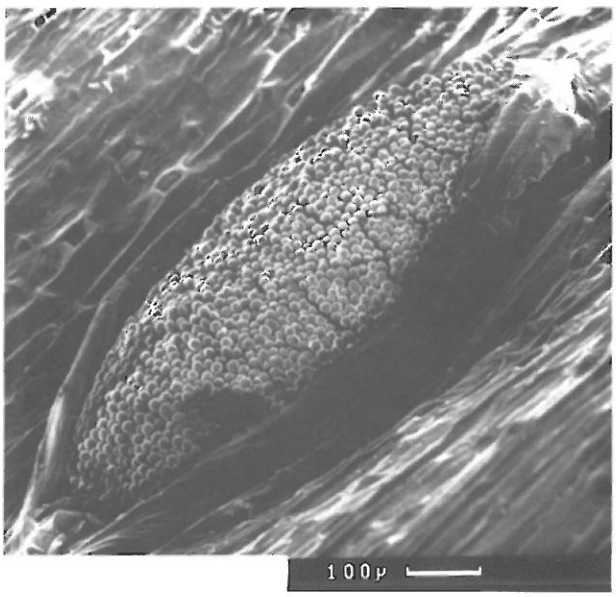
Species 80. *Puccinia hysterium*: aecia and aeciospores.

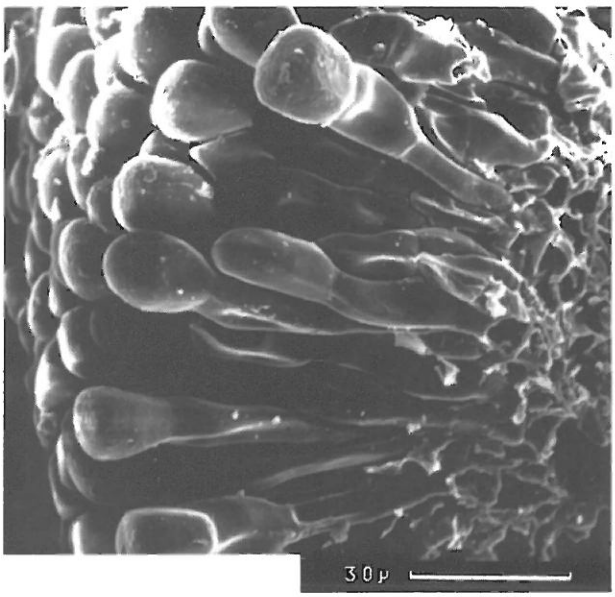




(See caption to photographs of telia and teliospores). Aeciospore surface: densely verrucose (WH).

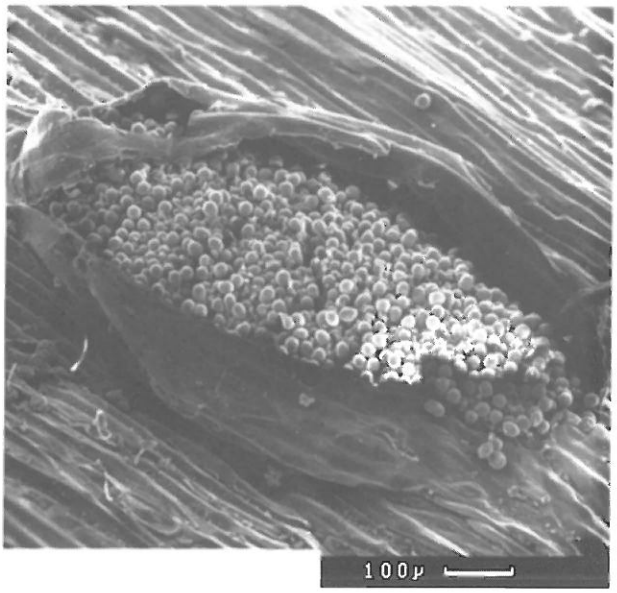
Species 81. *Puccinia iridis*: telia and teliospores.

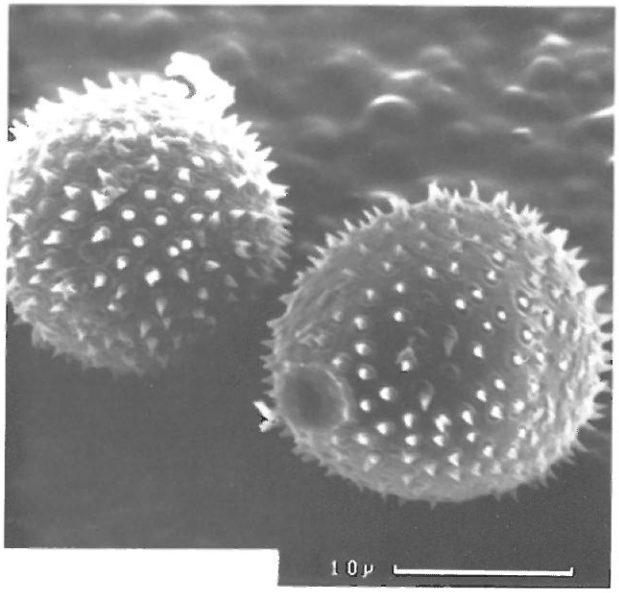




Yorks in B, 196. [UT] on Iris spp. Drawing of T in WH 227. Description in EE, 373. Photographs of U and T in CMID285. Teliospore surface: smooth (WH, EE, CMID).

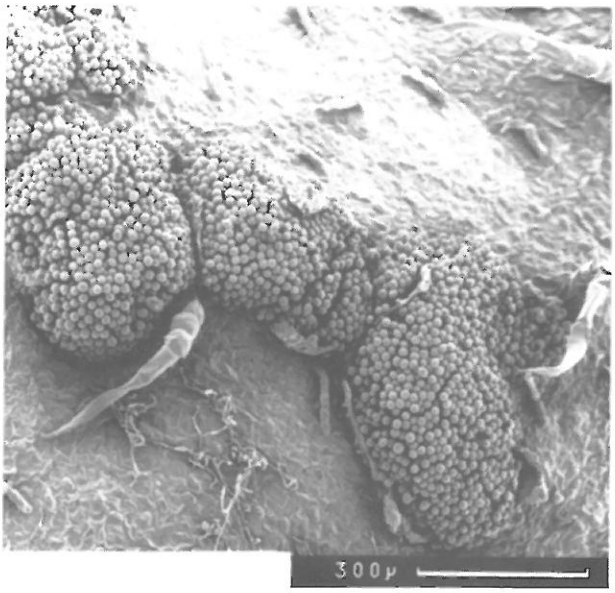
Species 81. *Puccinia iridis*: uredinia and urediniospores.

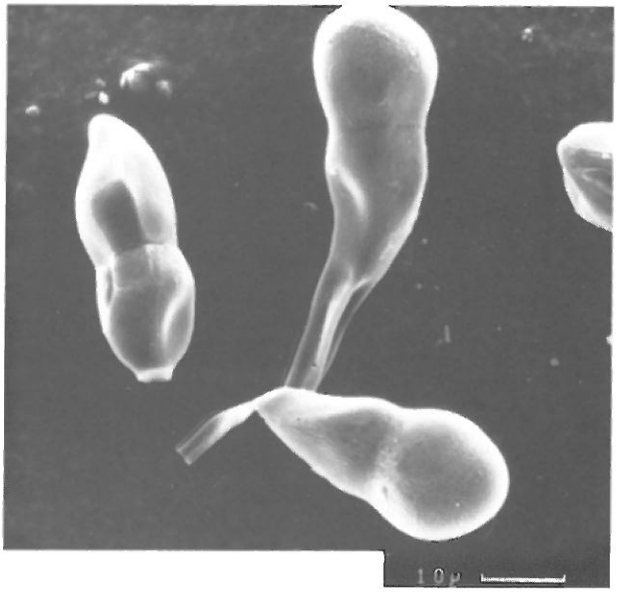




(See caption to photograph of telia and teliospores). Urediniospore surface: echinulate (WH, EE, CMID).

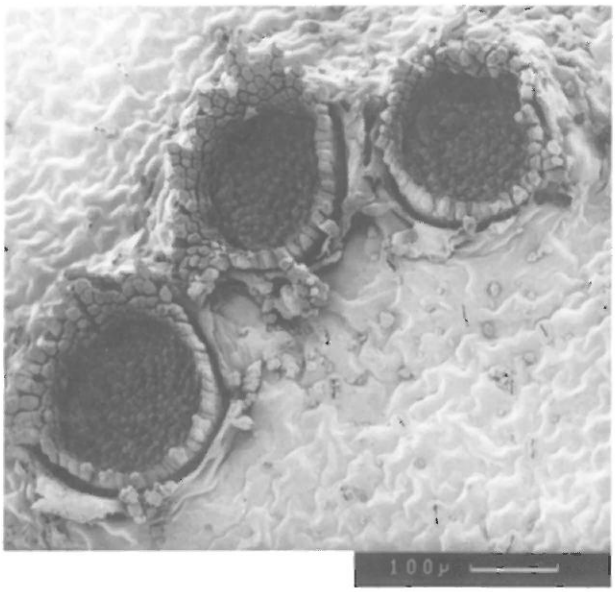
Species 82. *Puccinia lagenophorae*: telia and teliospores.

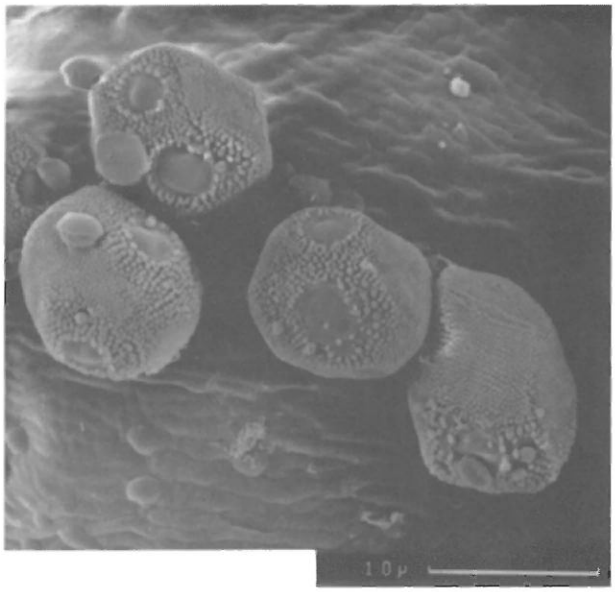




Yorks in B, 196. [AT] on Senecio spp. Drawing of T in WH 214. Description EE 420. Teliospore surface: smooth but for 1 or 2 longitudinal raised ridges and occasional transverse ridges on some spores (WH).

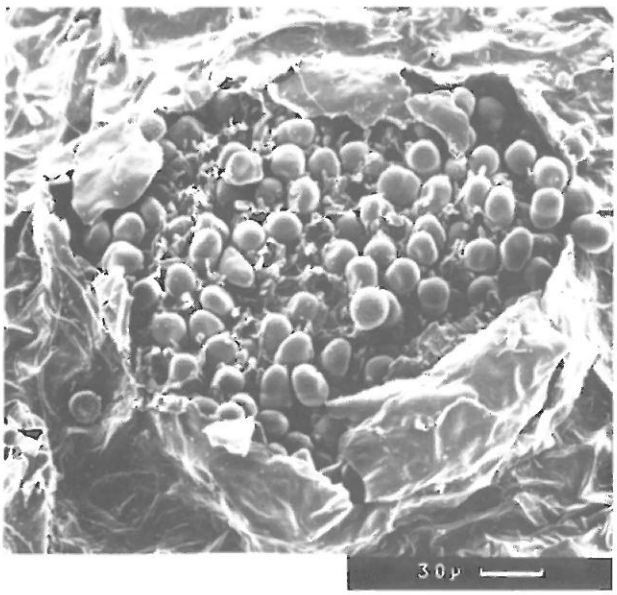
Species 82. *Puccinia lagenophorae*: aecia and aeciospores.

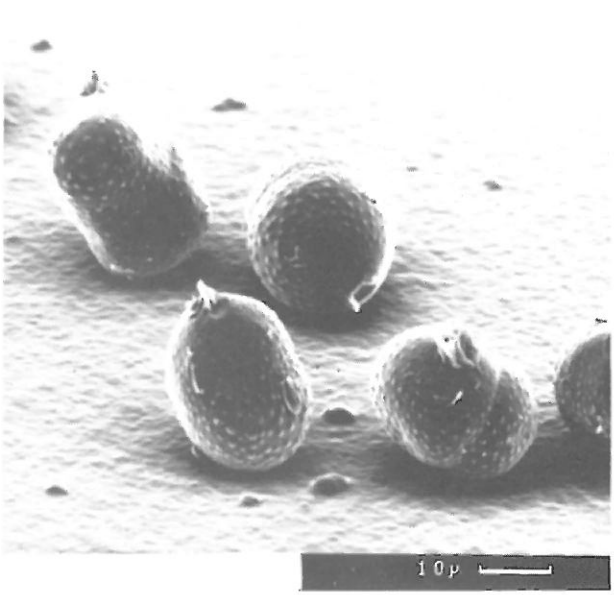




(See caption to photographs of telia and teliospores). Aeciospore surface: finely verruculose (WH).

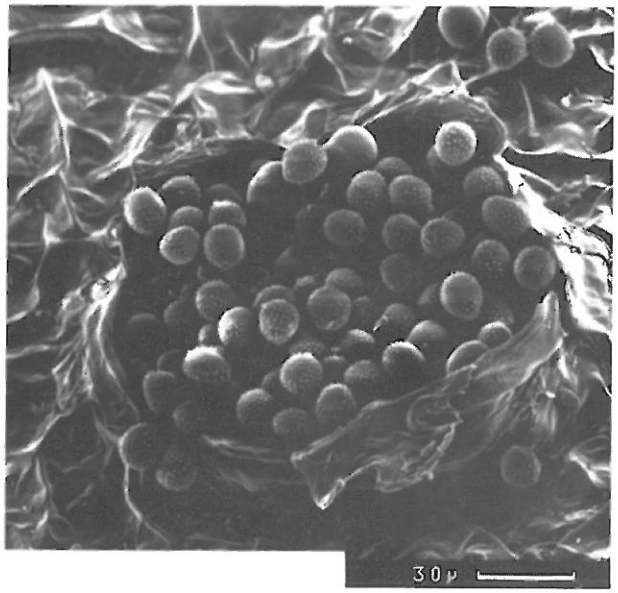
Species 83. *Puccinia lapsanae*: telia and teliospores.

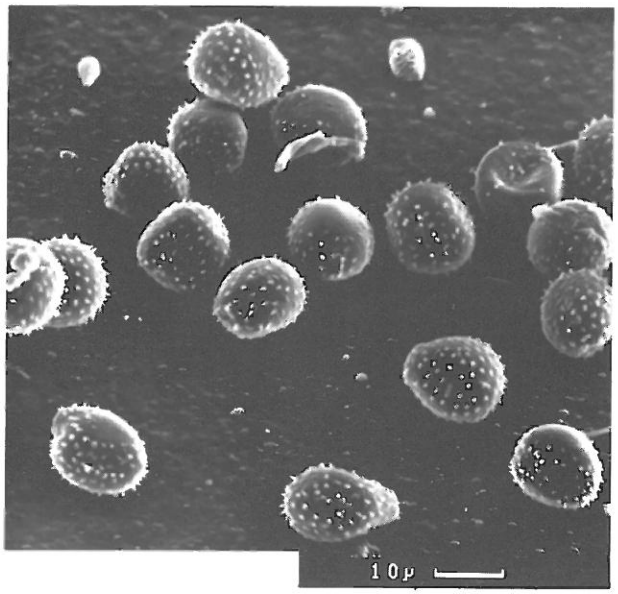




Yorks in B, 196. [AUT] on *Lapsana communis*. Drawing of T in WH 208 and Fig. 1548, EE. Description EE 377. Teliospore surface: delicately echinulate (WH), finely echinulate (EE).

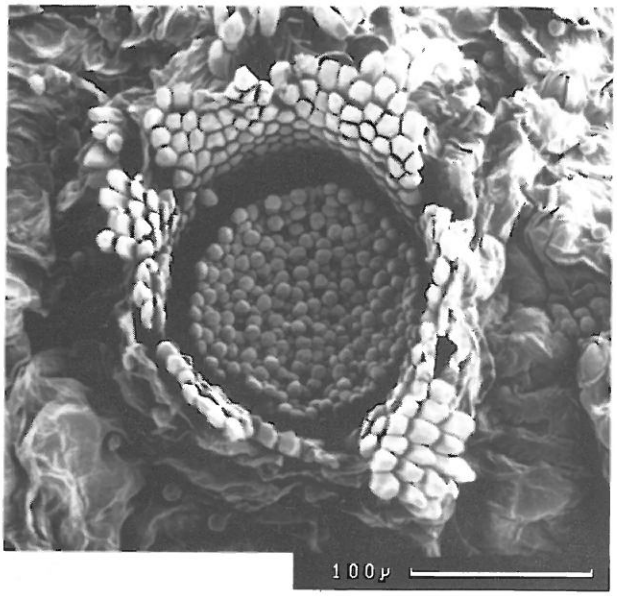
Species 83. *Puccinia lapsanae*: uredinia and urediniospores.

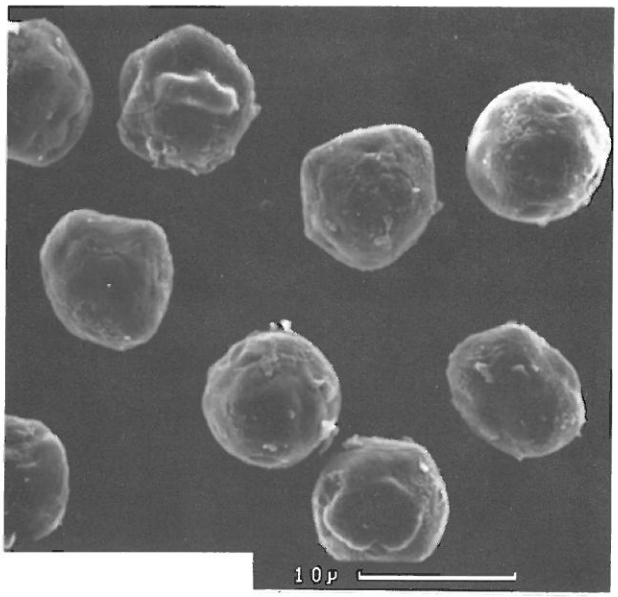




(See caption to photograph of telia and teliospores). Urediniospore surface: delicately echinulate (WH), finely echinulate (EE).

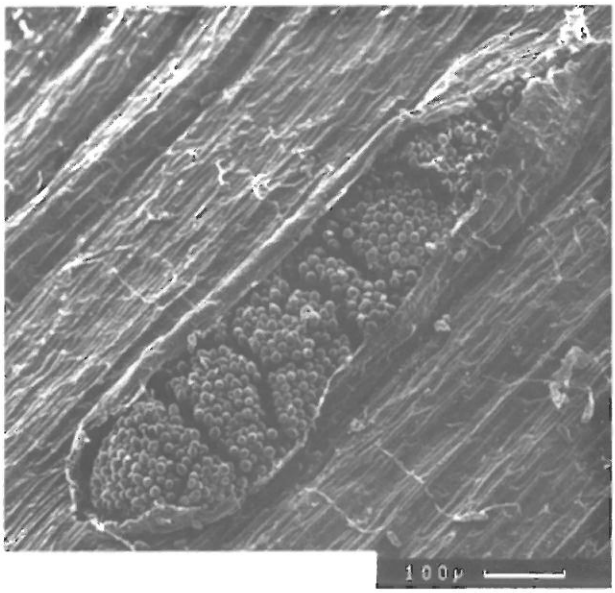
Species 83. *Puccinia lapsanae*: aecia and aeciospores.

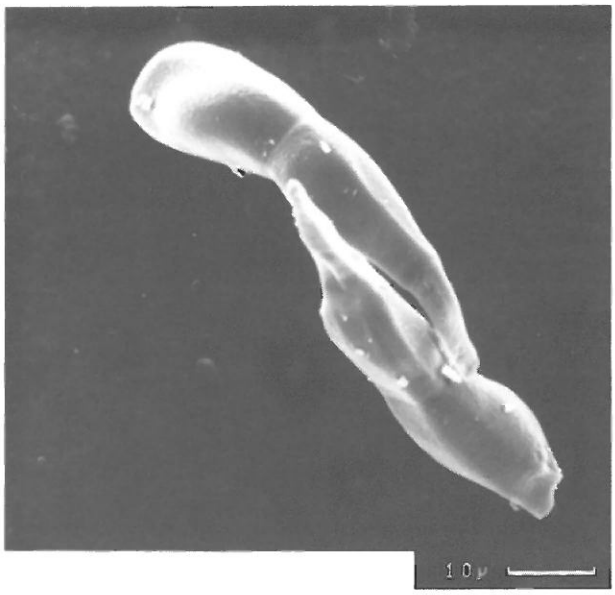




(See caption to photograph of telia and teliospores). Aeciospore surface: nearly smooth (WH).

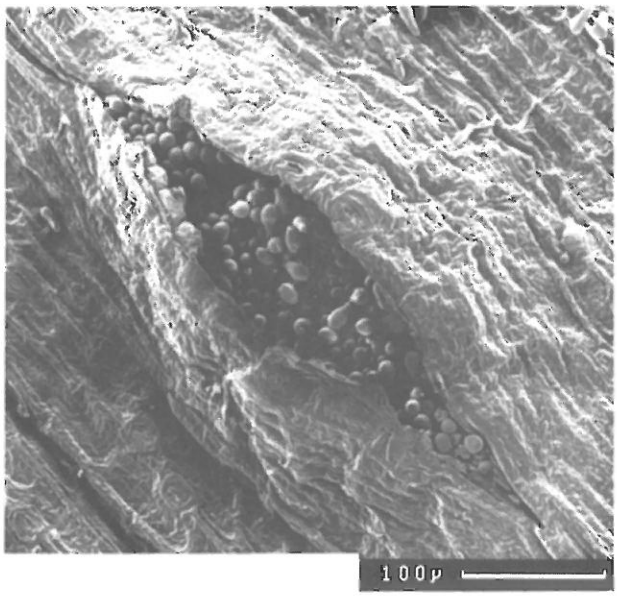
Species 84. *Puccinia luzulae*: telia and teliospores.

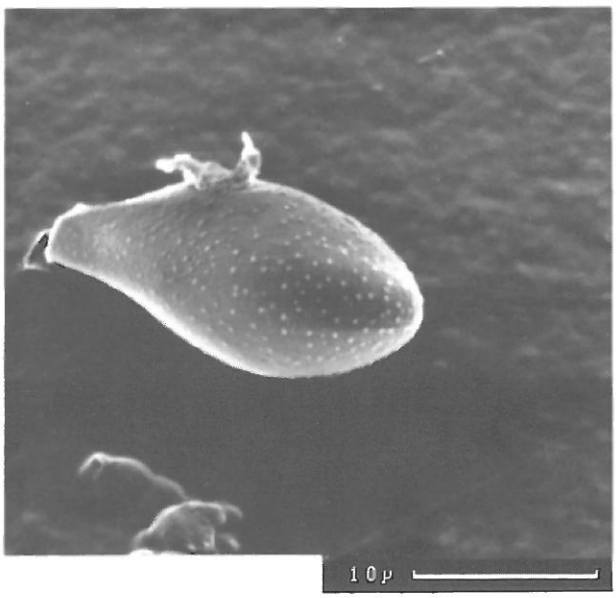




Yorks in B, 196. [UT] on *Luzula pilosa*. Drawing of T in WH 222. Description in EE 553. Teliospore surface: smooth (WH).

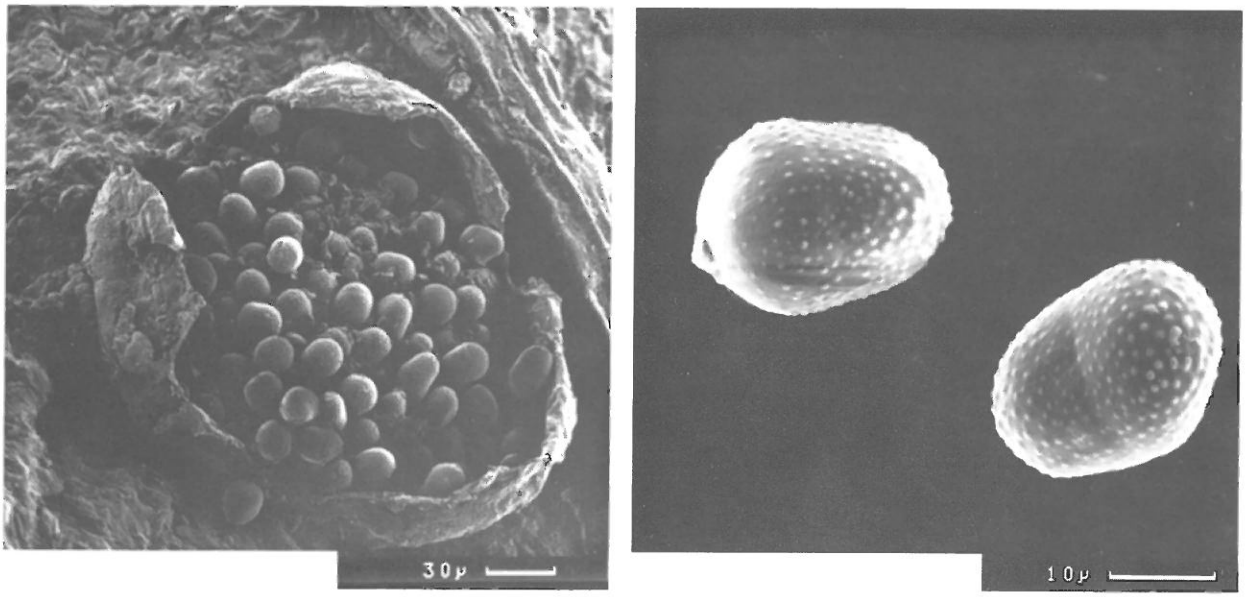
Species 84. *Puccinia luzulae*: uredinia and urediniospores.





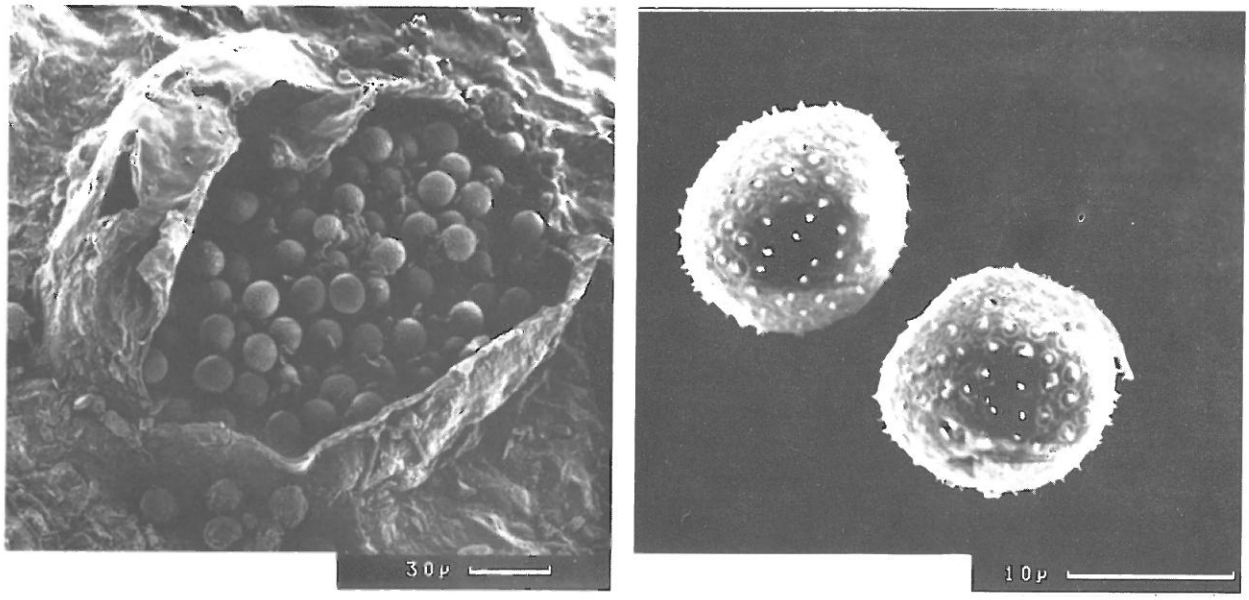
(See caption to photographs of telia and teliospores). Urediniospore surface: smooth, rarely aculeate at the summit (WH), almost or quite smooth (EE).

Species 85. *Puccinia maculosa*: telia and teliospores.



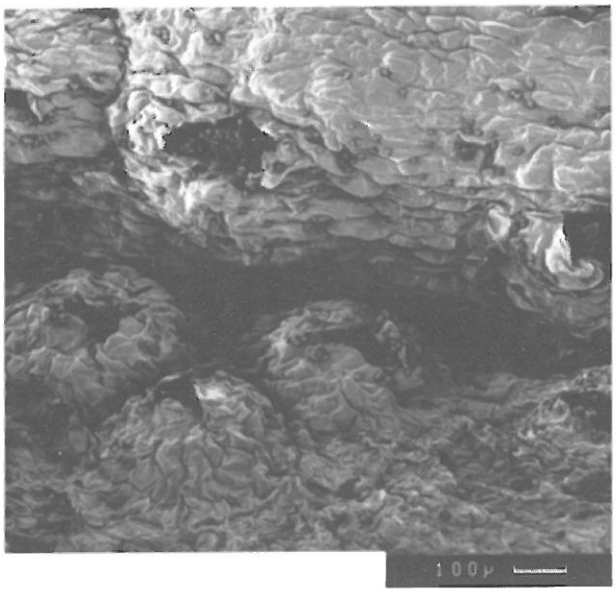
Yorks in B, 196. [AUT] on *Mycelis muralis*. Drawing of T in WH 209. Description EE 389. Teliospore surface: very delicately verruculose (WH), minutely roughened (EE).

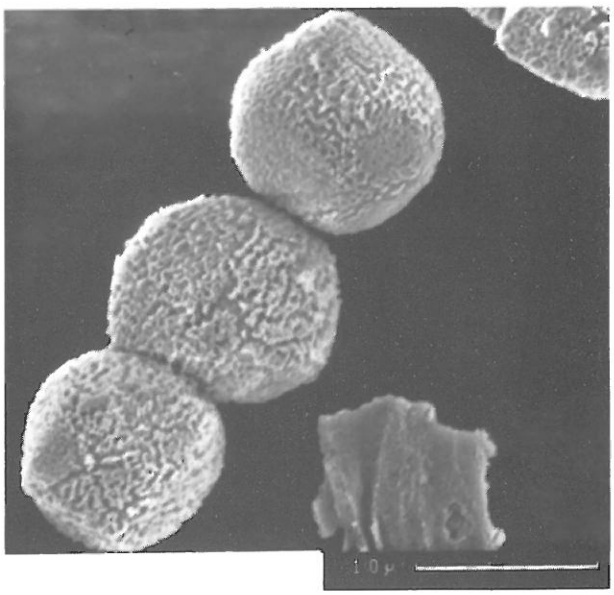
Species 85. *Puccinia maculosa*: uredinia and urediniospores.



(See caption to photographs of telia and teliospores). Urediniospore surface: echinulate (WH, EE).

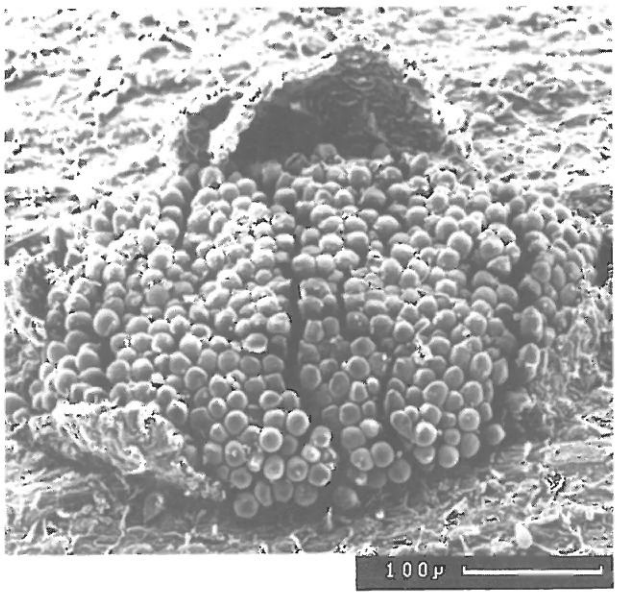
Species 85. *Puccinia maculosa*: aecia and aeciospores.

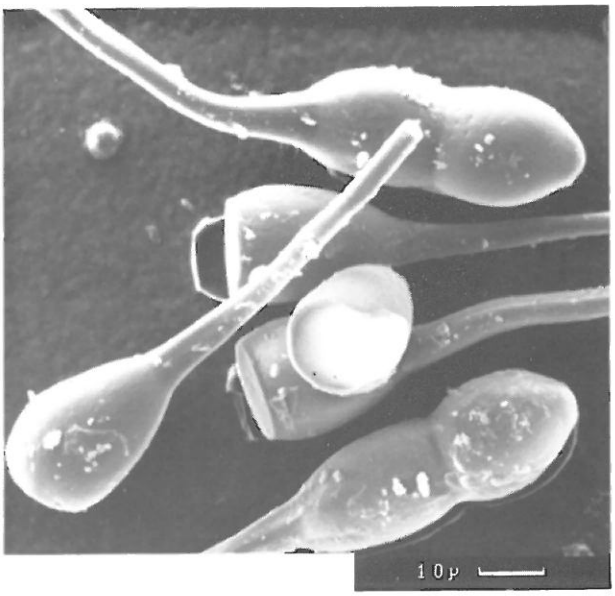




(See caption to photographs of telia and teliospores). Aeciospore surface: verruculose (WH).

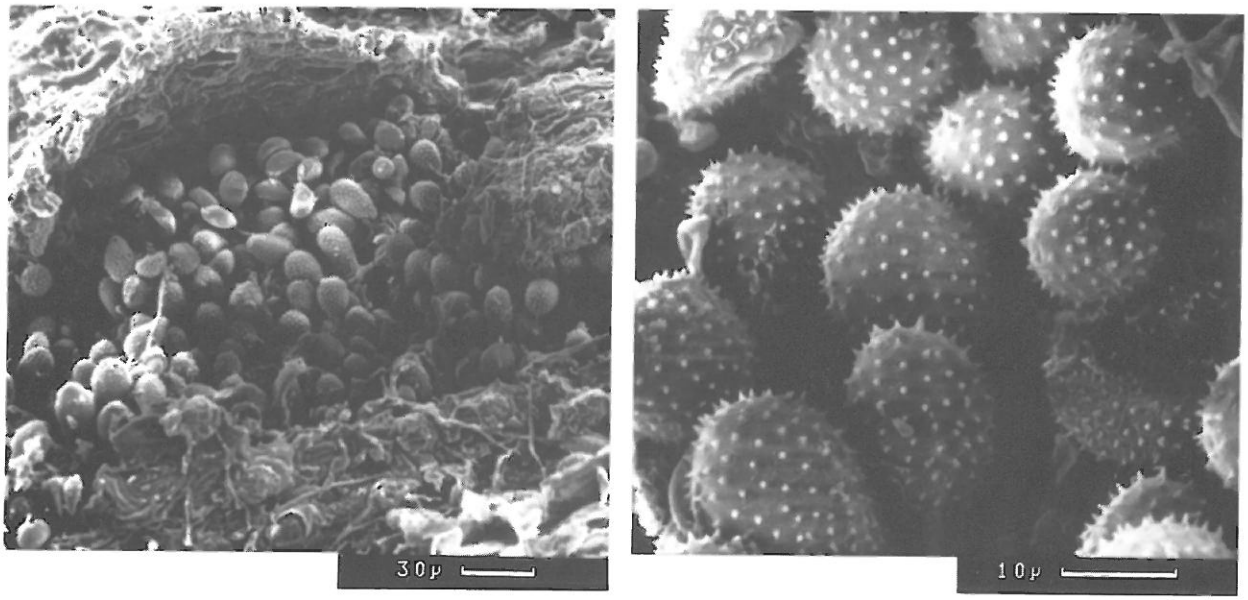
Species 86. *Puccinia magnusiana*: telia and teliospores.





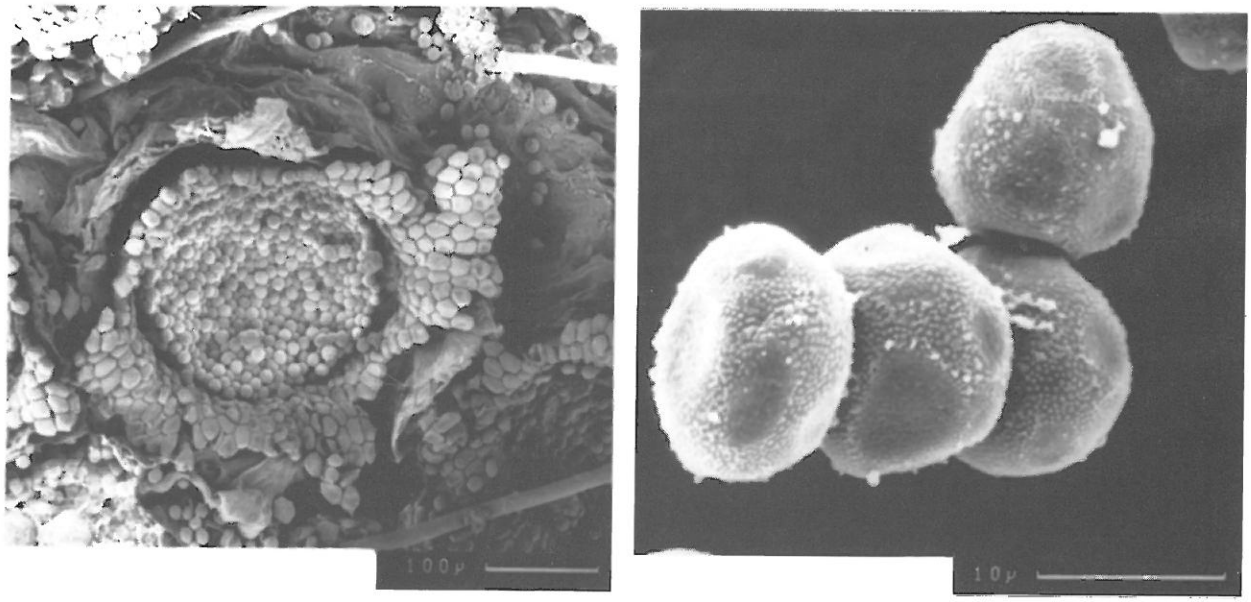
Yorks in B, 196. [A] on Ranunculus spp. [UT] on *Phragmites communis*, (now called *P.australe*). Drawing of T in WH 267 and Fig. 1906 in EE. Descriptions in EE 410 (A) and 509 (UT). Teliospore surface smooth (WH).

Species 86. *Puccinia magnusiana*: uredinia and urediniospores.



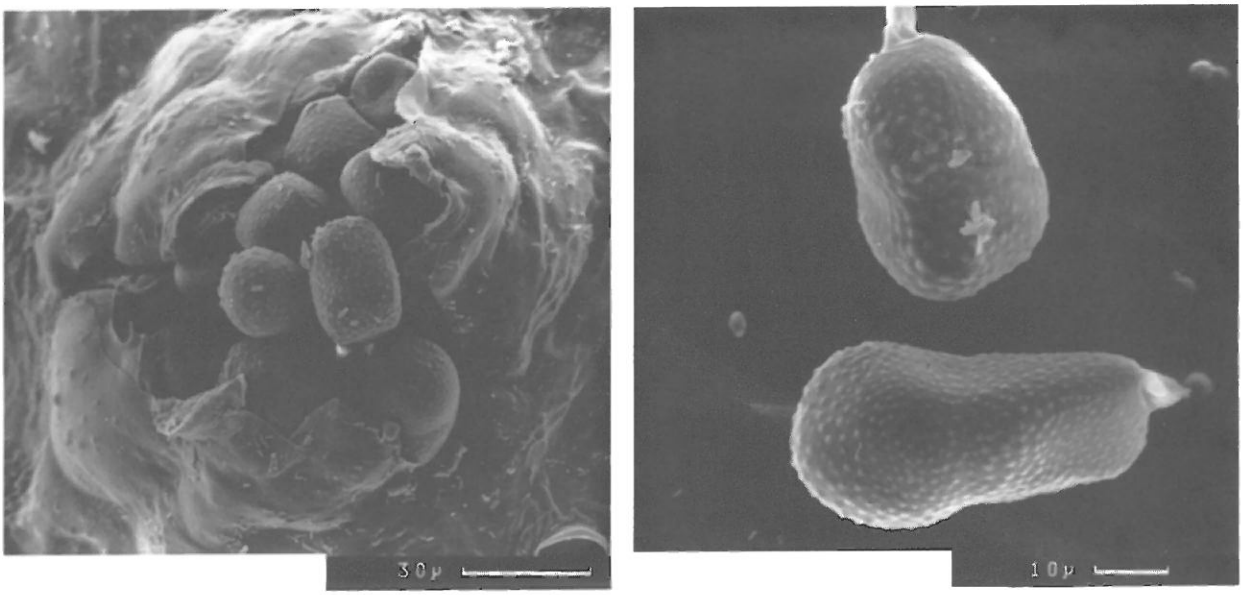
(See caption to photographs of telia and teliospores). Urediniospore surface: delicately echinulate (WH), finely echinulate (EE).

Species 86. *Puccinia magnusiana*: aecia and aeciospores.



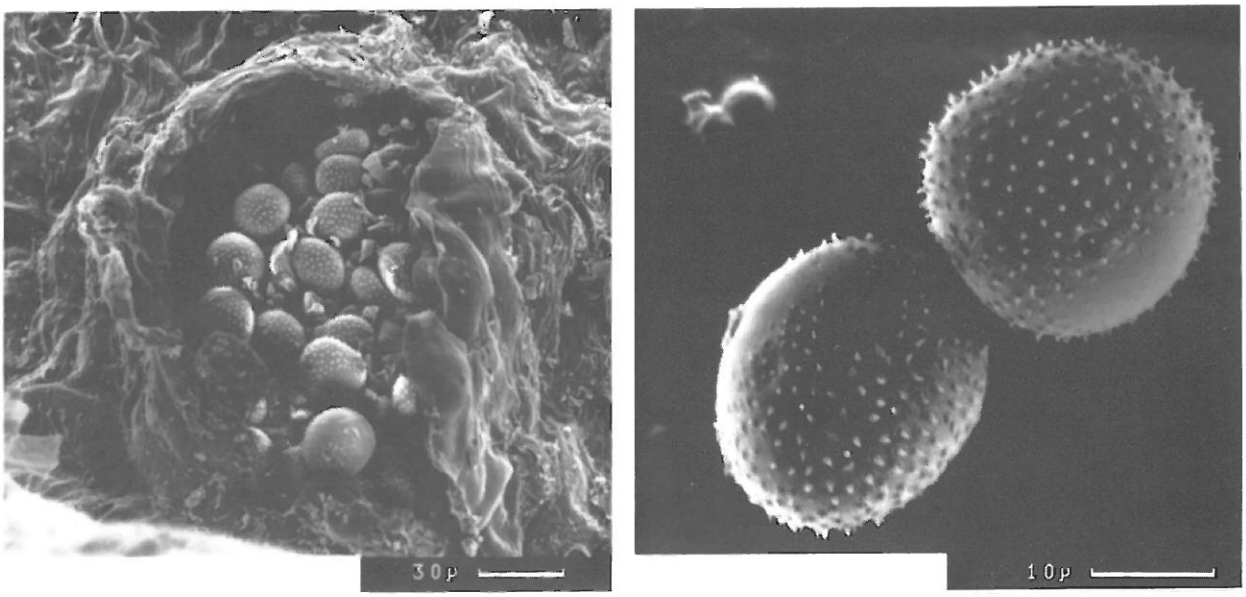
(See caption to photographs of telia and teliospores). Aeciospore surface: finely verruculose (WH), minutely verruculose (EE).

Species 87. *Puccinia major*: telia and teliospores.



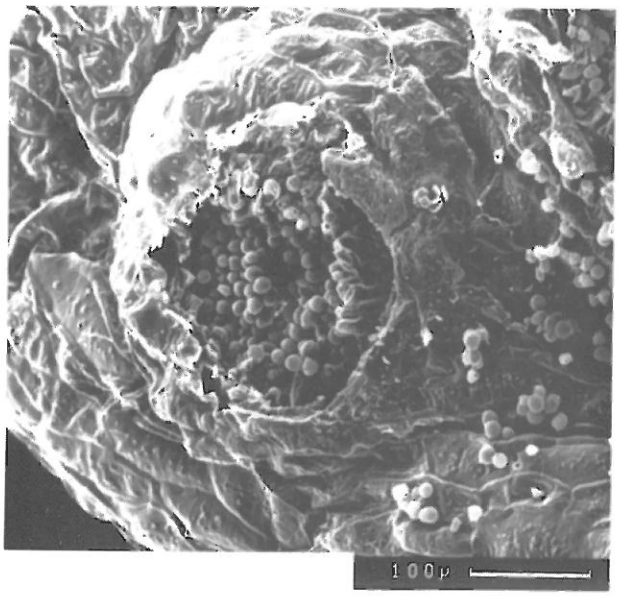
Yorks in B, 196. [AUT] on Crepis paludosa. Drawing of T in WH 210. Description in EE 339. Teliospore surface: delicately verruculose (WH), minutely verruculose (EE).

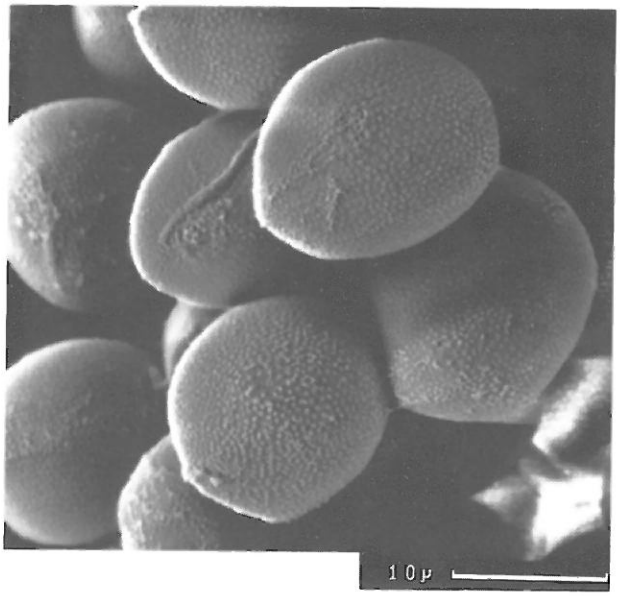
Species 87. *Puccinia major*: uredinia and urediniospores.



(See caption to photographs of telia and teliospores). Urediniospore surface: distantly echinulate (WH), finely echinulate (EE).

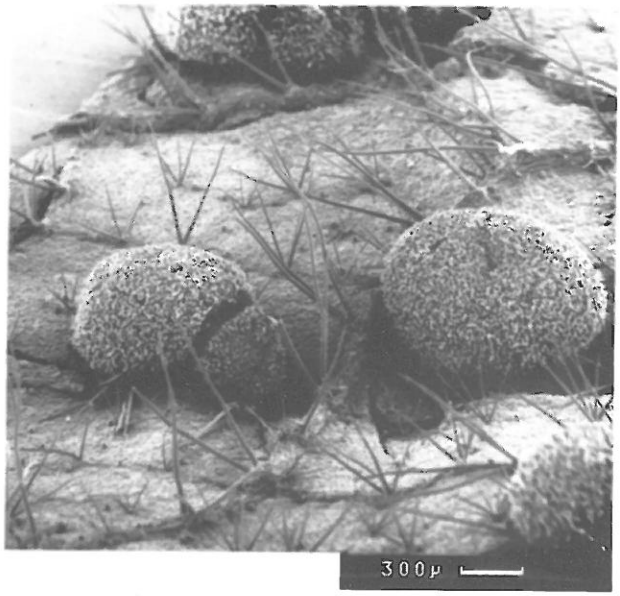
Species 87. *Puccinia major*: aecia and aeciospores.

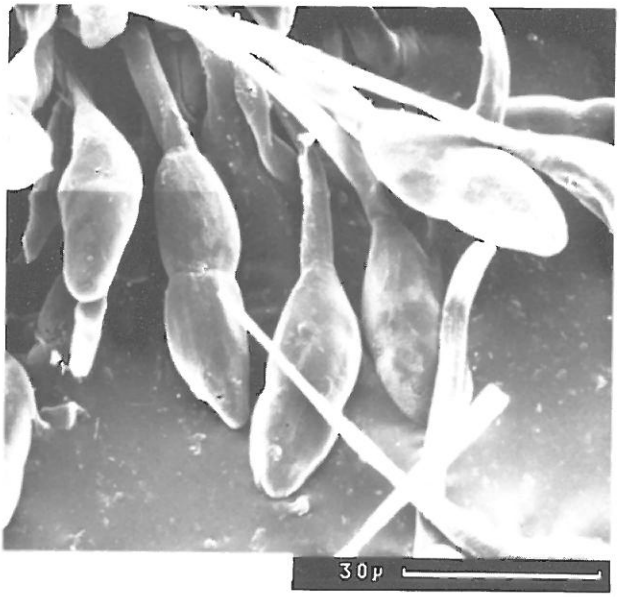




(See caption to photographs of telia and teliospores). Aeciospore surface: delicately verruculose (WH).

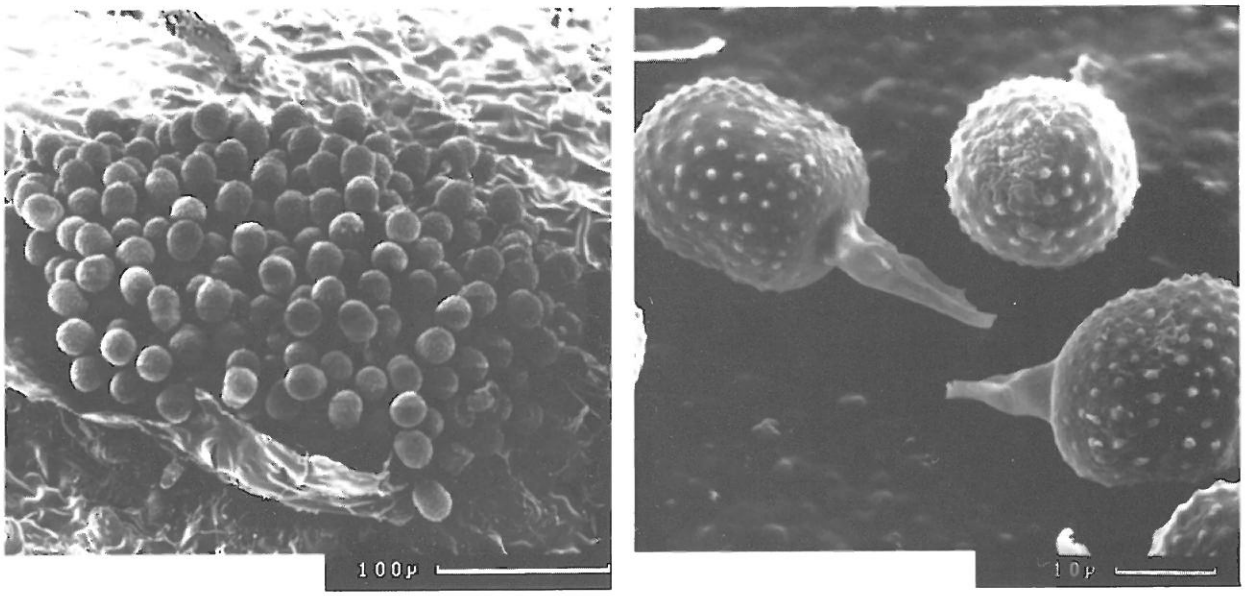
Species 88. *Puccinia malvacearum*: telia and teliospores.





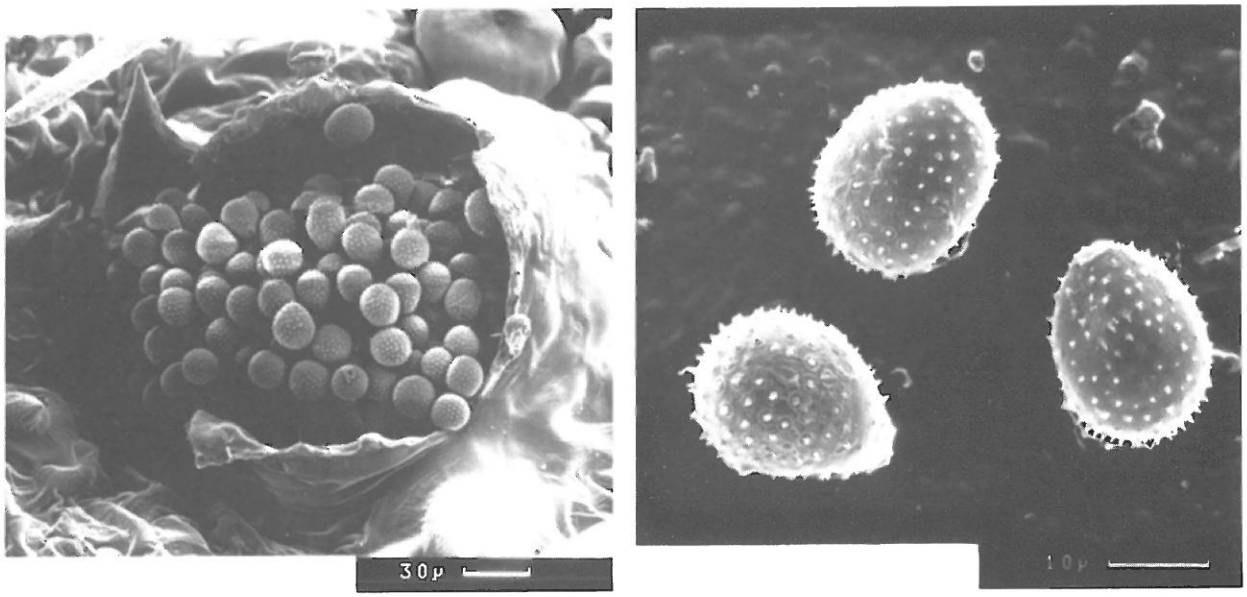
Yorks in B, 196. [T] e.g. on *Althea rosea*. Drawing of T in WH 132, in Fig. 1570, EE, and in CMID 265. Description in EE, 384. Teliospore surface: smooth (WH).

Species 89. *Puccinia menthae*: telia and teliospores.



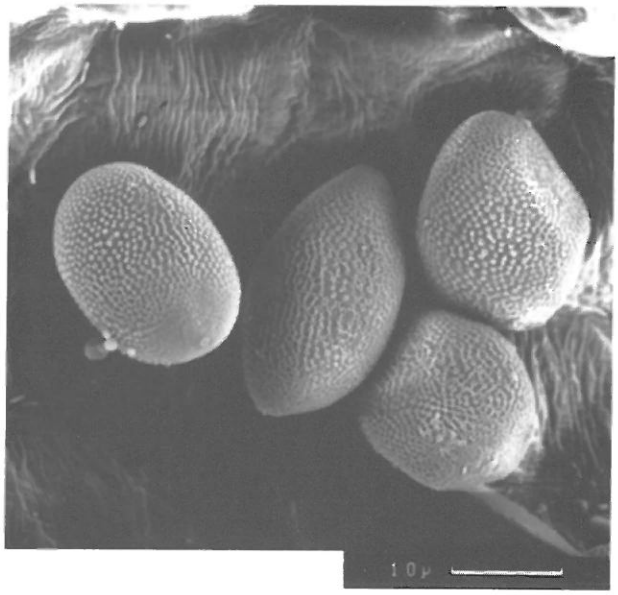
Yorks in B, 196. [AUT] e.g. Mentha spp. Drawing of T in WH 179 and photograph in CMID 7. Description in EE 387. Teliospore surface: indistinctly verruculose, sometimes smooth (WH), verrucose or occasionally smooth (CMID).

Species 89, *Puccinia menthae*: uredinia and urediniospores.



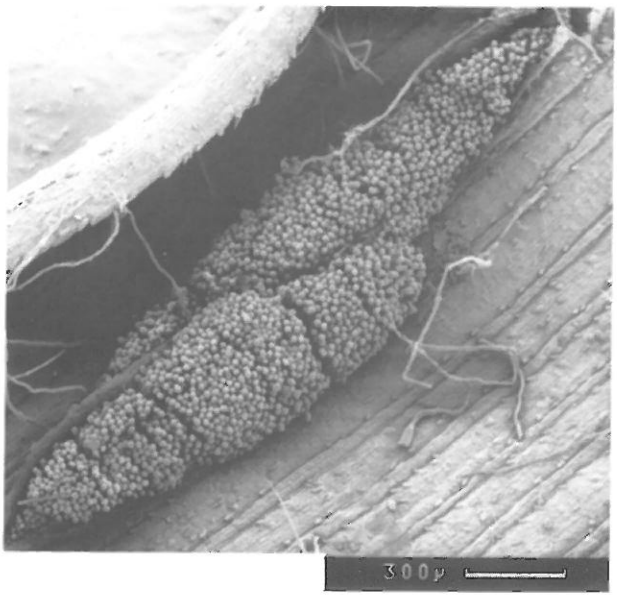
(See caption to photograph of telia and teliospores). Urediniospore surface: echinulate (WH), finely echinulate (CMID).

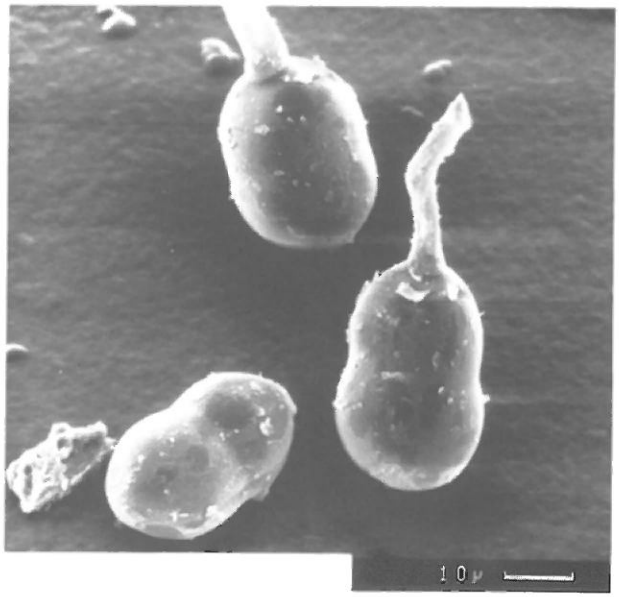
Species 89. *Puccinia menthae*: aecia and aeciospores.



(See caption to photographs of telia and teliospores). Aeciospore surface: verruculose (WH), evenly verruculose (CMID).

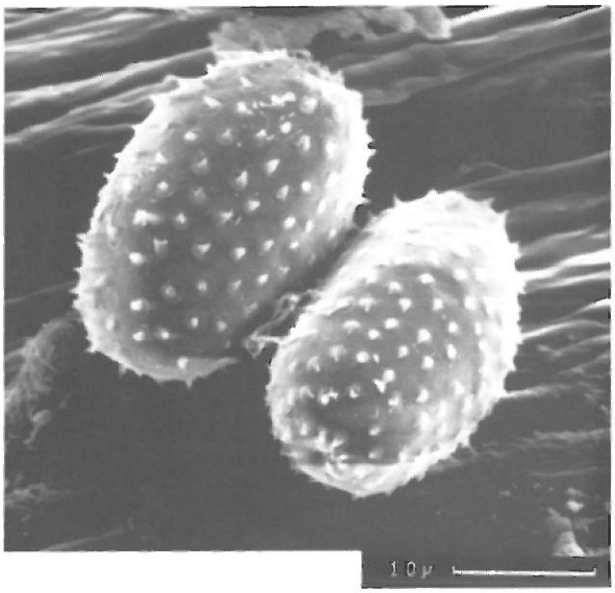
Species 90. *Puccina moliniae*: telia and teliospores

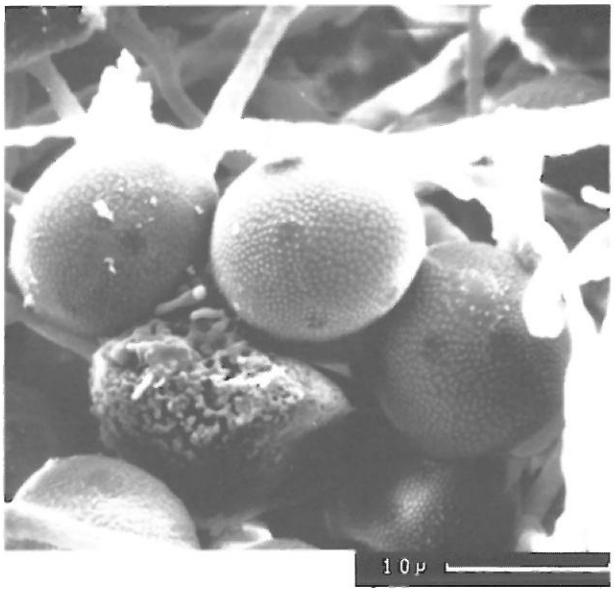




Yorks in B, [A] on *Prunella vulgaris*; [UT] on Molinia caerulea. Drawing of T in WH, 268. Teliospore surface: smooth (WH).

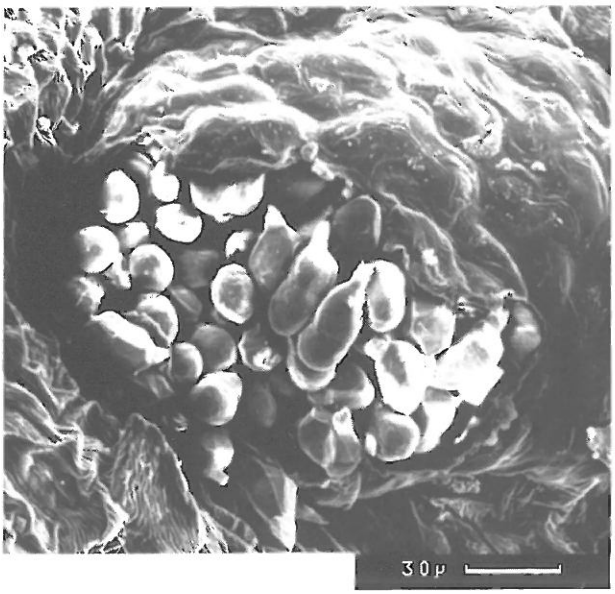
Species 90. *Puccinia moliniae*: urediniospores and aeciospores.





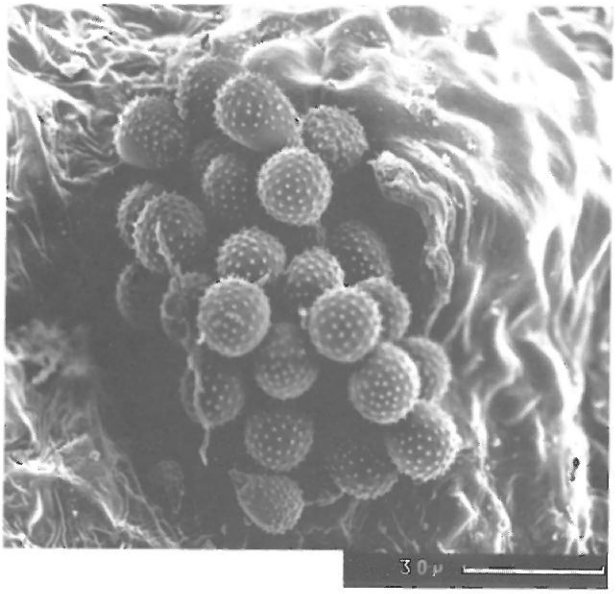
(See caption to photographs of telia and teliospores). Urediniospore surface: aculeate (WH). Aeciospore surface: verruculose (WH). (No uredosorus found in herbarium materal and all available aecia overgrown with other moulds).

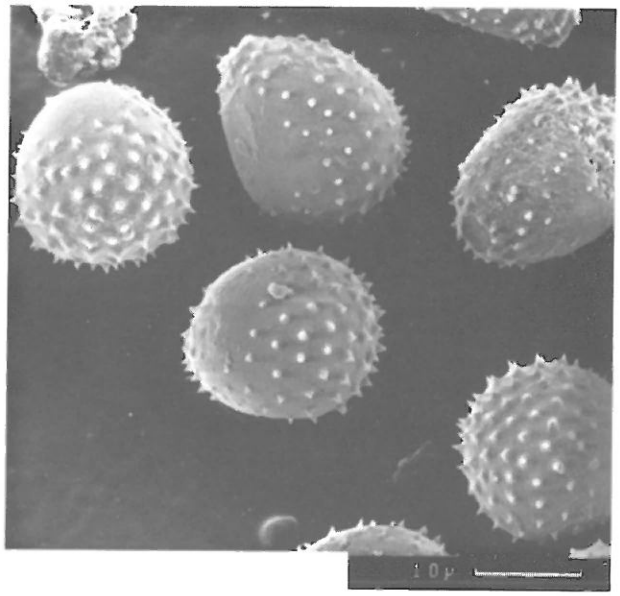
Species 91. *Puccinia nitida*: telia and teliospores.



Yorks in B, 197. [AUT] e.g. on *Petroselinum crispum*. Description in WH 153, and EE 301. Teliospore surface: smooth or nearly so (WH).

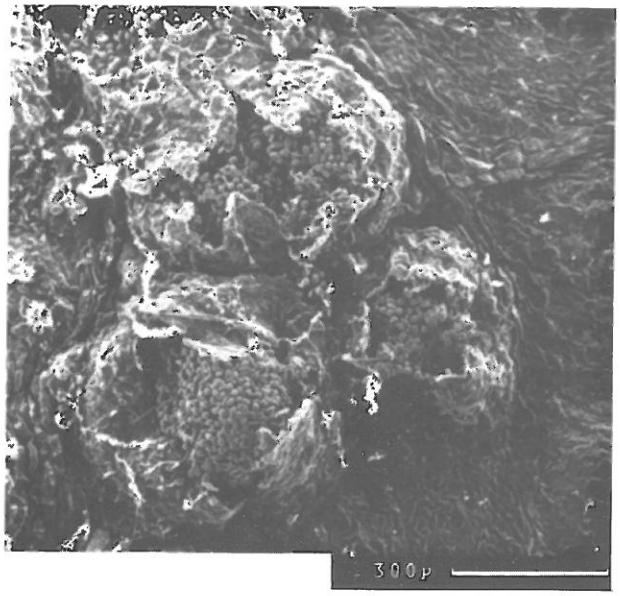
Species 91. *Puccinia nitida*: uredinia and urediniospores.

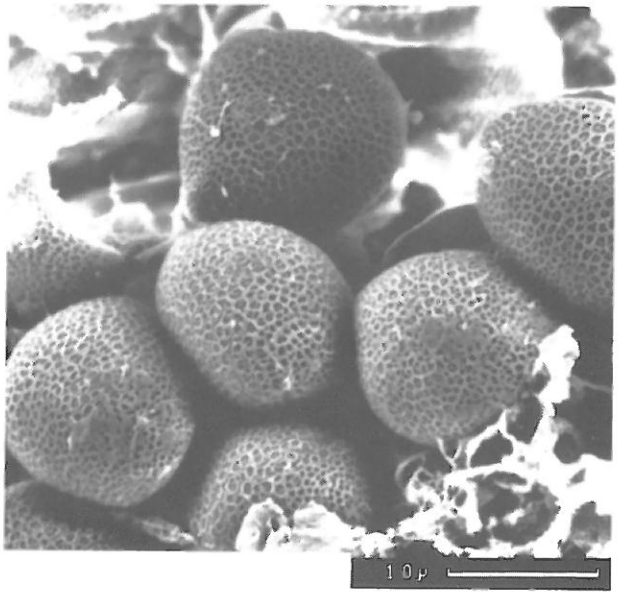




(See caption to photographs of telia and teliospores). Urediniospore surface: distantly echinulate all over or only in the upper part or in the upper part and base, leaving the central part smooth (WH).

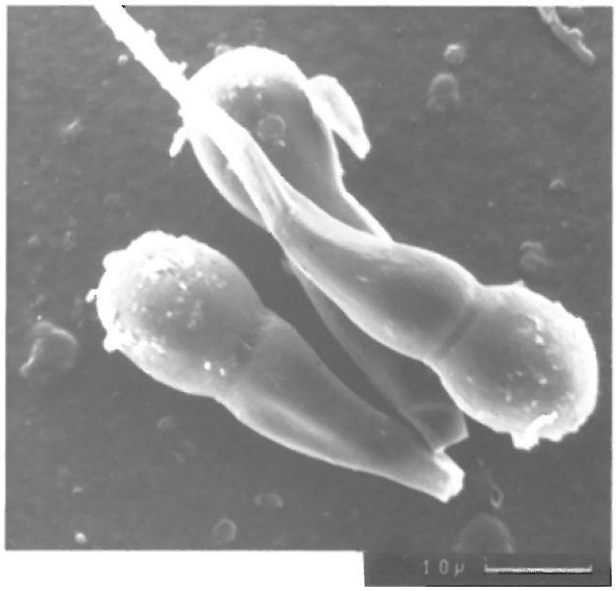
Species 91. *Puccinia nitida*: aecia and aeciospores.





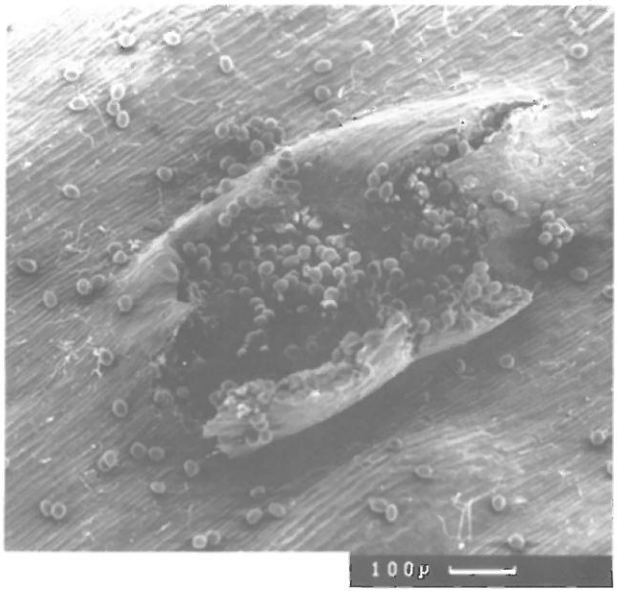
(See caption to photographs of telia and teliospores). Aeciospore surface: (as uredospores) aecidia uredinoid (WH).

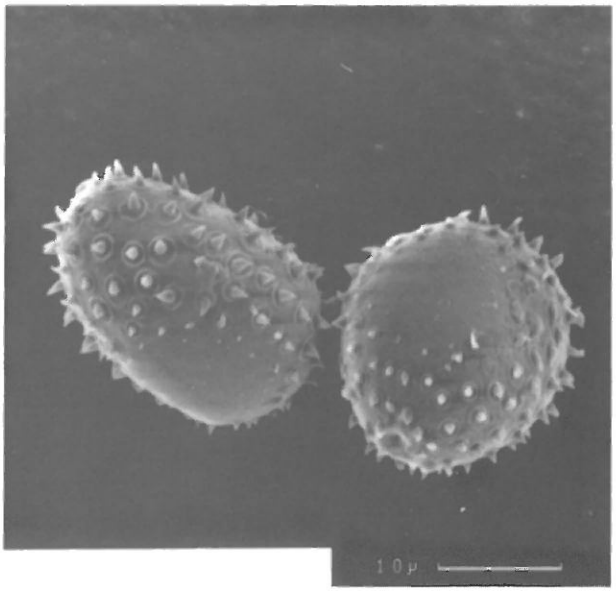
Species 92. *Puccinia obscura*: telia and teliospores.



Yorks in B, 197. [A] on *Bellis perennis*, [UT] on Luzula spp. Drawing in WH 223. Description in EE 317 (A) and 553 (U and T). Teliospore surface: smooth (WH).

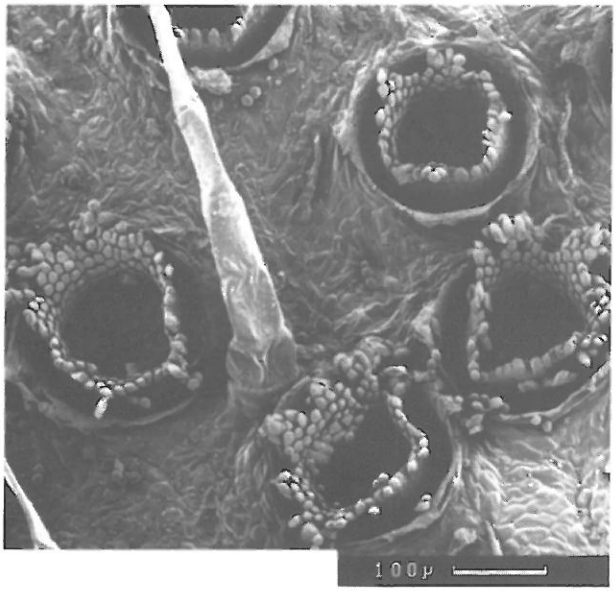
Species 92. *Puccinia obscura*: uredinia and urediniospores.

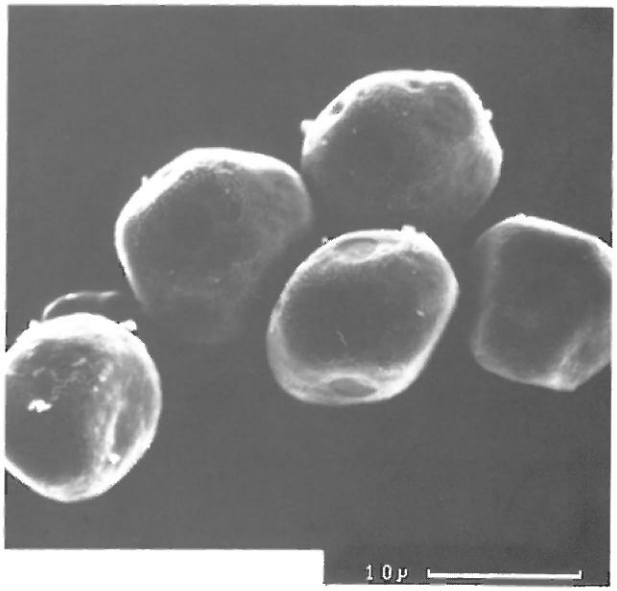




(See caption to photographs of telia and teliospores). Urediniospore surface: echinulate (WH, EE).

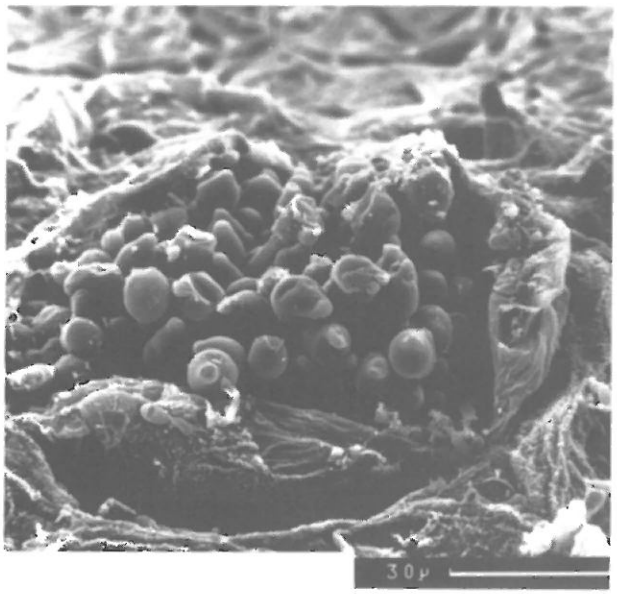
Species 92. *Puccinia obscura*: aecia and aeciospores.

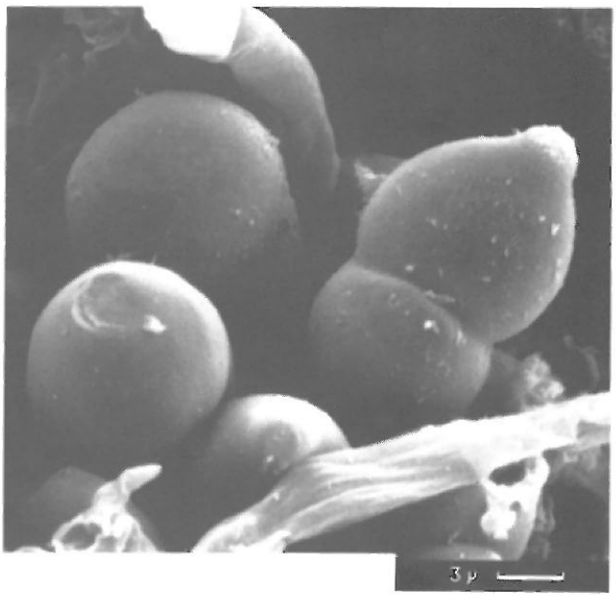




(See caption to photographs of telia and teliospores). Aeciospore surface: finely verruculose (WH), minutely verruculose (EE).

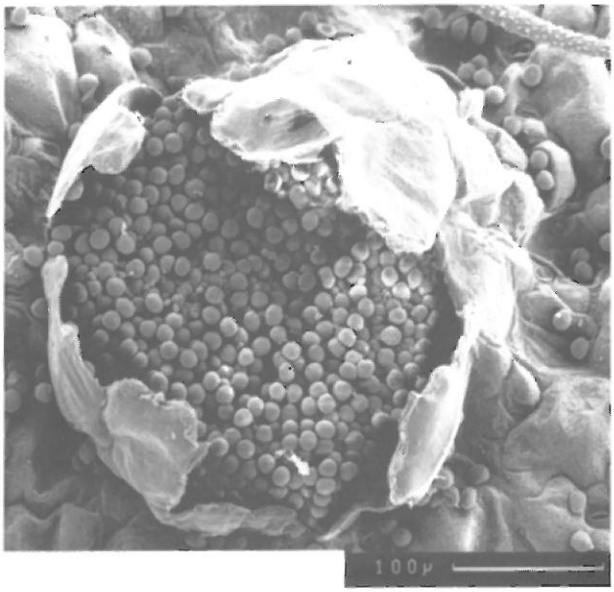
Species 92A. *Puccinia oxalidis*: telia and teliospores.

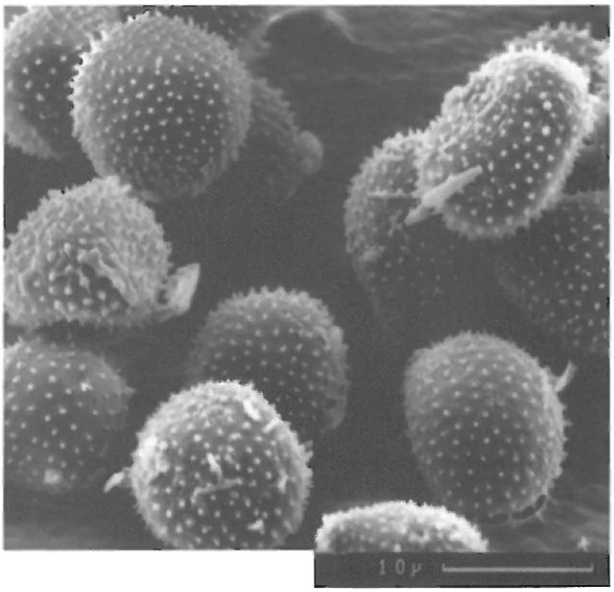




Not in B. Found at Scarborough, October 1986 (C. Yeates). [UT] on Oxalis spp. Drawing of U and T in WH477 (Additions and corrections, 1979). Descriptions in EE 394. Teliospore surface: smooth (WH, EE).

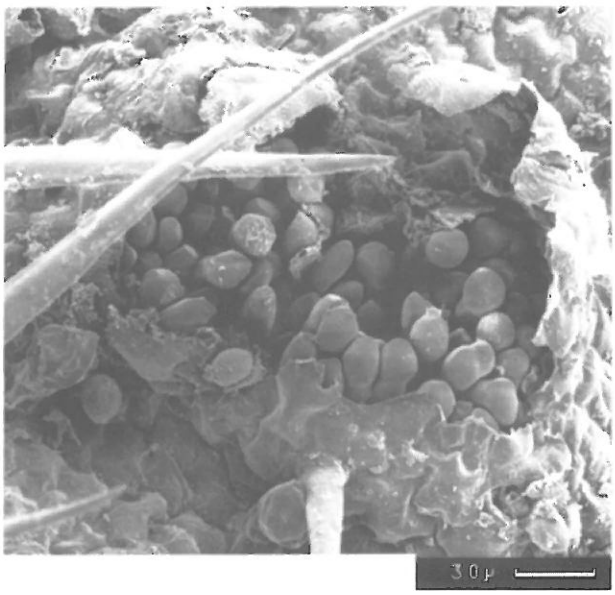
Species 92A. *Puccinia oxalidis*: uredinia and urediniospores.





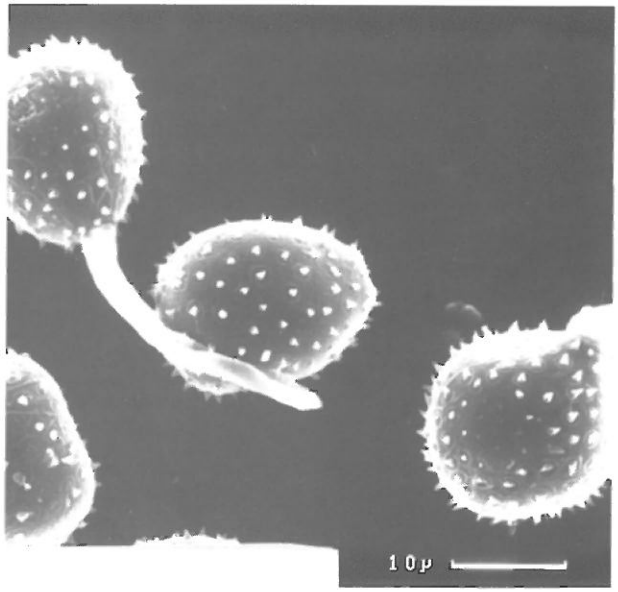
(See caption to photographs of telia and teliospores). Urediniospore surface: minutely echinulate (WH), echinulate (EE).

Species 93. *Puccinia pelargonii-zonalis*: telia and teliospores.



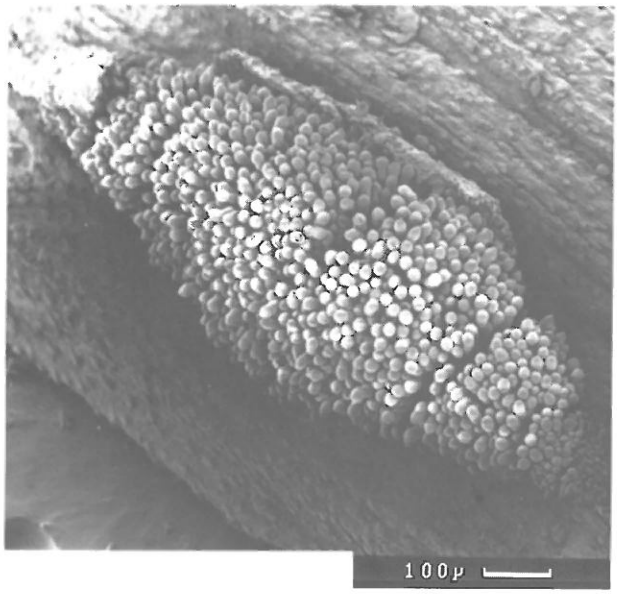
Yorks in B, 197. [UT] on *Pelargonium zonale*. Photograph of U and T in CMID 266. Description in WH 482 (additions and connections) and EE 397.

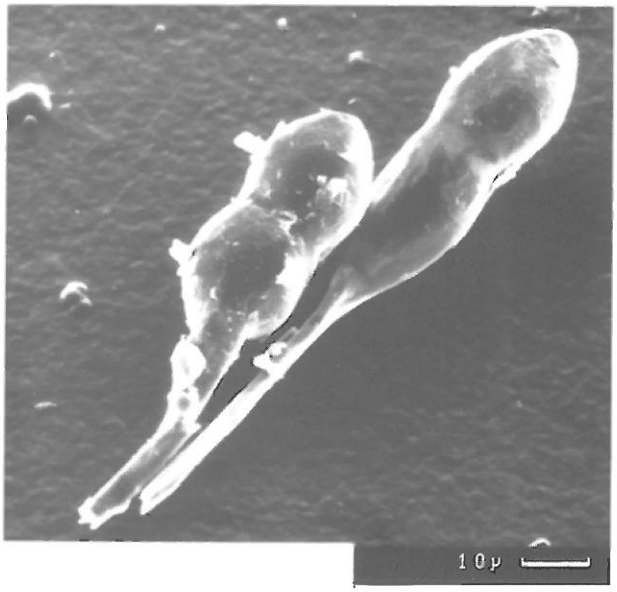
Species 93. *Puccinia pelargonii-zonalis*: uredinia and urediniospores.



(See caption to photographs of telia and teliospores). Urediniospore surface: finely echinulate (EE), delicately echinulate (CMID).

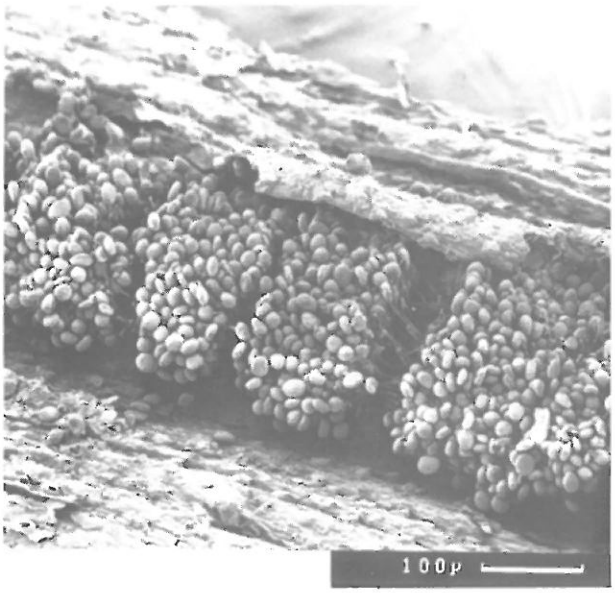
Species 94. *Puccinia phragmitis*: telia and teliospores.

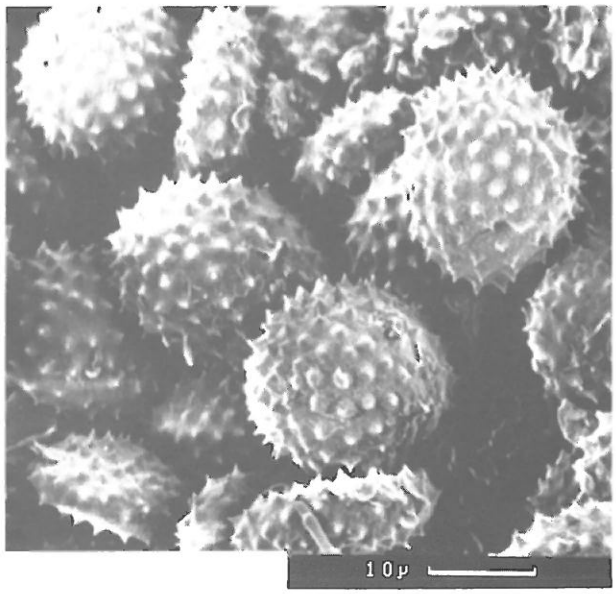




Yorks in B, 197. [A] e.g. on Rumex spp. [UT] on *Phragmites communis*. Drawing in WH 269 of T is different one from that in EE Fig. 1907 and described, with U on 509 EE. The A are described on EE 414. Teliospore surface: smooth or sometimes with very fine granulations (WH).

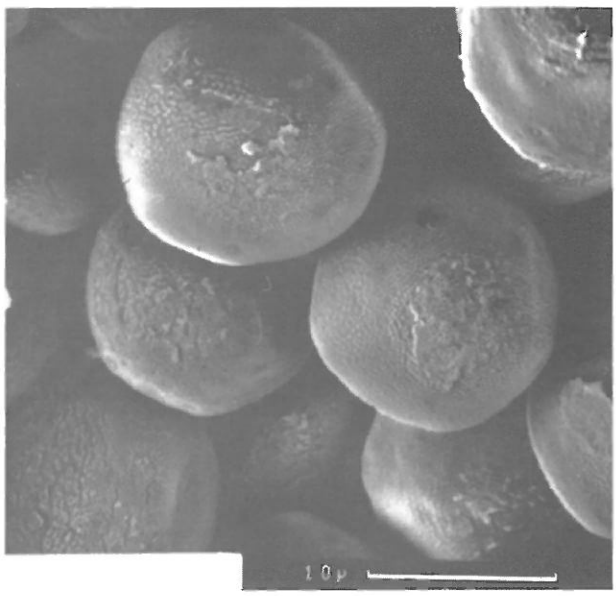
Species 94. *Puccinia phragmitis*: uredinia and urediniospores.





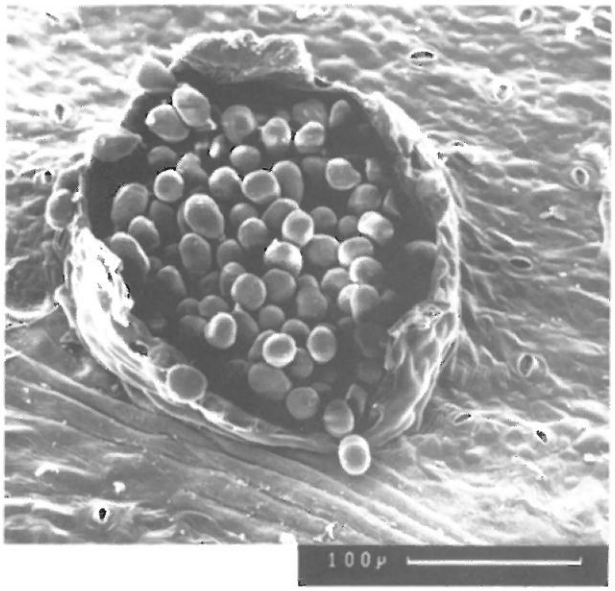
(See caption to photographs of telia and teliospores). Urediniospore surface: verruculose (WH).

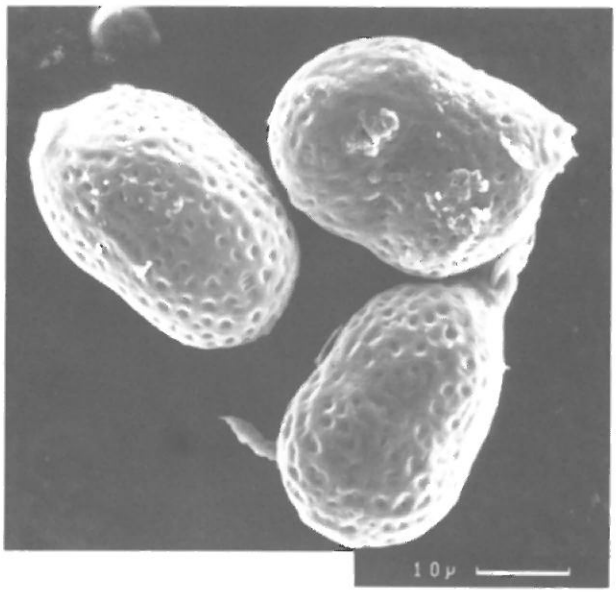
Species 94. *Puccinia phragmitis*: aecia and aeciospores.



(See caption to photographs of telia and teliospores). Aeciospore surface: verruculose (WH, EE).

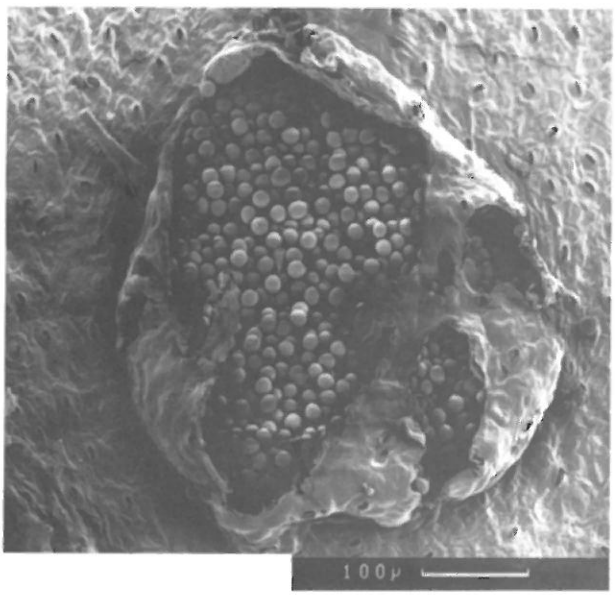
Species 95. *Puccinia pimpinellae*: telia and teliospores.

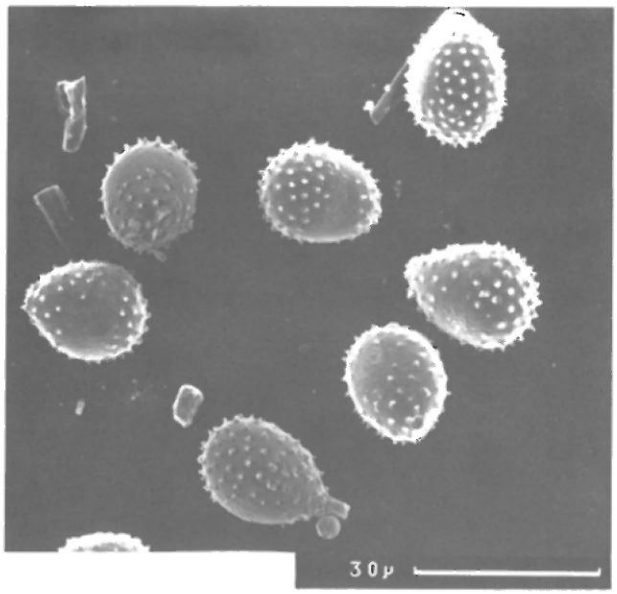




Yorks in B, 197. [AUT] on Pimpinella spp. Drawing WH 155. Description EE 400. Teliospore surface: reticulate (WH, EE). Surface: smooth (WH, EE).

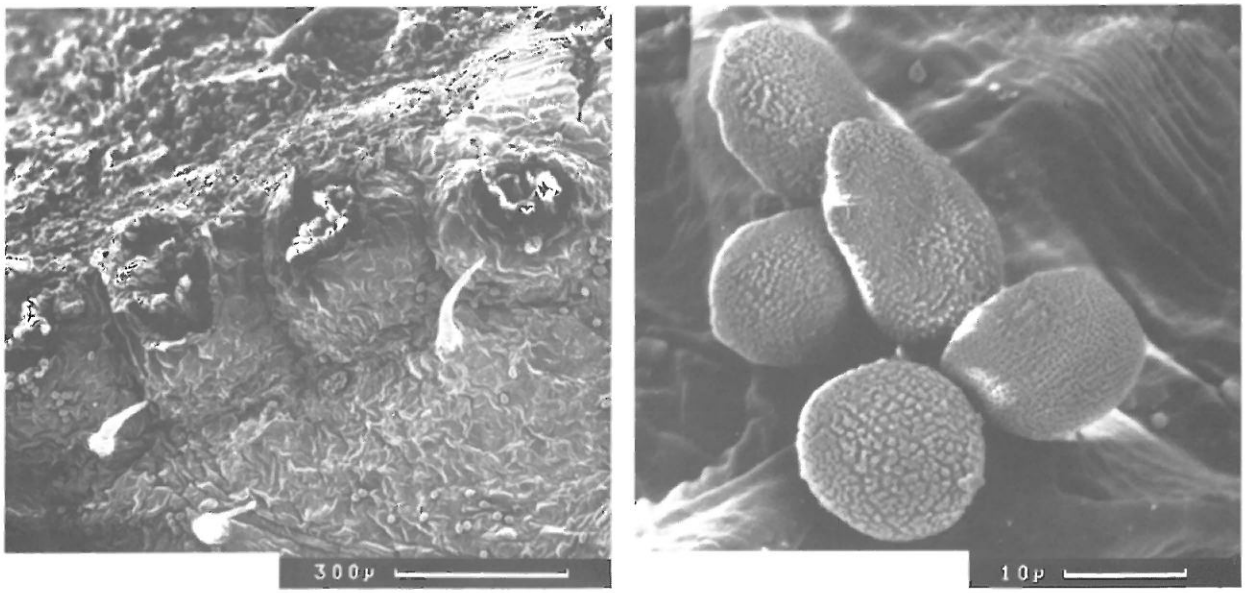
Species 95. *Puccinia pimpinellae*: uredinia and urediniospores.





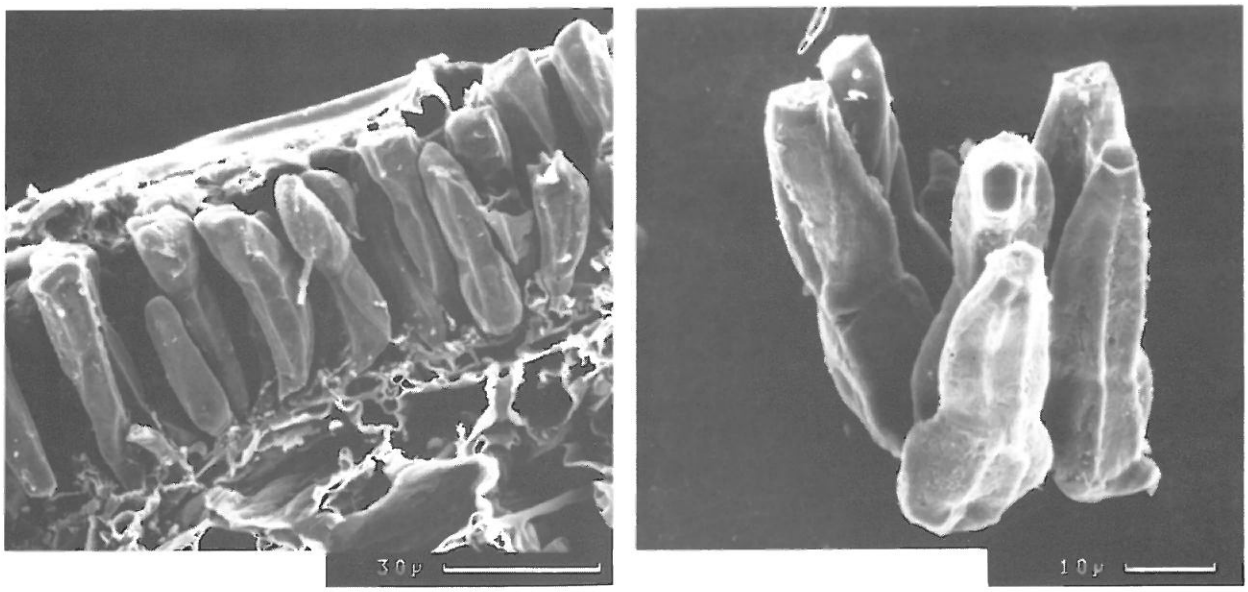
(See caption to photographs of telia and teliospores). Urediniospore surface: echinulate (WH, EE).

Species 95. *Puccinia pimpinellae*: aecia and aeciospores.



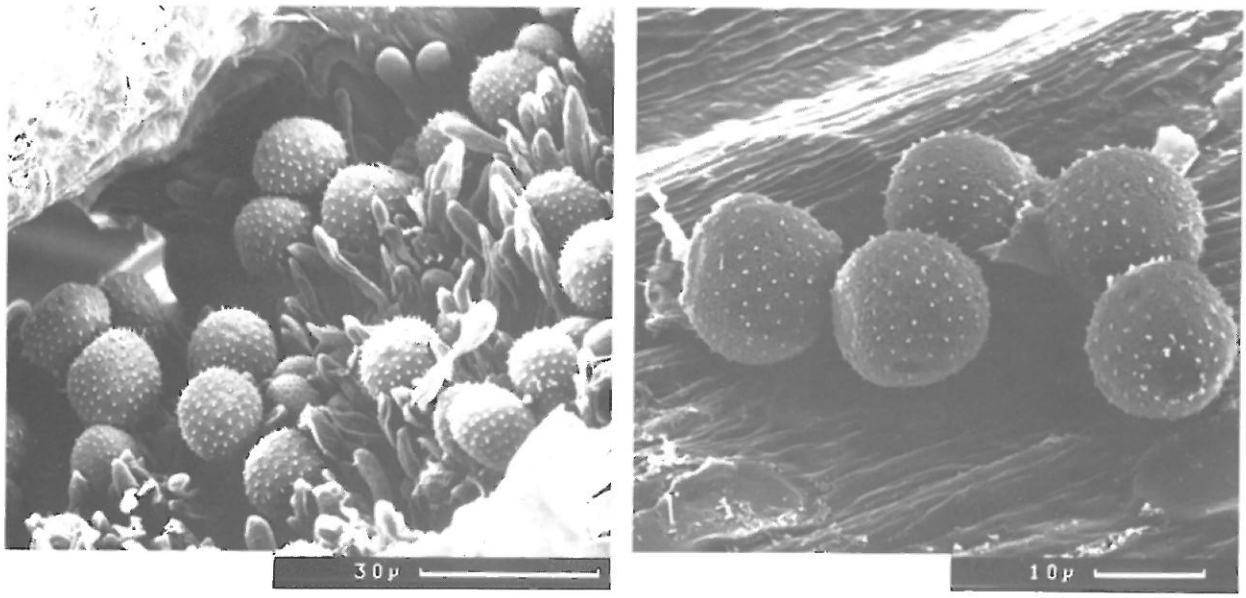
(See caption to photographs of telia and telisopores). Aeciospore surface: verruculose (WH).

Species 97. *Puccinia poarum*: telia and teliospores.



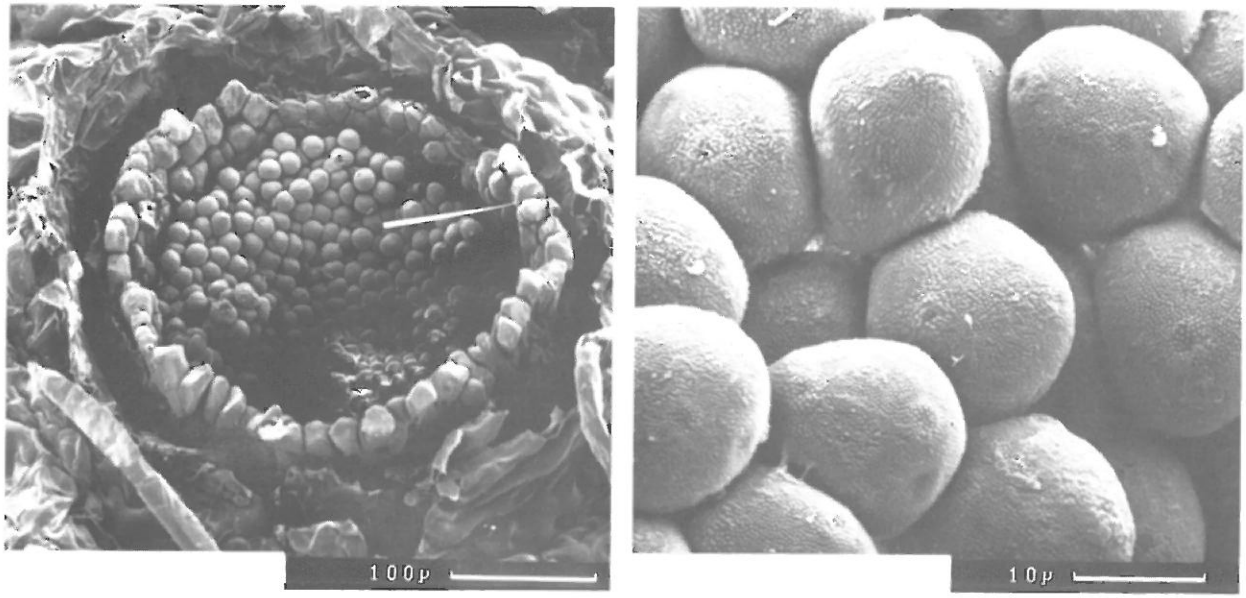
Yorks in B, 197. [A] on *Tussilago farfara*; [U and T] on Poa spp. Drawing in WH 274. Description of A in EE 440 and of UT in EE 513. Teliospore surface: smooth (WH).

Species 97. *Puccinia poarum*: uredinia and urediniospores.



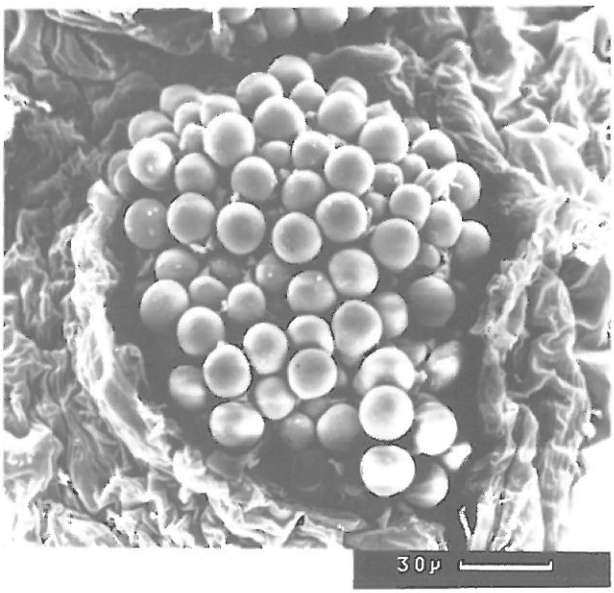
(See caption to photographs of telia and teliospores). Urediniospore surface: densely and minutely verruculose (WH).

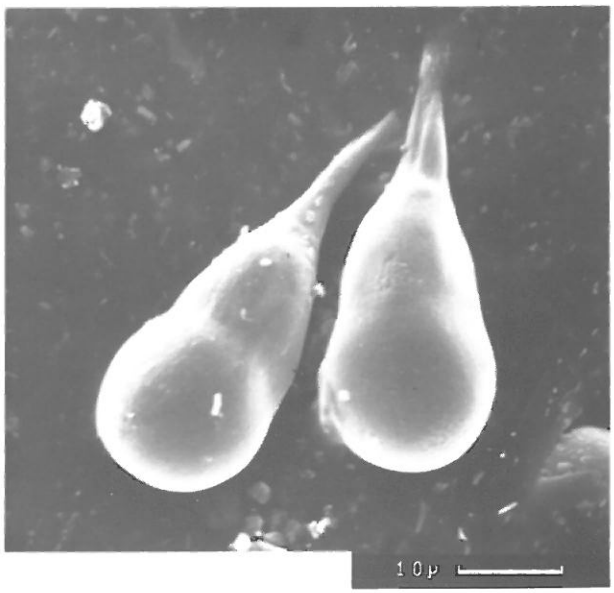
Species 97. *Puccinia poarum*: aecia and aeciospores.



(See caption to photographs of telia and teliospores). Aeciospore surface: verruculose (WH, EE).

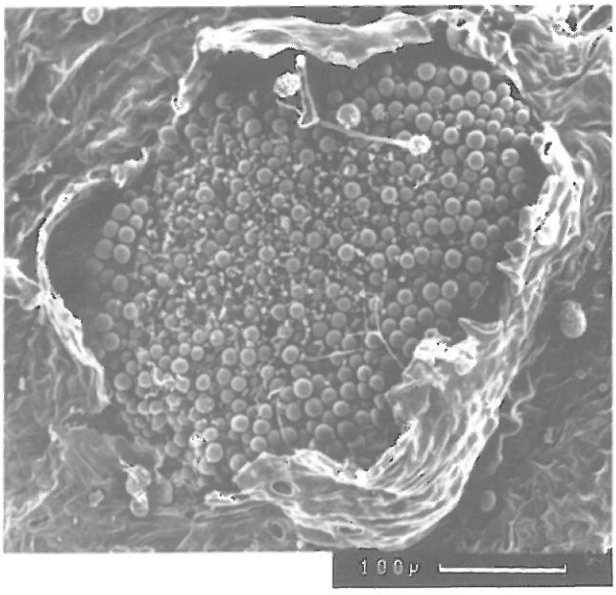
Species 98. *Puccinia polygoni- amphibii* var. *convolvuli*: telia and teliospores.

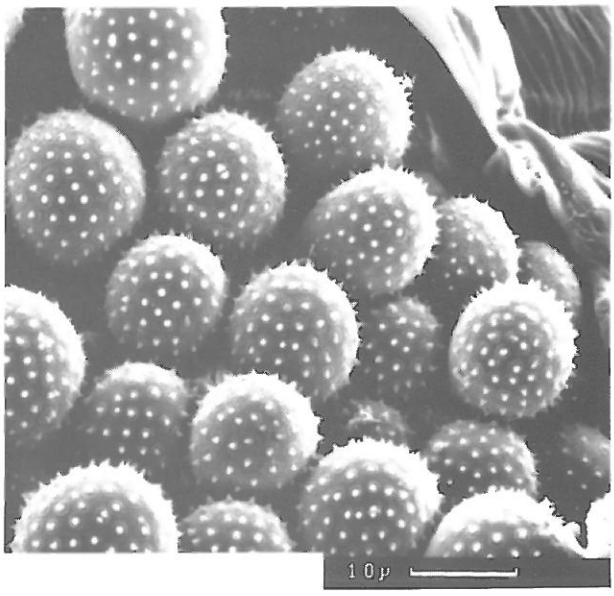




Yorks in B, 197. [A] on *Geranium dissectum* [U and T] on *Polygonum convolvulus*. Drawing of U and T in WH 165, Teliospore surface: smooth (WH).

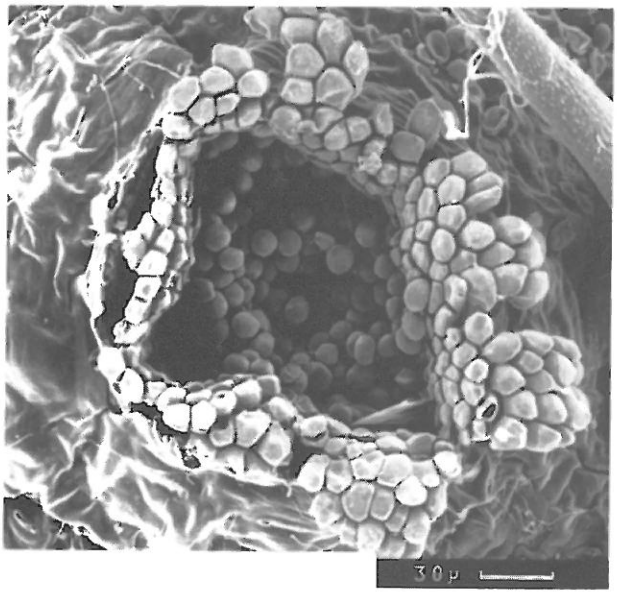
Species 98. *Puccinia polygoni - amphibii* var. *convolvuli*: uredinia and urediniospores





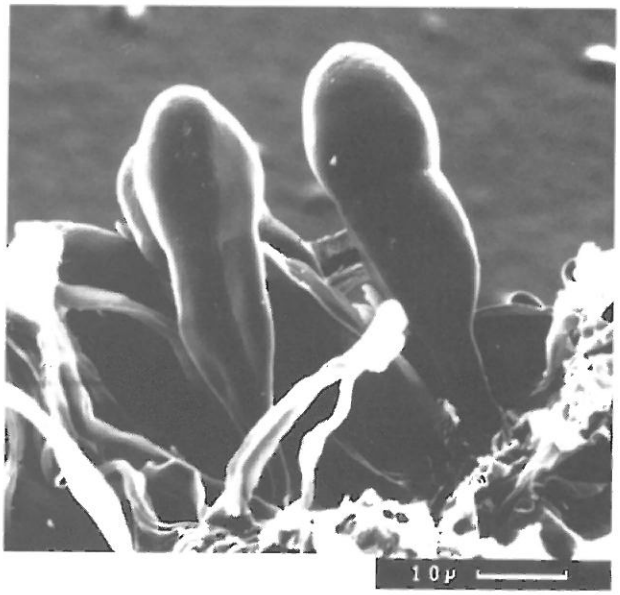
(See caption to photographs of telia and teliospores). Urediniospore surface: distantly echinulate (WH).

Species 98. *Puccinia polygoni-amphibii* var. *convolvuli*: aecia and aeciospores.



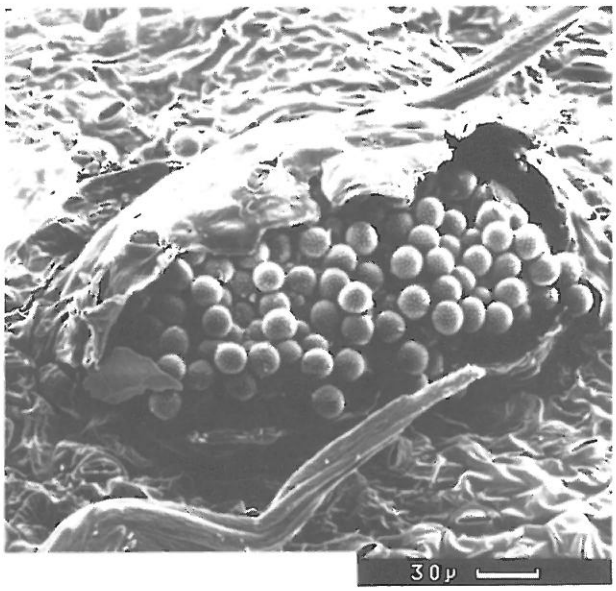
(See caption to photographs of telia and teliospores). Aeciospore surface: uniformly and very finely verruculose (WH).

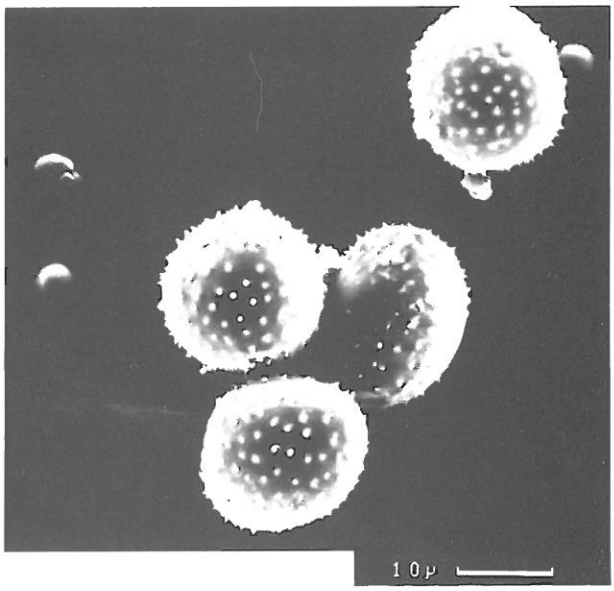
Species 98A. *Puccinia polygoni-amphibii* var. *polygoni-amphibii*: telia and teliospores.



Yorks in B, 197 [UT] on Polygonum spp. Drawing of U and T in WH 164 (as *P. polygoni-amphibii.*) A in Scandinavia on *Geranium sylvaticum*. Description in EE 403. Teliospore surface: smooth (EE).

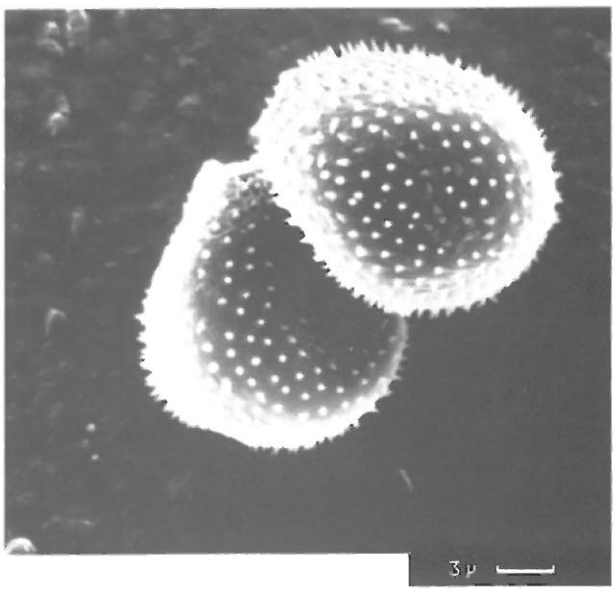
Species 98A. *Puccinia polygoni-amphibii* var. *polygoni - amphibii*: uredinia and urediniospores.





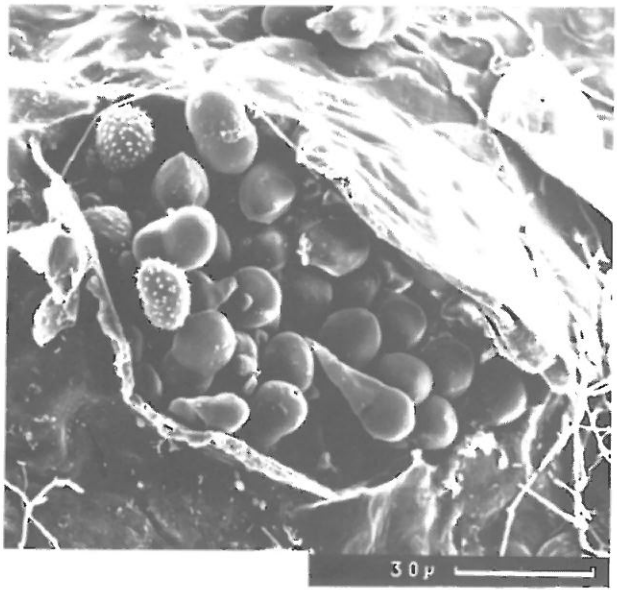
(See caption to photographs of telia and teliospores). Urediniospore surface: faintly echinulate (EE).

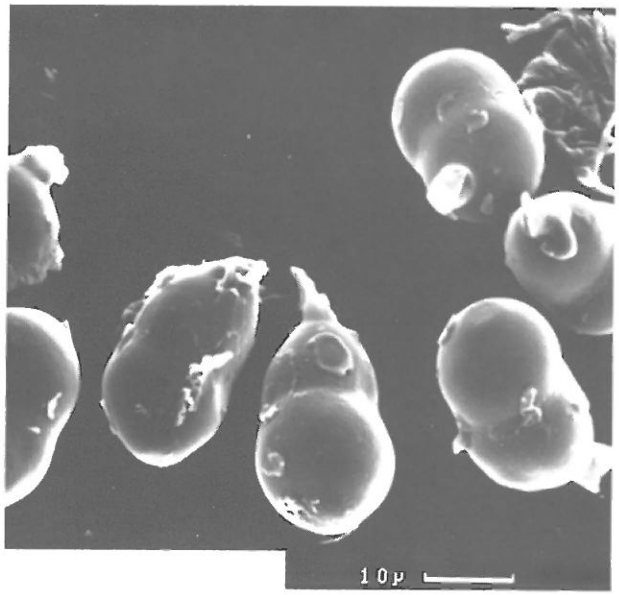
Species 99. *Puccinia pratensis*: uredinia and urediniospores.



Yorks in B, 197 [UT] on *Helictotrichon pratense*. Description WH 275, EE 500. Probably only found once in Britain, by W.G. Bramley, 1952. (No T material available). Urediniospore surface: coarsely echinulate (WH), echinulate (EE).

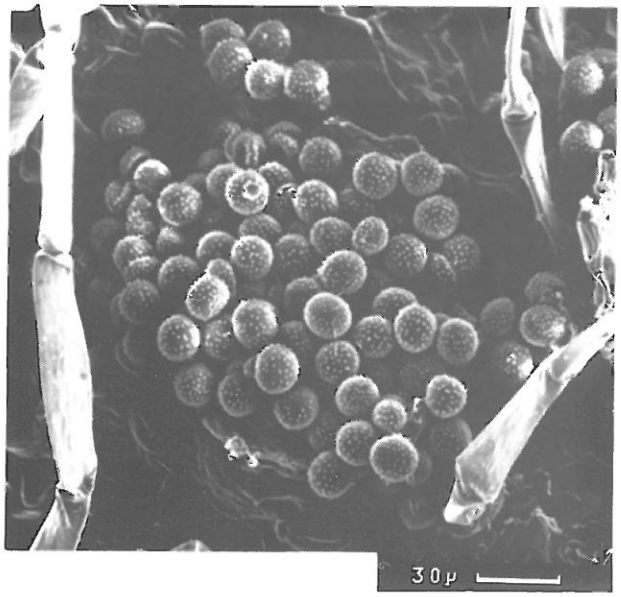
Species 100. *Puccinia primulae*: telia and teliospores.

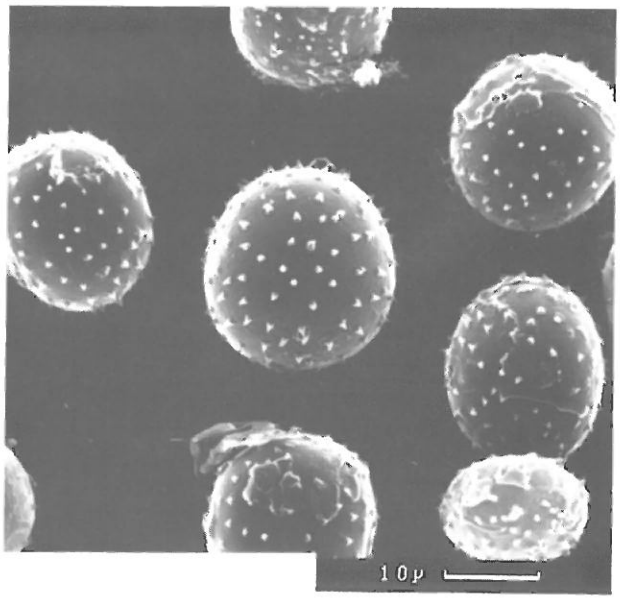




Yorks in B, 197. [AUT] on *Primula vulgaris*. Drawing of U and T on WH 167. Description in EE 408. Teliospore surface: smooth (WH, EE).

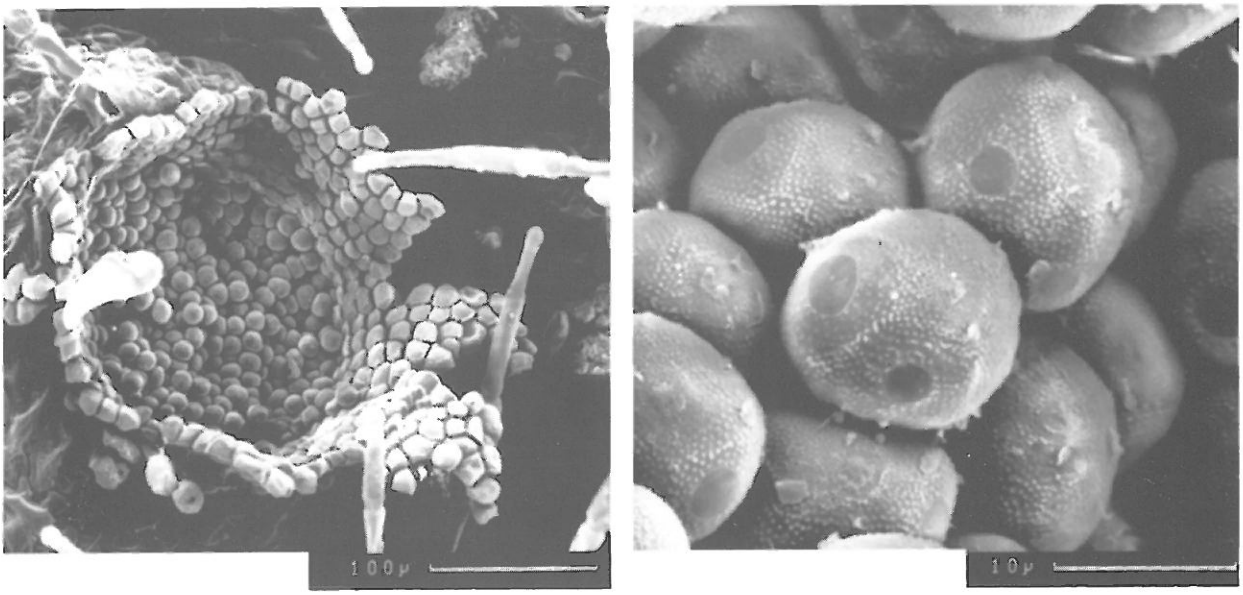
Species 100. *Puccinia primulae*: uredinia and urediniospores.





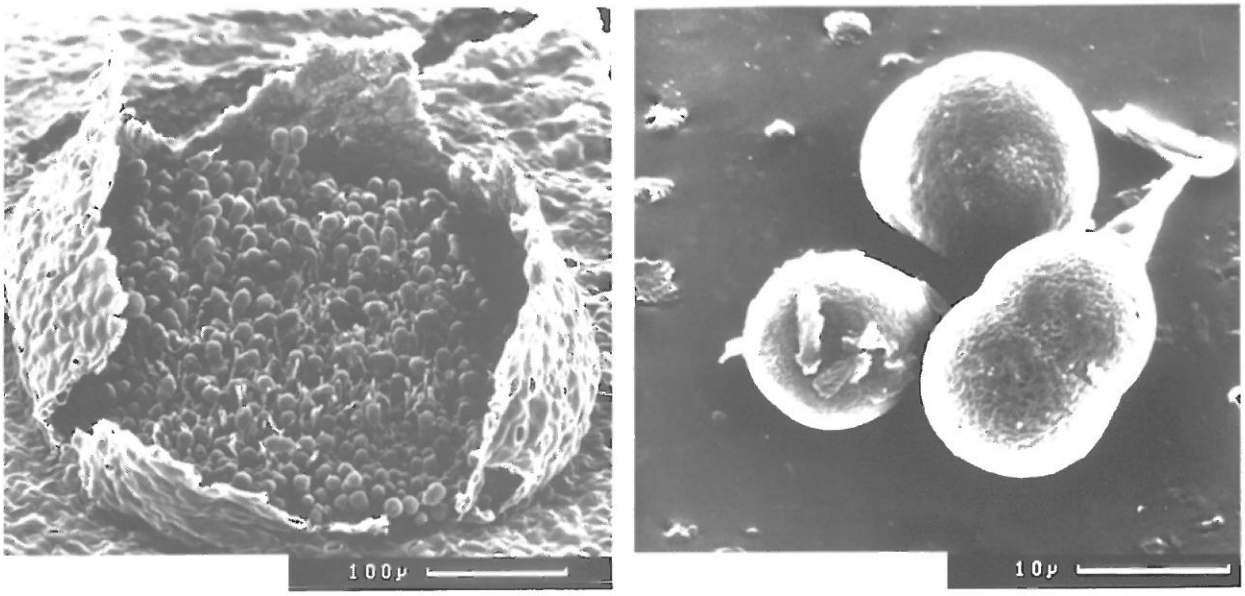
(See caption to photographs of telia and teliospores). Urediniospore surface: echinulate (WH, EE).

Species 100. *Puccinia primulae*: aecia and aeciospores.



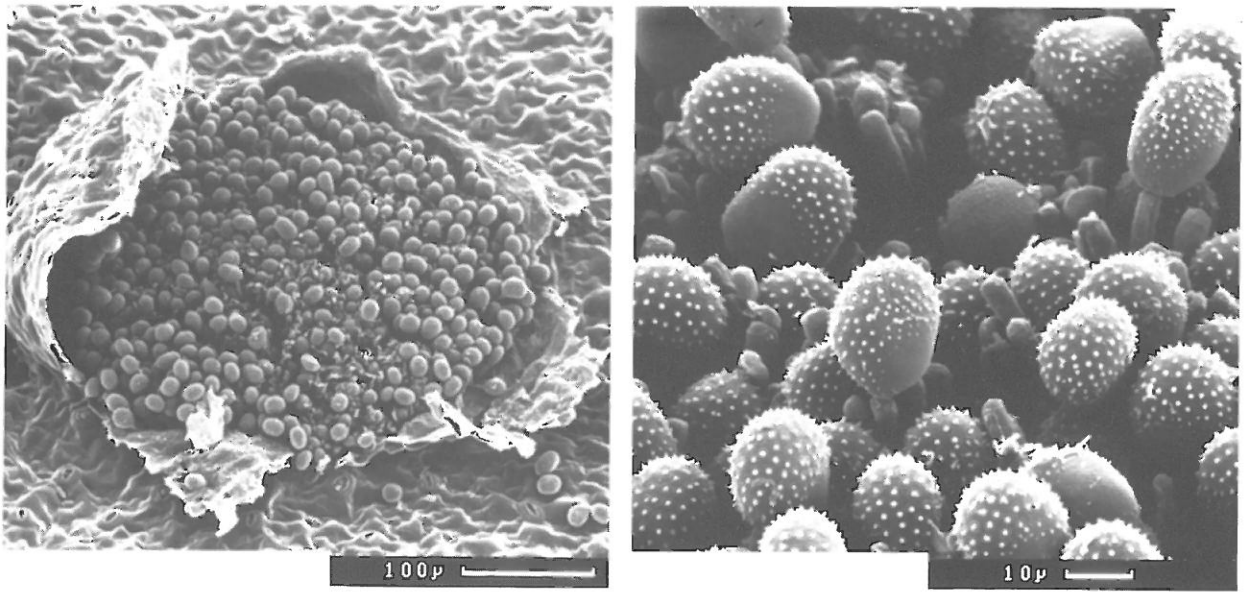
(See caption to photographs of telia and telisopores) Aeciospore surface: verruculose (WH).

Species 101. *Puccinia pulverulenta*: telia and teliospores.



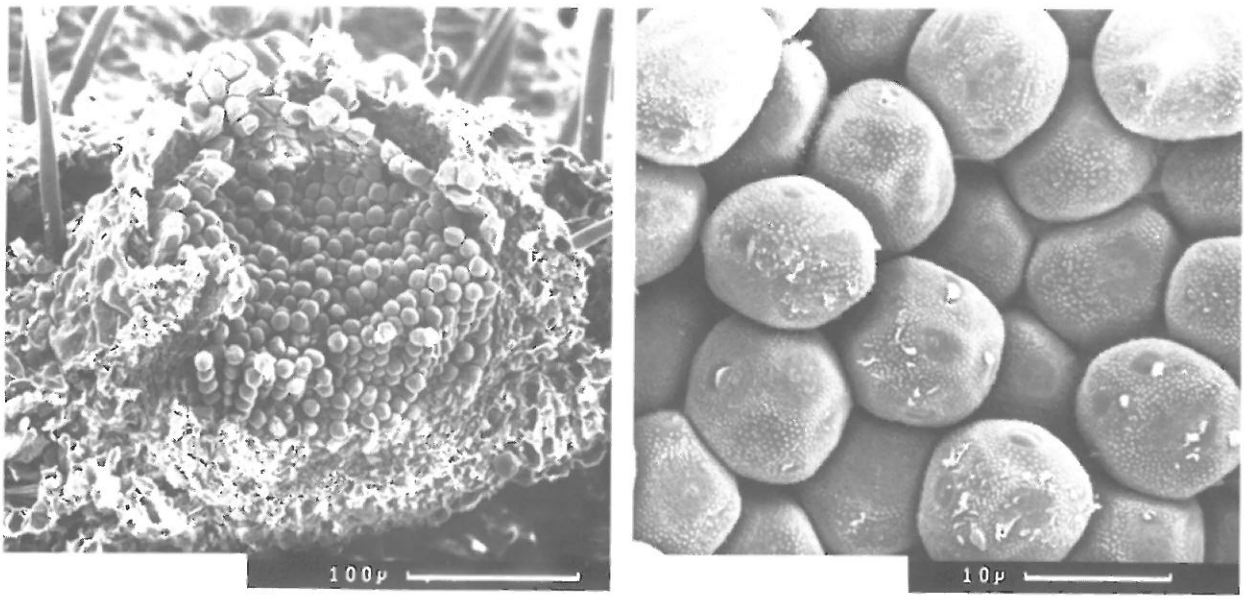
Yorks in B, 197. [AUT] on Epilobium spp. Drawings of UT in WH 143 and in Fig. 1450 in EE. Description EE 346. Teliospore surface: smooth (WH, EE).

Species 101. *Puccinia pulverulenta*: uredinia and urediniospores.



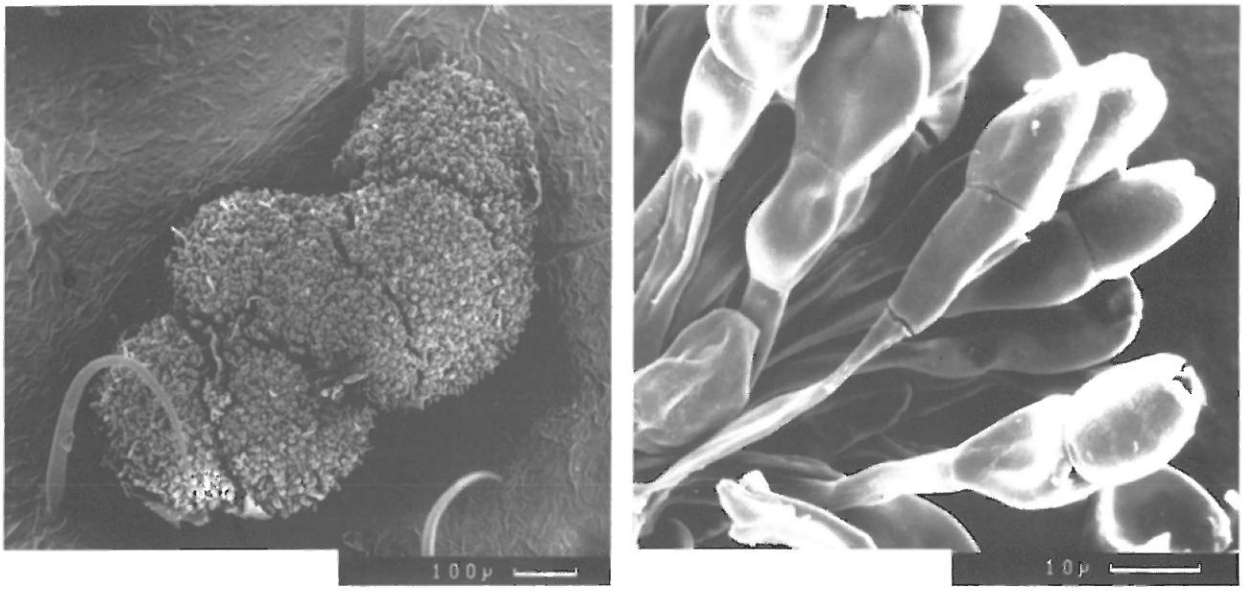
(See caption to photographs of telia and teliospores). Urediniospore surface: remotely echinulate (WH), echinulate (EE).

Species 101. *Puccinia pulverulenta*: aecia and aeciospores.



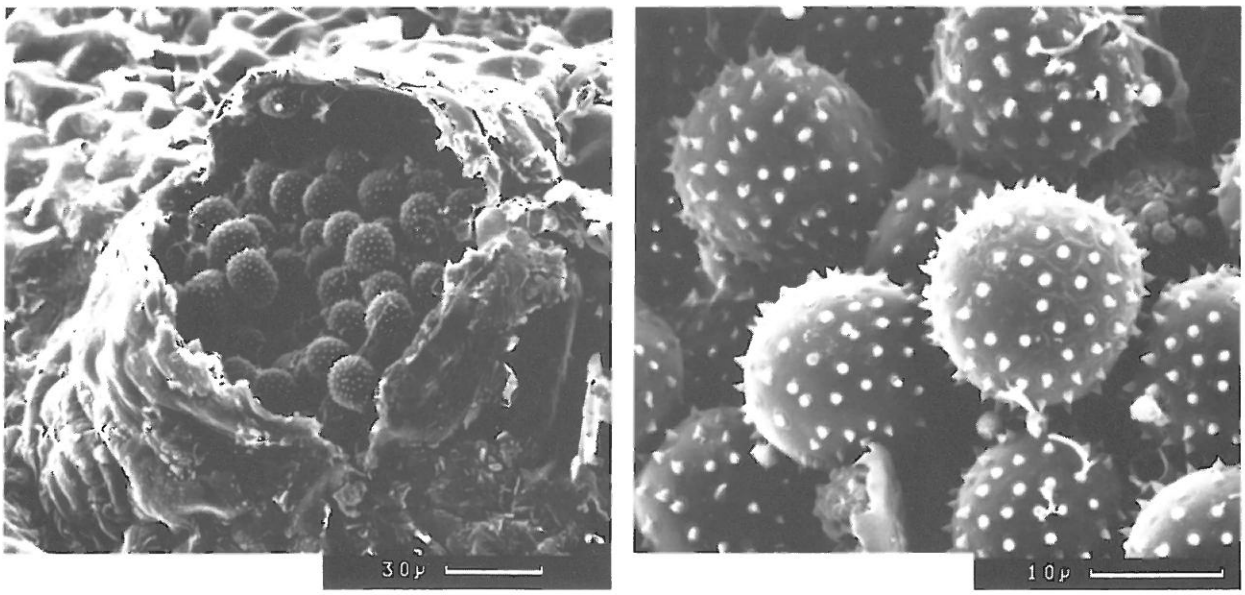
(See caption to photographs of telia and teliospores). Aeciospore surface: very delicately verruculose (WH).

Species 102. *Puccinia punctata*: telia and teliospores.



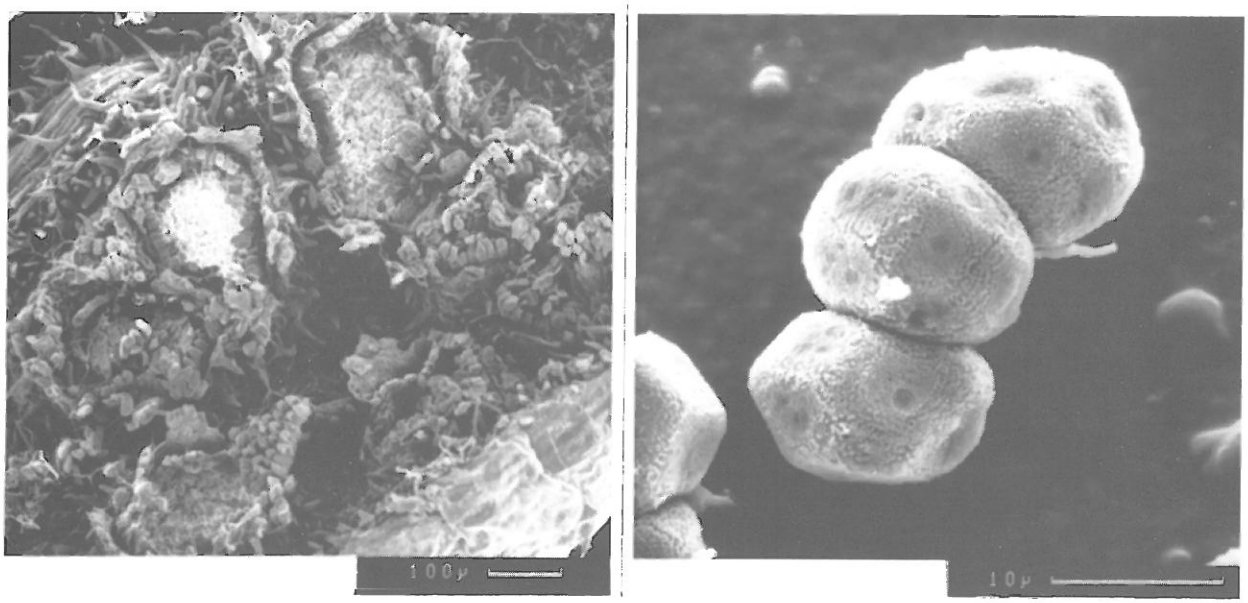
Yorks in B, 197. [AUT] on Galium spp. Drawings of [UT] in WH 185 and Fig. 1505 in EE. Description EE 361. Teliospore surface: smooth (WH).

Species 102. *Puccinia punctata*: uredinia and urediniospores.



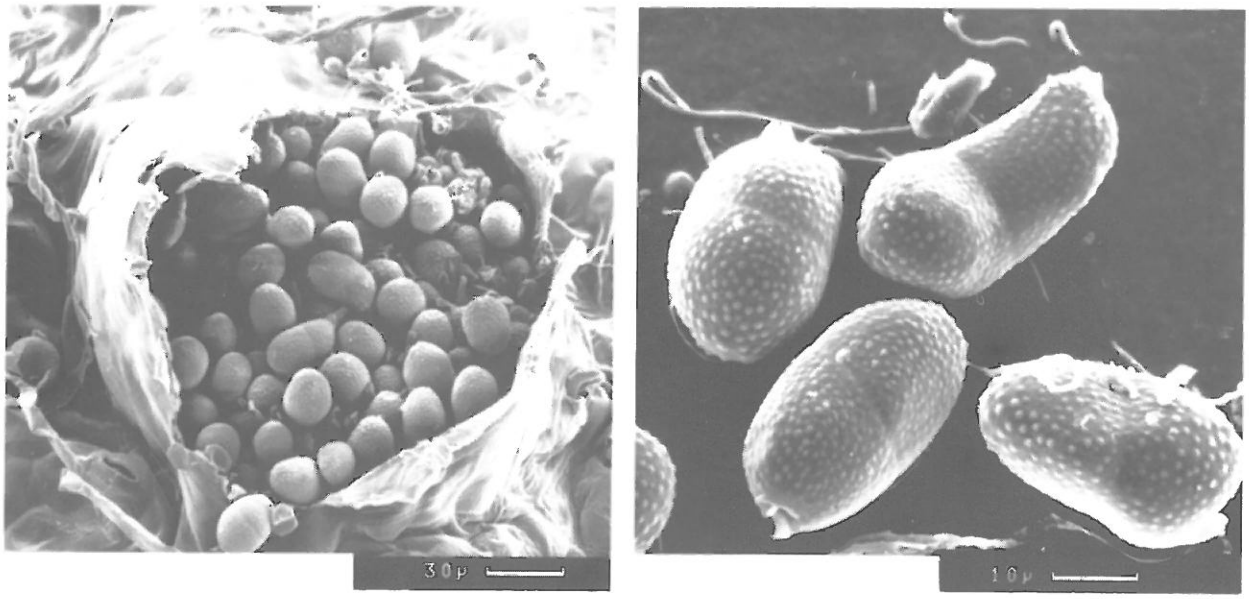
(See caption to photographs of telia and teliospores). Urediniospore surface: aculeolate (WH), finely echinulate (EE).

Species 102. *Puccinia punctata*: aecia and aeciospores.



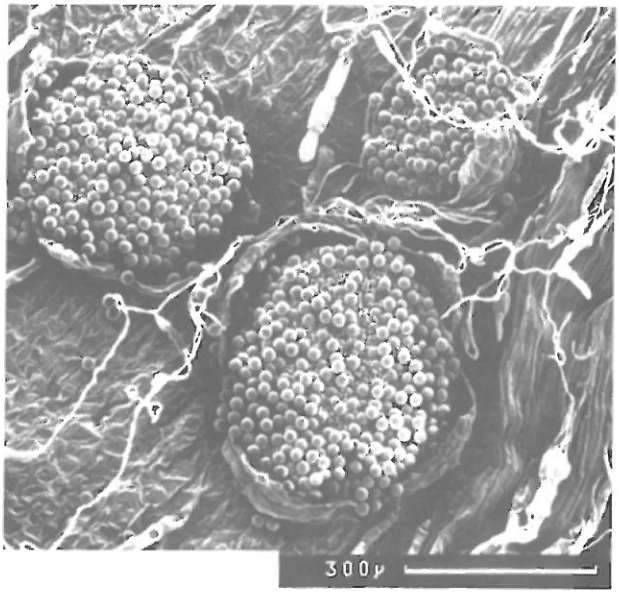
(See caption to photographs of telia and teliospores). Aeciospore surface: finely verrucose (WH), finely verruculose (EE).

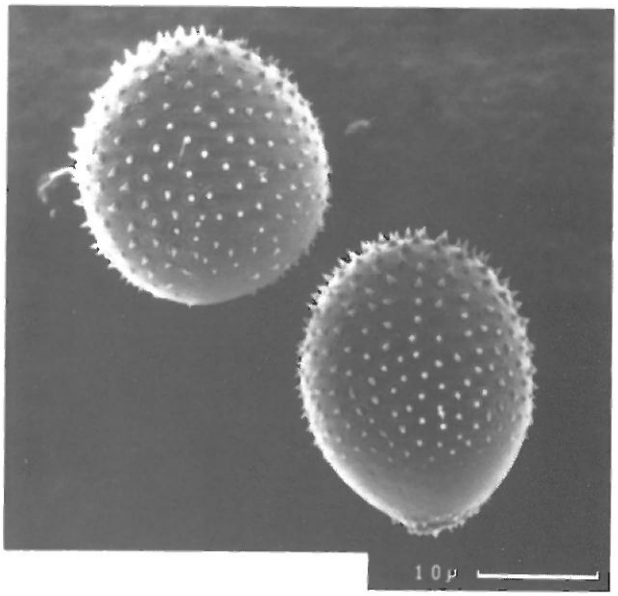
Species 103. *Puccinia punctiformis*: telia and teliospores.



Yorks in B, 197. [AUT] on *Cirsium arvense*. Drawings of UT on WH 210. Description EE 335. Teliospore surface: delicately verruculose (WH), finely verruculose (EE).

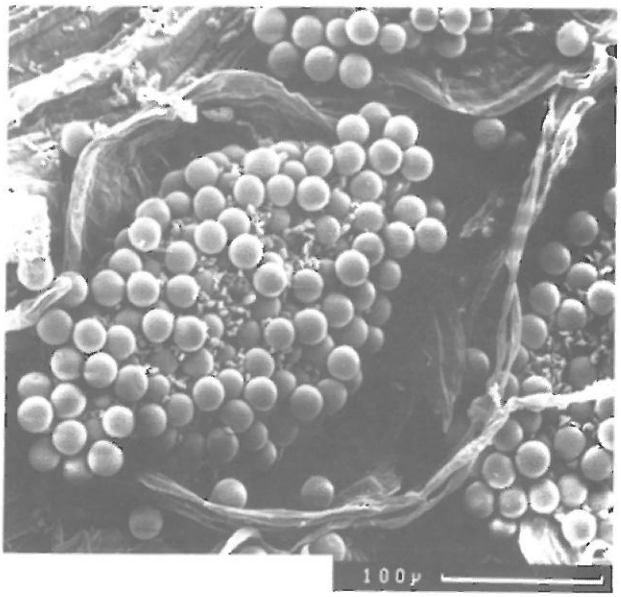
Species 103. *Puccinia punctiformis*: uredinia and urediniospores.

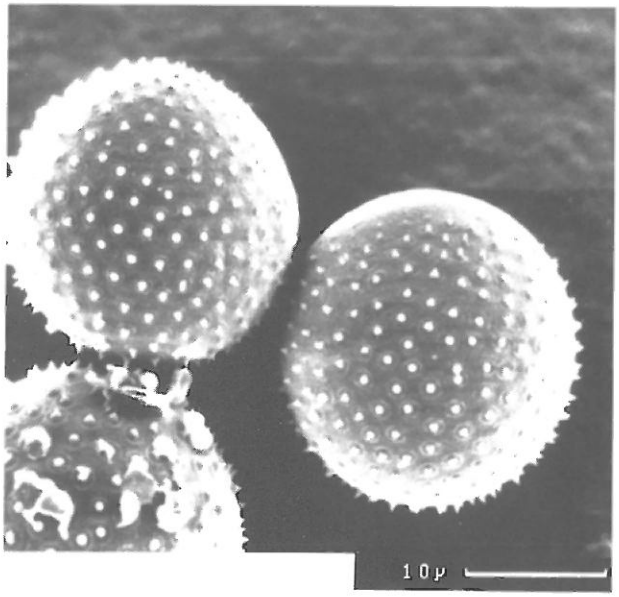




(See caption to photographs of telia and teliospores). Urediniospore surface: echinulate (WH), minutely echinulate (EE).

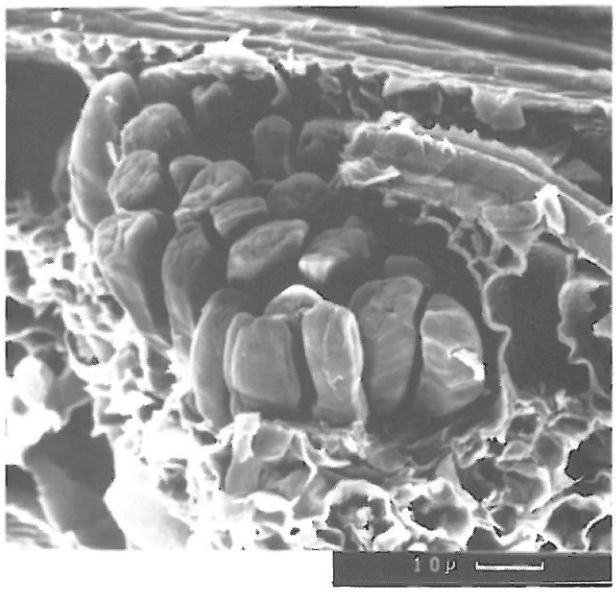
Species 103. *Puccinia punctiformis*: aecia and aeciospores.





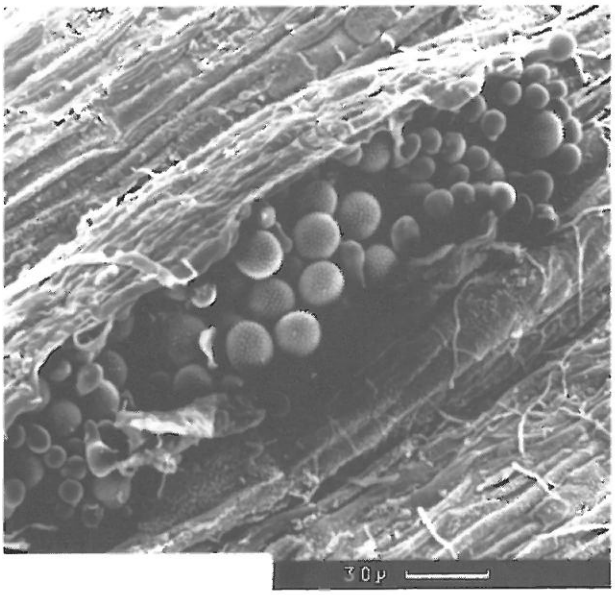
(See caption to photographs of telia and teliospores). Aeciospore surface: presumably like the urediniospores.

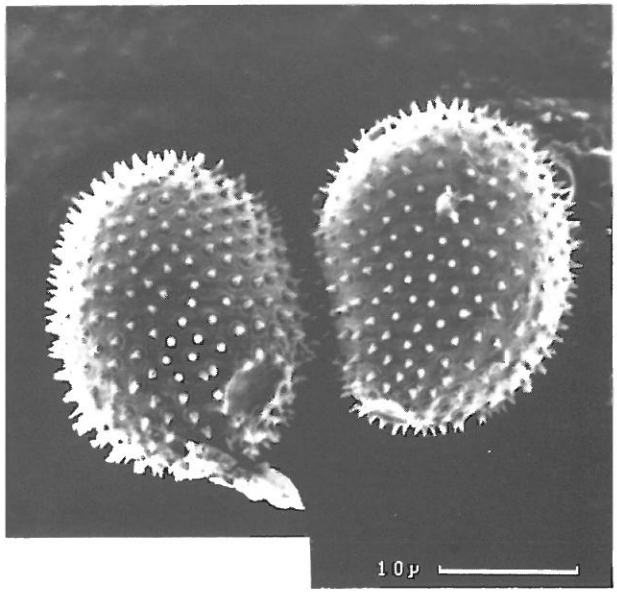
Species 104. *Puccinia pygmaea*: telia and teliospores



Yorks in B, 197. [UT] on *Calamagrostis epigejos*. Drawing of U from Ammophila (not in Yorks) in Fig. 1824, EE. Drawings of UT in WH 276. Descriptions in EE478. Teliospore surface: smooth (WH).

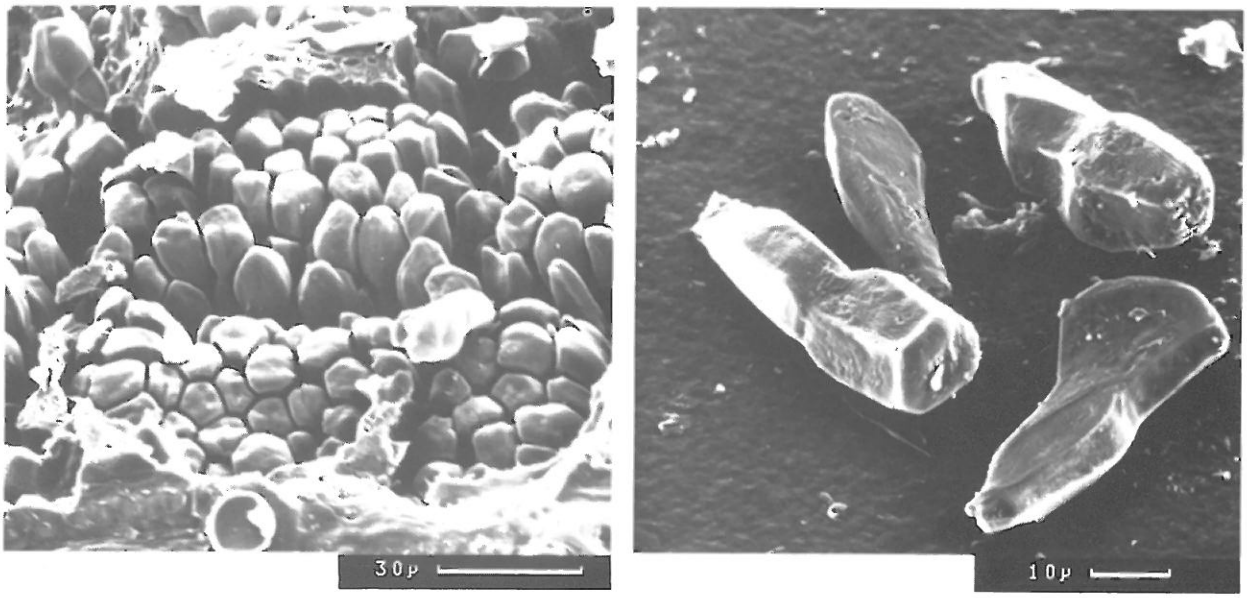
Species 104. *Puccinia pygmaea*: uredinia and urediniospores.





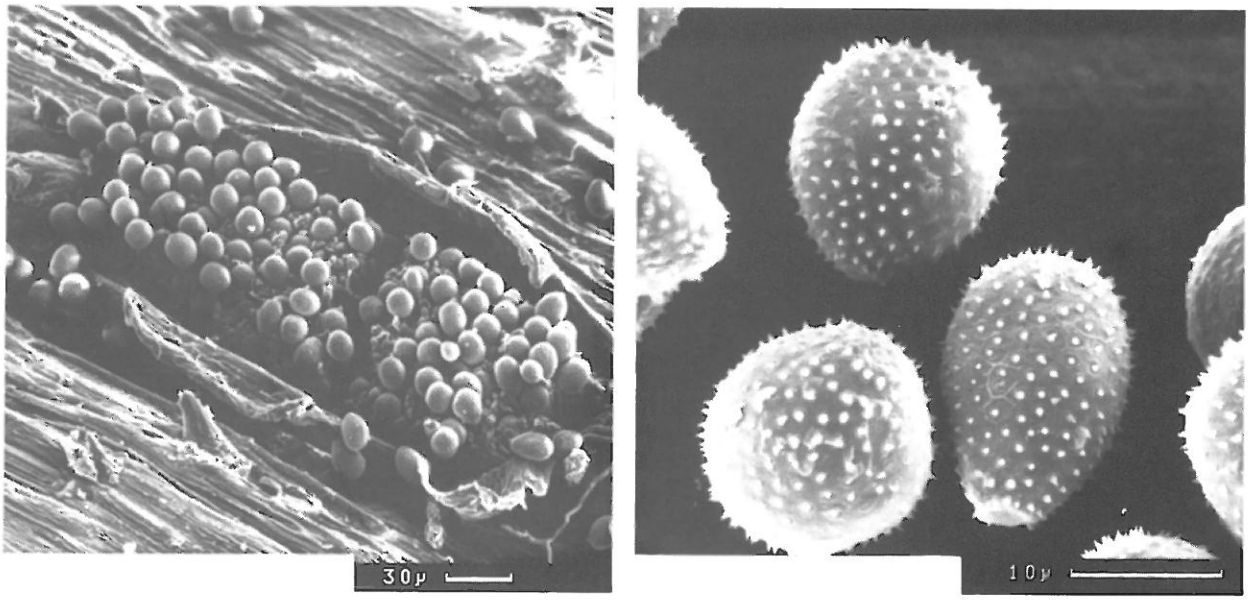
(See caption to photographs of telia and teliospores). Urediniospore surface: finely echinulate (WH).

Species 105. *Puccinia recondita*: telia and teliospores.



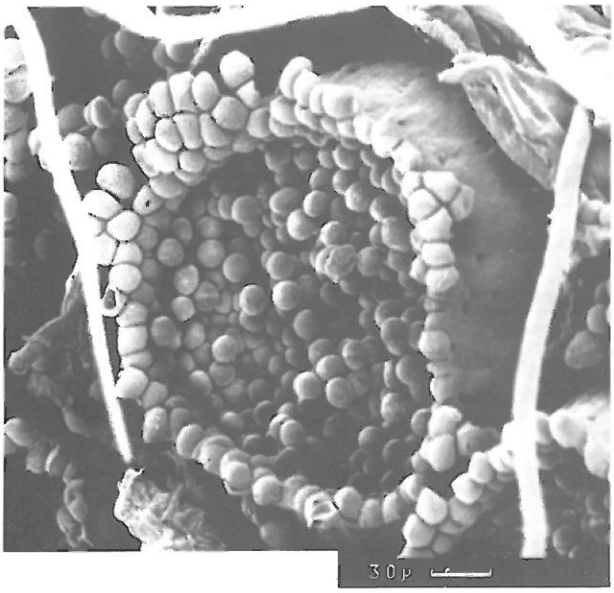
Yorks in B, 198. A complex spp. [A] e.g. on Thalictrum spp., etc. [UT], e.g. on *Triticum aestivum* (but A stage not known of this f. sp.). Drawing of UT in WH 278. Description EE 452. Teliospore surface: presumably smooth.

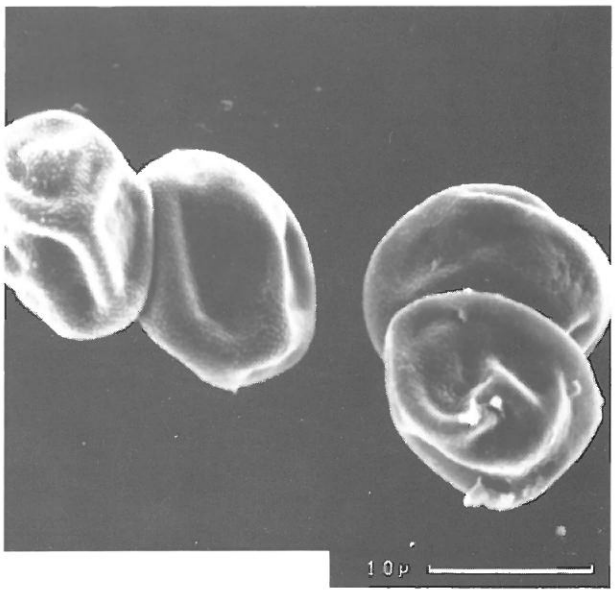
Species 105. *Puccinia recondita*: uredinia and urediniospores.



(See caption to photographs of telia and teliospores). Urediniospore surface: echinulate (WH), minutely echinulate (EE).

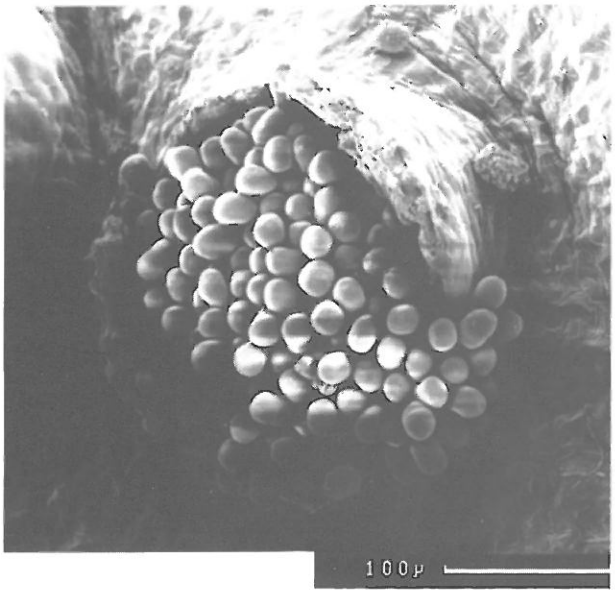
Species 105. *Puccinia recondita*: aecia and aeciospores.

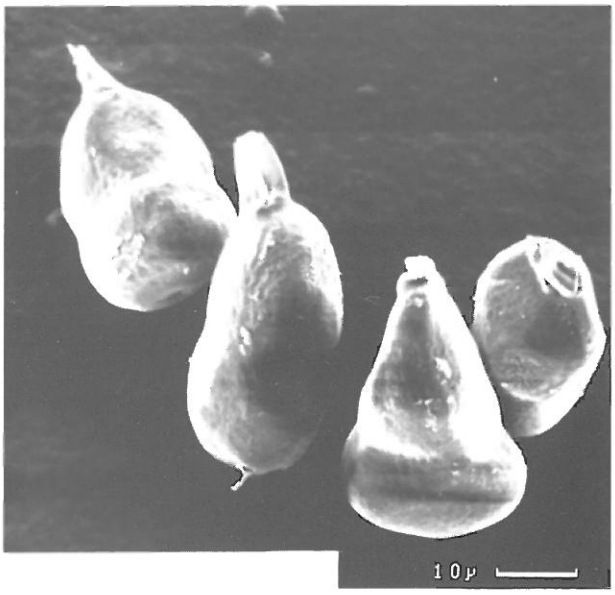




(See caption to photographs of telia and teliospores). Aeciospore surface: finely verrucose (WH).

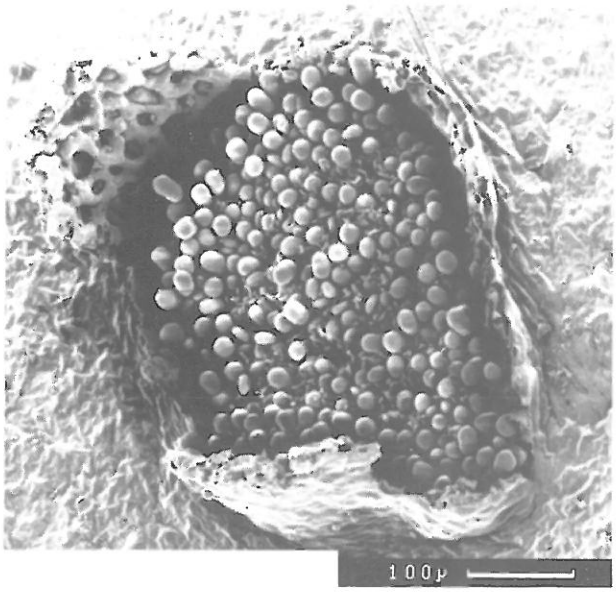
Species 106. *Puccinia saniculae*: telia and teliospores.

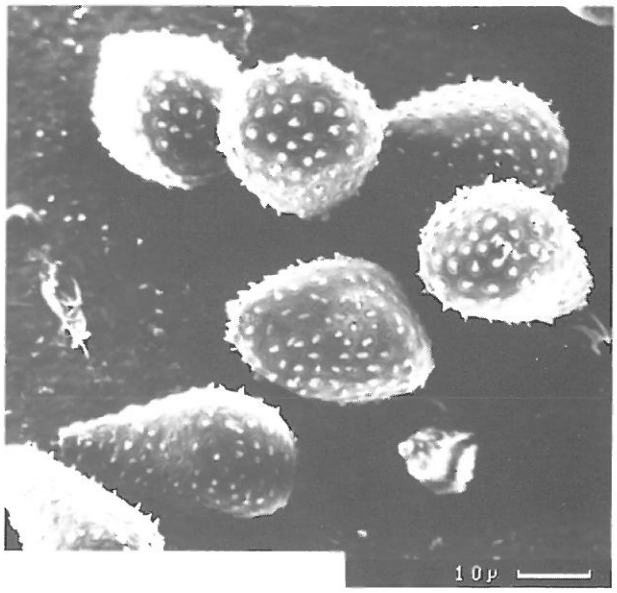




Yorks in B, 198 [AUT] on *Sanicula europaea*. Drawings of UT in WH 157. (Descriptions of AUT also in WH 157). Description of UT EE 417. Teliospore surface: smooth (WH, EE).

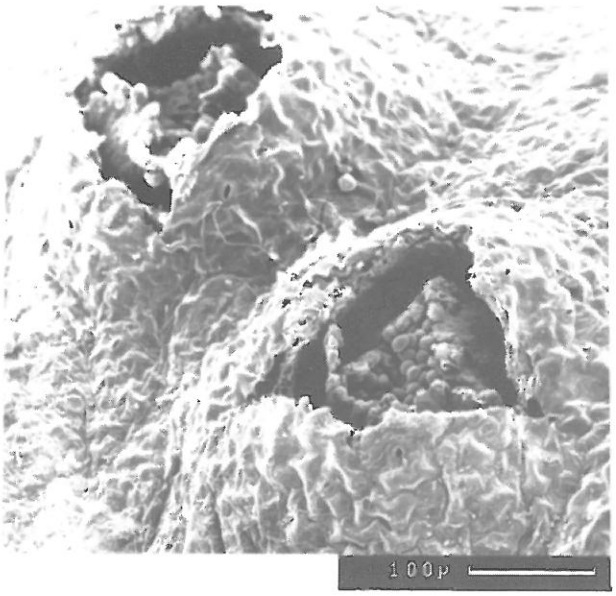
Species 106. *Puccinia saniculae*: uredinia and urediniospores.

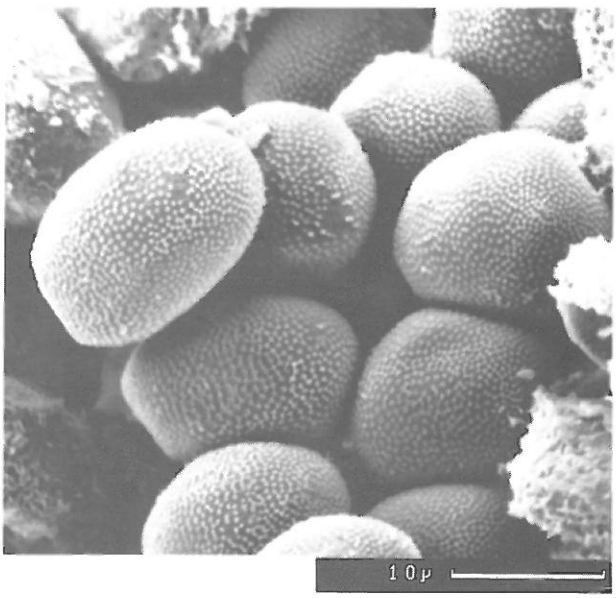




(See caption to photographs of telia and teliospores). Urediniospore surface: echinulate (WH, EE).

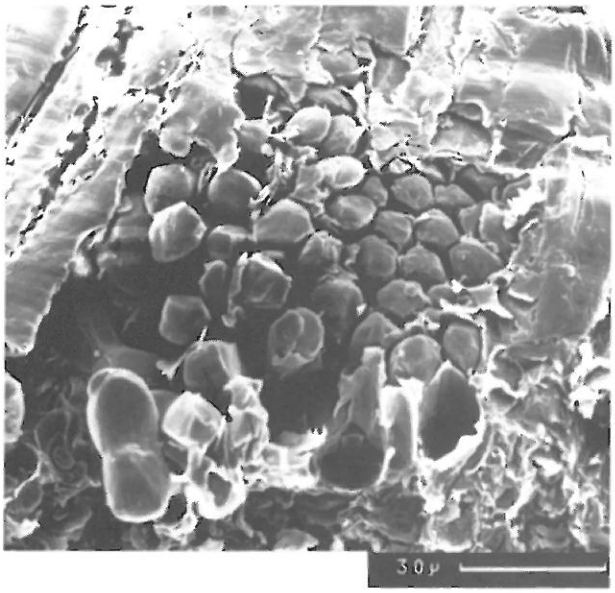
Species 106. *Puccinia saniculae*: aecia and aeciospores.

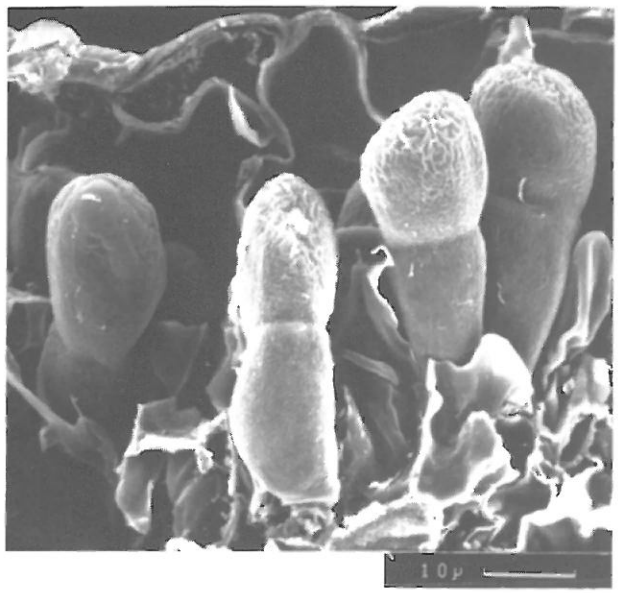




(See caption to photographs of telia and teliospores). Aeciospore surface: delicately verruculose (WH).

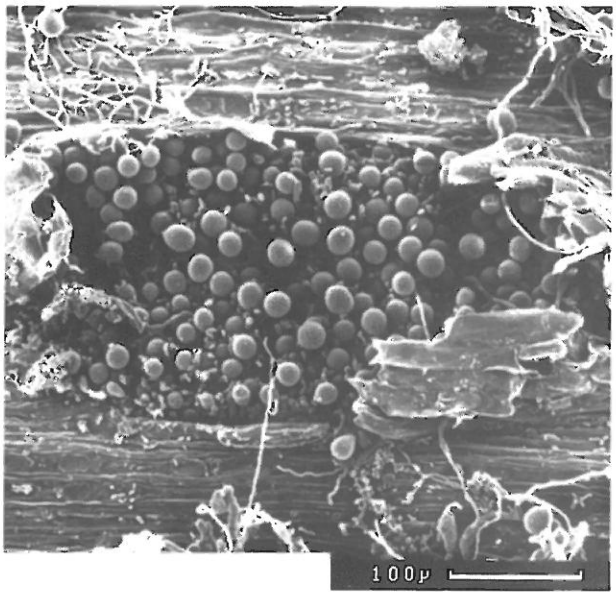
Species 107. *Puccinia sessilis*: telia and teliospores.

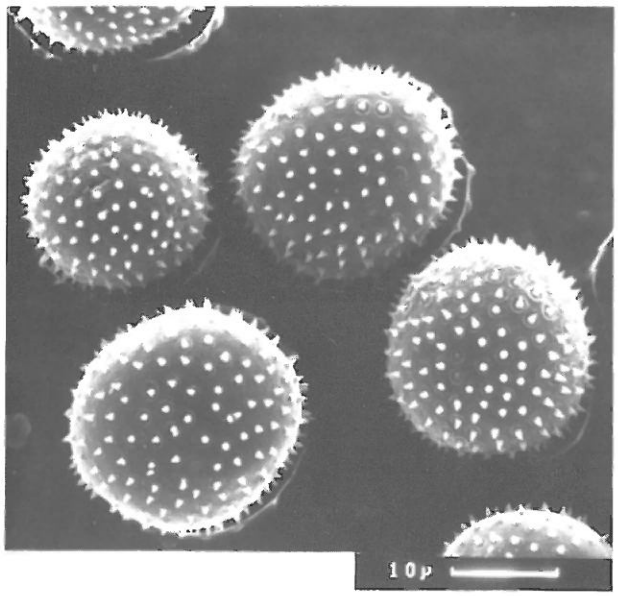




Yorks in B, 198 [A] e.g. on *Allium ursinum*. [UT] on *Phalaris arundinacea*. Drawings UT in WH 291 and in EE Fig. 1897 (T only). Descriptions of AUT WH 291 and in EE 506 (UT) Teliospore surface: smooth (WH).

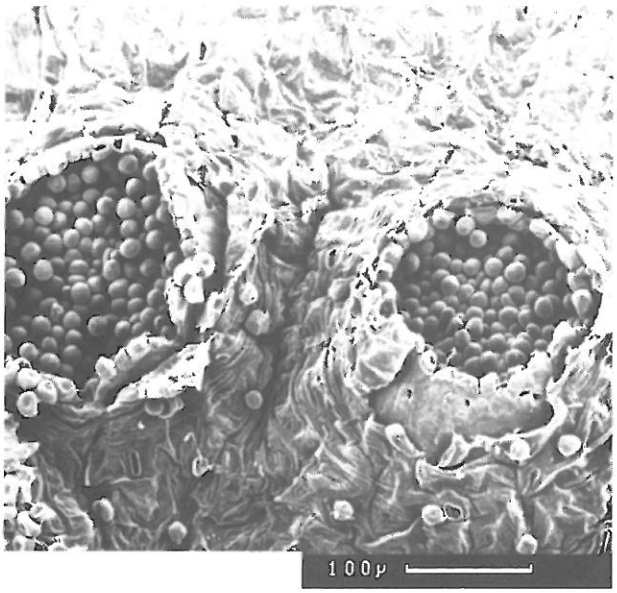
Species 107. *Puccinia sessilis*: uredinia and urediniospores.

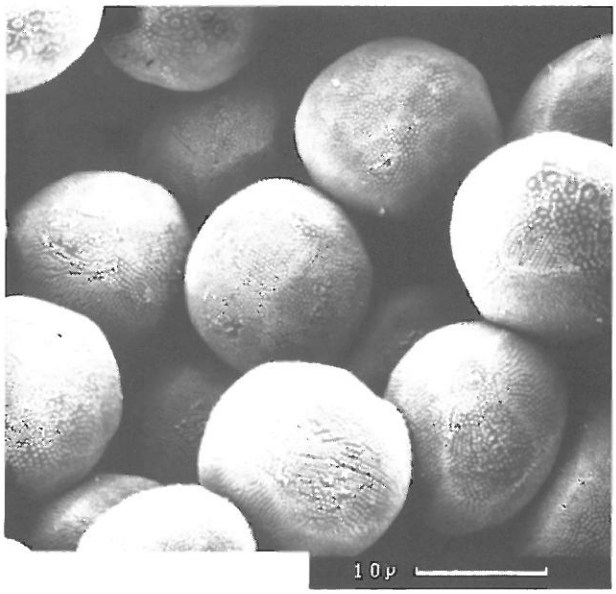




(See caption to photographs of telia and teliospores). Urediniospore surface: distantly echinulate (WH), minutely echinulate (EE).

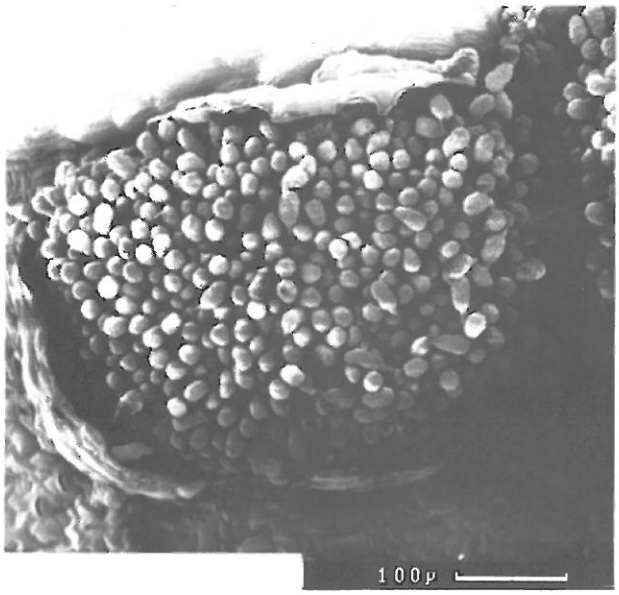
Species 107. *Puccinia sessilis*: aecia and aeciospores.

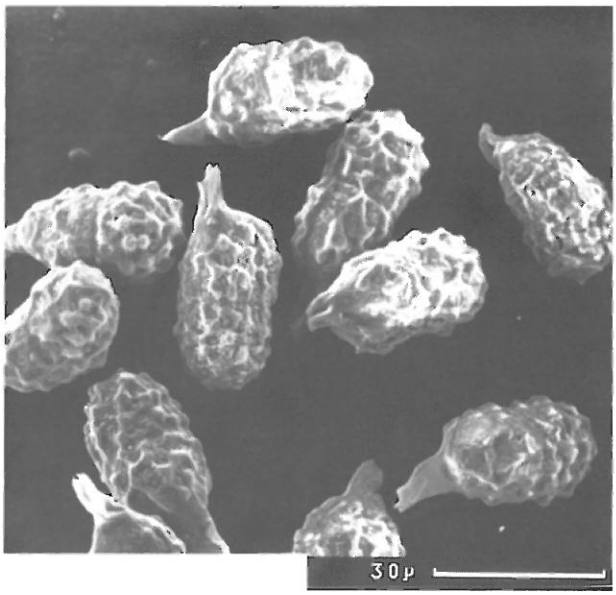




(See caption to photographs of telia and teliospores). Aeciospore surface: finely verruculose (WH).

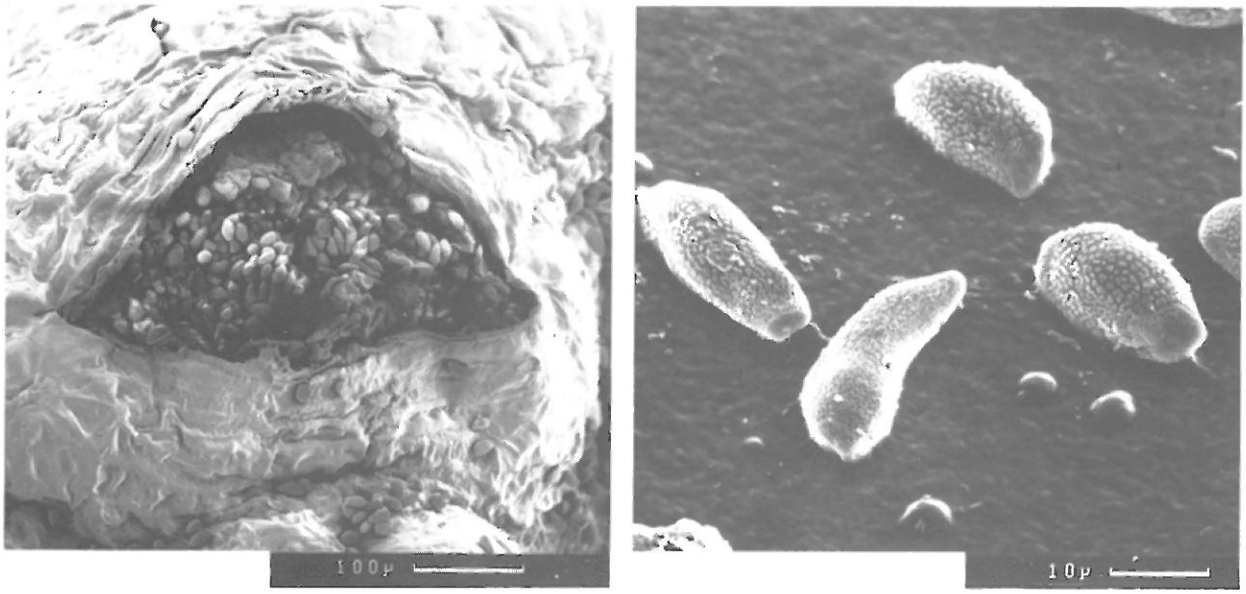
Species 108. *Puccinia smyrnii*: telia and teliospores.





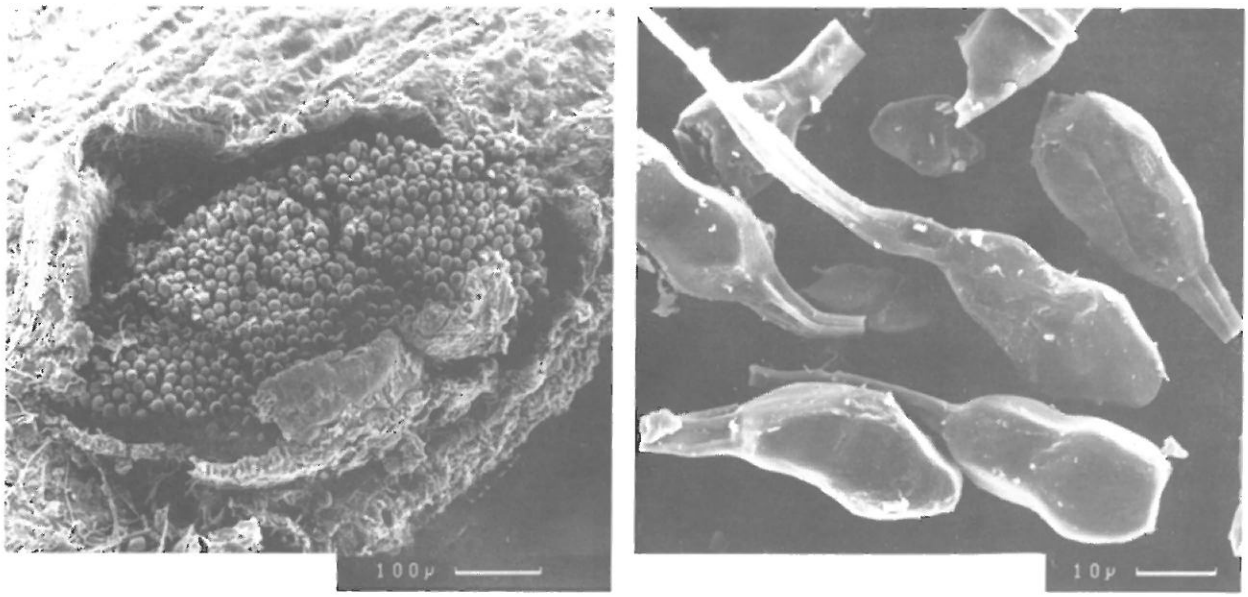
Yorks in B, 198. [AT] on *Smyrnium olusatrum,* Drawings of T in WH 157. Descriptions in WH 157 and EE 424. Teliospore surface: coarsely and remotely reticulate and tuberculate (WH), coarsely tuberculate (EE).

Species 108. *Puccinia smyrnii*: aecia and aeciospores.



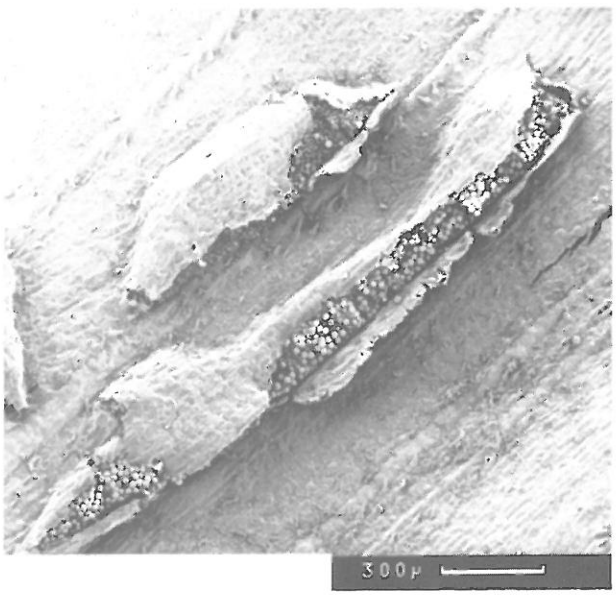
(See caption to photographs of telia and teliospores). Aeciospore surface: delicately verruculose (WH).

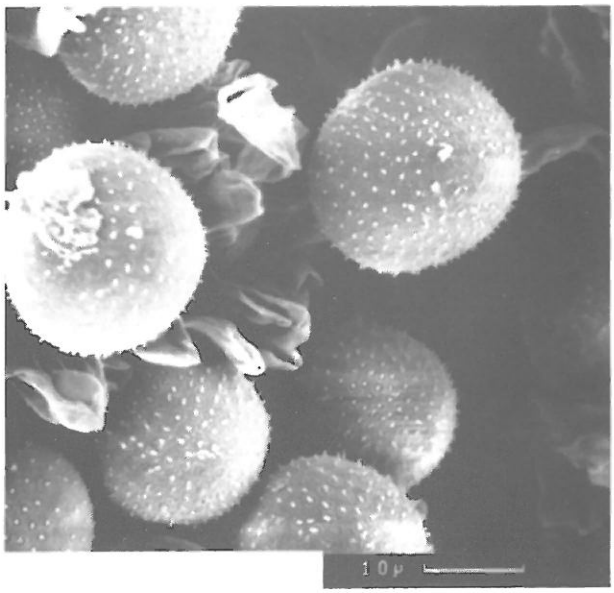
Species 109. *Puccinia sorghi*: telia and teliospores.



Yorks in B, 198 [UT] on *Zea mays*. [a] on Oxalis spp. apparently not yet found in britain. Descriptions WH 293. Teliospore surface: smooth (WH).

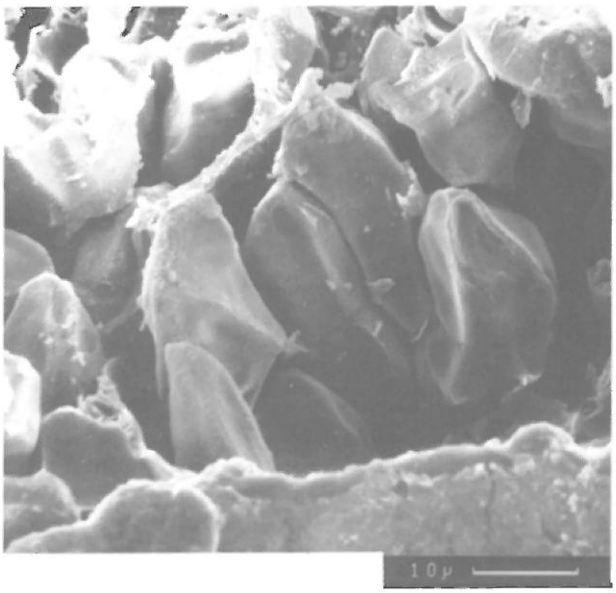
Species 109. *Puccinia sorghi*: uredinia and urediniospores.

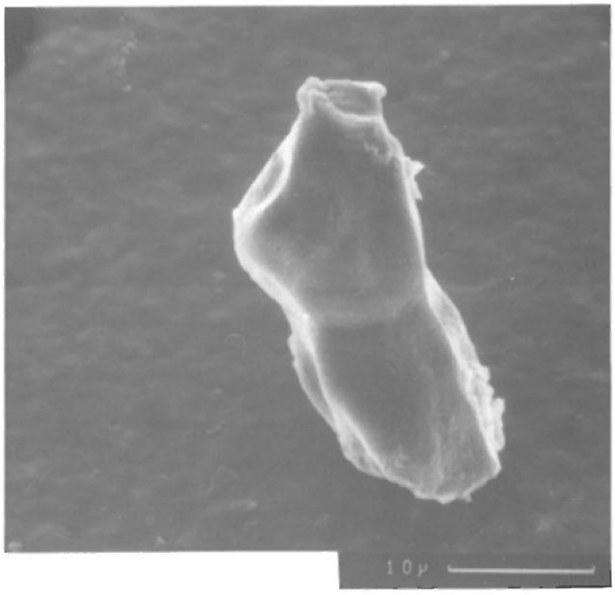




(See caption to photographs of telia and teliospores). Urediniospore surface: finely echinulate (WH).

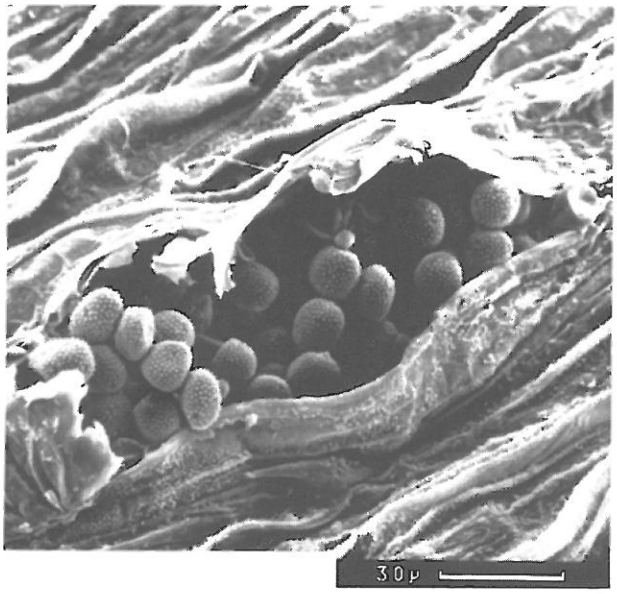
Species 110. *Puccinia striiformis* var. *dactylidis*: telia and teliospores.

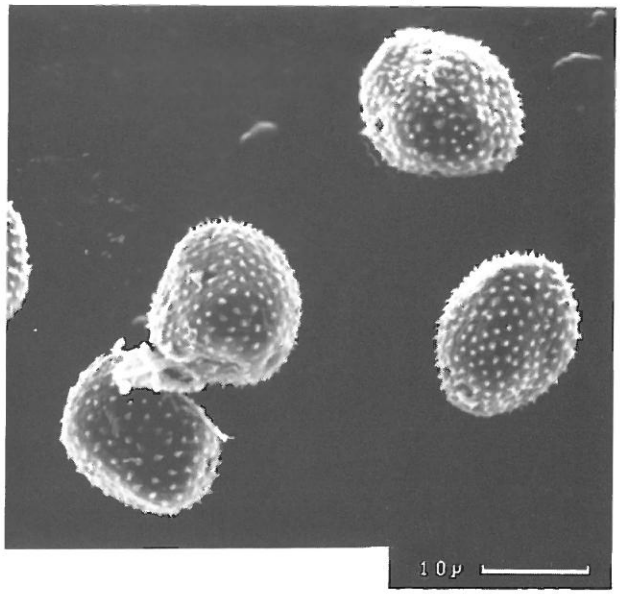




Yorks in B, 198. [UT] on *Dactylis glomerata*. Description in WH 297. Teliospore surface: presumably smooth. (Needs further study).

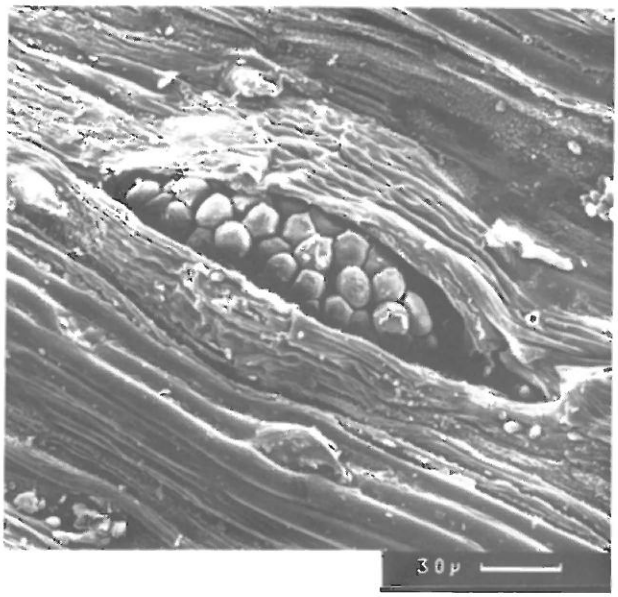
Species 110. *Puccinia striiformis* var.*dactylidis*. Uredinia and urediniospores.

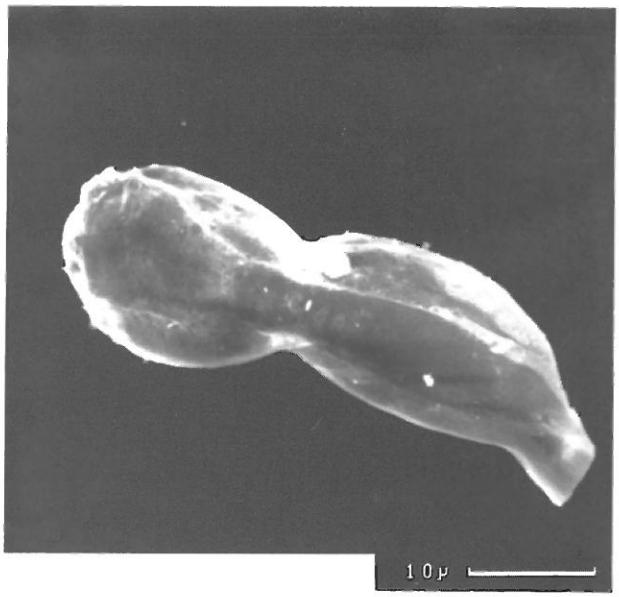




(See caption to photographs of telia and teliospores). Urediniospore surface: short blunt spines (as *P. striiformis,* WH) Urediniospores smaller than those of var. *striiformis*.

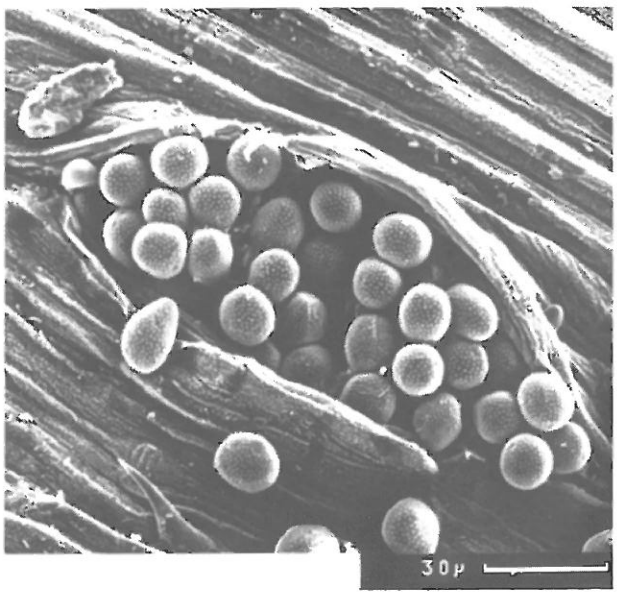
Species 110A. *Puccinia striiformis* var. *striiformis*: telia and teliospore.

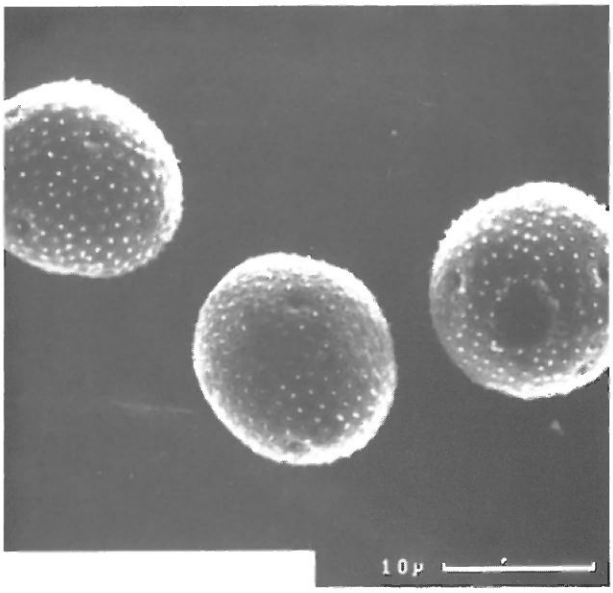




Yorks in B, 198. [UT] on, e.g. *Hordeum vulgare*. Drawings of UT on WH 294 and in EE Fig. 1733. Descriptions in WH 294 and EE 452. Teliospore surface: smooth (WH).

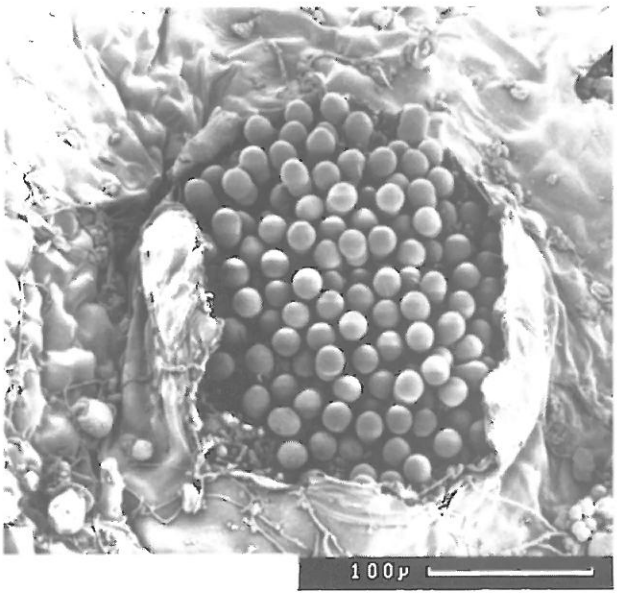
Species 110A. *Puccinia striiformis* var. *striiformis*: uredinia and urediniospores

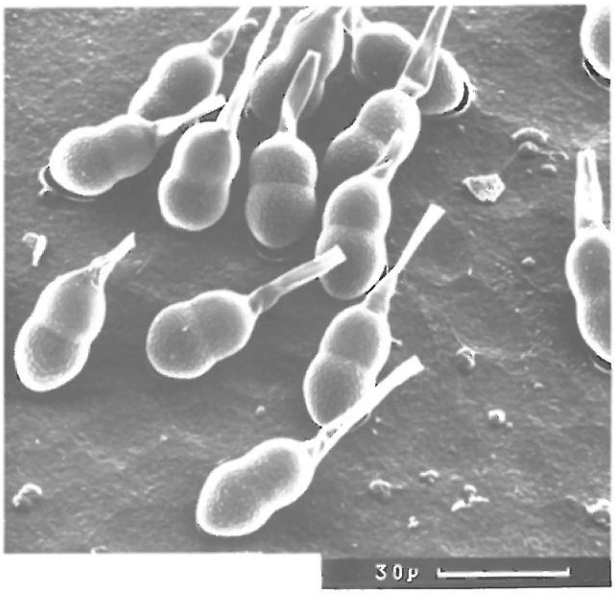




(See caption to photographs of telia and teliospores). Urediniospore surface: with short blunt spines (WH), shortly echinulate (EE).

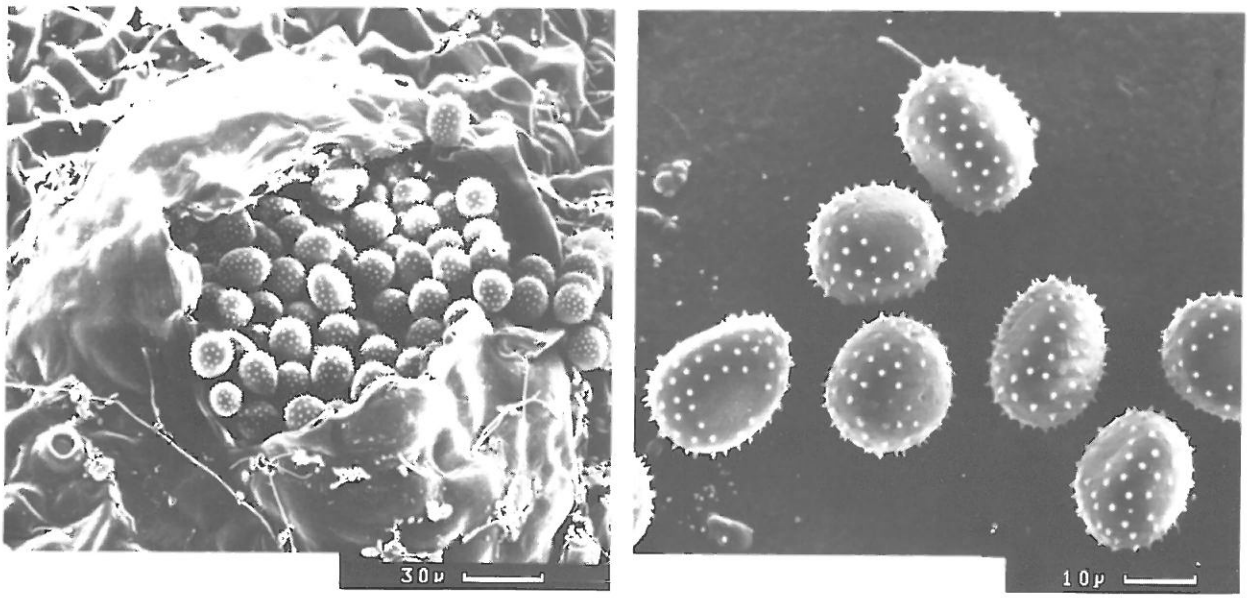
Species 110B. *Puccinia tanaceti*: telia and teliospores.





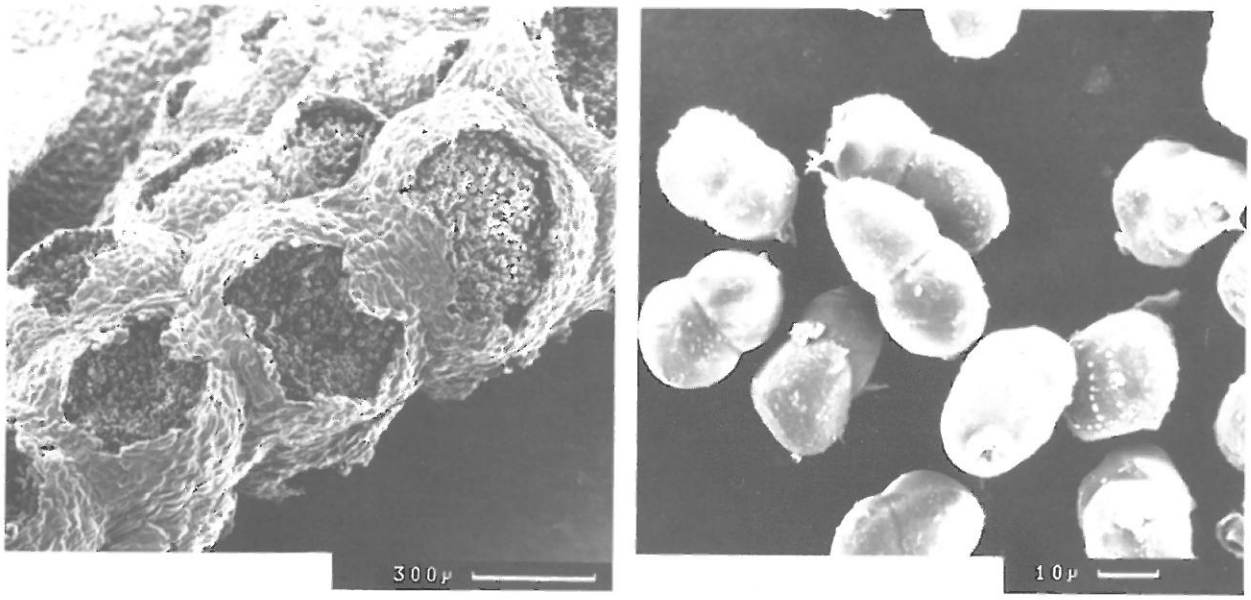
Not in B, new Yorks record, 1986.[AUT] on, e.g. *Artemisia absinthium*. A apparently not yet seen in Britain. Drawings of UT in WH212. Descriptions in WH 212 and EE 314. Teliospore surface: wall of the upper cell finely verruculose and that of the lower cell frequently smooth (WH), slightly verrucose at apex, otherwise smooth (EE).

Species 110B. *Puccinia tanaceti*: uredinia and urediniospores.



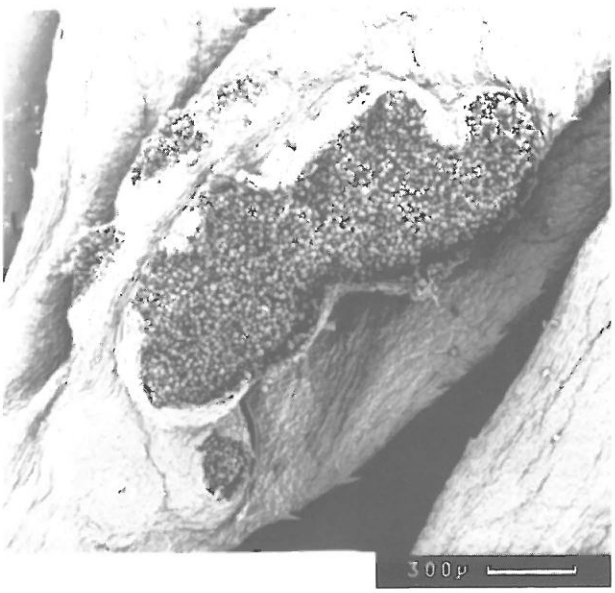
(See caption to photographs of telia and teliospores). Urediniospore surface: finely echinulate (WH), minutely echinulate (EE).

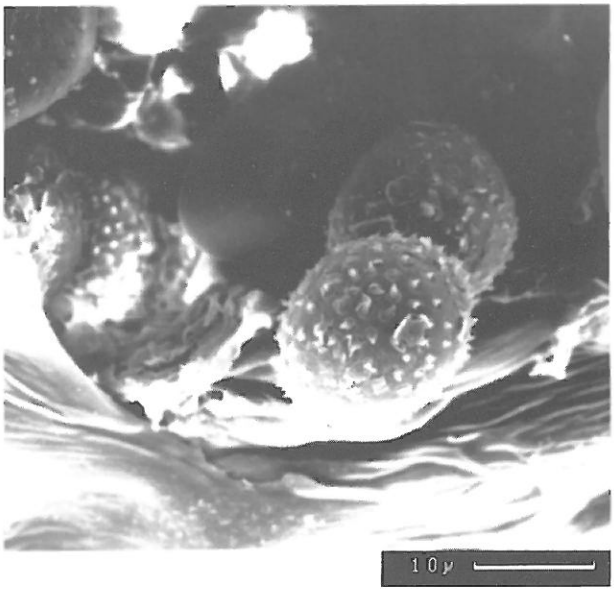
Species 111. *Puccinia tumida*: telia and teliospores.



Yorks in B, 198. [UT] on *Conopodium majus*. Drawing of T in WH 158. Descriptions in WH 158 and EE 338. Teliospore surface: wall smooth or with a few groups of verrucae (WH).

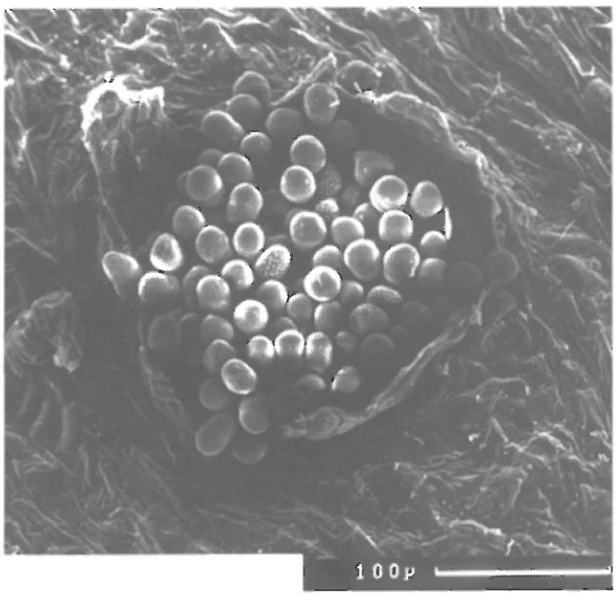
Species 111. *Puccinia tumida*: uredinia and urediniospores.

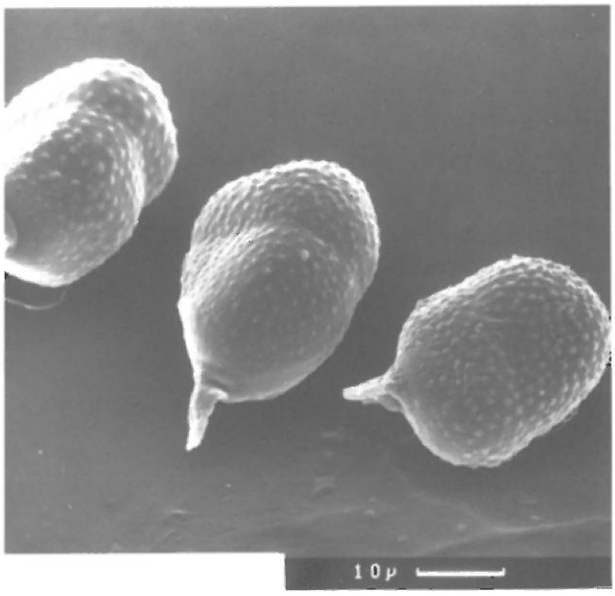




(See caption to photograph of telia and teliospores). Urediniospores are found in some telia as shown here. Urediniospores surface: sparsely verruculose (WH).

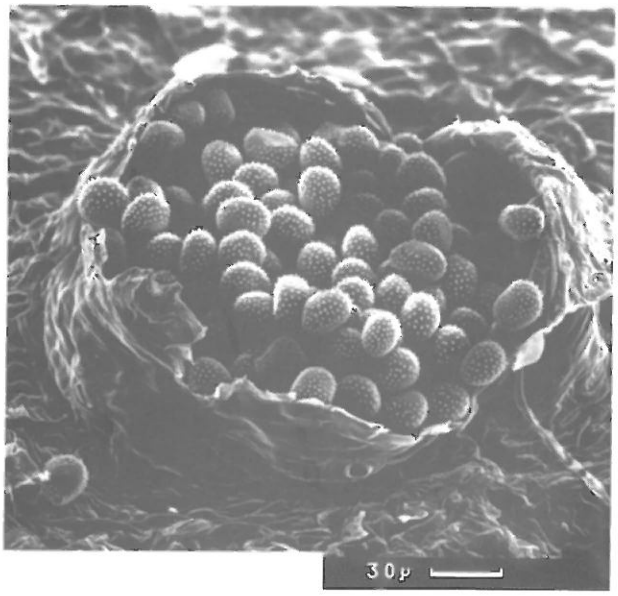
Species 112. *Puccinia variabilis*: telia and teliospores.

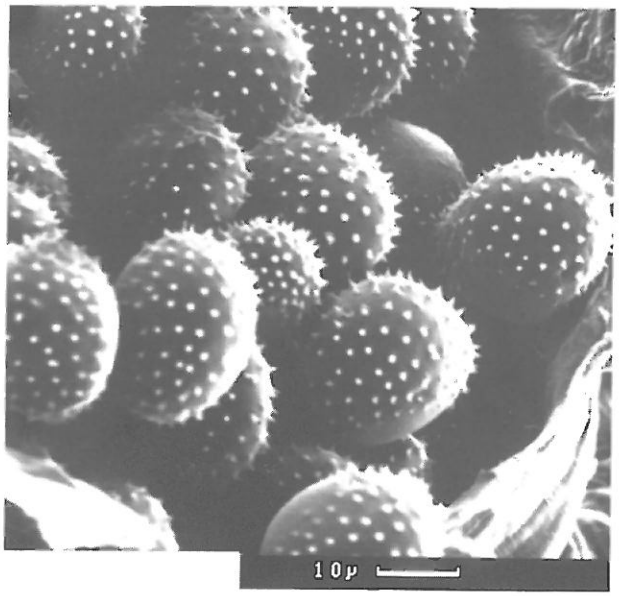




Yorks in B, 198. [AUT] on Taraxacum spp. Drawings of UT in WH 215. Descriptions WH 215 and EE 432. Teliospore surface: finely verruculose (WH), minutely verruculose (EE).

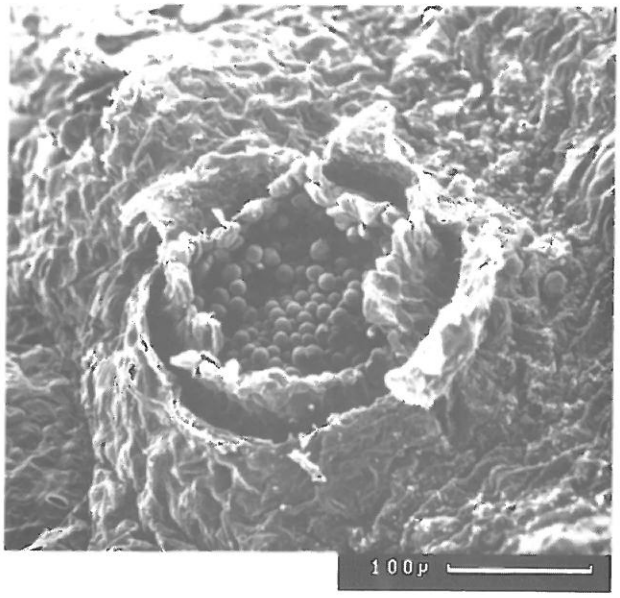
Species 112. *Puccinia variabilis*: uredinia and urediniospores.

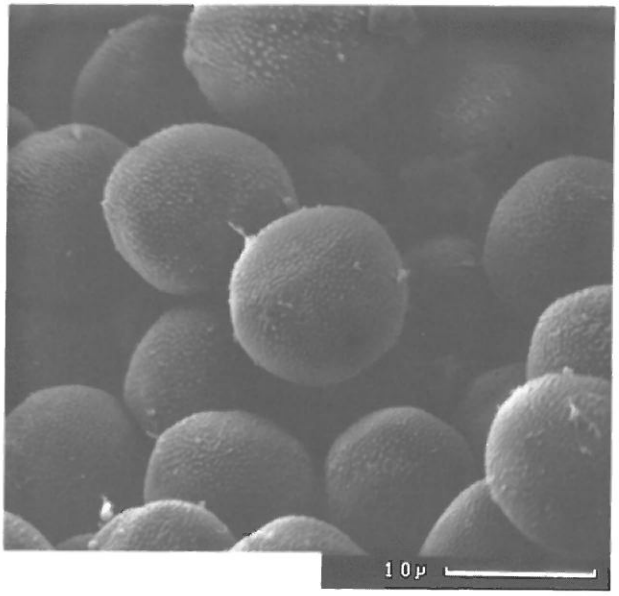




(See caption to photographs of telia and teliospores). Urediniospore surface: echinulate (WH, EE).

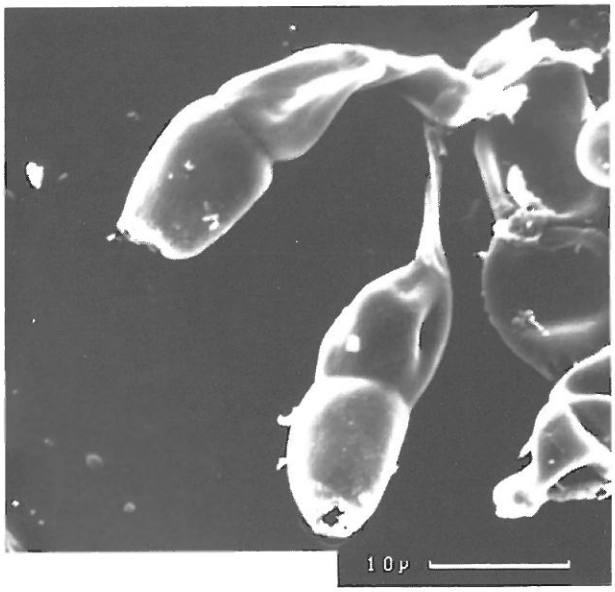
Species 112. *Puccinia variabilis*: aecia and aeciospores.





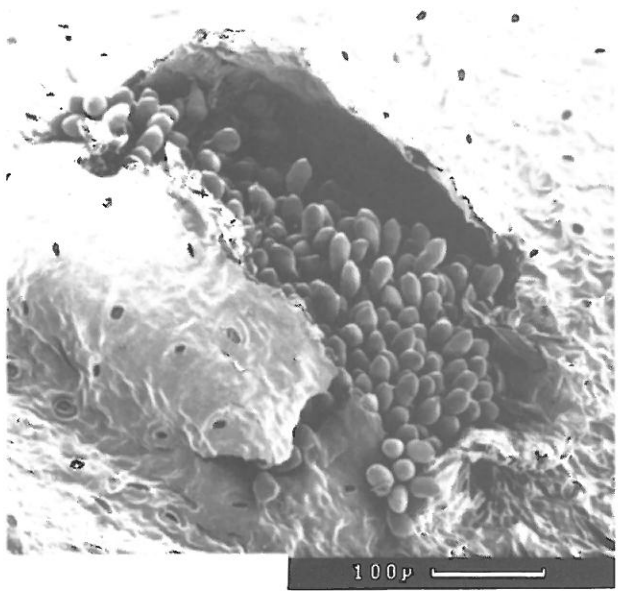
(See caption to photographs of telia and teliospores) Aeciospore surface: verruculose (WH, EE).

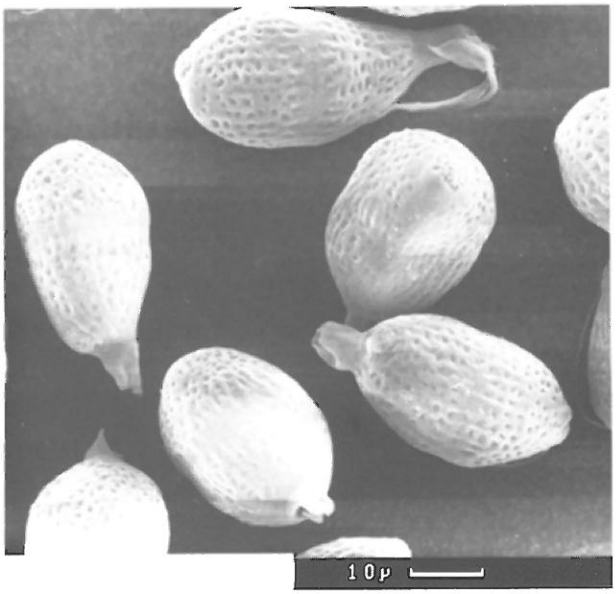
Species 113. *Puccinia veronicae*: telia and teliospores.



Yorks in B, 198. [T] on Veronica spp. Drawings of T in WH 176 and in Fig. 1716 in EE. Descriptions WH 176 and EE 445. Teliospore surface: presumably smooth.

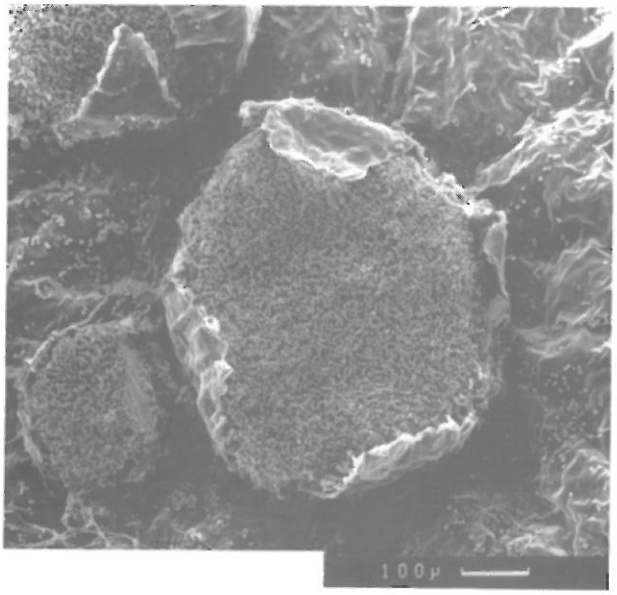
Species 114. *Puccinia vincae*: telia and teliospores.

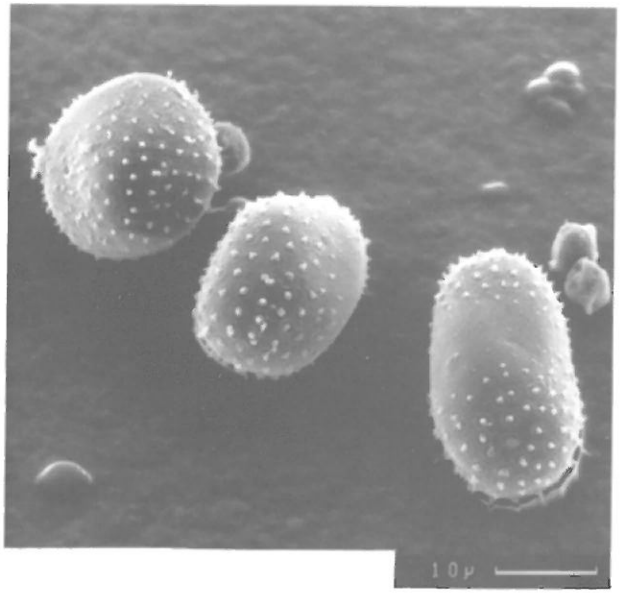




Yorks in B, 198. [AUT] on *Vinca major*. Drawings UT in WH 169. Descriptions of A and T only in WH 169 and EE 448. Teliospore surface: verrucae arranged in irregular longitudinal lines (WH), verrucose (EE).

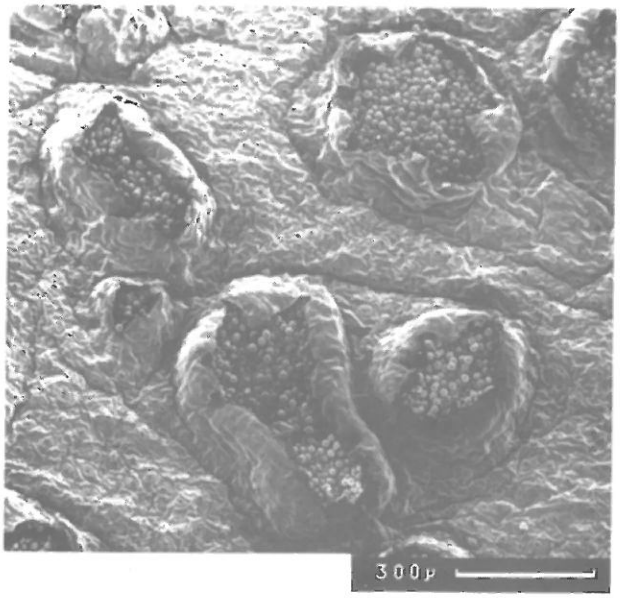
Species 114. *Puccinia vincae*: uredinia and urediniospores.

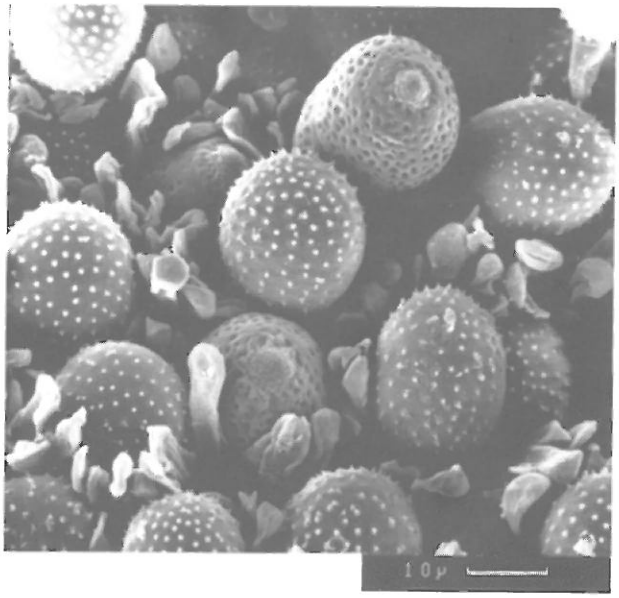




(See caption to photographs of telia and teliospores). Urediniospore surface: drawing in WH shows spines, no description.

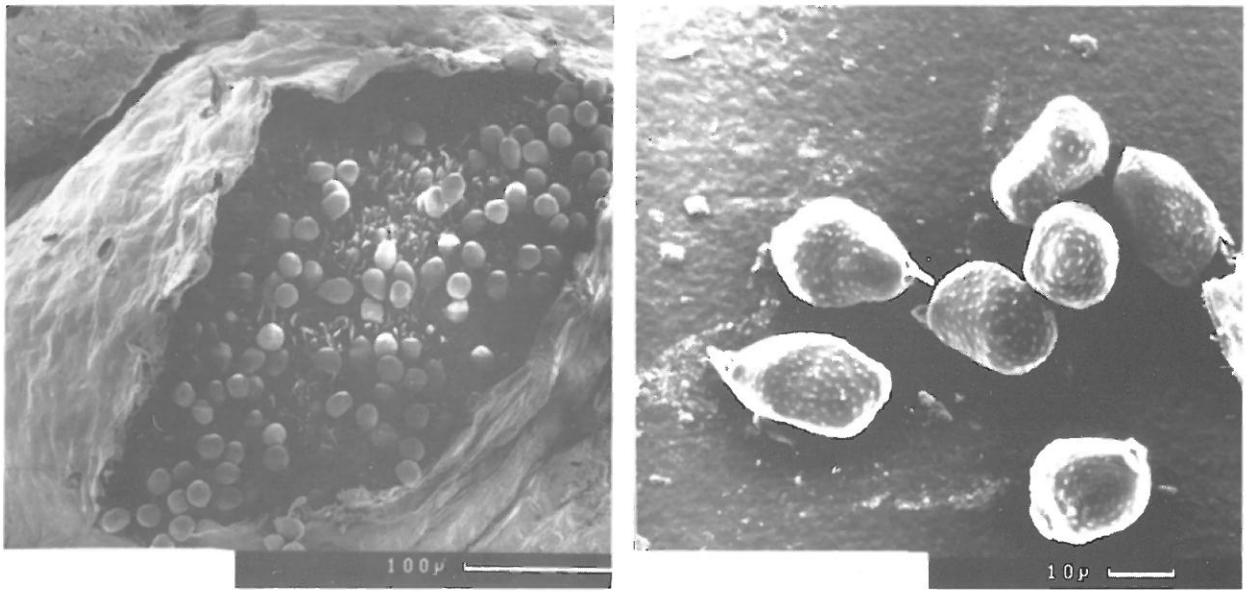
Species 114. *Puccinia vincae*: aecia and aeciospores.





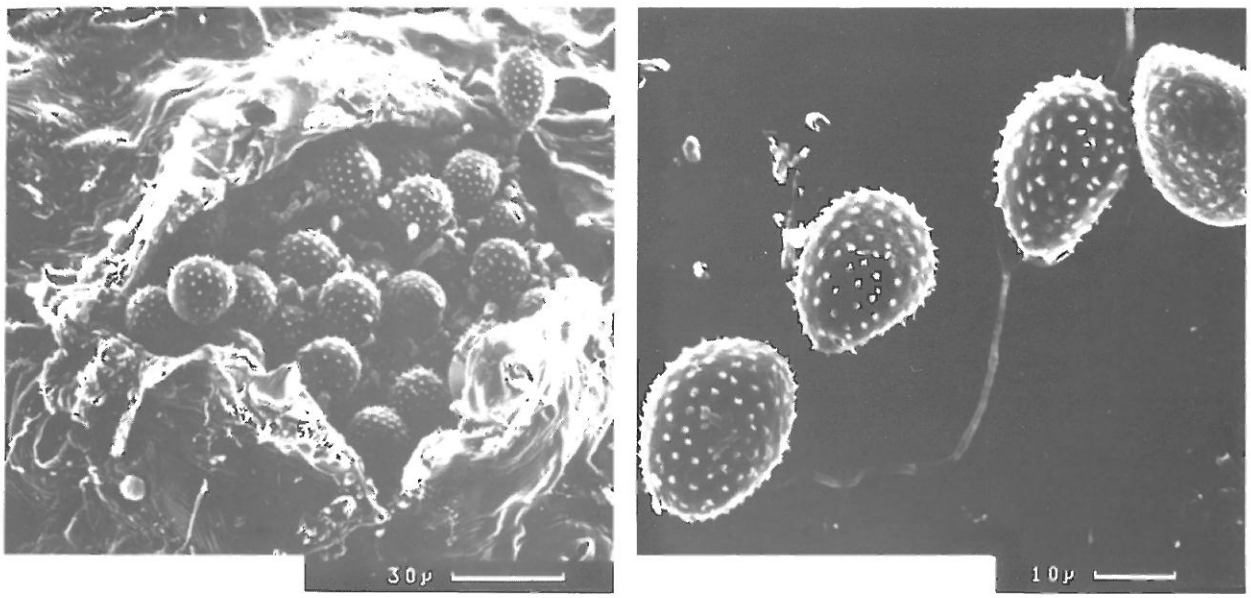
(See caption to photographs of telia and teliospores). Aeciospore surface: echinulate (WH, EE). (Teliospores arise in aecia).

Species 115. *Puccinia violae*: telia and teliospores.



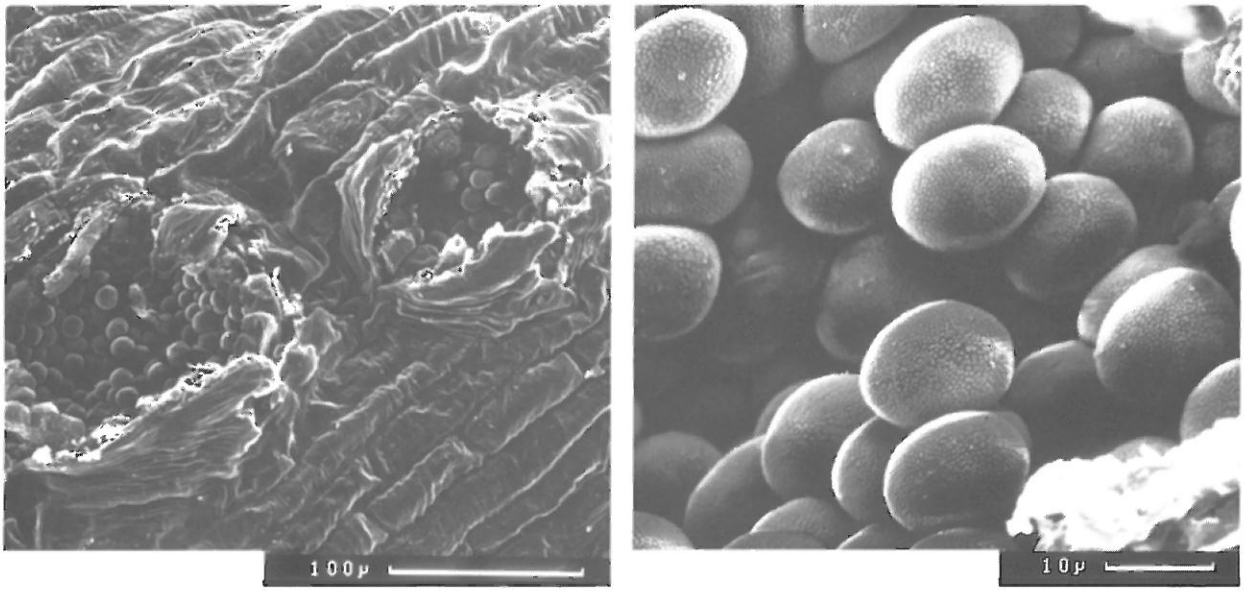
Yorks in B, 198. [AUT] on Viola spp. Drawing of UT in WH 127. Descriptions in WH 127 and EE 449. Teliospore surface: faintly verrucose (WH), minutely verruculose (EE).

Species 115. *Puccinia violae*: uredinia and urediniospores.



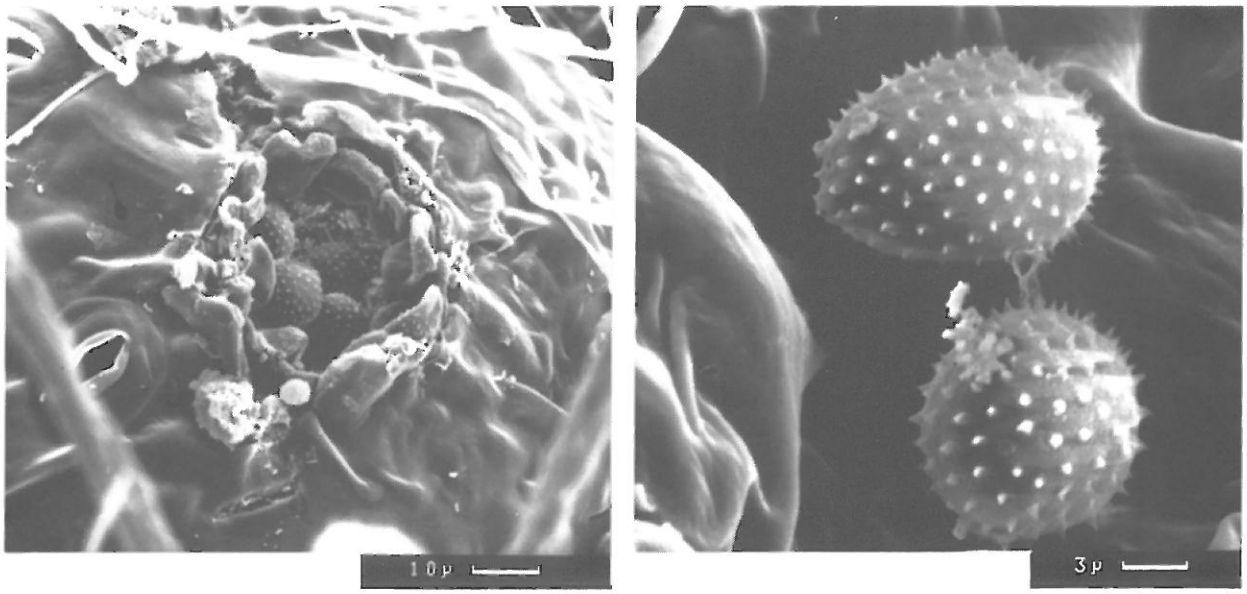
(See caption to photographs of telia and teliospores). Urediniospore surface: echinulate (WH, EE).

Species 115. *Puccinia violae*: aecia and aeciospores.



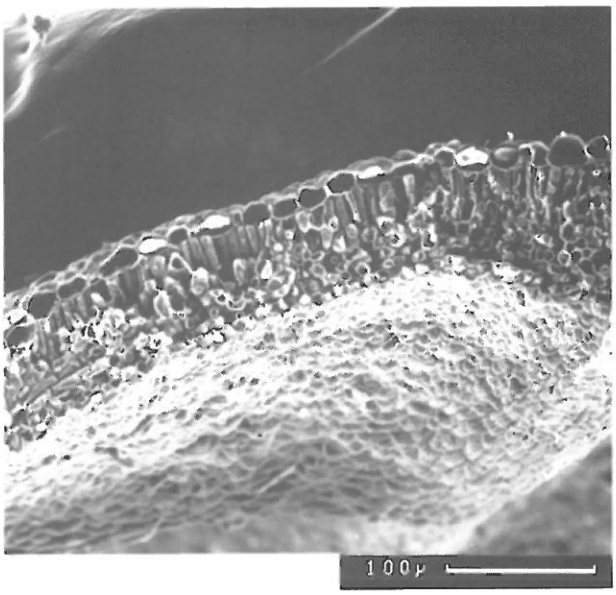
(See caption to photographs of telia and teliospores). Aeciospore surface: minutely verruculose (WH).

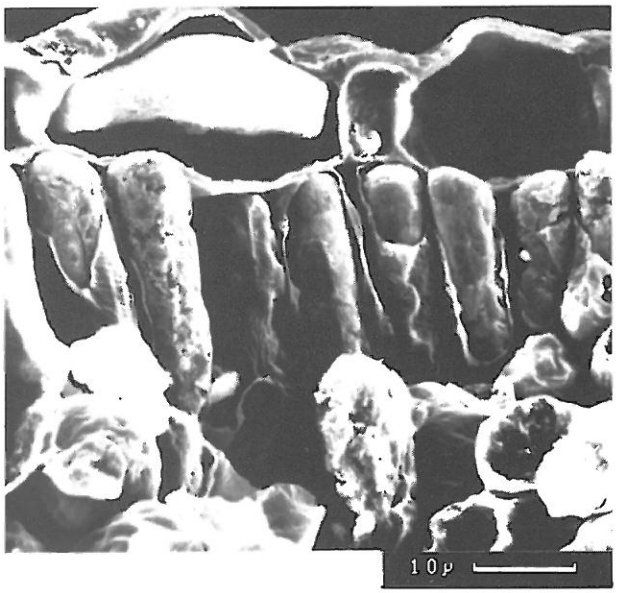
Species 116. *Pucciniastrum agrimoniae*: uredinia and urediniospores.



Yorks in B, 199 [U] on *Agrimonia eupatoria*. Drawing of U on WH 35. Description in EE 302. Urediniospore surface: echinulate (WH, EE) Telia not found in Britain

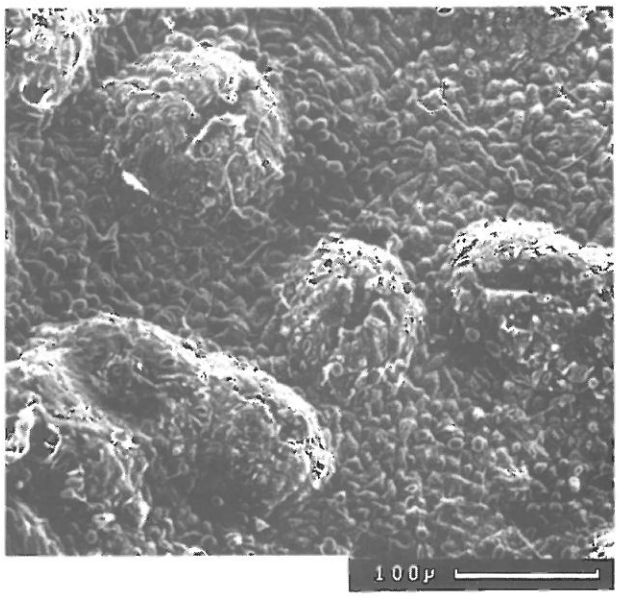
Species 117. *Pucciniastrum areolatum*: telia and teliospores.

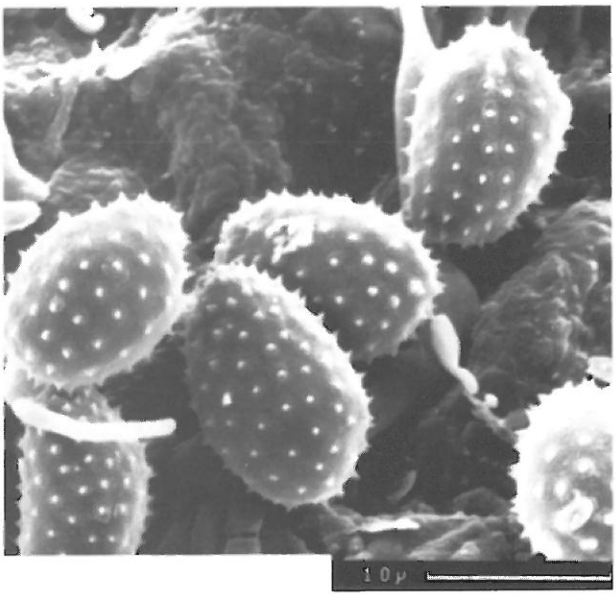




Yorks in B, 199. [A] on *Picea abies*. [UT] on *Prunus padus*. Drawing of U in WH 36. Descriptions of A in EE 168 and of UT in EE 194. Teliospore surface: smooth (WH, EE) intra-epidermal.

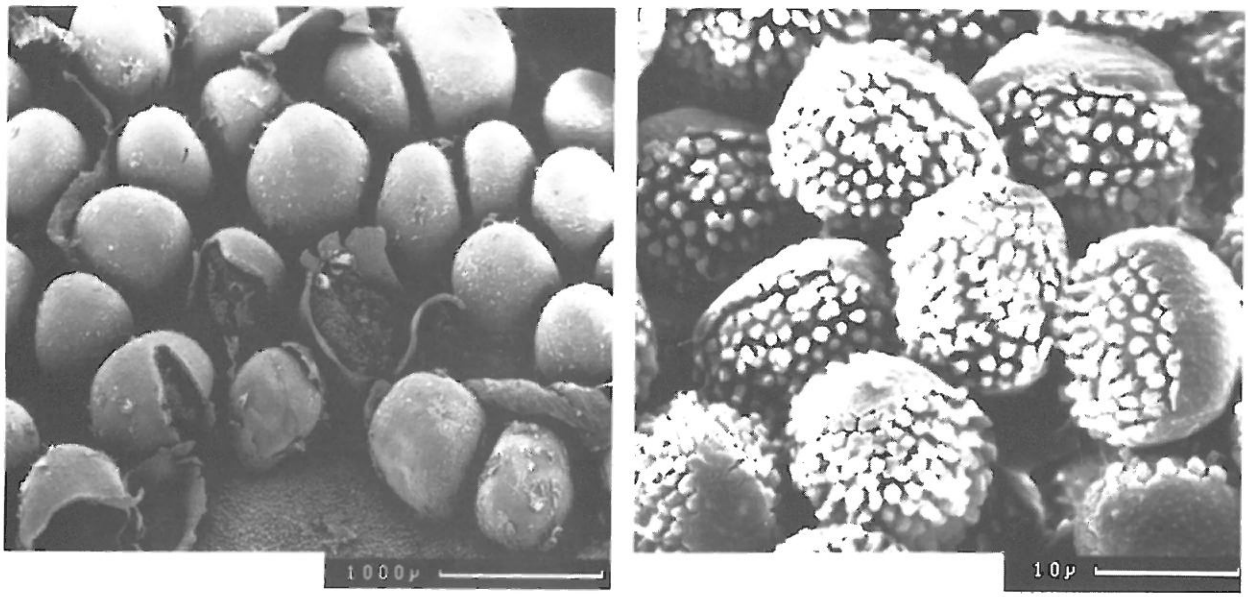
Species 117. *Pucciniastrum areolatum*: uredinia and urediniospores.





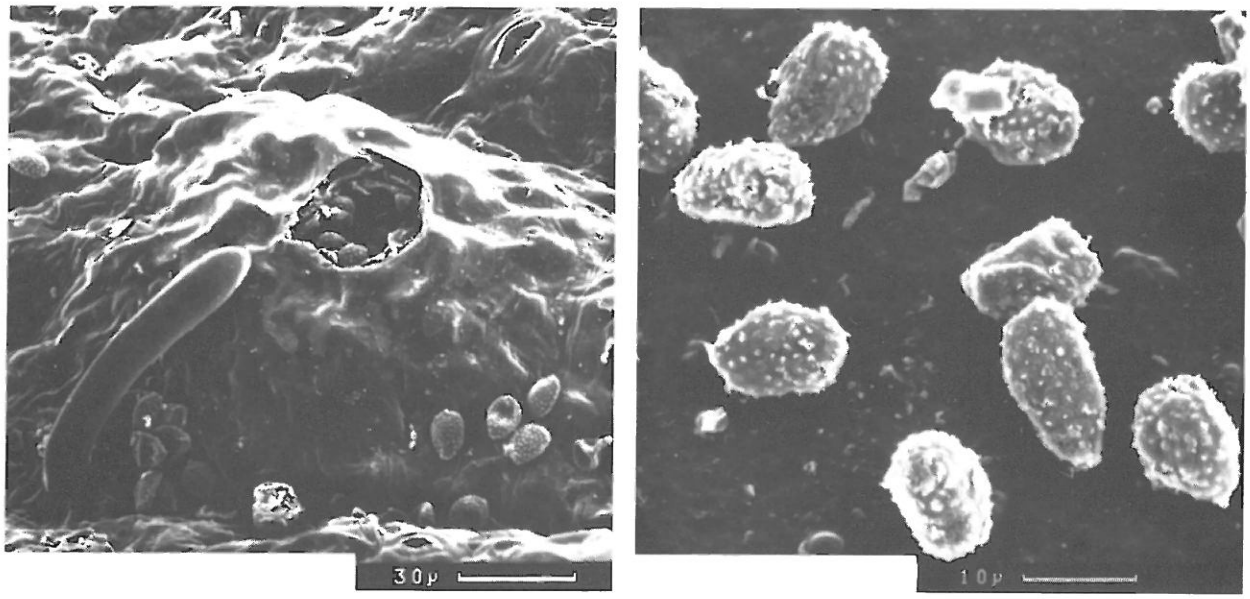
(See caption to photographs of telia and teliospores). Urediniospore surface: shortly echinulate (WH, EE).

Species 117. *Pucciniastrum areolatum*: aecia and aeciospores.



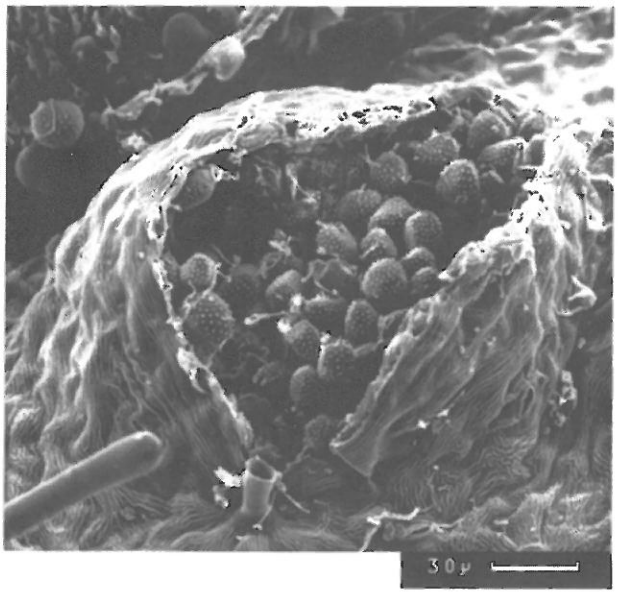
(See caption to photographs of telia and teliospores). Aeciospore surface: densely verrucose (WH), verrucose (EE).

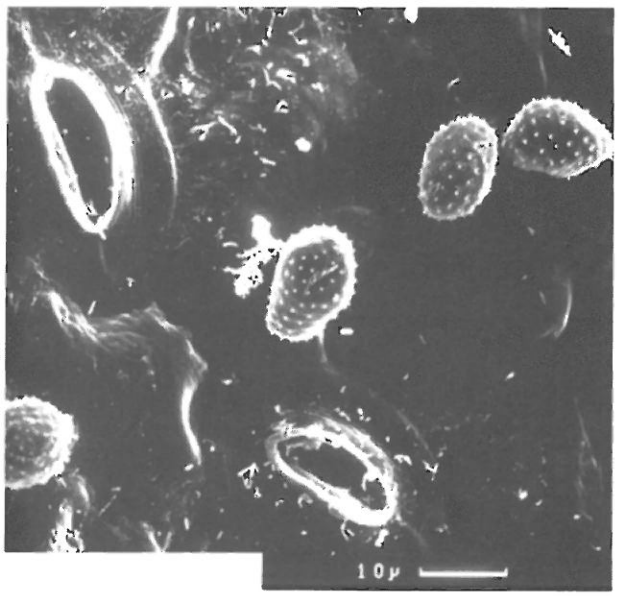
Species 118. *Pucciniastrum circaeae*: uredinia and urediniospores.



Yorks in B, 199. [A] uncertain, possibly on *Abies alba*. [UT] on Circaea spp. Drawing of U in WH 34. Descriptions of AUT in WH 34 and of UT in EE 334. Urediniospore surface: minutely echinulate (WH), finely echinulate (EE).

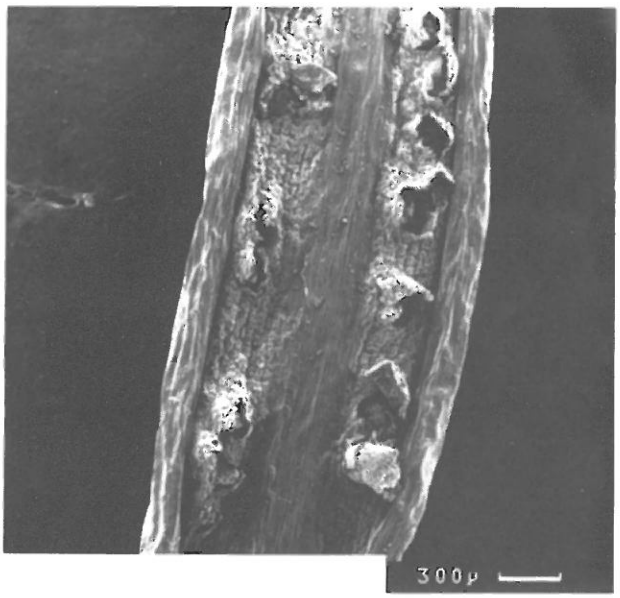
Species 119. *Pucciniastrum epilobii*: uredinia and urediniospores.

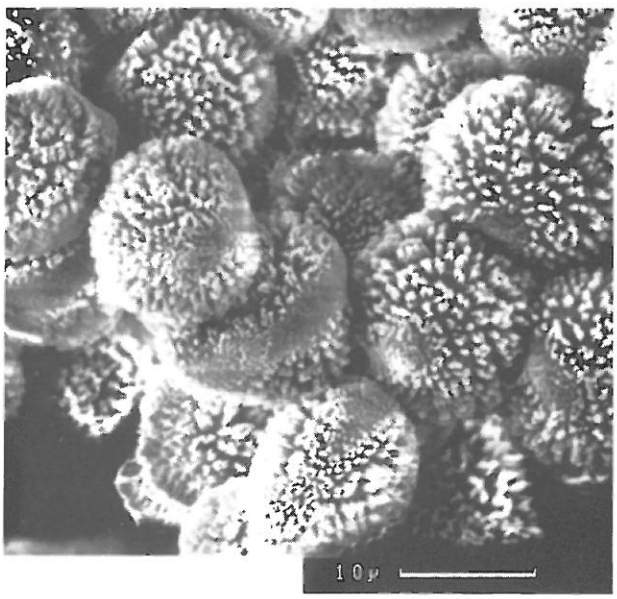




Yorks in B, 199. [A] on *Abies grandis*. [UT] on Epilobium spp. Drawing of U and T in WH 31. Descriptions of A in EE 76 and of U and T in EE 346. Urediniospore surface: remotely and shortly echinulate (WH), minutely echinulate (EE).

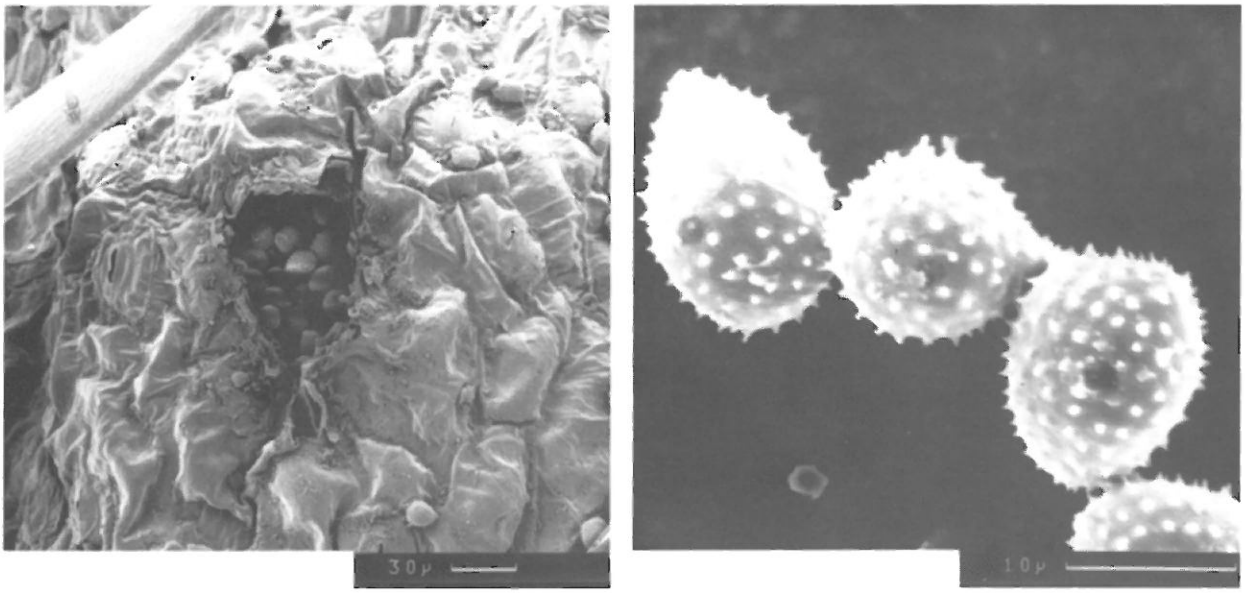
Species 119. *Pucciniastrum epilobii*: aecia and aeciospores.





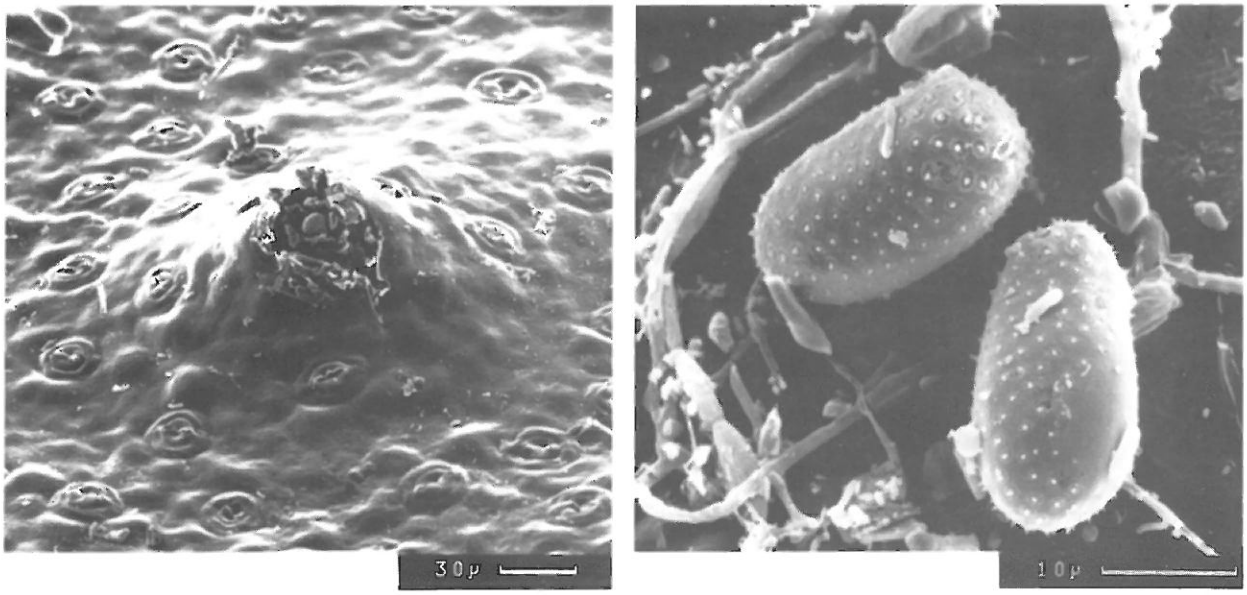
(See caption to photographs of uredinia and urediniospores). Aeciospore surface: minutely verrucose with a smooth spot on one side (WH), minutely verruculose with a smooth area on one side (EE).

Species 120. *Pucciniastrum guttatum*: uredinia and urediniospores.



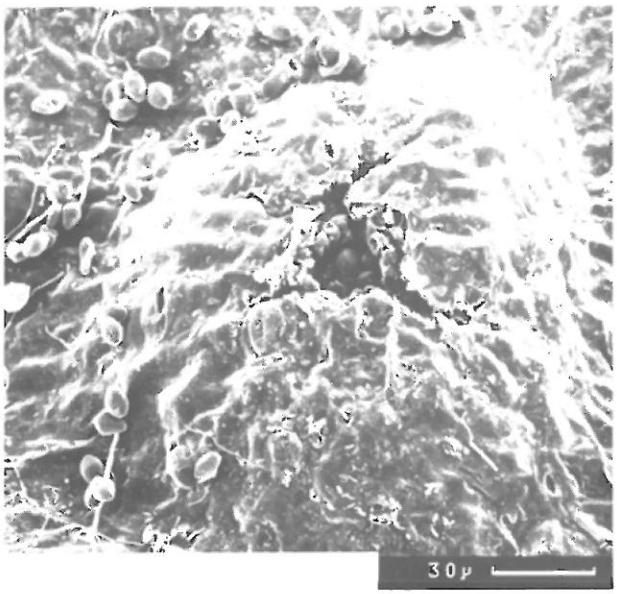
Yorks in B, 199. [UT] e.g. on *Galium odoratum*. Drawings of U and T in WH 41. Descriptions of U and T in EE 361. Urediniospore surface: minutely echinulate (WH, EE).

Species 121. *Pucciniastrum pyrolae*: uredinia and urediniospores.



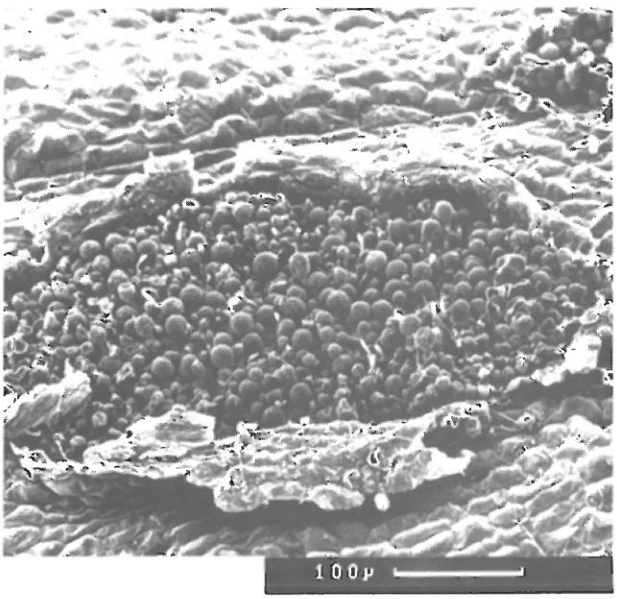
Yorks in B, 199. [U] on, e.g. *Pyrola media*. Drawing of U in WH37. Description of U in EE409. T. subepidermal, not yet found in Britian. Urediniospore surface: with pointed warts (WH), finely echinulate (EE).

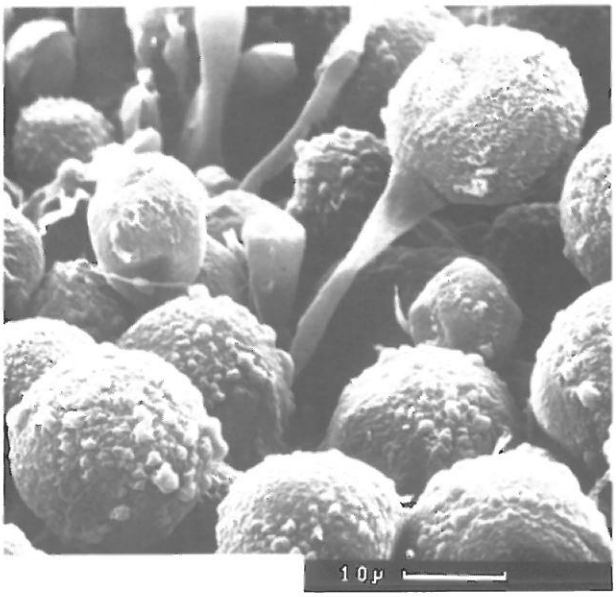
Species 122. *Pucciniastrum vaccinii*: uredinia and urediniospores.



Yorks in B, 199. [A] on Tsuga spp. [U] on Vaccinium spp. A not yet found in Britian. T very rare. Drawing of U in WH38. Description of U in EE270. UT subepidermal.. Urediniospore surface: minutely echinulate (WH, EE).

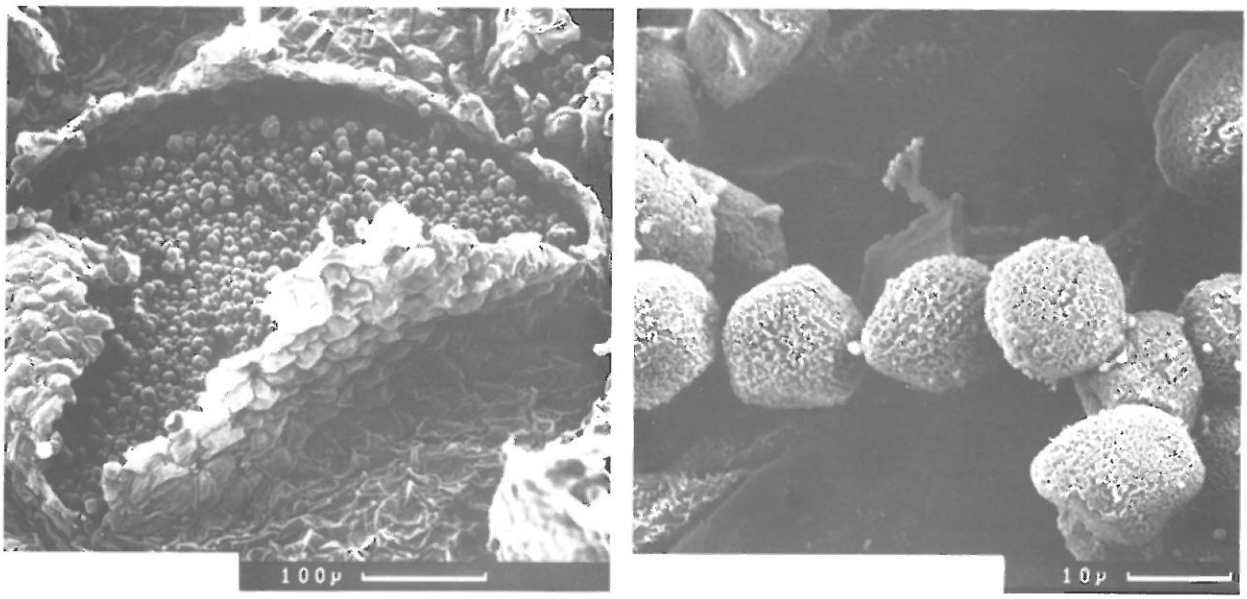
Species 123. *Trachyspora intrusa*: telia and teliospores





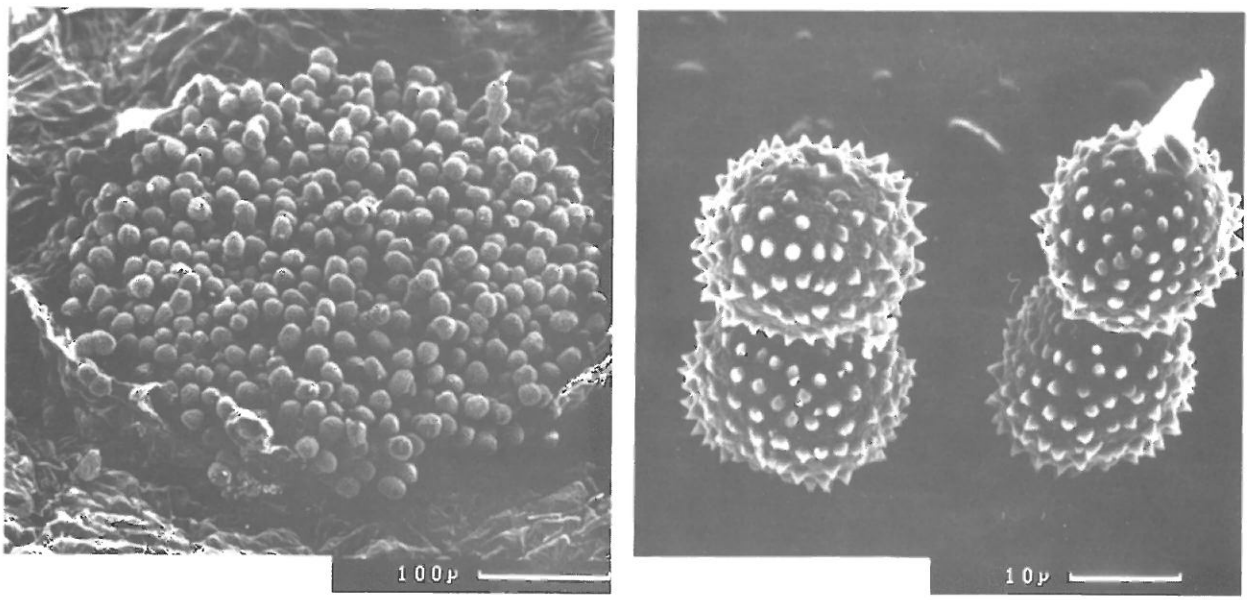
Yorks in B, 199. [AT] on Alchemilla spp. U of doubtful occurrence. drawings of T on WH 364. Descriptions of A and T on WH364 and T on EE302. Teliospore surface; coarsely and irregularly warted especially in the upper part with the lower part almost or quite smooth (WH), coarsely verrucose (EE).

Species 123. *Trachyspora intrusa*: aecia and aeciospores.



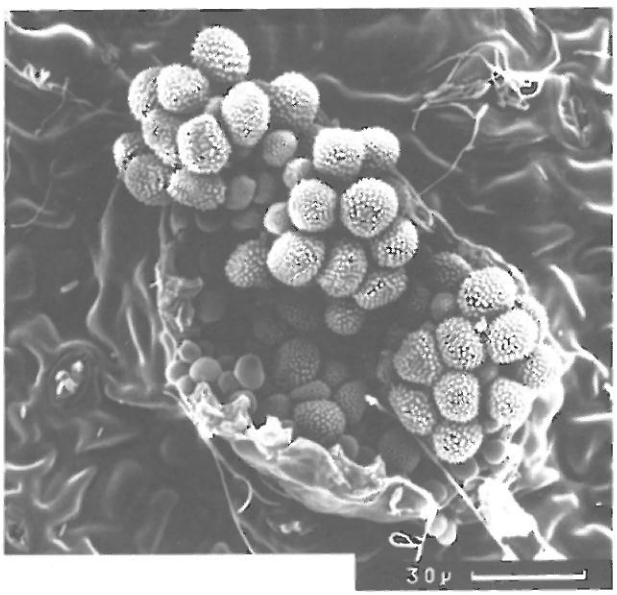
(See caption to photographs of telia and teliospores). Aeciospore surface: faintly echinulate (WH).

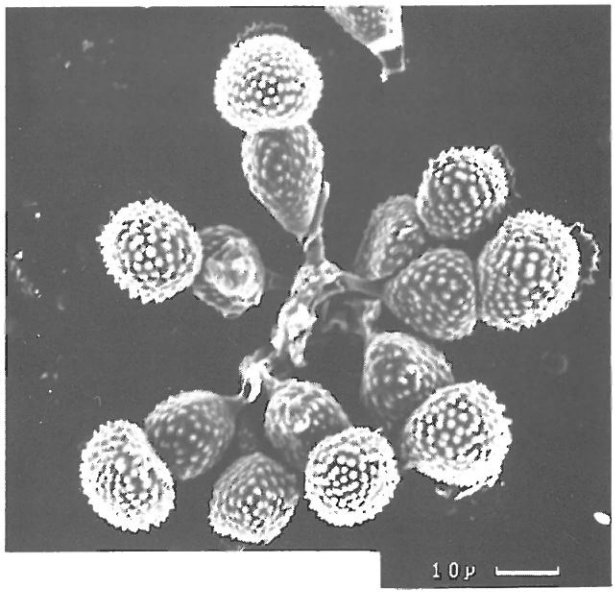
Species 124. *Tranzschelia anemones*: telia and teliospores.



Yorks in B, 199. [T] e.g. on *Anemone nemorosa*. Drawings of T on WH303 and in EE, Fig. 1346. Description of T on WH303. Teliospore surface: densely covered with large, sometimes pointed, warts (WH), warted (EE).

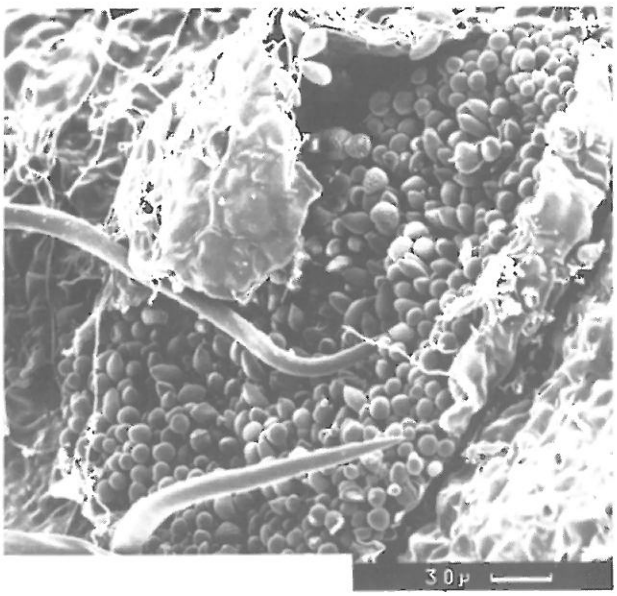
Species 125. *Tranzschelia discolor*: telia and teliospores.

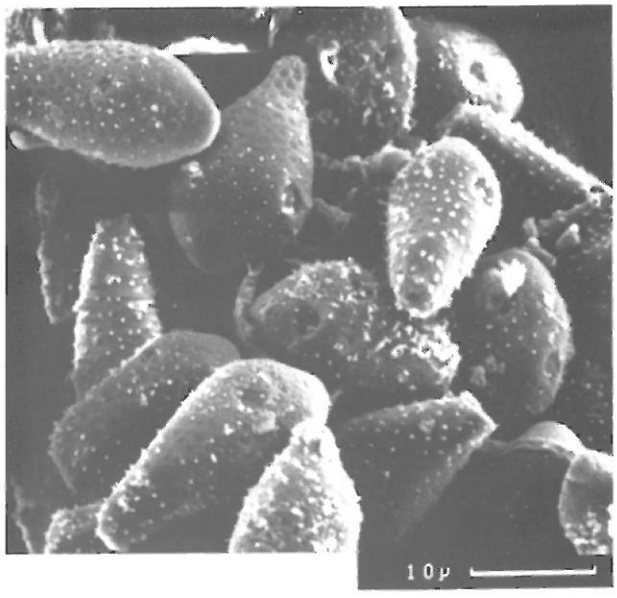




Yorks in B, 199. [A] on Anemone spp. [UT] on Prunus spp. Drawings of U and T on WH304 and EE Fig. 858. Descriptions of A in EE307 and of U and T in EE 194. Photographs of U and T (as *Tranzschelia pruni-spinosae* var. *discolor*) CMID 287, Teliospore surface: upper cell densely and coarsely verrucose, lower cell almost smooth (WH).

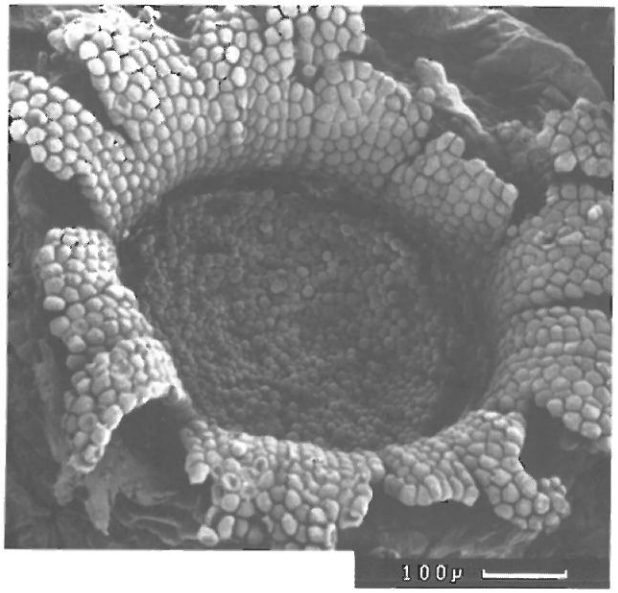
Species 125. *Tranzschelia discolor*: uredinia and urediniospores.

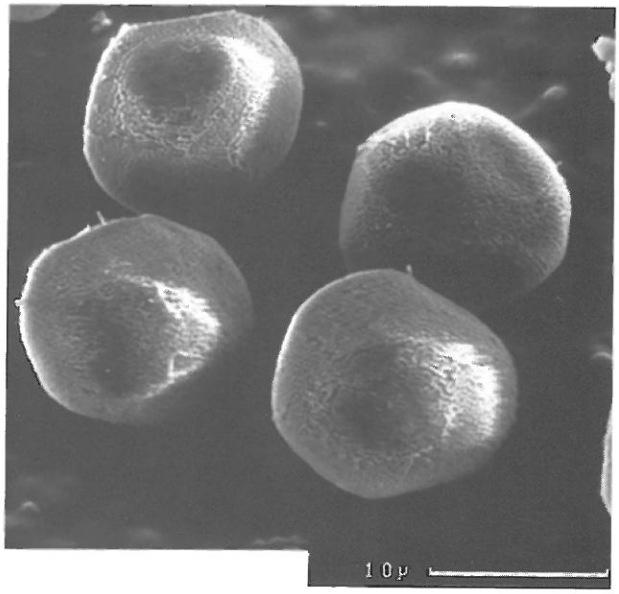




(See caption to photographs of telia and teliospores). Urediniospore surface: wall smooth and more or less thickened and dark brown at the conical apex, in lower half paler, sharply verrucose or echinulate (WH).

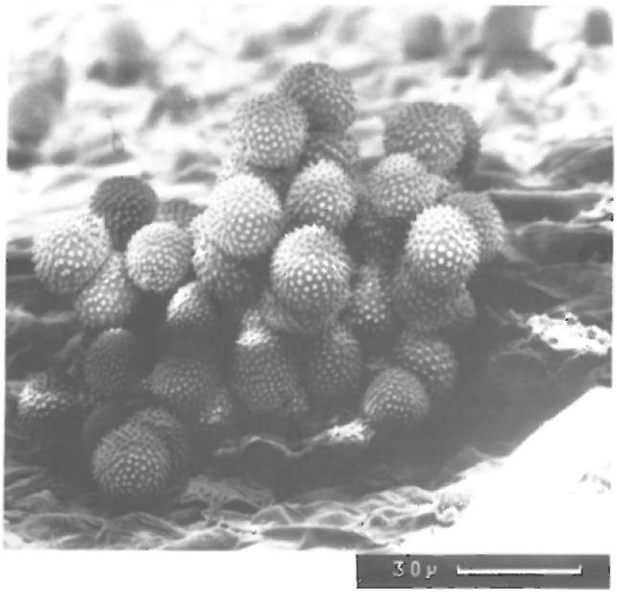
Species 125. *Tranzschelia discolor*: aecia and aeciospores.

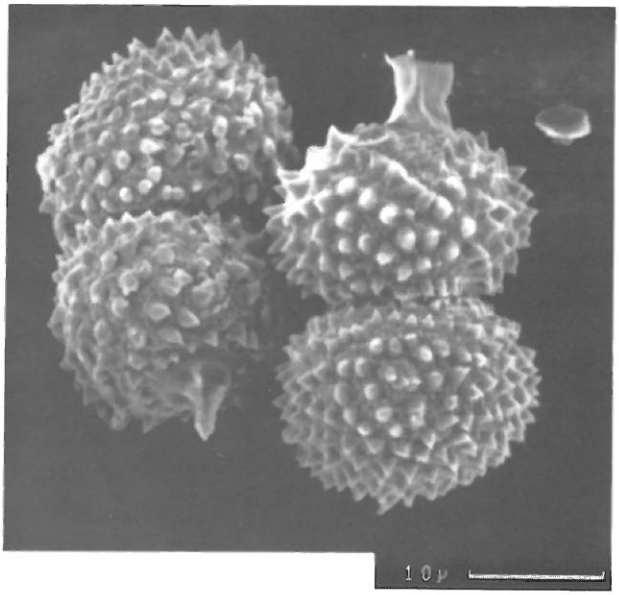




(See caption to photographs of telia and teliospores). Aeciospore surface: finely verruculose (WH), almost smooth, sometimes irregularly or very finely verrucose (CMID).

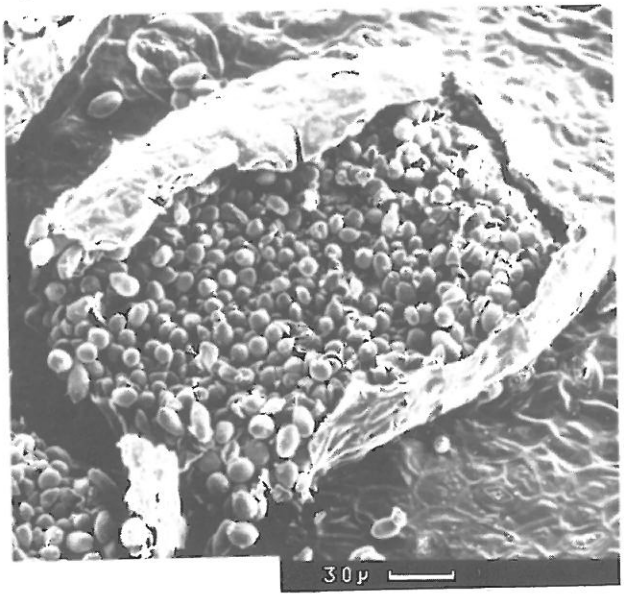
Species 126. *Tranzschelia pruni-spinosae*: telia and teliospores.

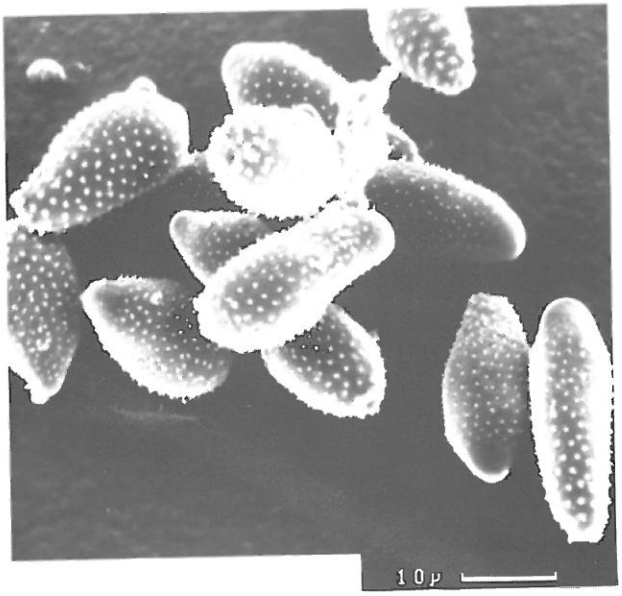




Yorks in B, 199. [UT] on Prunus spp. Drawings of T in WH 307 and EE Fig. 859. Descriptions of U and T in EE 194 and in CMID 288 (as *Tranzschelia pruni-spinosae* var. *pruni-spinosae*). Photographs of U also in CMID. Teliospore surface: both cells coarsely verrucose (WH), verrucose (EE), strongly verrucose, warts crowded but quite distinct (CMID).

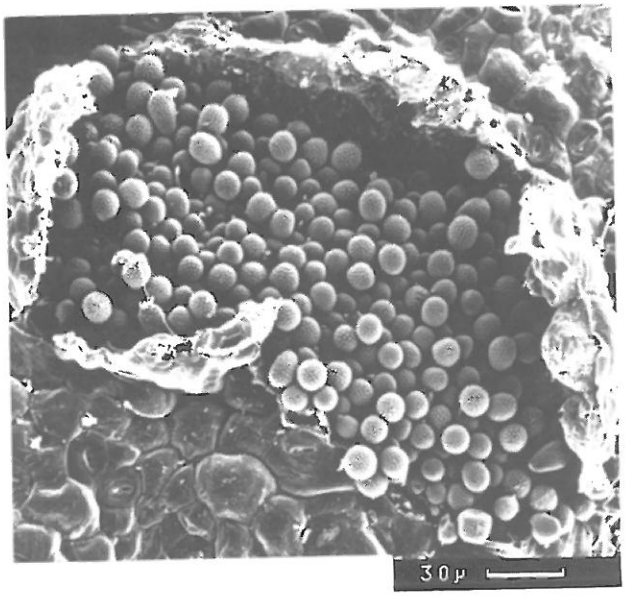
Species 126. *Tranzschelia pruni-spinosae*: uredinia and urediniospores.

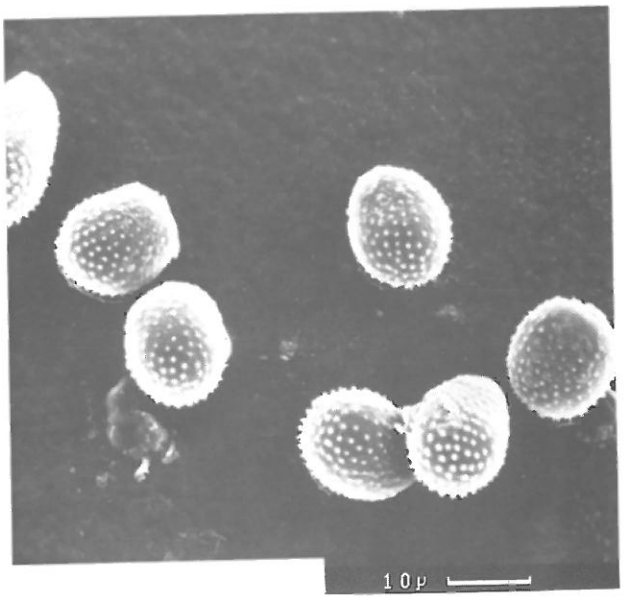




(See caption to photographs of telia and teliospores). Urediniospore surface: as *Tranzschelia discolor* (WH).

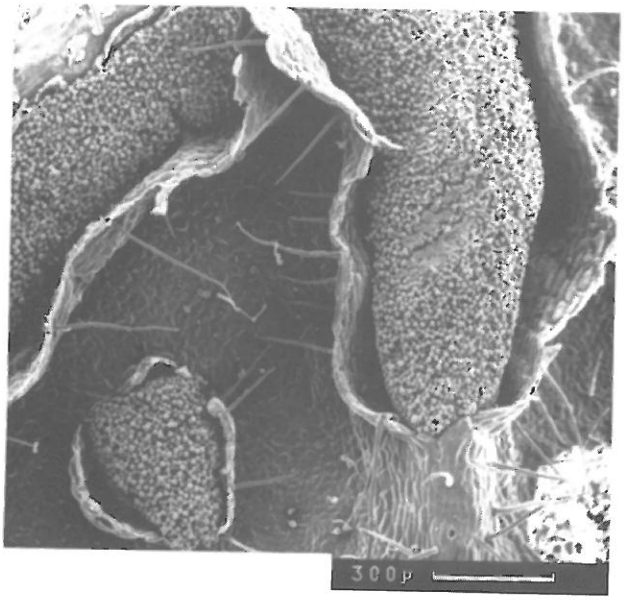
Species 127. *Triphragmium filipendulae*: uredinia and urediniospores.

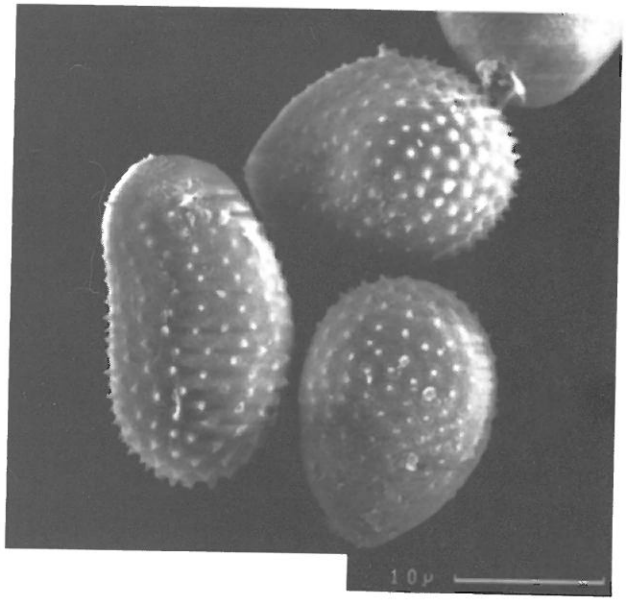




Yorks in B, 199 [AUT] on *Filipendula vulgaris*. Drawing of T in WH 112. Descriptions of Triphragmium ulmariae (species 128) are very similar. Urediniospore surface: echinulate (as aeciospores) (WH).

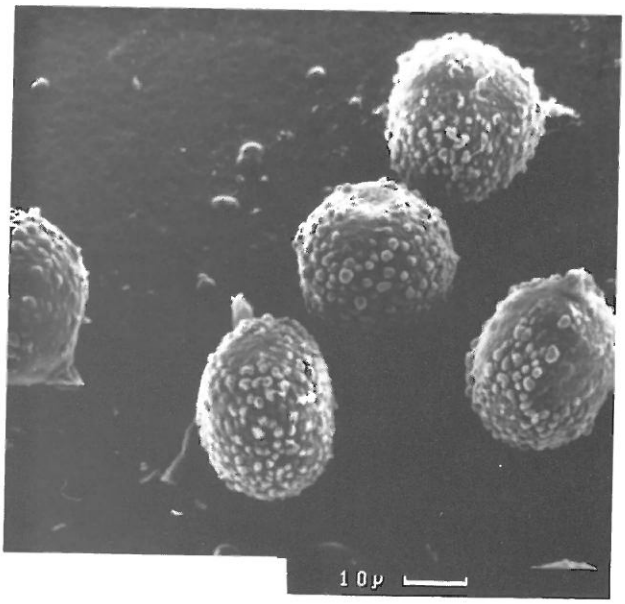
Species 127. *Triphragmium filipendulae*: aecia and aeciospores.





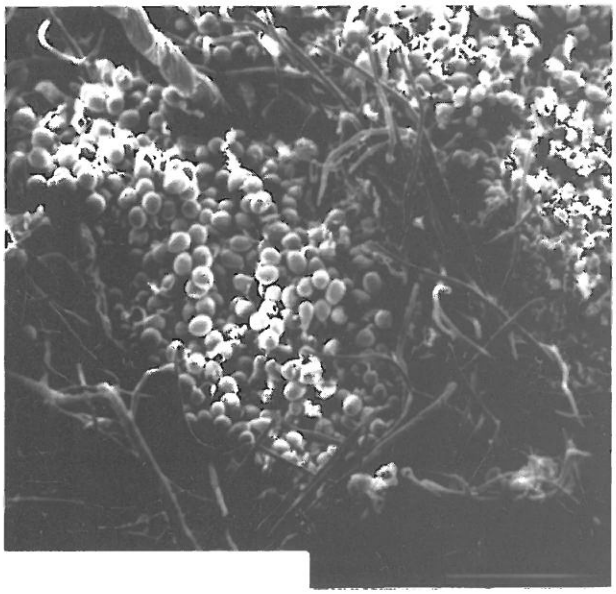
(See caption to photographs of uredinia and urediniospores). Aeciospore surface: echinulate (WH).

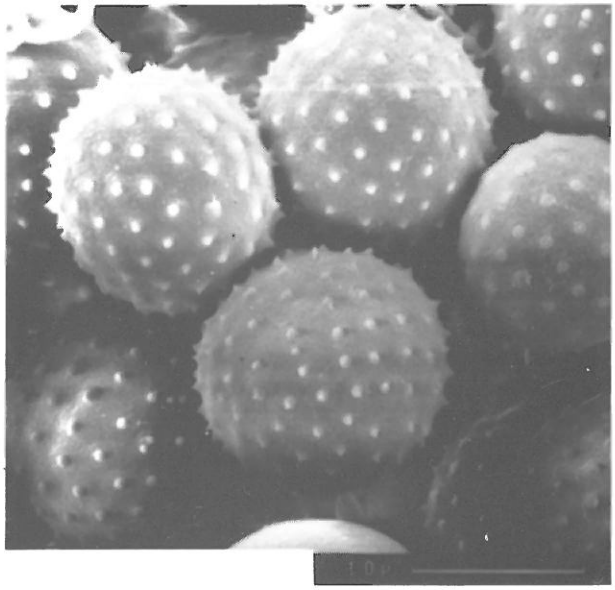
Species 128. *Triphragmium ulmariae*: telia and teliospores.



Yorks in B, 199. [AUT] on *Filipendula ulmaria*. Drawings of U and T in WH 112 and EE Fig. 1481. Descriptions AUT EE 354. Teliospore surface: obtuse warts especially about the pores (WH).

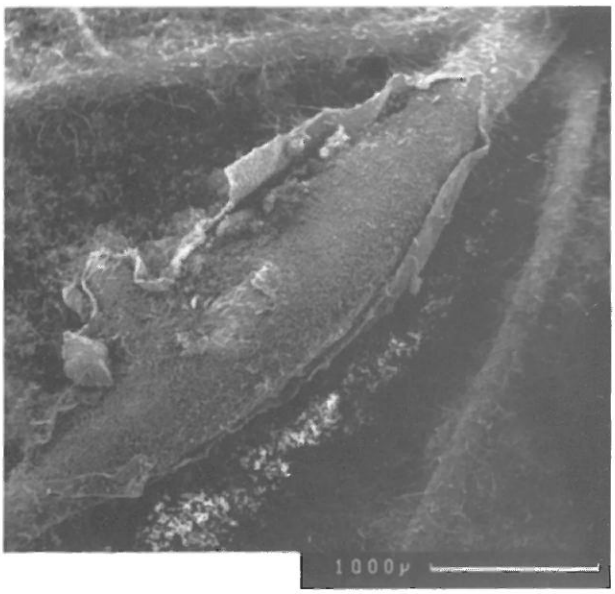
Species 128. *Triphragmium ulmariae*: uredinia and urediniospores.

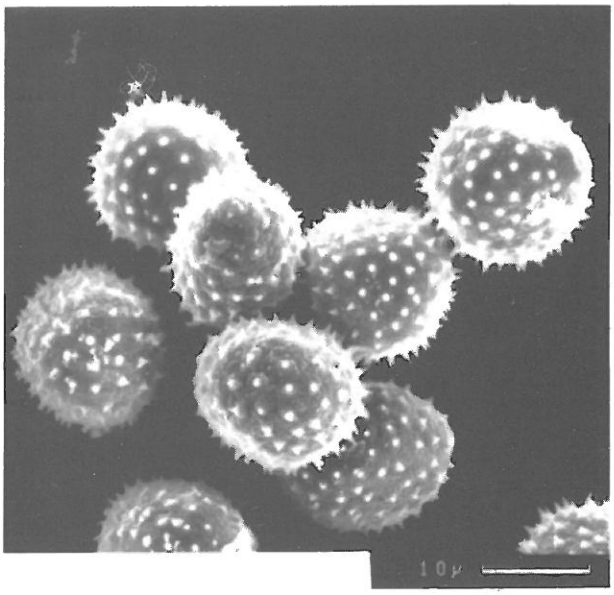




(See caption to photographs of telia and teliospores). Urediniospore surface: sharply echinulate above, less so below (WH).

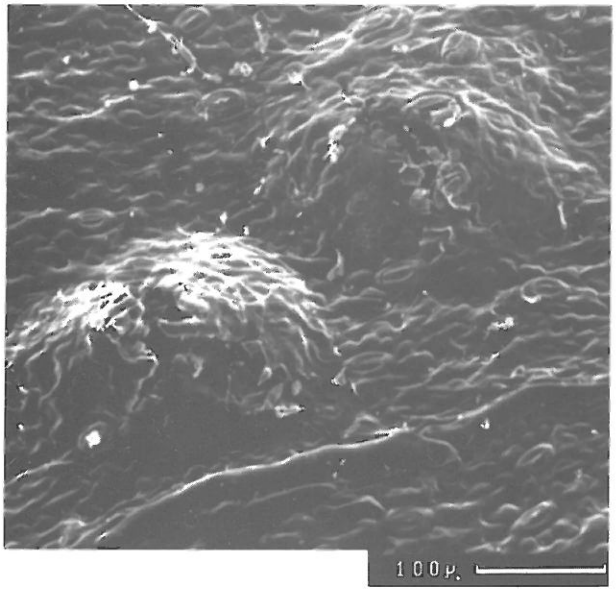
Species 128. *Triphragmium ulmariae*: aecia and aeciospores.

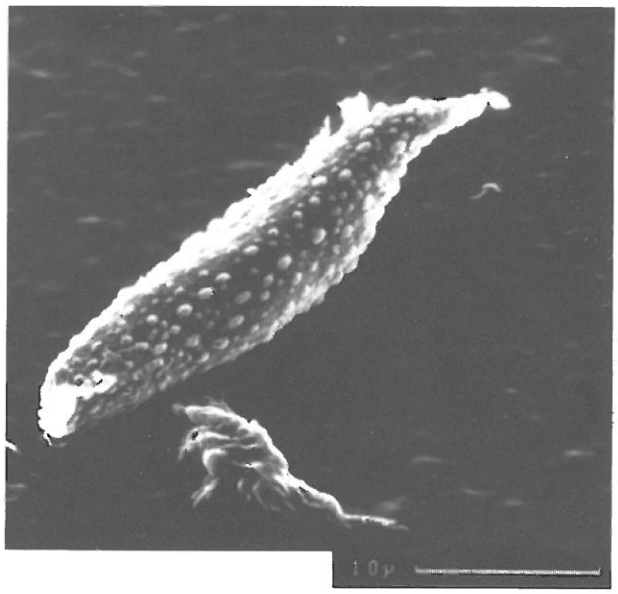




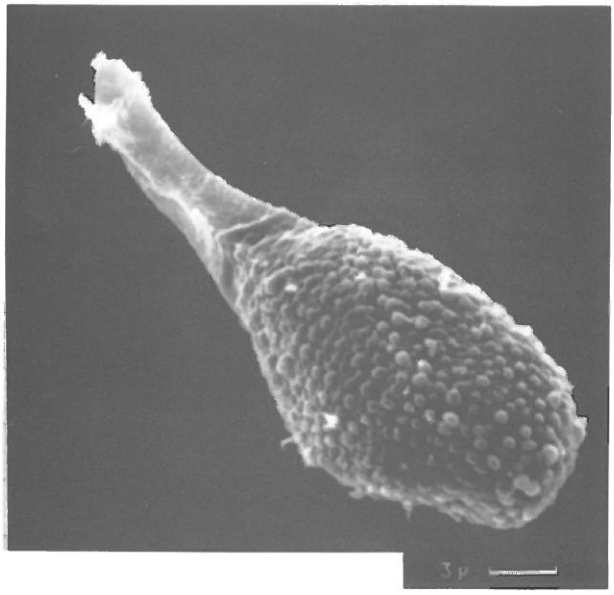
(See caption to photographs of telia and teliospores). Aeciospore surface: echinulate grading to smooth at base (WH), echinulate (EE).

Species 129. *Uredinopsis filicina*: uredinia and urediniospores.



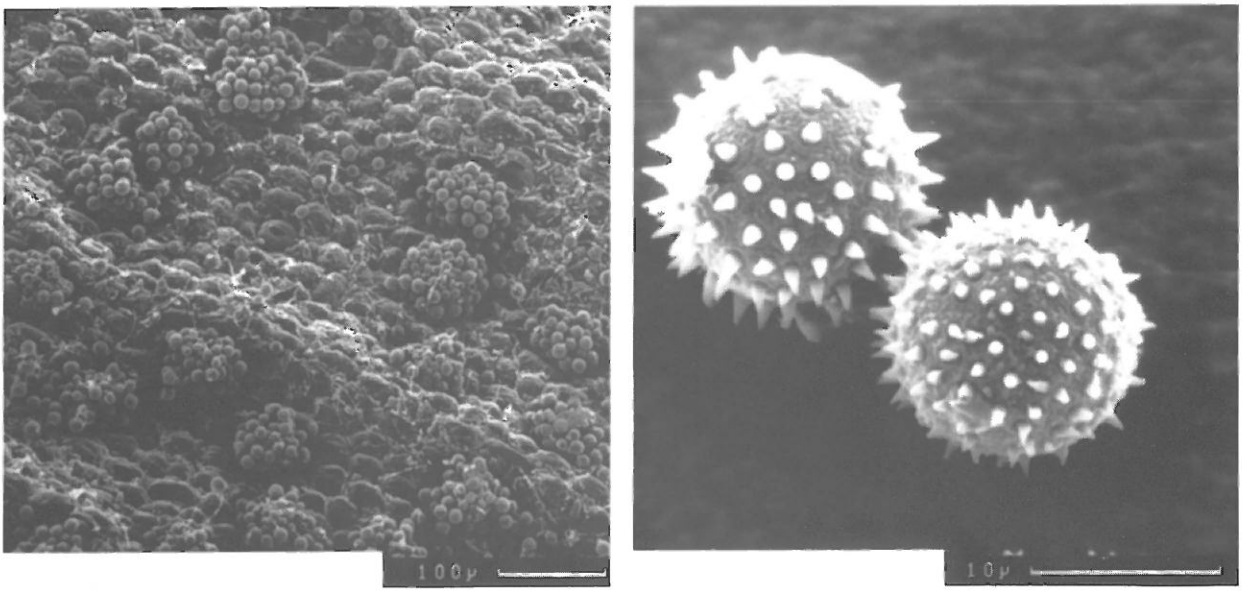


Yorks in B, 199 [UT] on *Thelypteris phegopteris*. Teliospores subepidermal and intercellular. Urediniospores of 2 kinds, (i) (see above) elongated, stalkless and with a slender beak and (ii) see below so-called amphispores, thickwalled polyhedral and long-stalked. Descriptions U and T in WH16 and EE 570. Urediniospore surfaces: normal spores smooth except for a few low scattered hyaline warts. Amphispores finely and coarsely verrucose (WH).



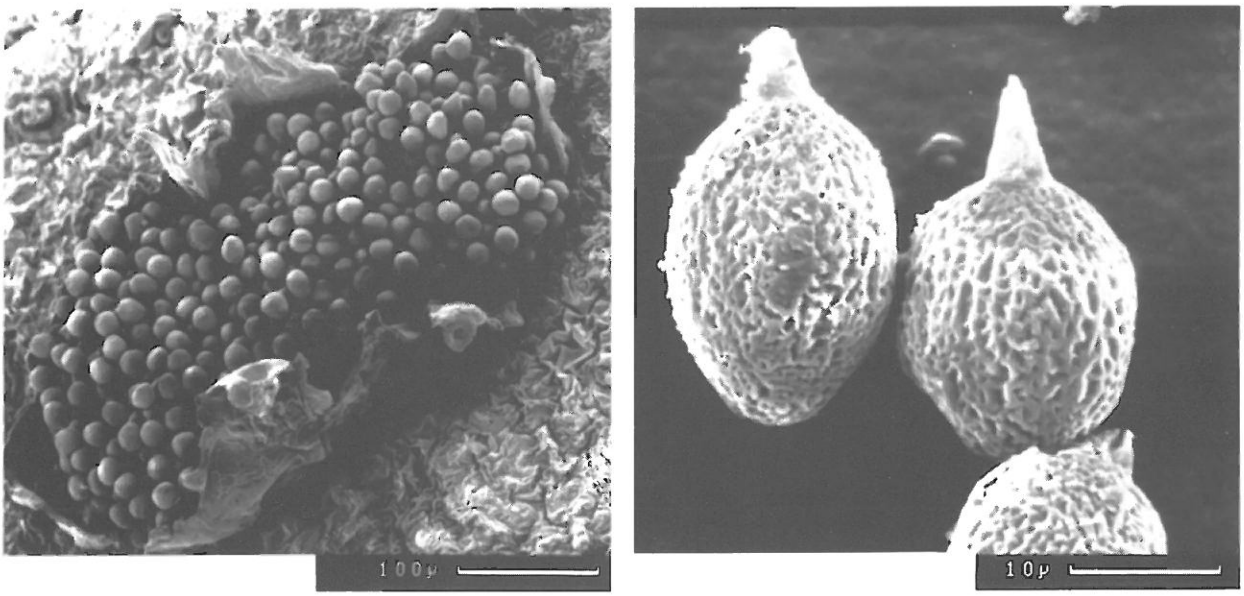
Amphiospore of *Uredinopsis filicina*.

Species 130. *Uredo behnickiana*: uredinia and urediniospores.



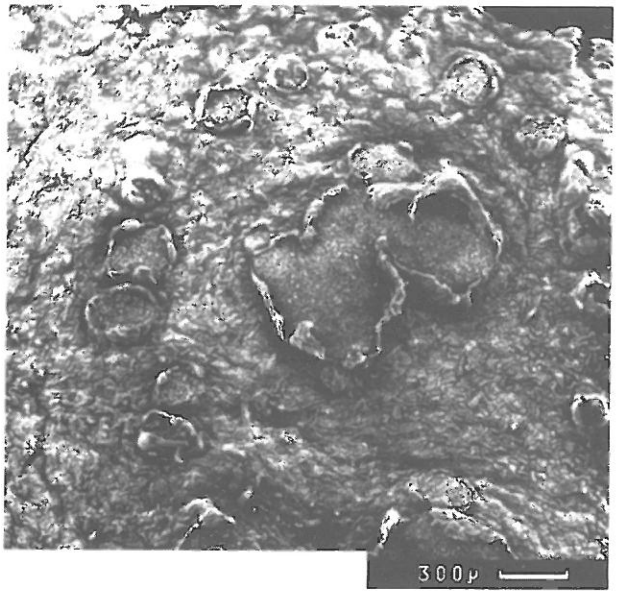
Yorks in B, 199. On tropical orchids. It is not clear where the record on Mason and Grainger (1937) was made. Description of U in WH 366. Urediniospore surface presumably echinulate.

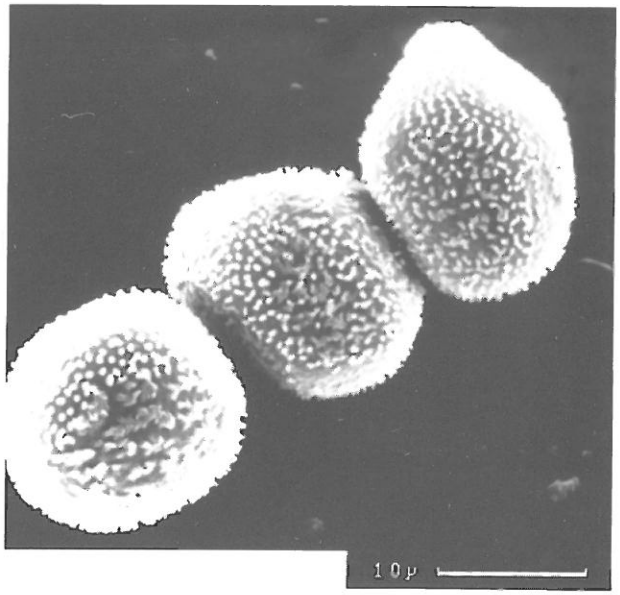
Species 131. *Uromyces acetosae*: telia and teliospores.



Yorks in B, 199. [AUT] on Rumex spp. Drawings of U and T in WH 341. Description AUT in EE 414. Teliospore surface: minutely verrucose (WH).

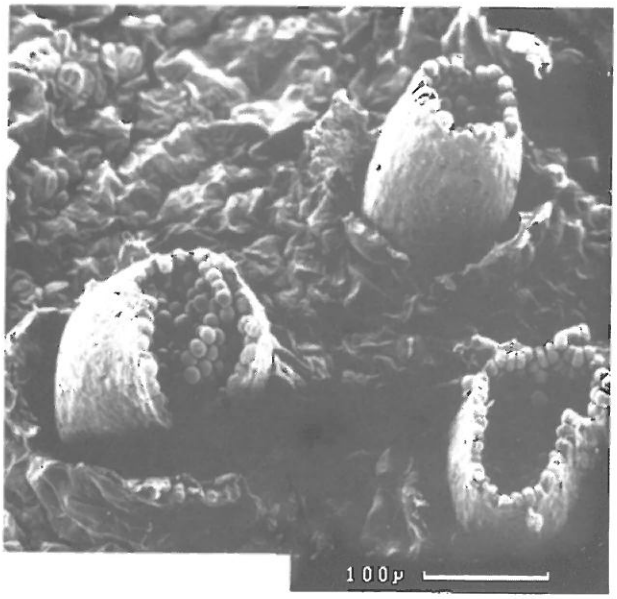
Species 131. *Uromyces acetosae*: uredinia and urediniospores.

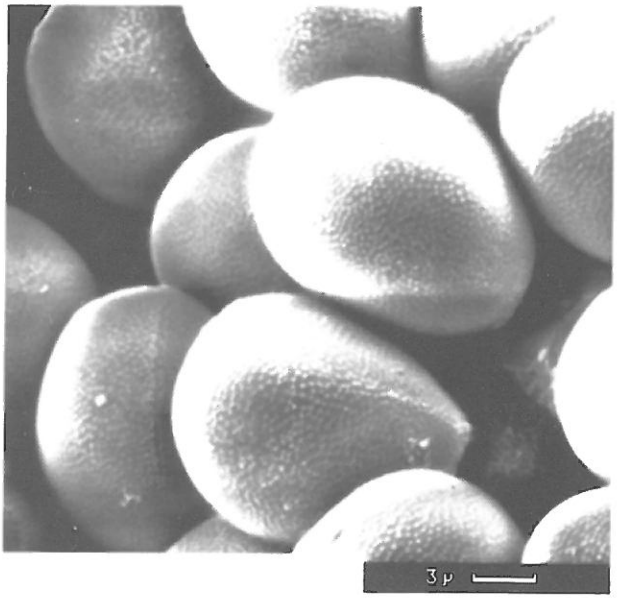




(See caption to photographs of telia and teliospores). Urediniospore surface: finely and densely verruculose (WH, EE)

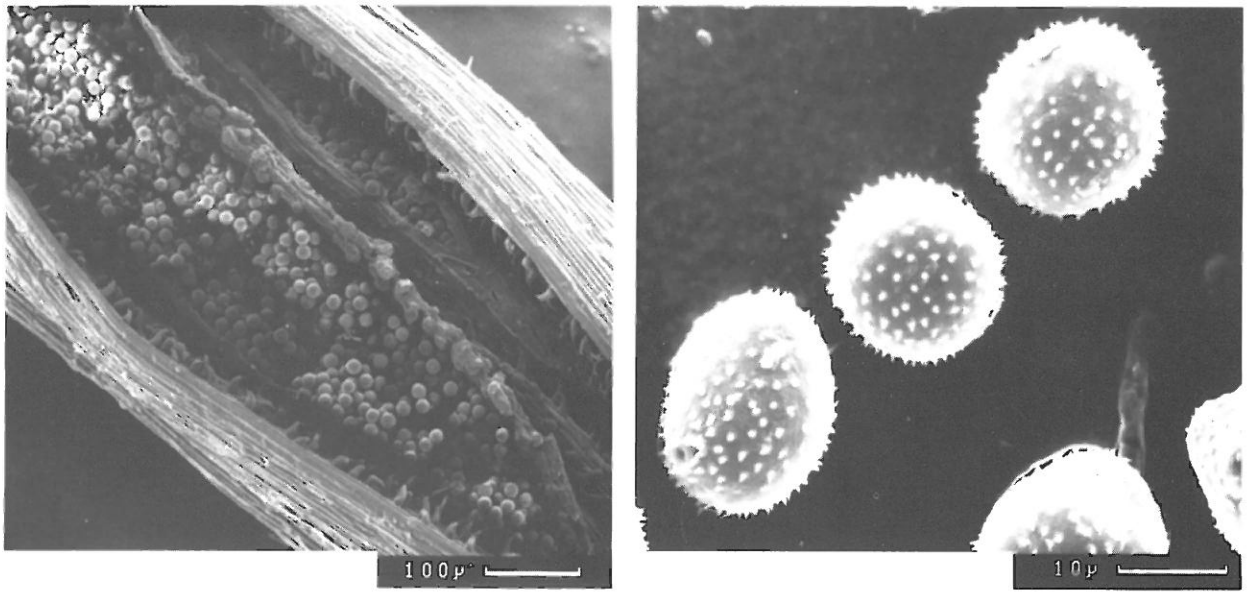
Species 131. *Uromyces acetosae*: aecia and aeciospores.





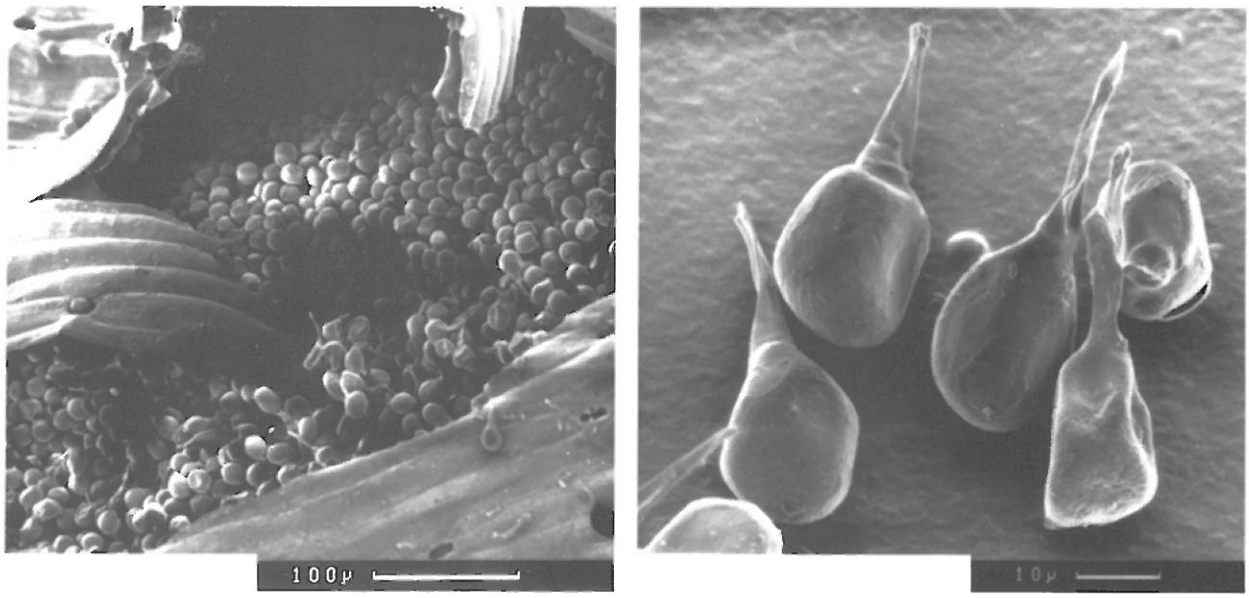
(See caption to photographs of telia and teliospores). Aeciospore surface: nearly smooth or very minutely punctate (WH), almost smooth (EE).

Species 132 *Uromyces airae-flexuosae*: uredinia and urediniospores.



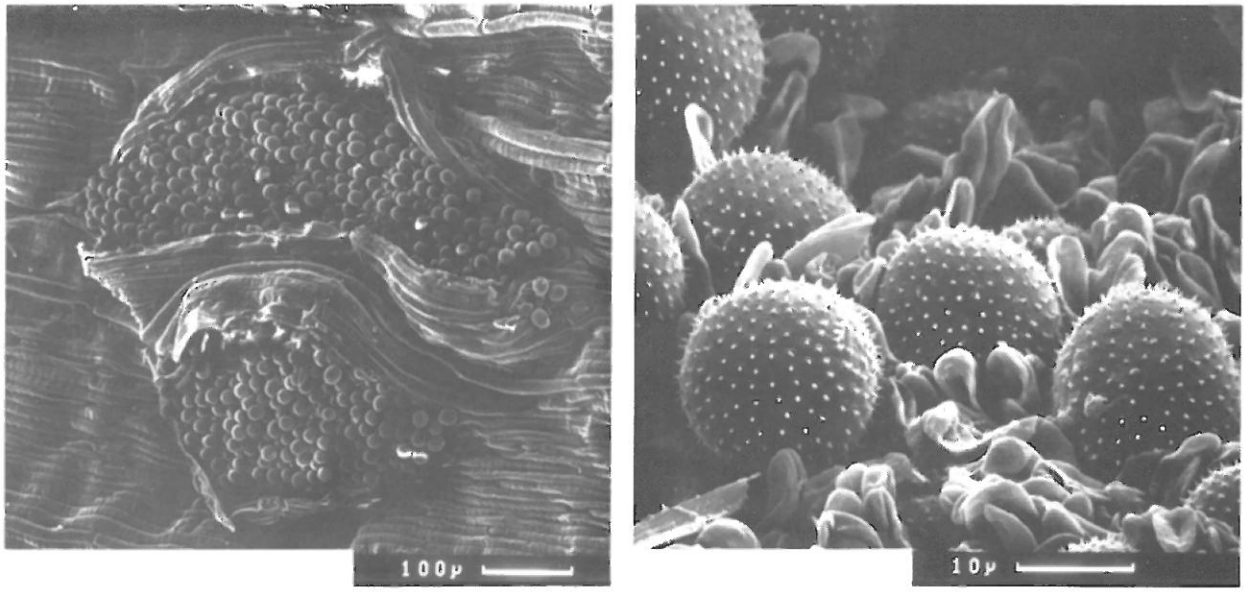
Yorks in B, 199. [UT] on *Deschampsia flexuosa*. Drawings of U and T in WH 359. Descriptions of these in EE 492. Urediniospore surface: distantly verruculose (WH), remotely verruculose (EE).

Species 133. *Uromyces ambiguus*: telia and teliospores.



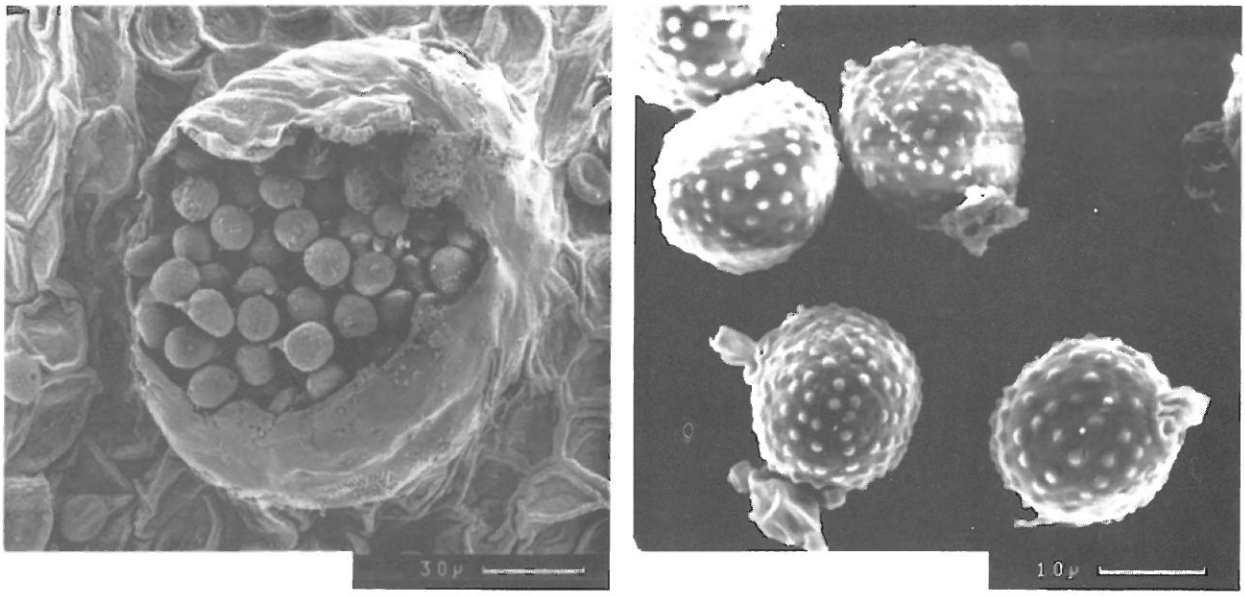
Yorks in B, 200. [UT] on Allium spp. Drawings of U and T in WH 349 and of U in EE, Fig. 1337. Descriptions in EE 303, Teliospore surface: smooth (WH, EE).

Species 133. *Uromyces ambiguus*: uredinia and urediniospores.



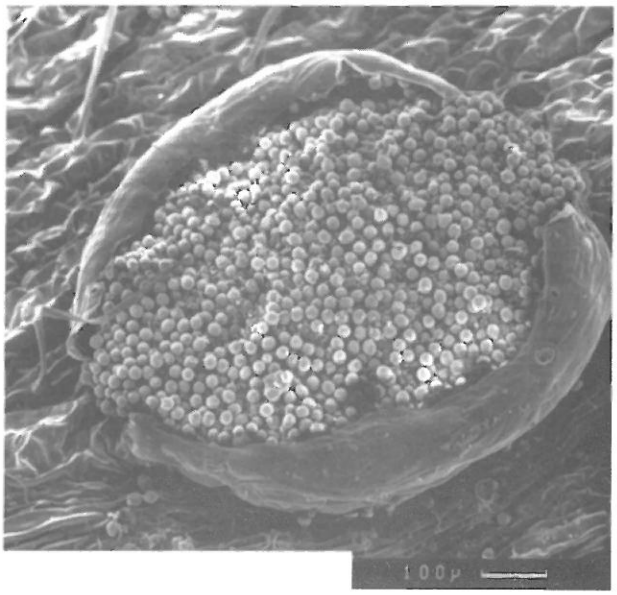
(See caption to photographs of telia and teliospores). Urediniospore surface: finely verrucose (EE).

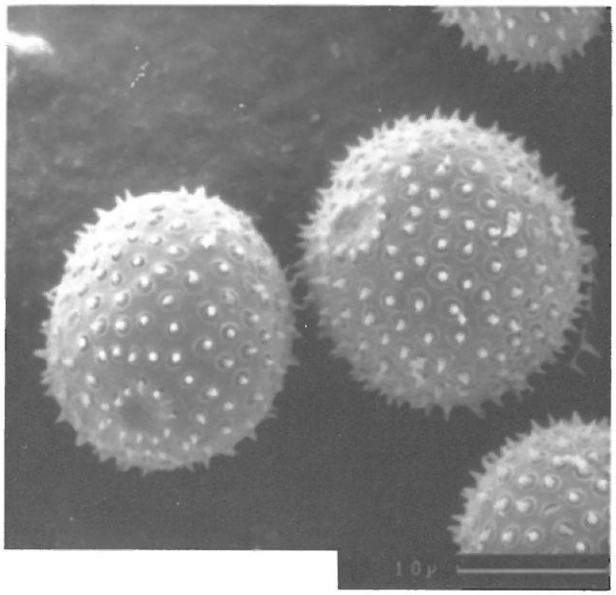
Species 134. *Uromyces anthyllidis*: telia and teliospores.



Yorks in B, 200. [UT] on, e.g. *Anthyllis vulneraria*. Drawings of U and T in WH 319. Descriptions of these in EE 310. Teliospore surface: verrucose (WH), with scattered warts (EE).

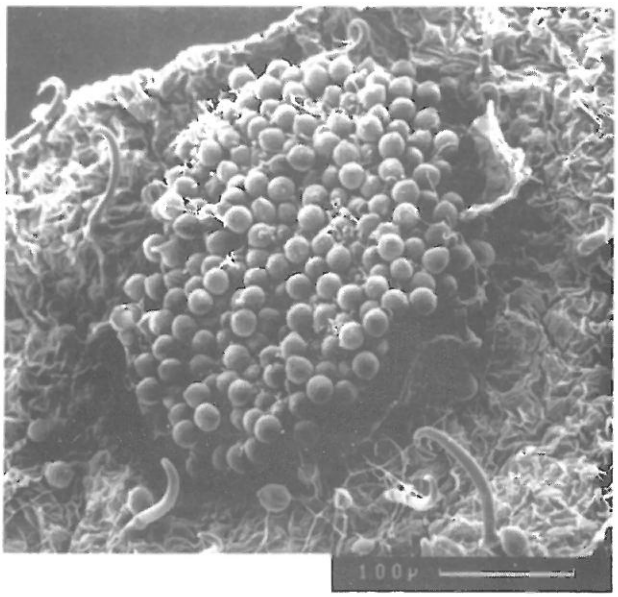
Species 134. *Uromyces anthyllidis*: uredinia and urediniospores.

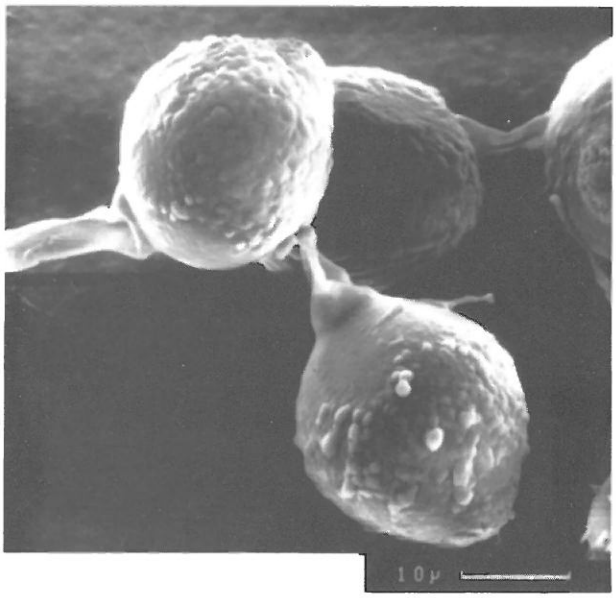




(See caption to photographs of telia and teliospores). Urediniospore surface: sparsely and finely echinulate (WH), sparsely echinulate (EE).

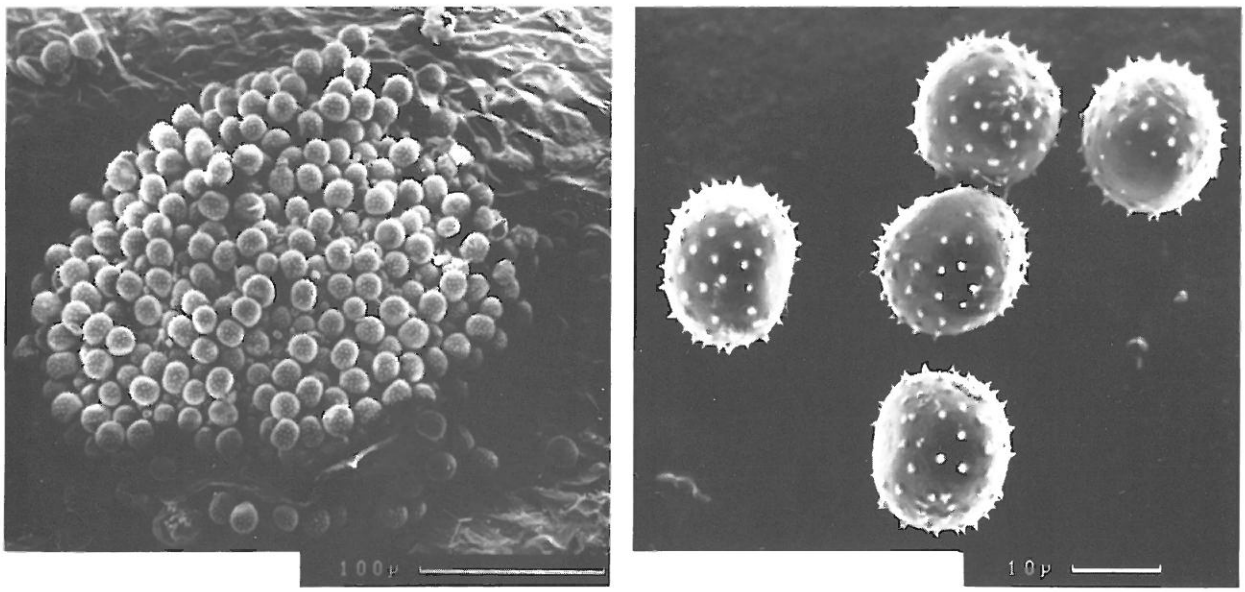
Species 135. *Uromyces appendiculatus*: telia and teliospores.





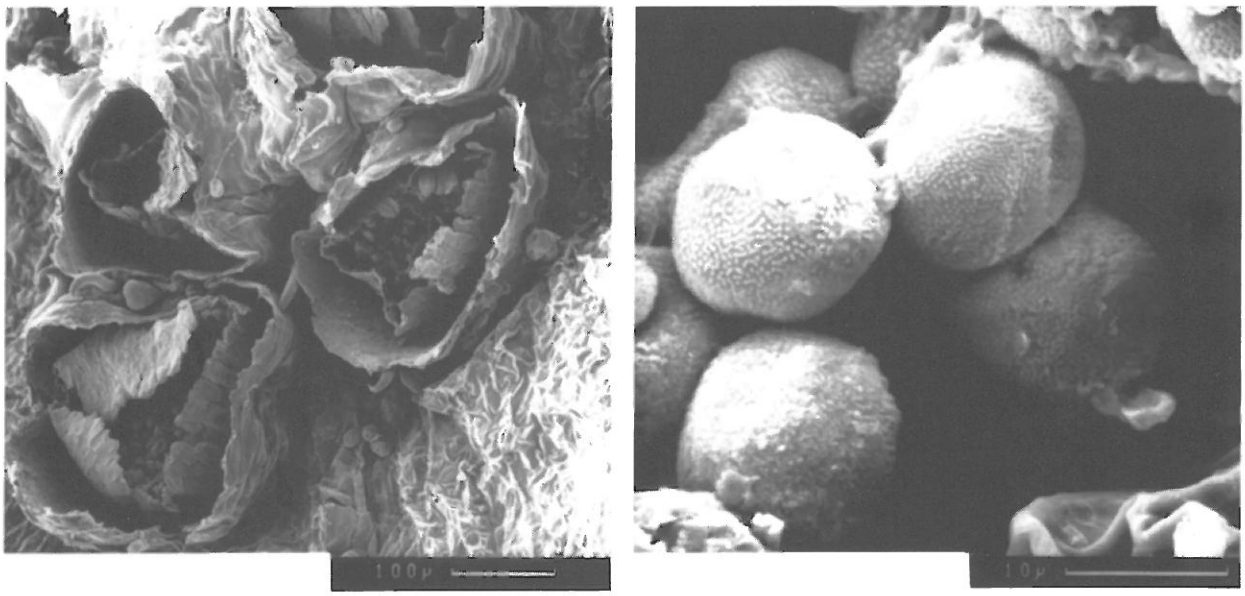
Yorks in B, 200. [AUT] on Phaseolus spp. Drawings of U and T in WH 321. Descriptions in EE 398. Photographs of U and T in CMID 57. Teliospore surface: smooth or rarely provided, especially near the apex, with a few hyaline warts (WH), smooth or slightly warted (EE), smooth or sparsely warted or striate (CMID).

Species 135. *Uromyces appendiculatus*: uredinia and urediniospores.



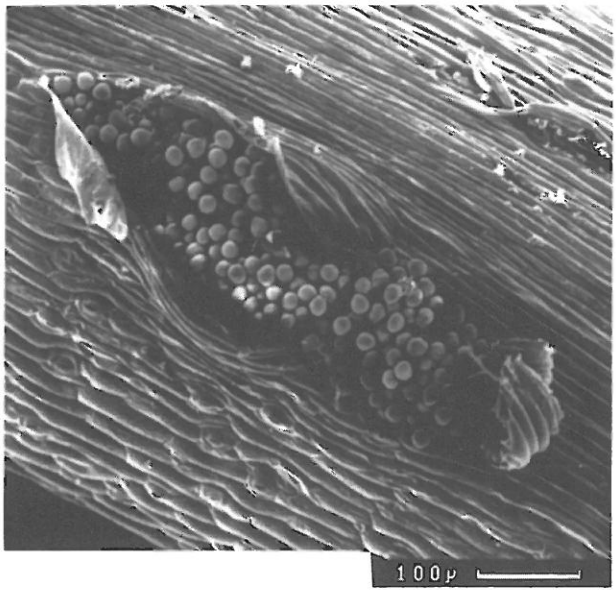
(See caption to photographs of telia and teliospores). Urediniospore surface: distantly but sharply echinulate (WH), echinulate (EE), finely echinulate (CMID).

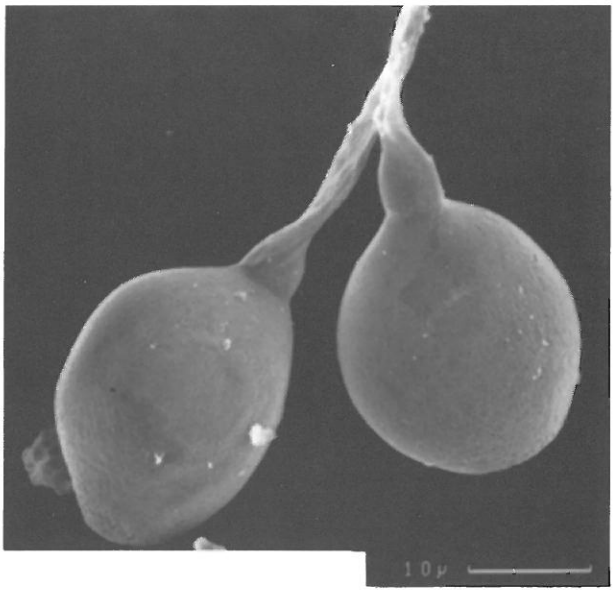
Species 135. *Uromyces appendiculatus*: aecia and aeciospores.



(See caption to photographs of telia and teliospores). Aeciospore surface: minutely verruculose (WH), verrucose (CMID).

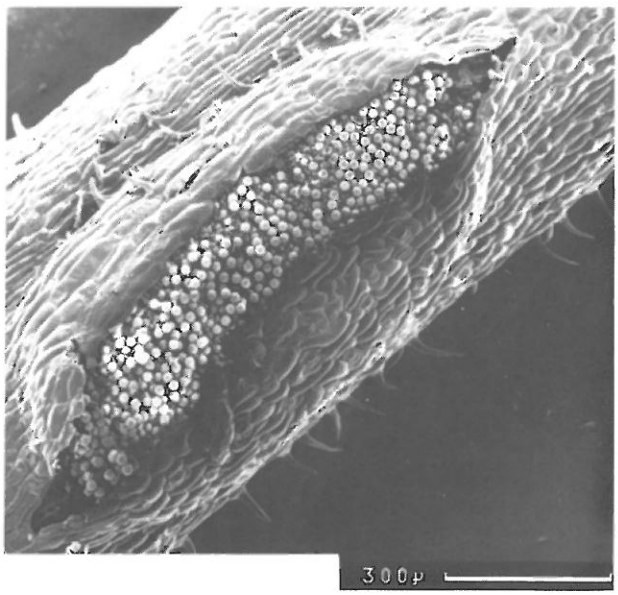
Species 136. *Uromyces armeriae*: telia and teliospores.

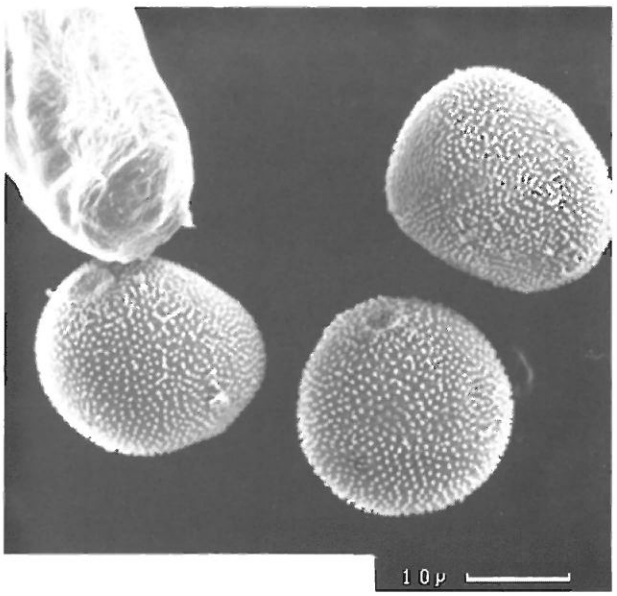




Yorks in B, 200. [AUT] on Armeria spp. Drawings of U and T in WH 345. Descriptions in EE 313. Teliospore surface: smooth (WH).

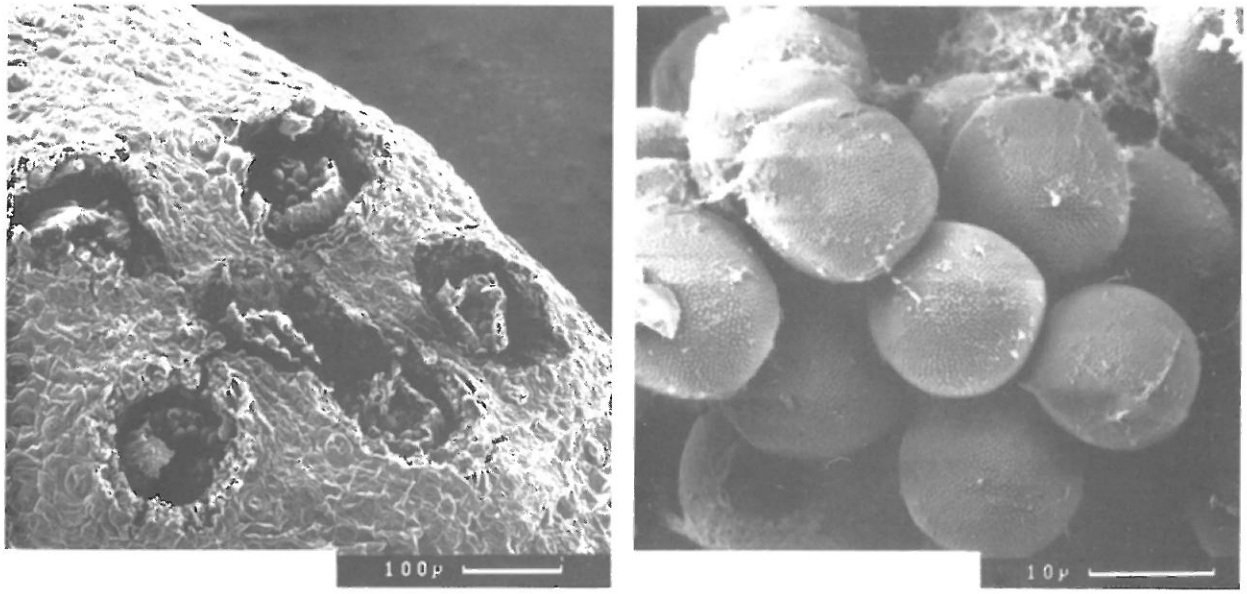
Species 136. *Uromyces armeriae*: uredinia and urediniospores.





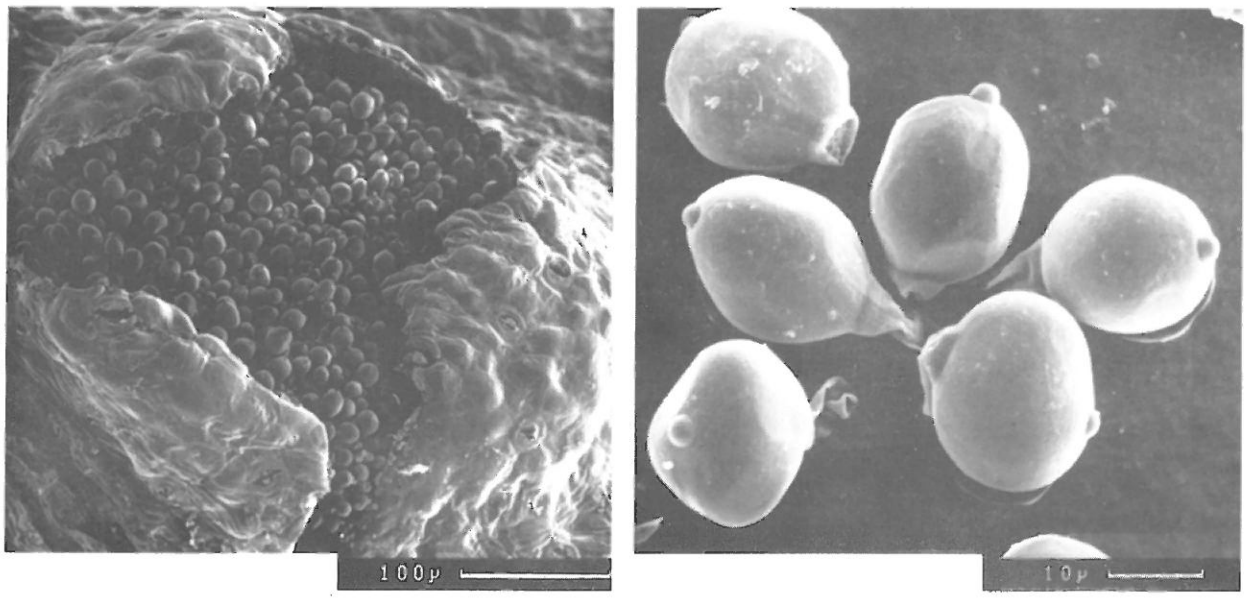
(See caption to photographs of telia and teliospores). Urediniospore surface: very densely and minutely verruculose (WH), minutely verruculose (EE).

Species 136. *Uromyces armeriae*: aecia and aeciospores.



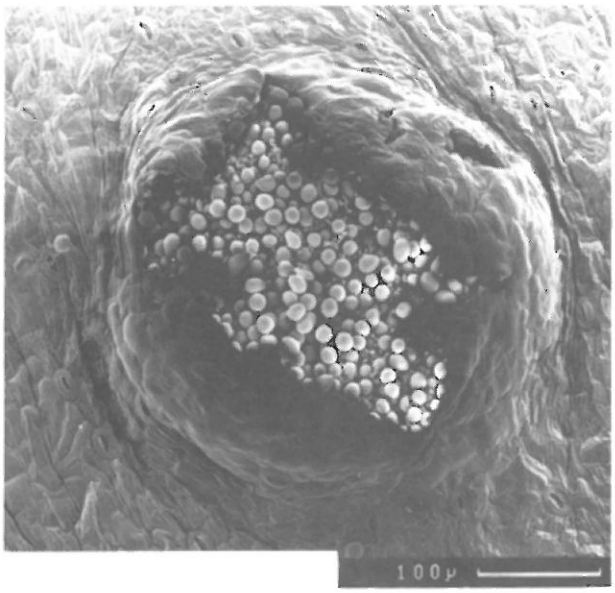
(See caption to photographs of telia and teliospores). Aeciospore surface: densely and minutely verruculose (WH).

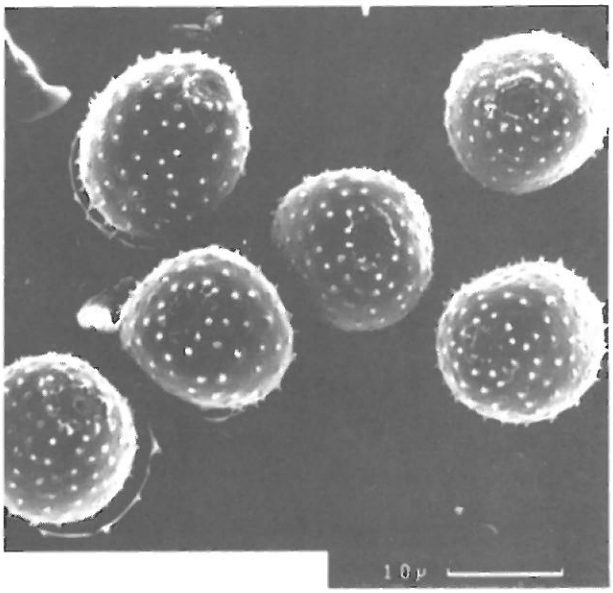
Species 137. *Uromyces betae*: telia and teliospores.



Yorks in B, 200. [AUT] on *Beta vulgaris*. Drawings of U on WH 315, and of U and T in CMID 177. Teliospore surface: smooth (WH, EE).

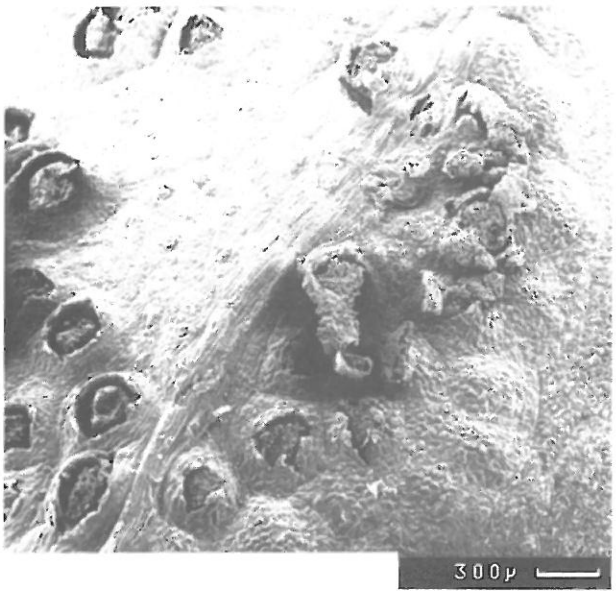
Species 137. *Uromyces betae*: uredinia and urediniospores.

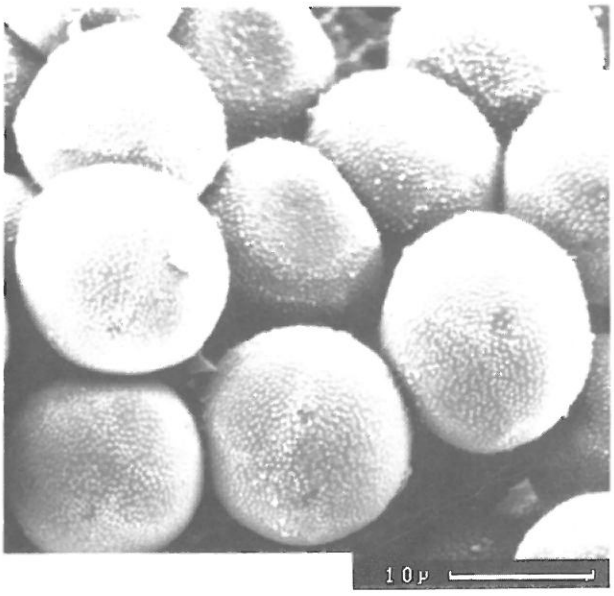




(See caption to photographs of telia and teliospores). Urediniospores surface: sparsely and minutely echinulate (WH), shortly echinulate (EE), echinulate (CMID).

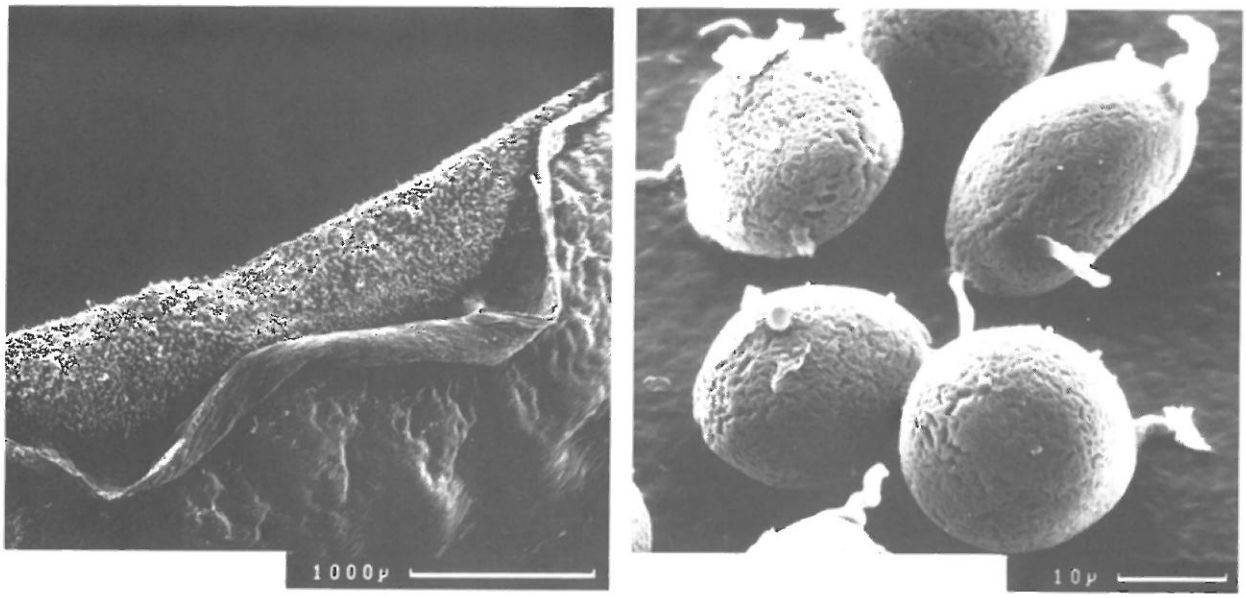
Species 137. *Uromyces betae*: aecia and aeciospores.





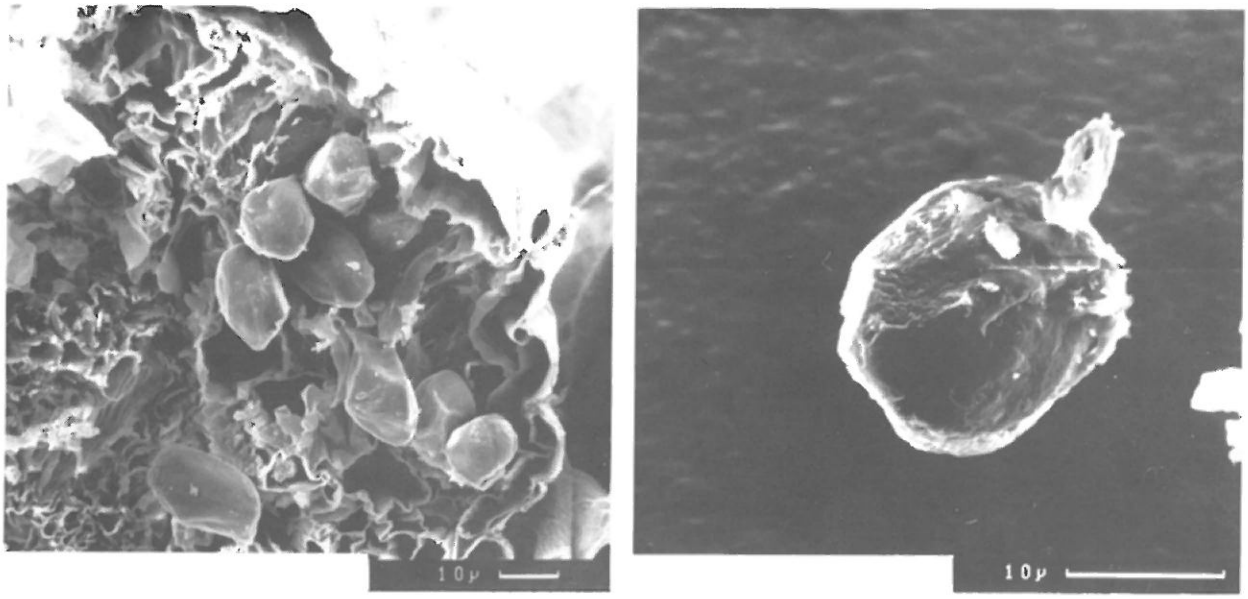
(See caption to photographs of telia and teliospores). Aeciospore surface: delicately verruculose (WH), finely verruculose (CMID).

Species 138. *Uromyces colchici*: telia and teliospores.



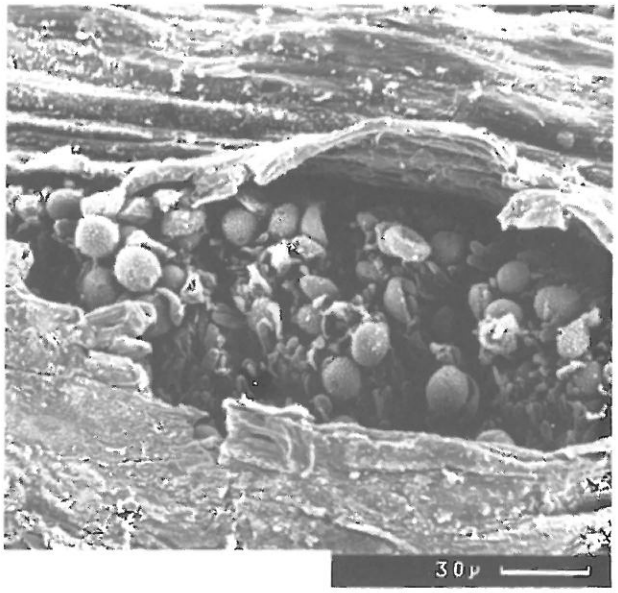
Yorks in B, 200. [T] on Colchicum spp. Description in WH 354 and EE 337. Teliospore surface: smooth (WH, EE)

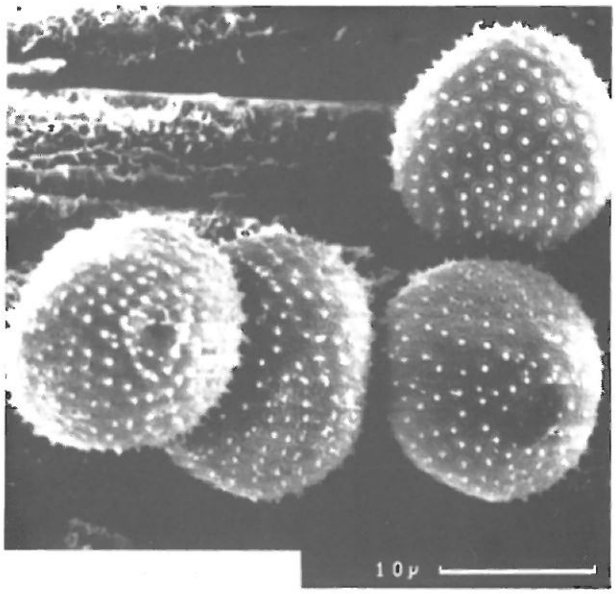
Species 139 *Uromyces dactylidis*: telia and teliospore.



Yorks in B, 200. [A] on Ranunculus spp. [UT] on, e.g. *Dactylis glomerata*. Drawings of U and T in WH 360. Description of A in EE 410 and of U and T in EE 452. Teliospore surface: smooth (WH).

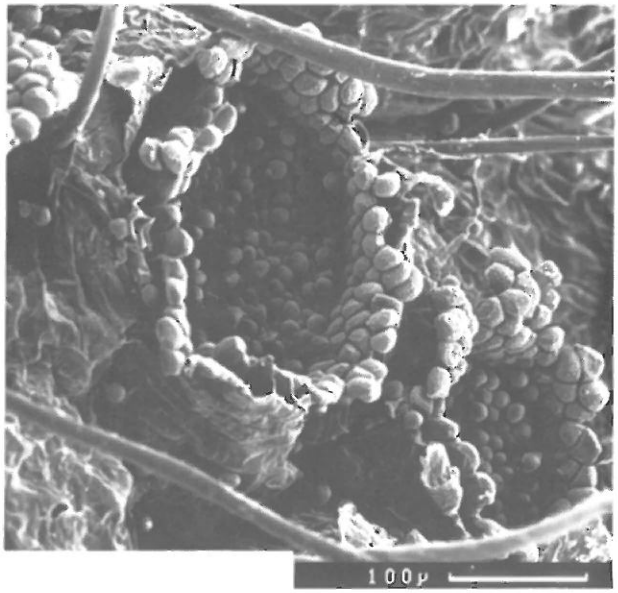
Species 139. *Uromyces dactylidis*: uredinia and urediniospores.

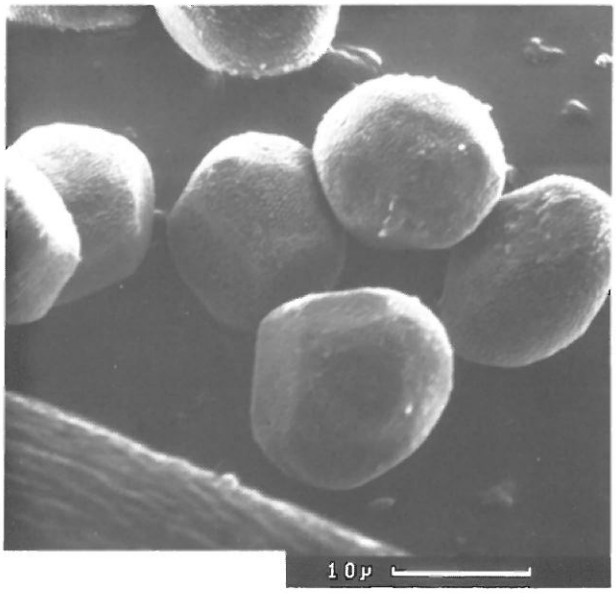




(See caption to photographs of telia and teliospores). Urediniospore surface: finely echinulate (WH, EE).

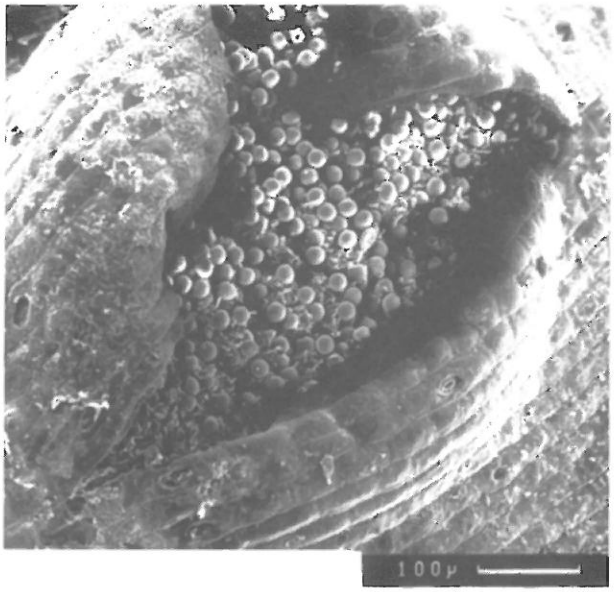
Species 139. *Uromyces dactylidis*: aecia and aeciospores.

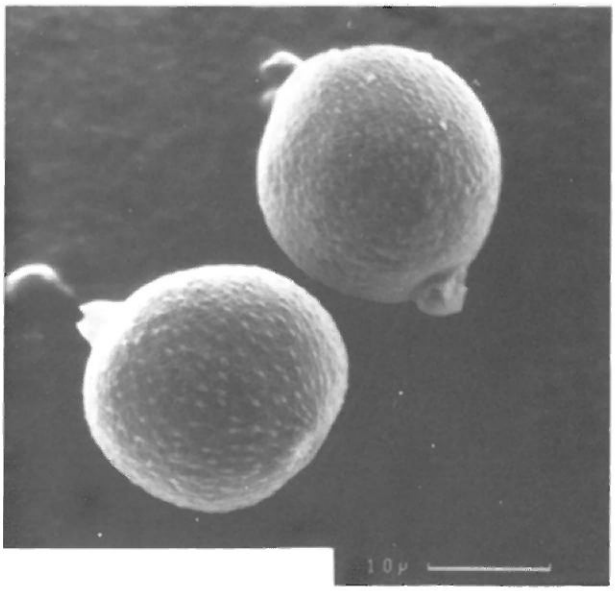




(See caption to photographs of telia and teliospores). Aeciospore surface: finely verruculose (WH), minutely verruculose (EE).

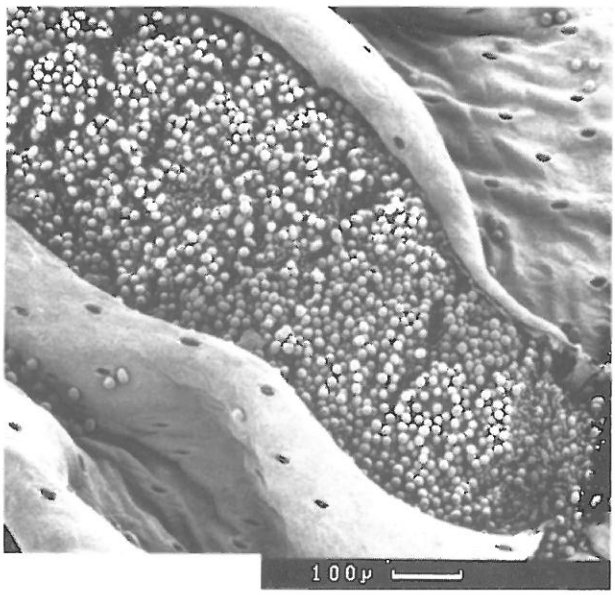
Species 140. *Uromyces dianthi*: telia and teliospores.

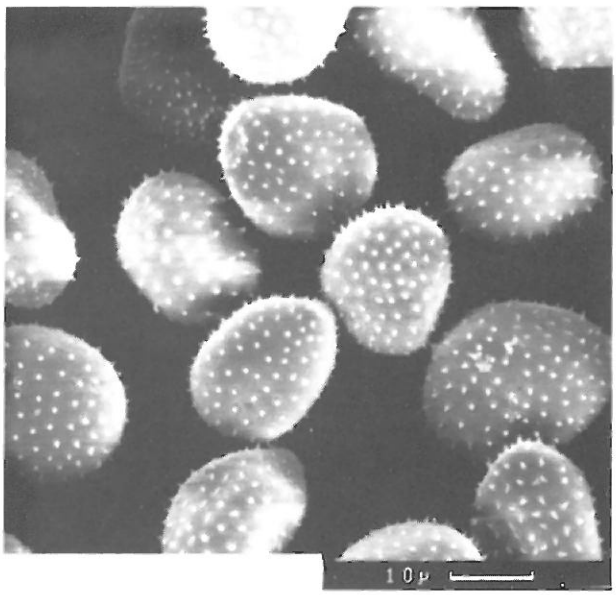




Yorks in B, 200. [UT] on, e.g. Dianthus spp. Drawings of U and T in WH 313 and CMID 180. Descriptions of U and T in EE 343. Teliospore surface: densely and minutely echinulate (WH), finely verrucose (CMID).

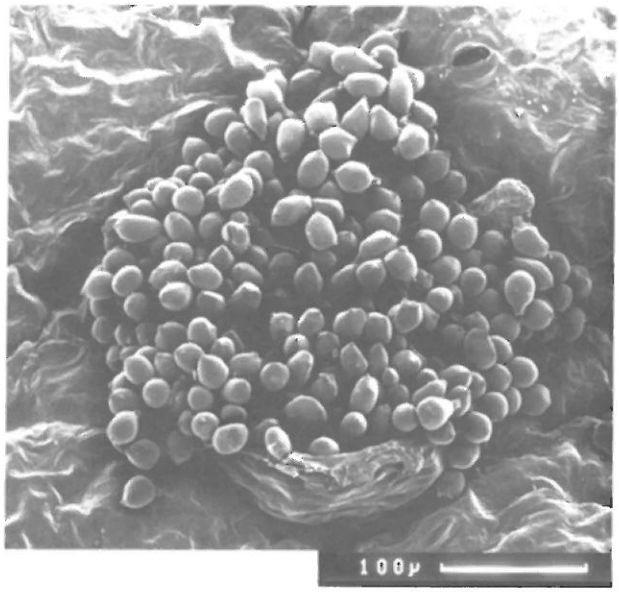
Species 140. *Uromyces dianthi*: uredinia and urediniospores.

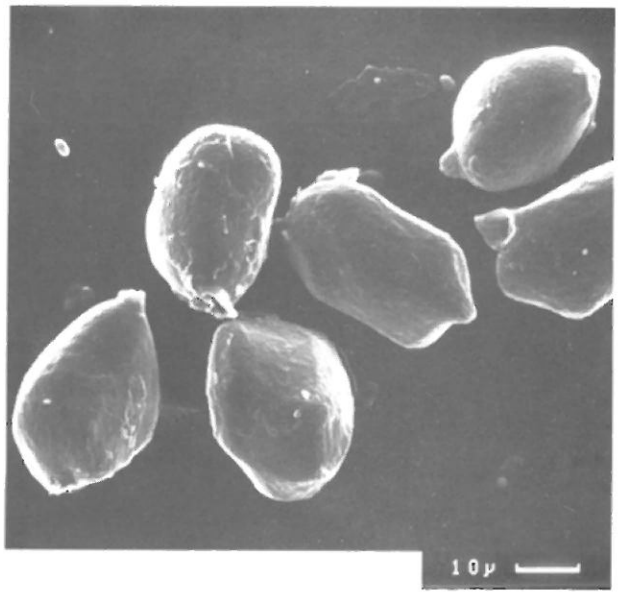




(See caption to photographs of telia and teliospores). Urediniospore surface: sparsely echinulate (WH), echinulate (EE),strongly echinulate (CMID).

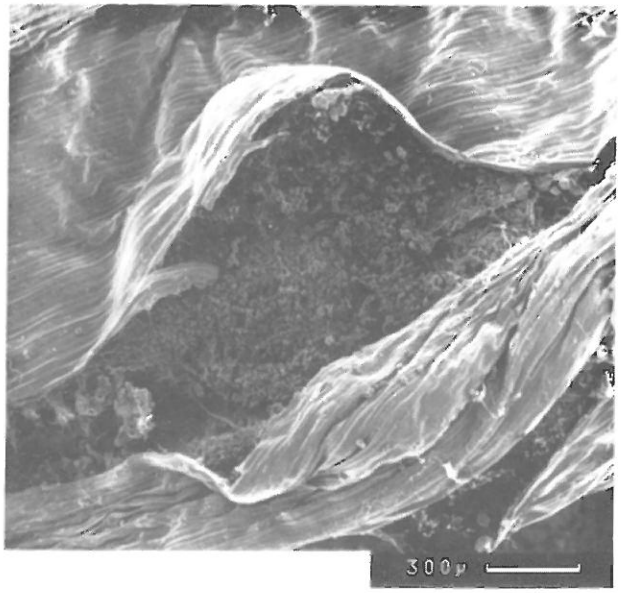
Species 141. *Uromyces ficariae*: telia and teliospores.

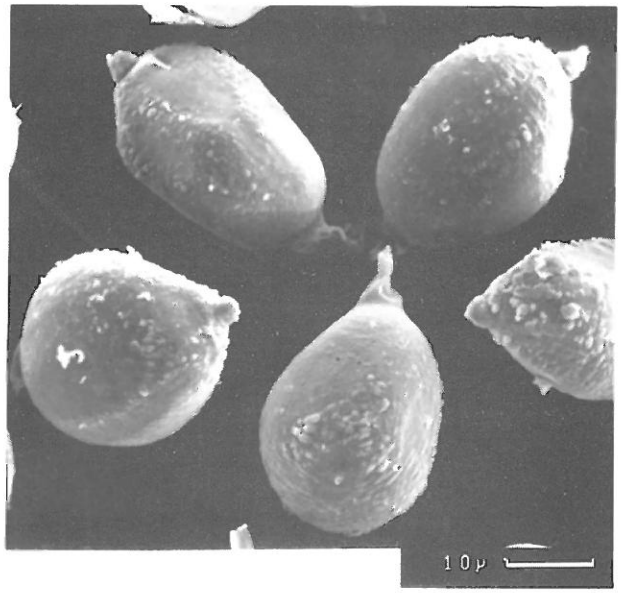




Yorks in B, 200. [T] on *Ranunculus ficaria*. Drawings of T in WH 310 and Fig. 1635 in EE. Description in EE 410. Teliospore surface: smooth (WH, EE).

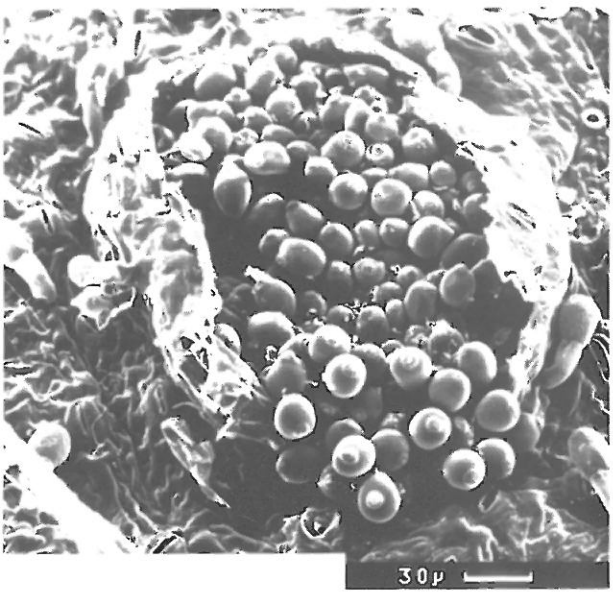
Species 142. *Uromyces gageae*: telia and teliospores.

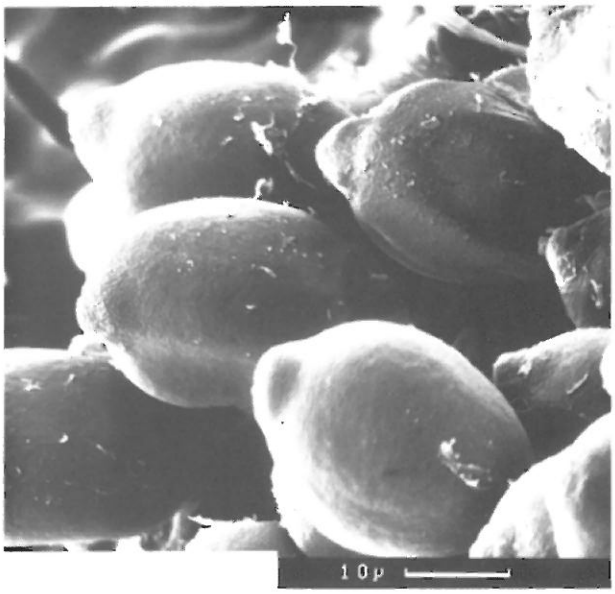




Yorks in B, 200 [T] on *Gagea lutea*. Descriptions of T in WH 351, and EE 359. Teliospore surface; smooth (WH, EE).

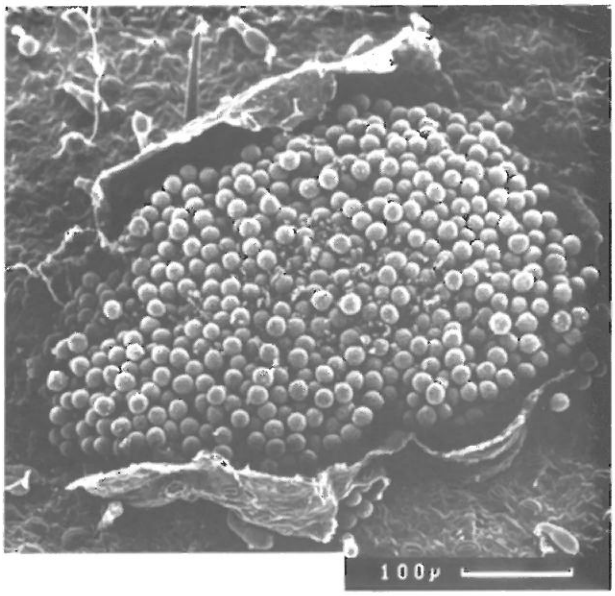
Species 143. *Uromyces geranii*: telia and teliospores.

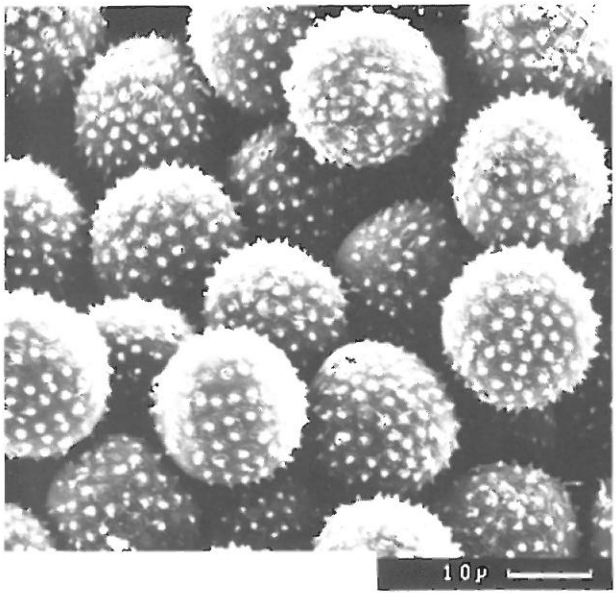




Yorks in B, 200 [AUT] on Geranium spp. Drawings of U and T in WH 318. Photograph of U and T in CMID 270. Descriptions in EE 363. Teliospore surface: smooth (WH, EE).

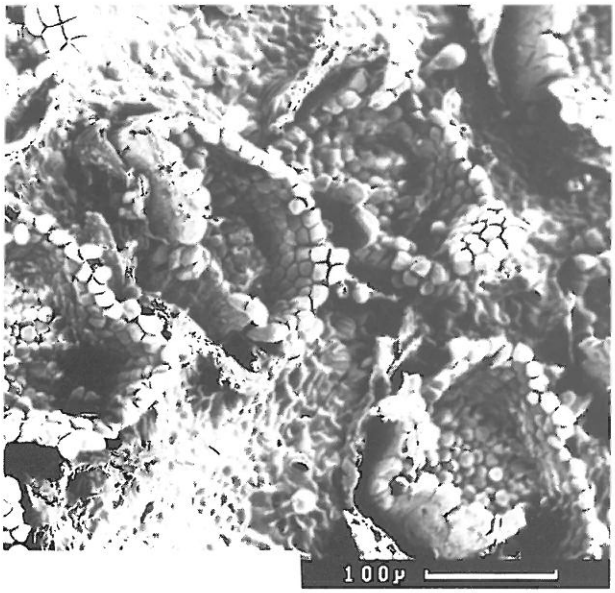
Species 143. *Uromyces geranii*: uredinia and urediniospores.

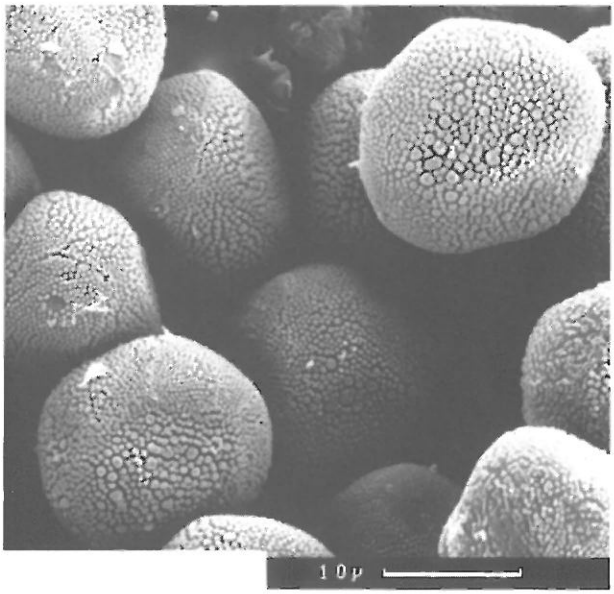




(See caption to photographs of telia and teliospores). Urediniospore surface: sparsely echinulate (WH, CMID), minutely echinulate (EE).

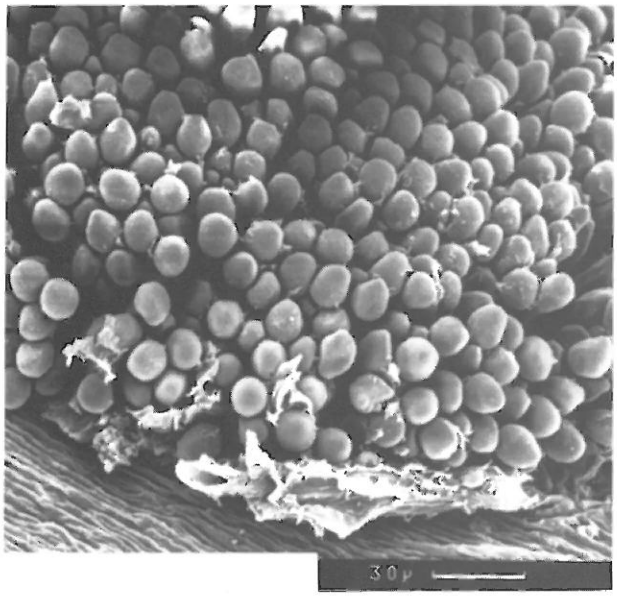
Species 143; *Uromyces geranii*: aecia and aeciospores.

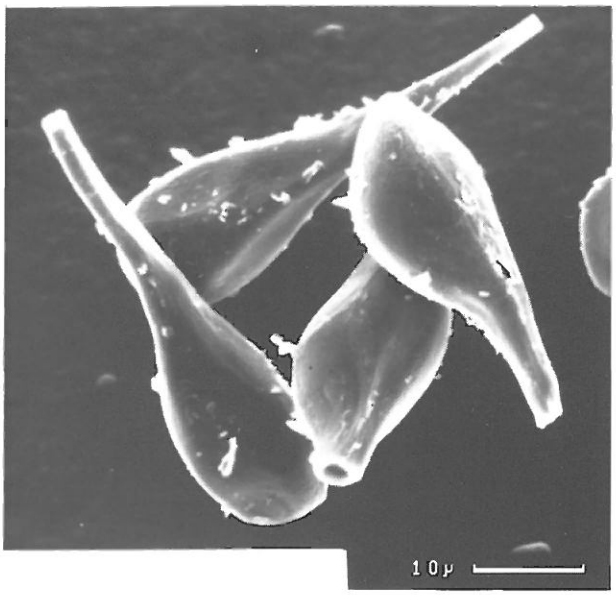




(See caption to photographs of telia and teliospores). Aeciospore surface: densely and minutely verruculose (WH), densely and minutely verrucose (CMID).

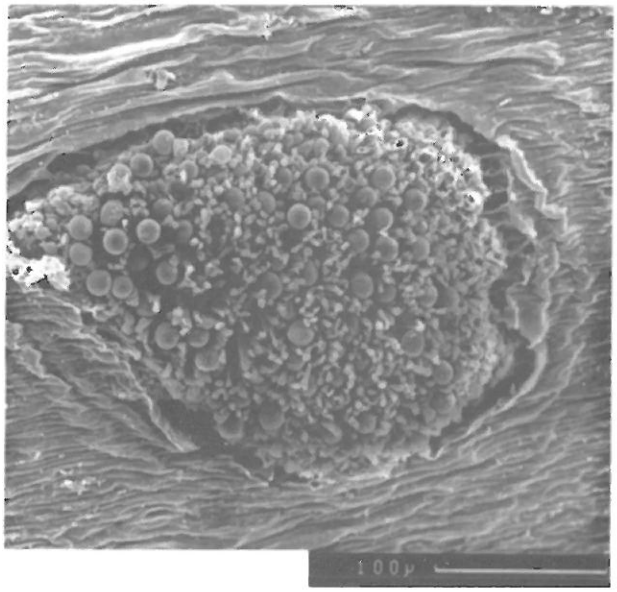
Species 144. *Uromyces junci*: telia and teliospores.

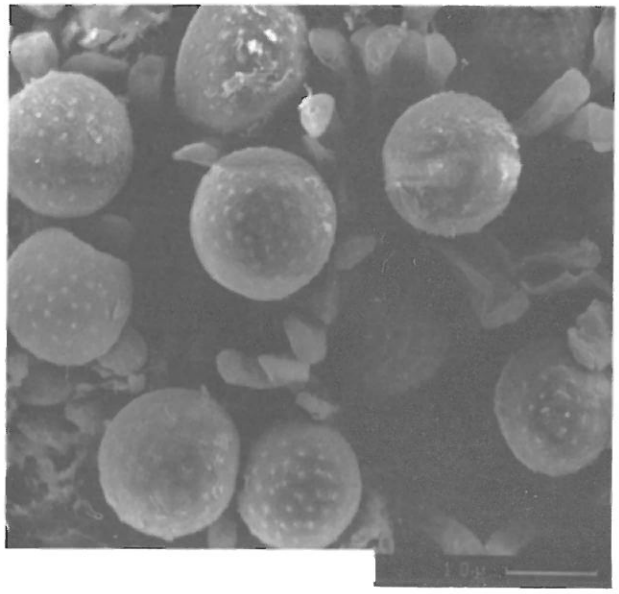




Yorks in B, 200. [A] on *Pulicaria dysenterica*. [UT] on Juncus spp. Drawing of U and T on Juncus spp. Drawing of U and T in WH 355. Description of A in EE 409 and U T in EE 545. Teliospore surface: smooth (WH, EE).

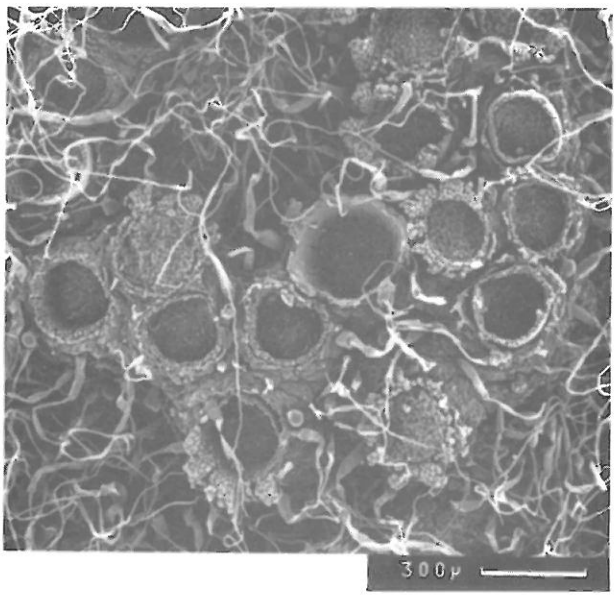
Species 144. *Uromyces junci*: uredinia and urediniospores.

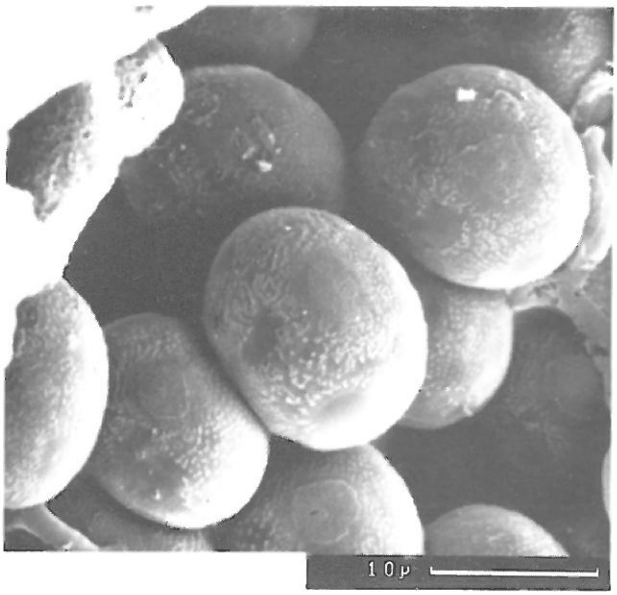




(See caption to photographs of telia and teliospores). Urediniospore surface: faintly echinulate (WH), finely echinulate (EE).

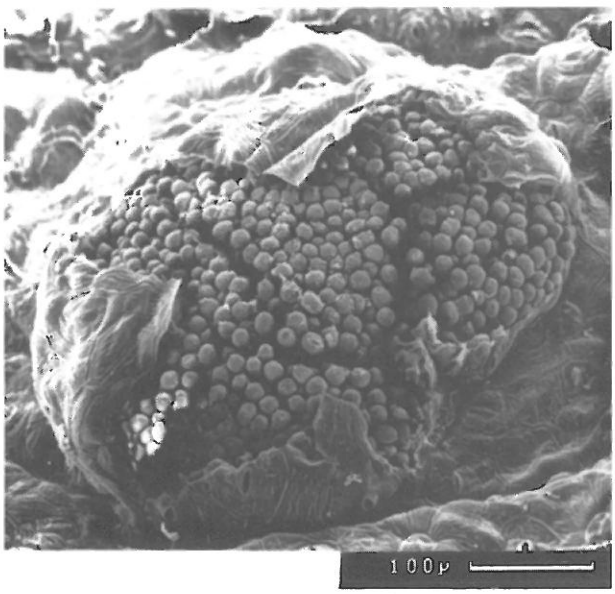
Species 144. *Uromyces junci*: aecia and aeciospores.

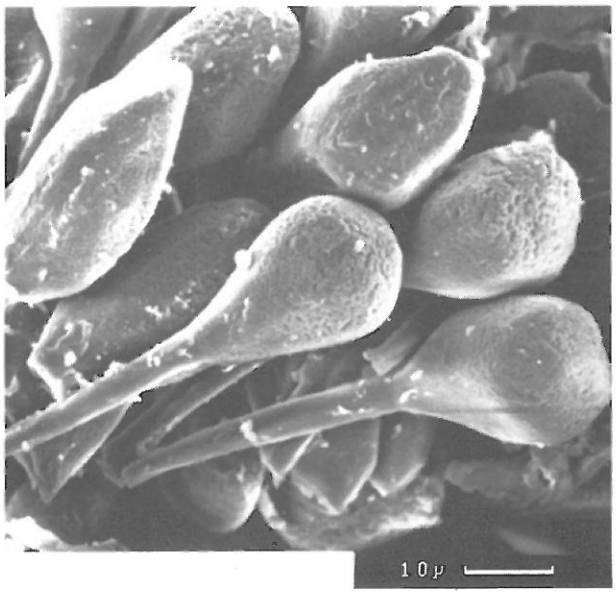




(See caption to photographs of telia and teliospores). Aeciospore surface: densely and minutely verruculose (WH), finely verruculose (EE).

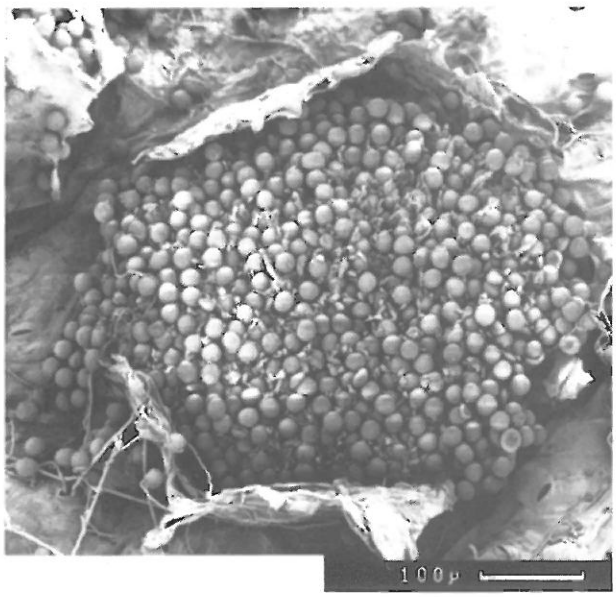
Species 145. *Uromyces limonii*: telia and teliospores.

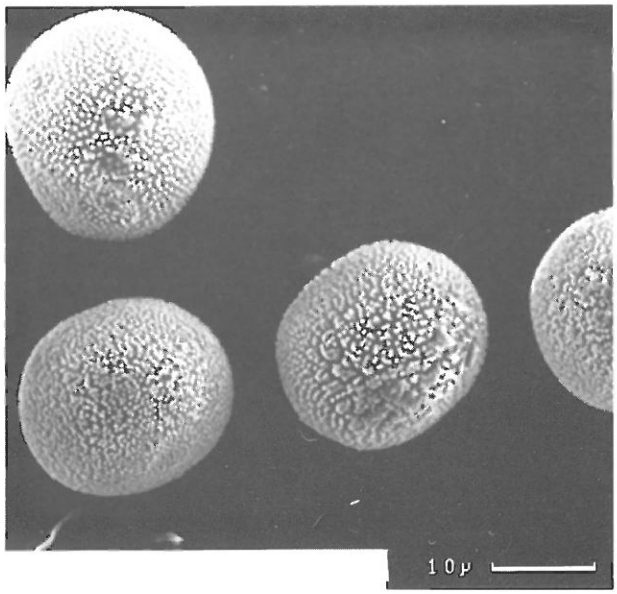




Yorks in B, 200 [AUT] on Limonium spp. Drawings of U and T in WH 346. Descriptions in EE 379. Teliospore surface: smooth (WH, EE).

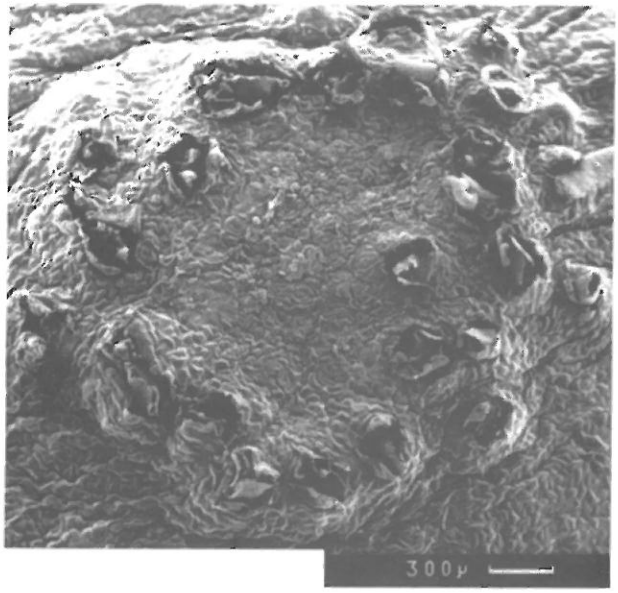
Species 145. *Uromyces limonii*: uredinia and urediniospores.

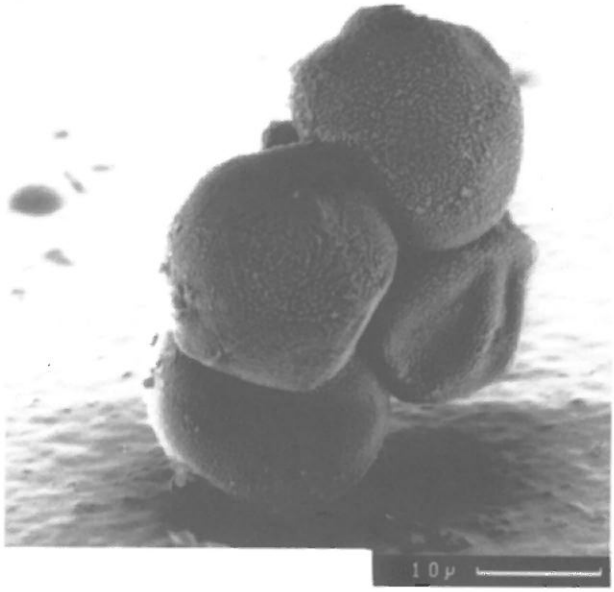




(See caption to photographs of telia and teliospores). Urediniospore surface: densely verruculose (WH), verruculose (EE).

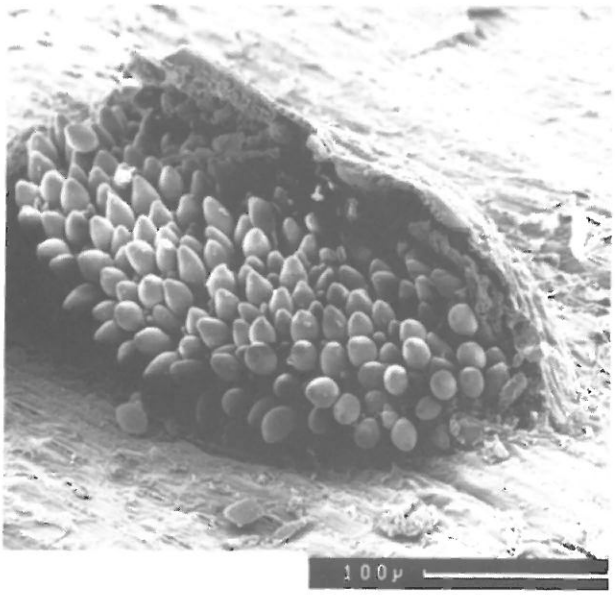
Species 145. *Uromyces limonii*: aecia and aeciospores.

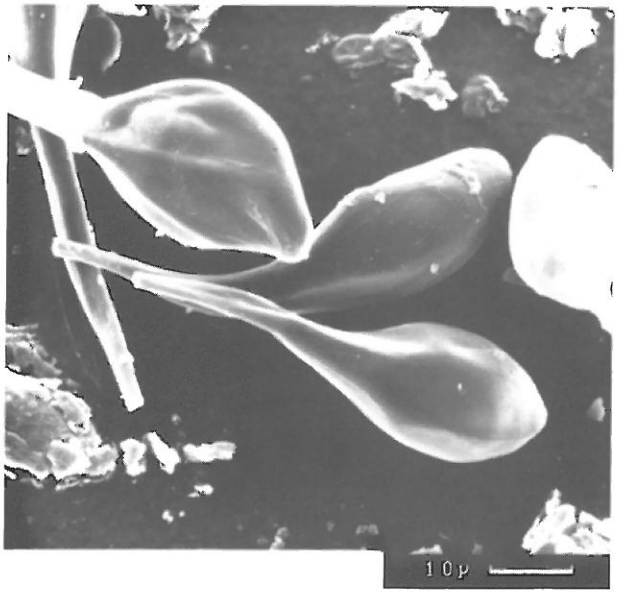




(See caption to photographs of telia and teliospores). Aeciospore surface: densely and minutely verruculose (WH).

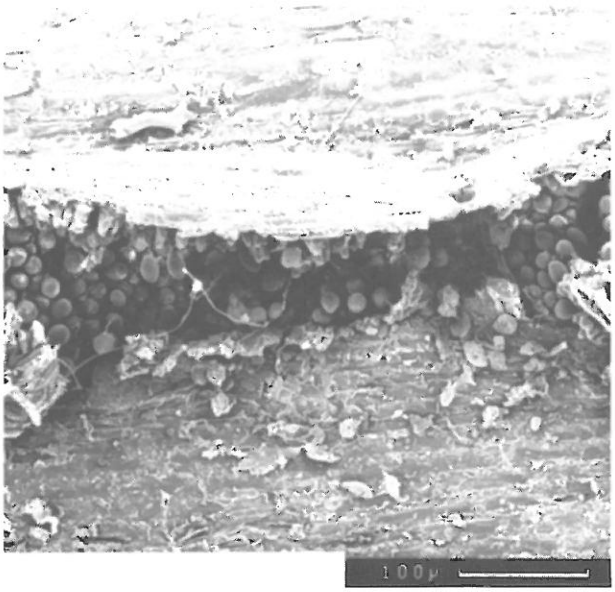
Species 146. *Uromyces lineolatus*: telia and teliospores.

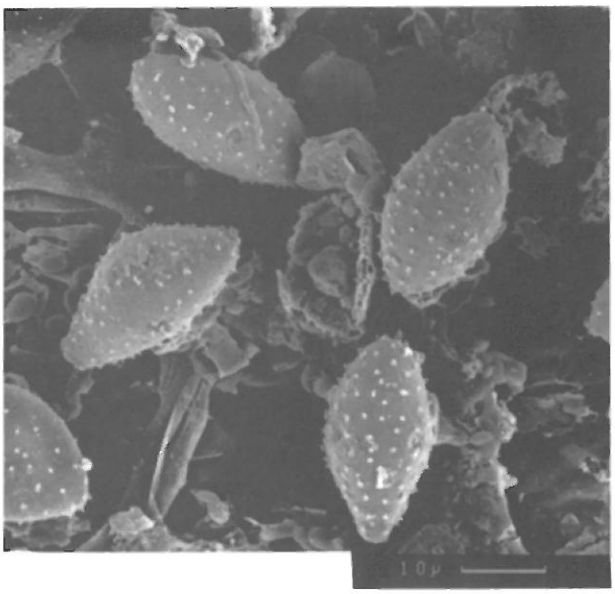




Yorks in B, 200. [A] e.g. on *Oenanthe crocata*. [UT] on *Scirpus maritimus*. Drawings of U and T in WH 358. Descriptions of U and T in EE 557. Teliospore surface: smooth (WH, EE).

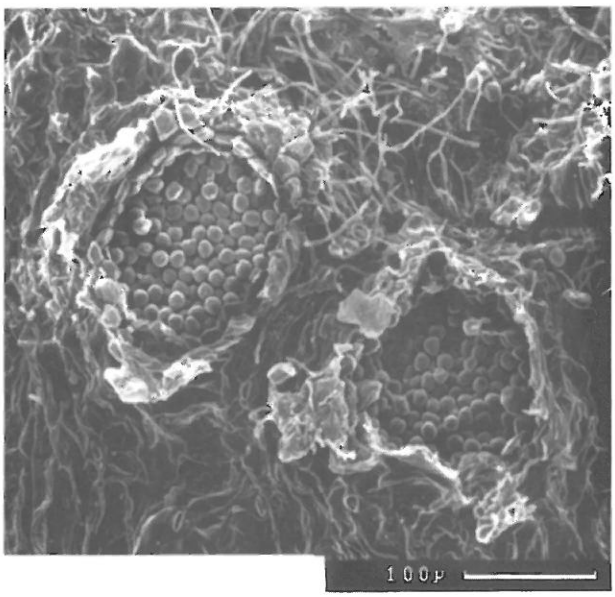
Species 146. *Uromyces lineolatus*: uredinia and urediniospores.

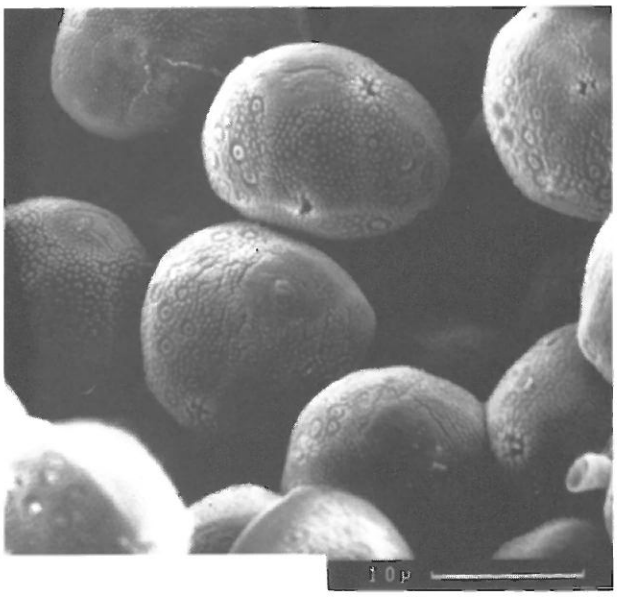




(See caption to photographs of telia and teliospores). Urediniospore surface: distantly and minutely echinulate (WH), minutely echinulate (EE).

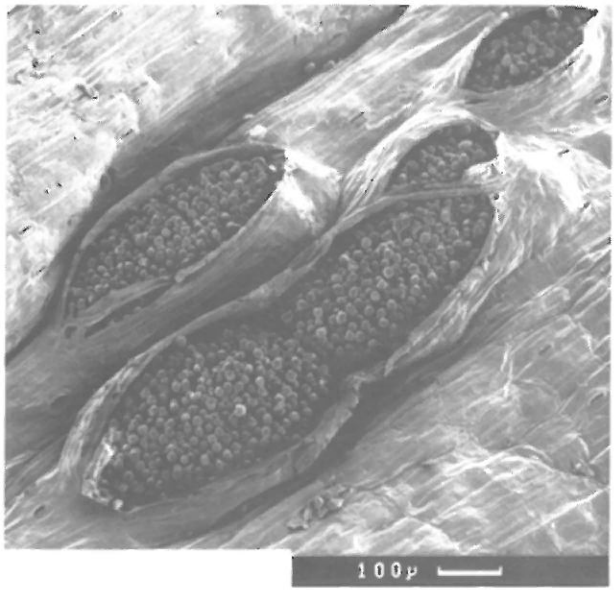
Species 146. *Uromyces lineolatus*: aecia and aeciospores.

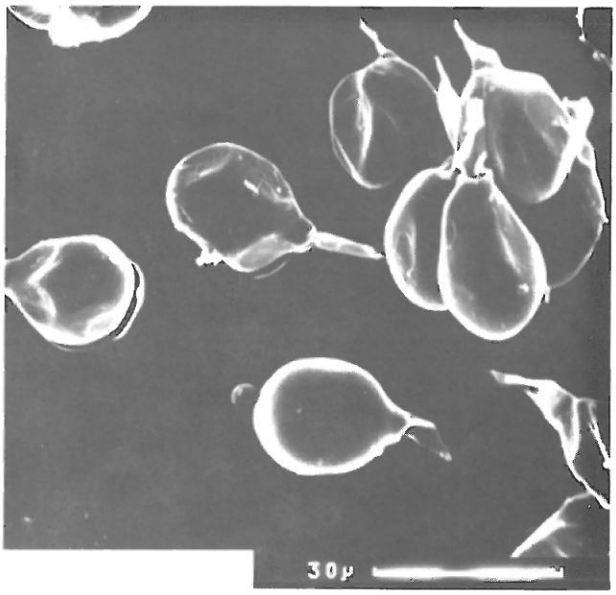




(See caption to photographs of telia and teliospores). Aeciospore surface: densely and minutely verruculose (WH).

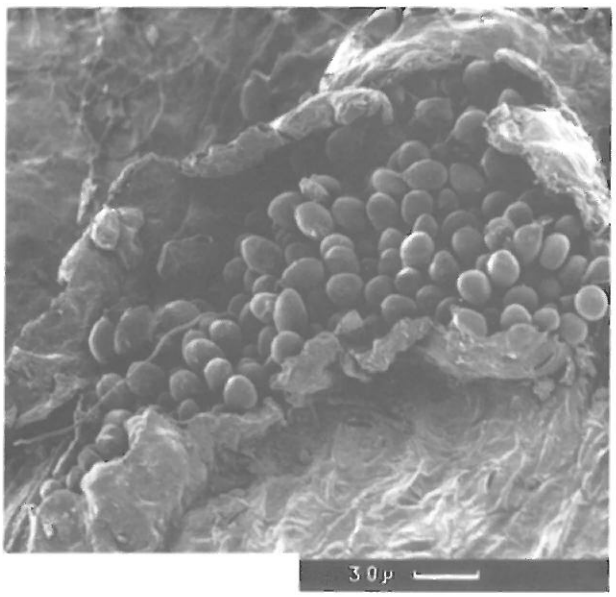
Species 147. *Uromyces muscari*: telia and teliospores.

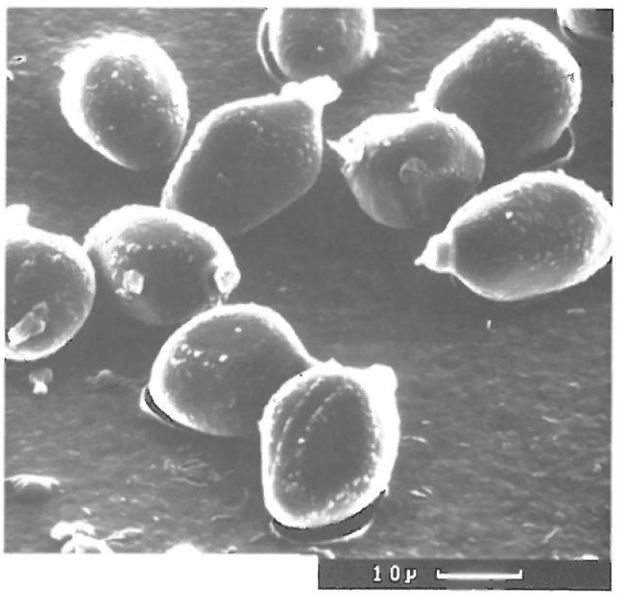




Yorks in B, 200. T on, e.g. *Endymion non-scriptus*. Drawing of T on WH 353. Description of T on EE 346. Teliospore surface: smooth (WH).

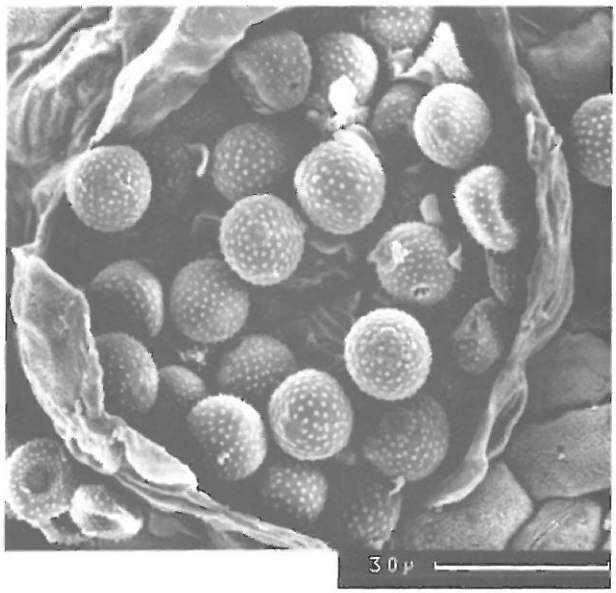
Species 148. *Uromyces nerviphilus*: telia and teliospores.

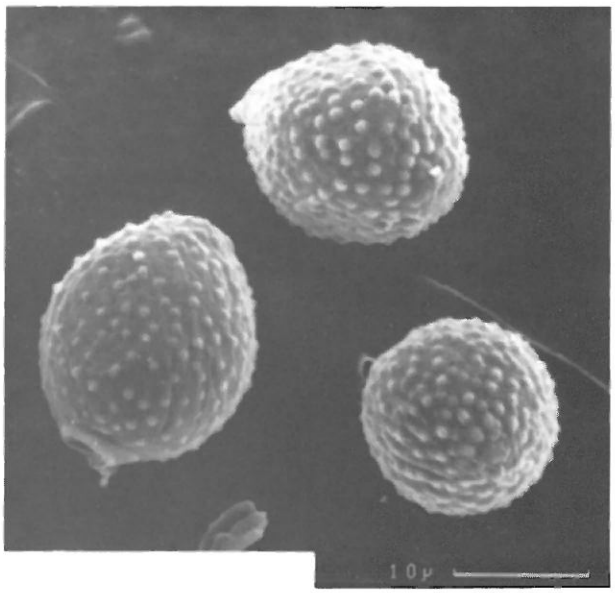




Yorks in B, 200. T on Trifolium spp. Drawings of T on WH 328. Teliospore surface: smooth or with a few minute warts arranged more or less in a line (WH).

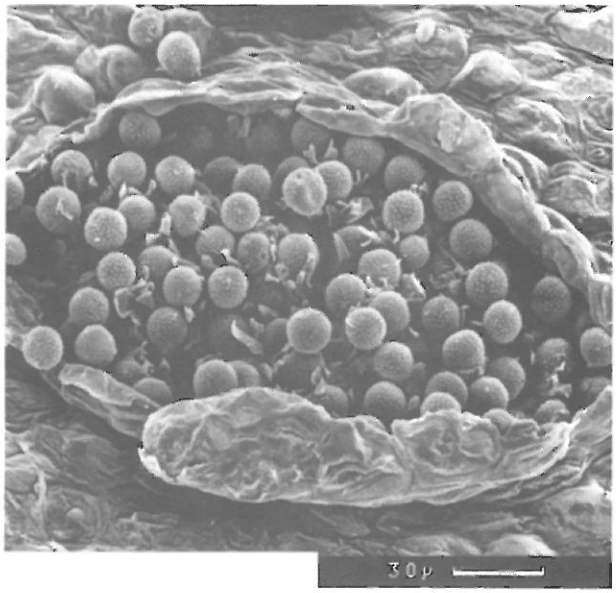
Species 149. *Uromyces pisi*: telia and teliospores.

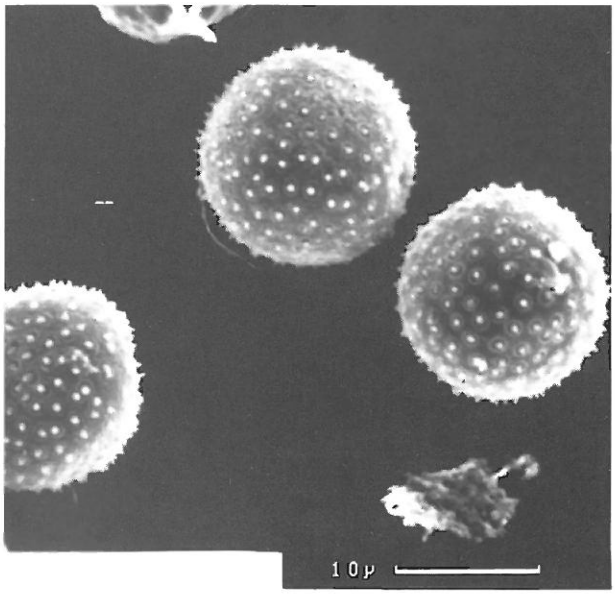




Yorks in B, 200. [A] on *Euphorbia cyparissias*. [UT] on, e.g. *Pisum sativum*. Drawings of U and T in WH 330. Photographs of U and T in CMID 58 (as *U.pisi-sativi*).
Descriptions (also of *U.pisi-sativi*) in EE 353 (A) and EE 400 (UT). Teliospore surface: everywhere verrucose, with usually elongate warts, scattered or more or less in lines (WH), finely verruculose, sometimes appearing somewhat striate (EE). Finely warted (CMID).

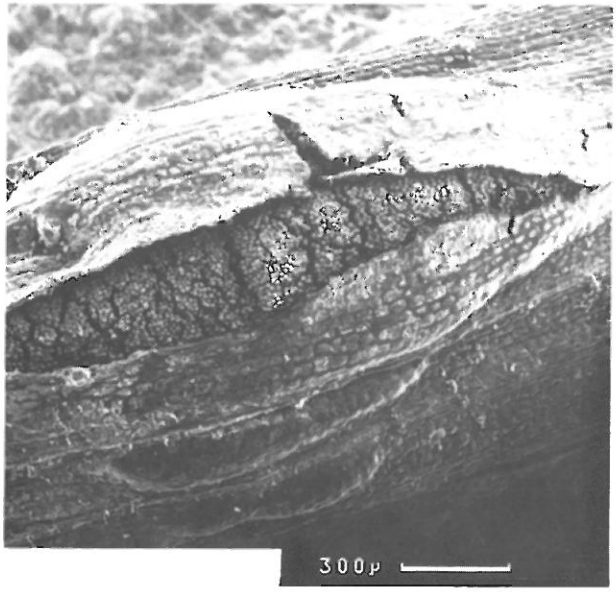
Species 149. *Uromyces pisi*: uredinia and urediniospores.

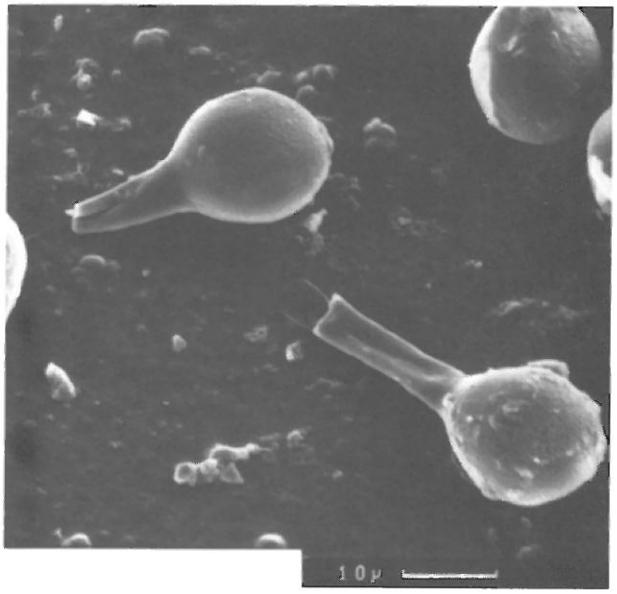




(See caption to photographs of telia and teliospores). Urediniospore surface: minutely verruculose (WH), finely verruculose (EE),very finely echinulate (CMID).

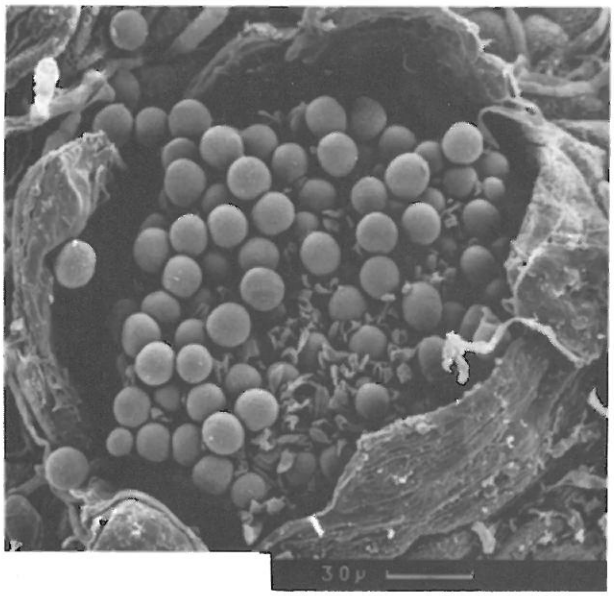
Species 150. *Uromyces polygoni-aviculare*: telia and teliospores.

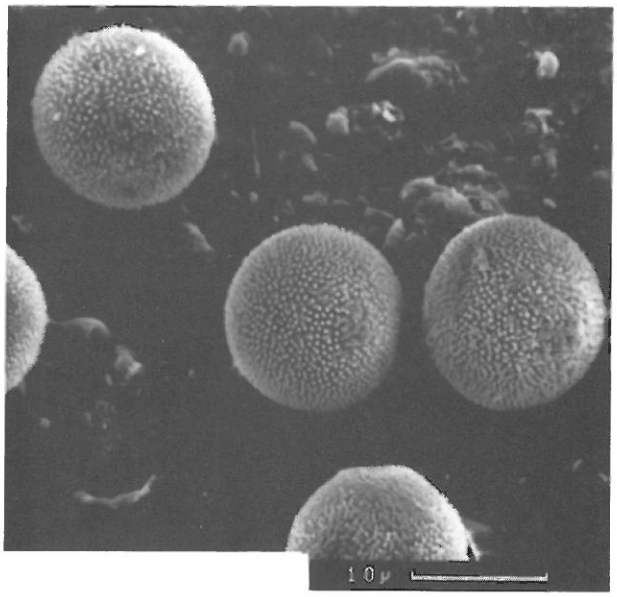




Yorks in B, 201. [AUT] on, e.g. *Polygonum aviculare*. Drawings of U and T in WH 342. Descriptions in EE 403. Teliospore surface: smooth (WH, EE).

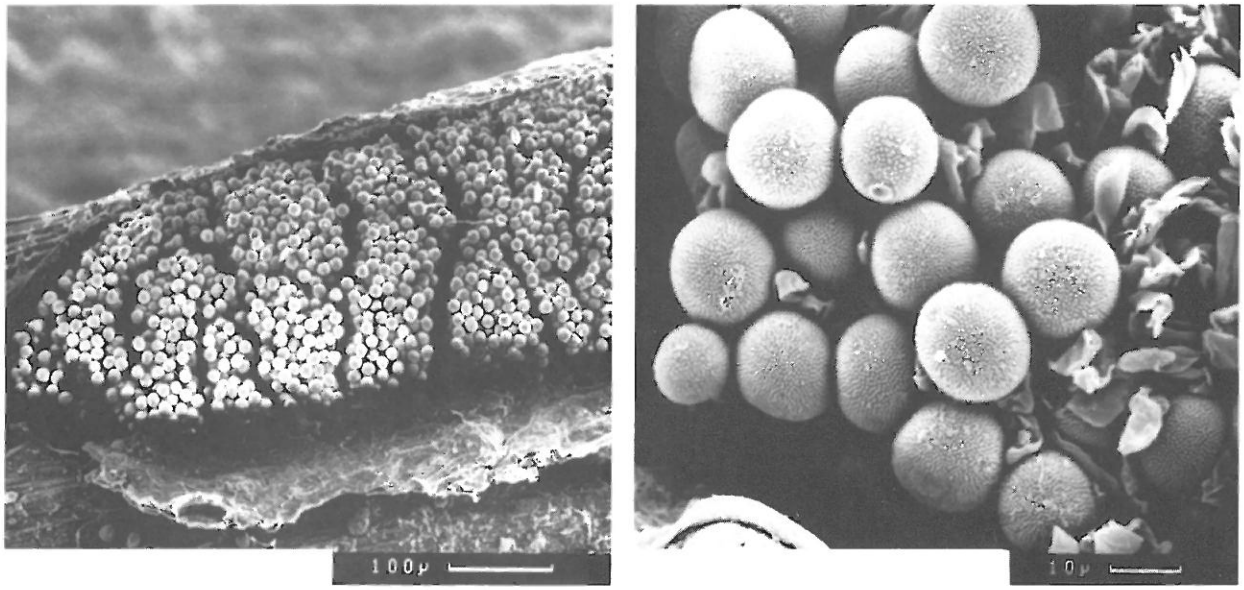
Species 150. *Uromyces polygoni-aviculare*: uredinia and urediniospores.





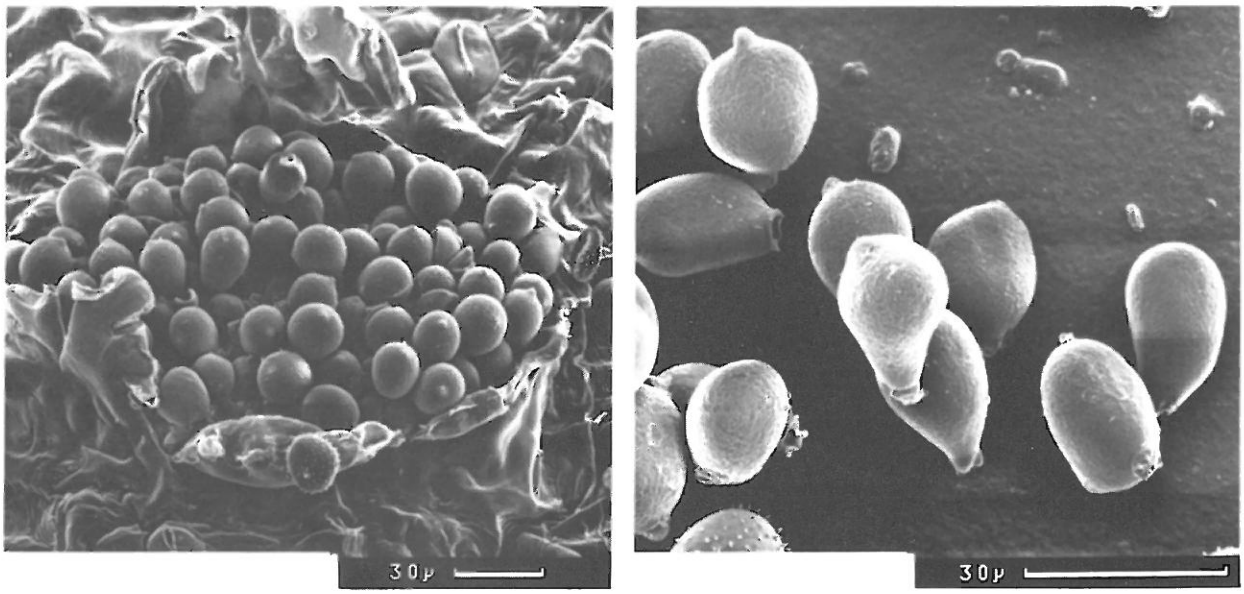
(See caption to photographs of telia and teliospores). Urediniospore surface: densely and minutely verruculose (WH), minutely verruculose (EE).

Species 150. *Uromyces polygoni-aviculare*: aecia and aeciospores.



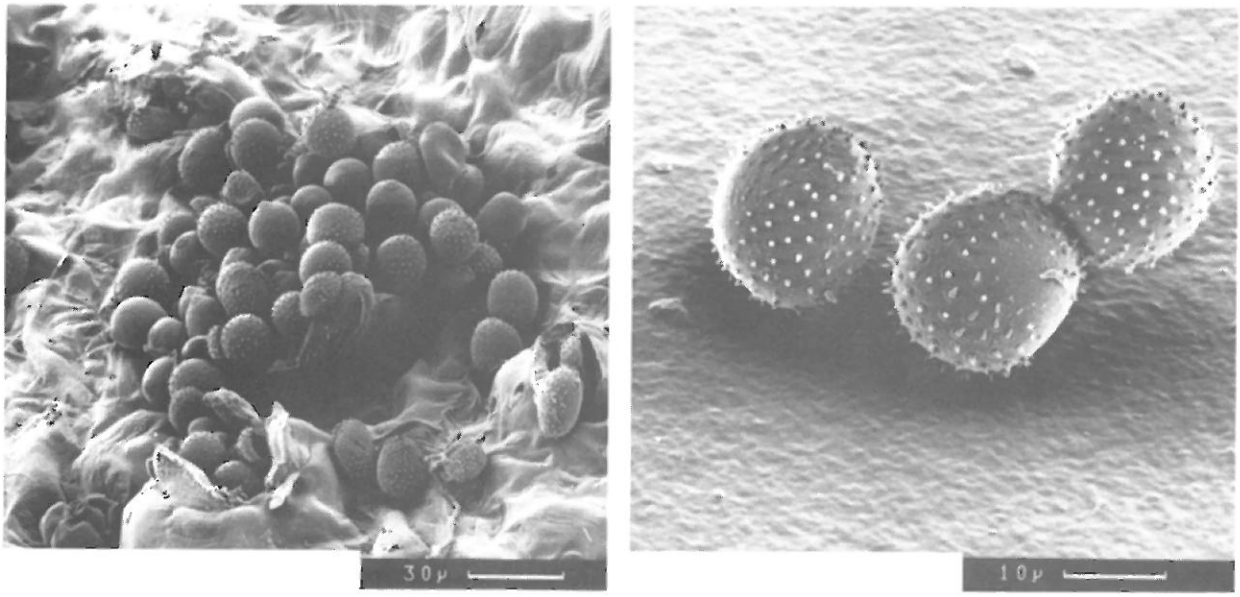
(See caption to photographs of telia and teliospores). Aeciospore surface: verruculose (WH).

Species 151. *Uromyces rumicis*: telia and teliospores.



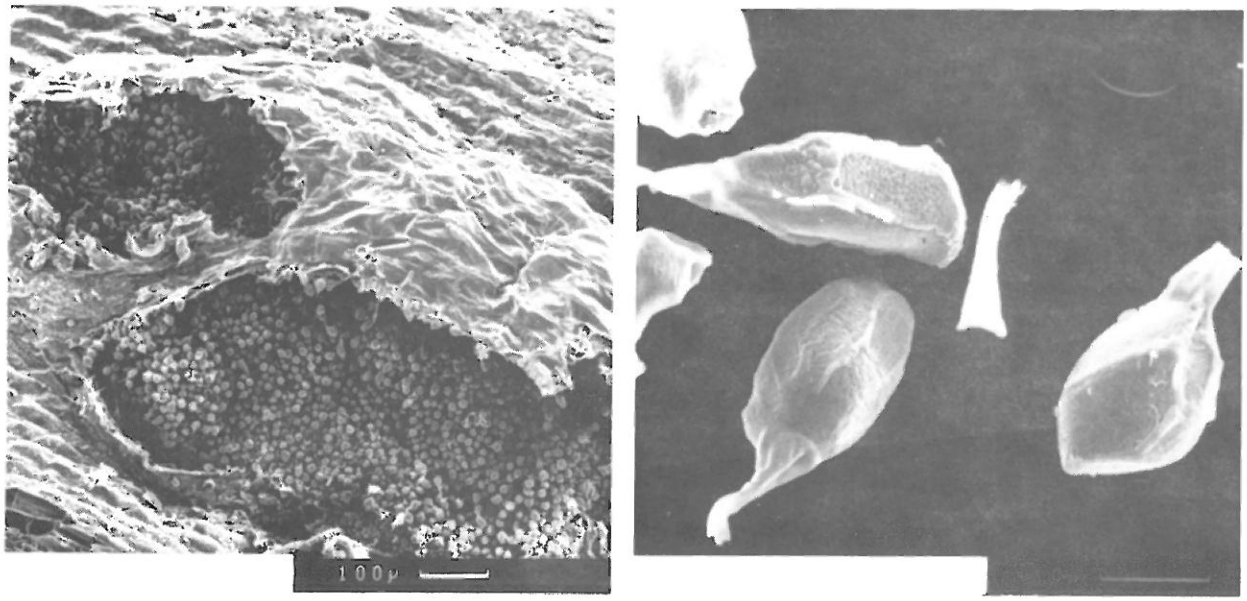
Yorks in B, 201. [UT] on Rumex spp. Drawings of U and T in WH 343. Description of A in EE 410 and UT in EE 415. Teliospore surface: smooth or nearly so (WH), smooth (EE).

Species 151. *Uromyces rumicis*: uredinia and urediniospores.



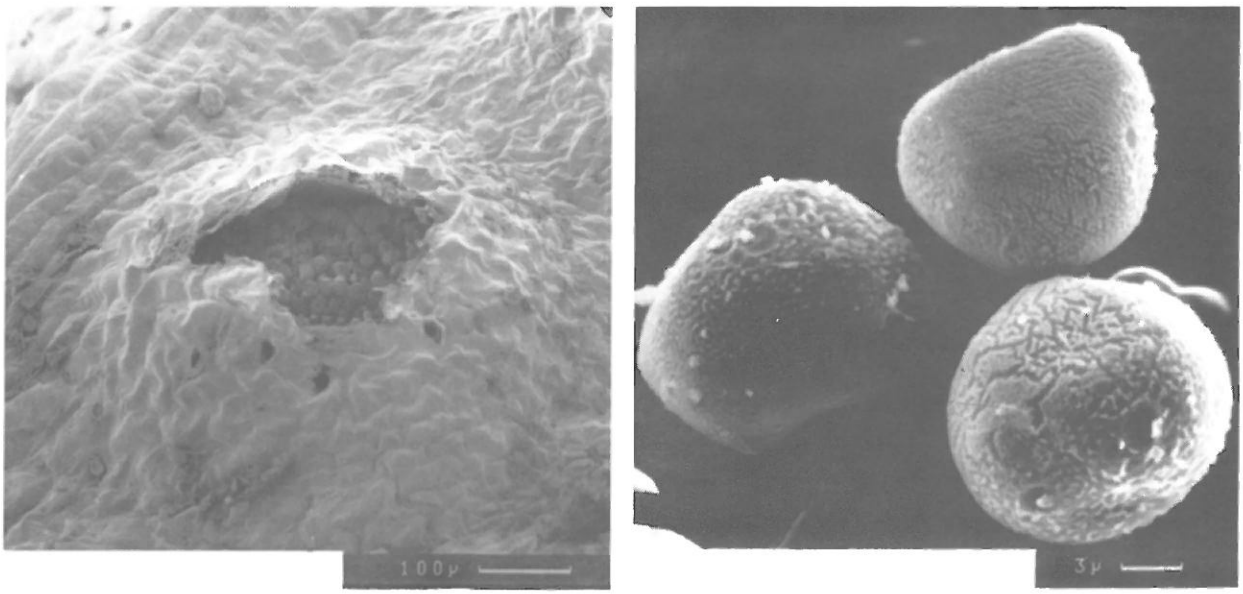
(See caption to photographs of telia and teliospores). Urediniospore surface: sparsely echinulate (WH), with short scattered spines (EE).

Species 152. *Uromyces scrophulariae*: telia and teliospores.



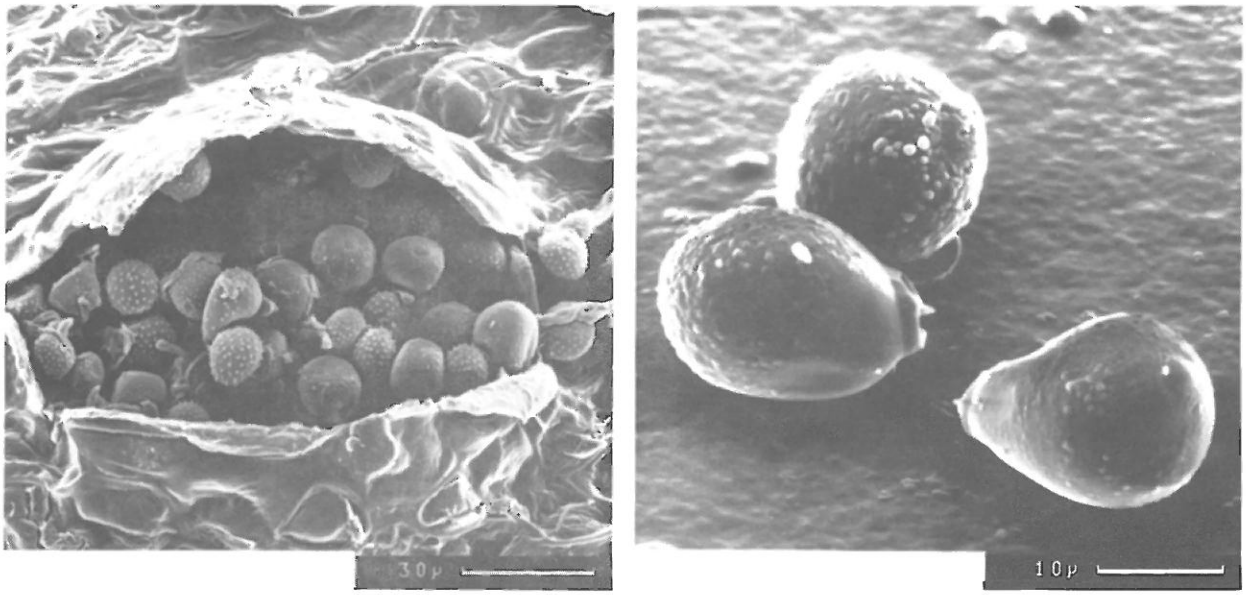
Yorks in B, 201. [AT] on Scrophularia spp. Drawings of T in WH 347. Description of T in EE 419. Teliospore surface: smooth (WH, EE).

Species 152. *Uromyces scrophulariae*: aecia and aeciospores.



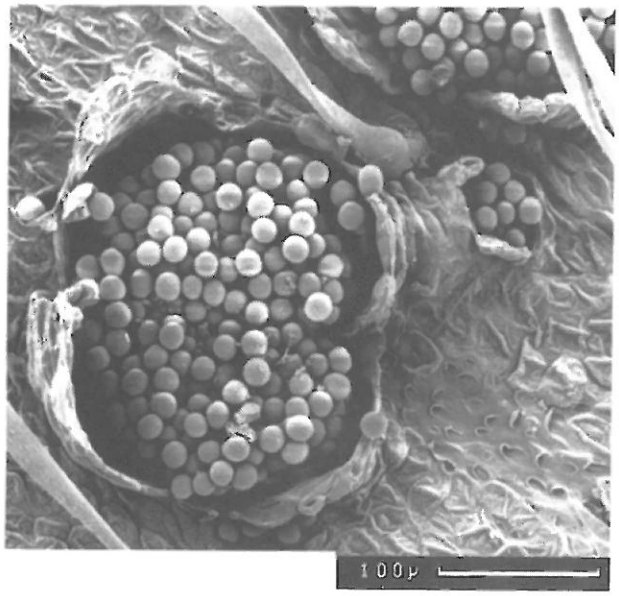
(See caption to photographs of telia and teliospores). Aeciospore surface: verruculose, smooth below (WH).

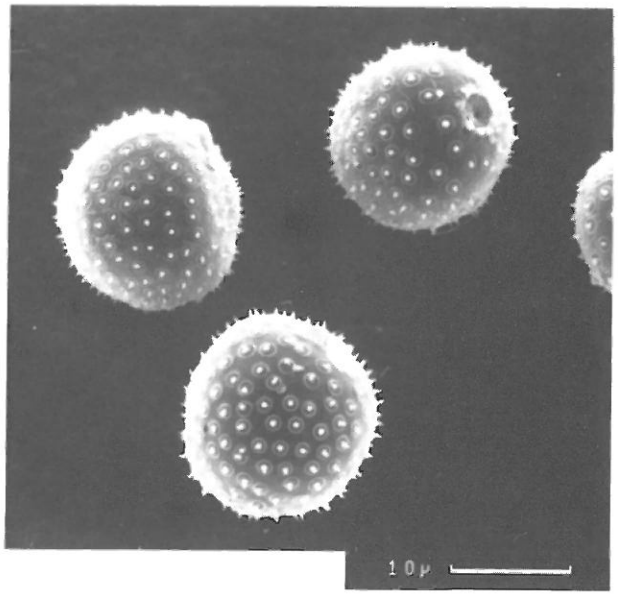
Species 153. *Uromyces trifolii*: telia and teliospores.



Yorks in B, 201 [AUT] on Trifolium spp. Drawings of U and T in WH 337. Description of T in EE 436. Teliospore surface: smooth or with a few scattered warts (WH), smooth or with a line of small warts (EE). (Urediniospores can be seen in this SEM of a telium)

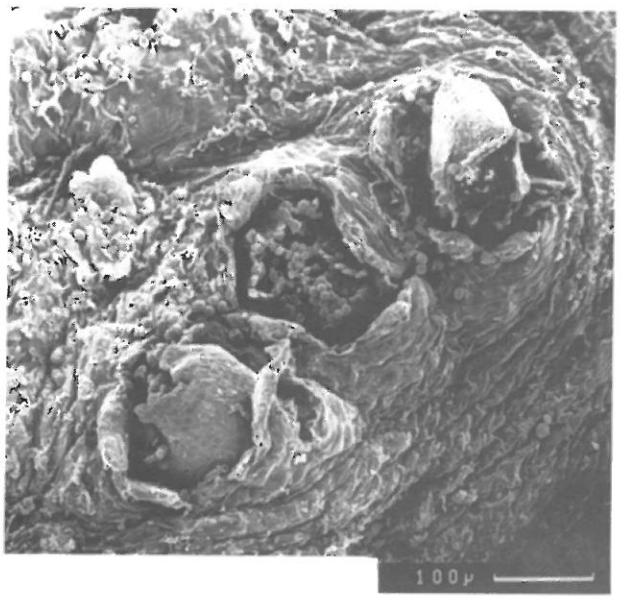
Species 153. *Uromyces trifolii*: uredinia and urediniospores.

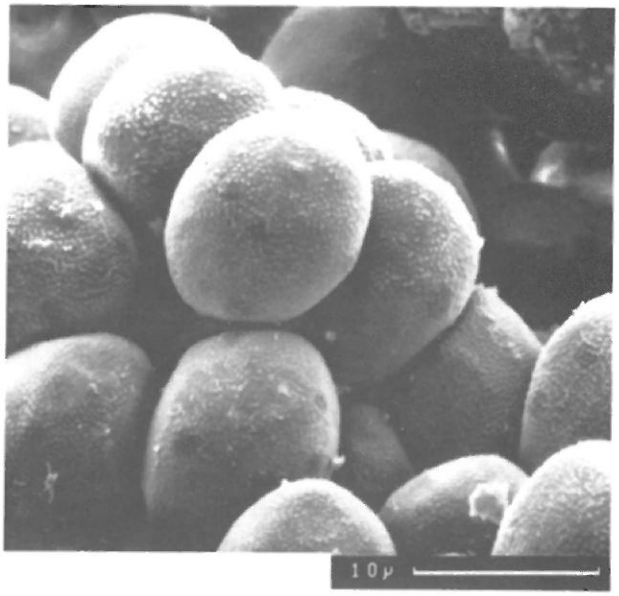




(See caption to telia and teliospores). Urediniospore surface: rather distantly echinulate (WH).

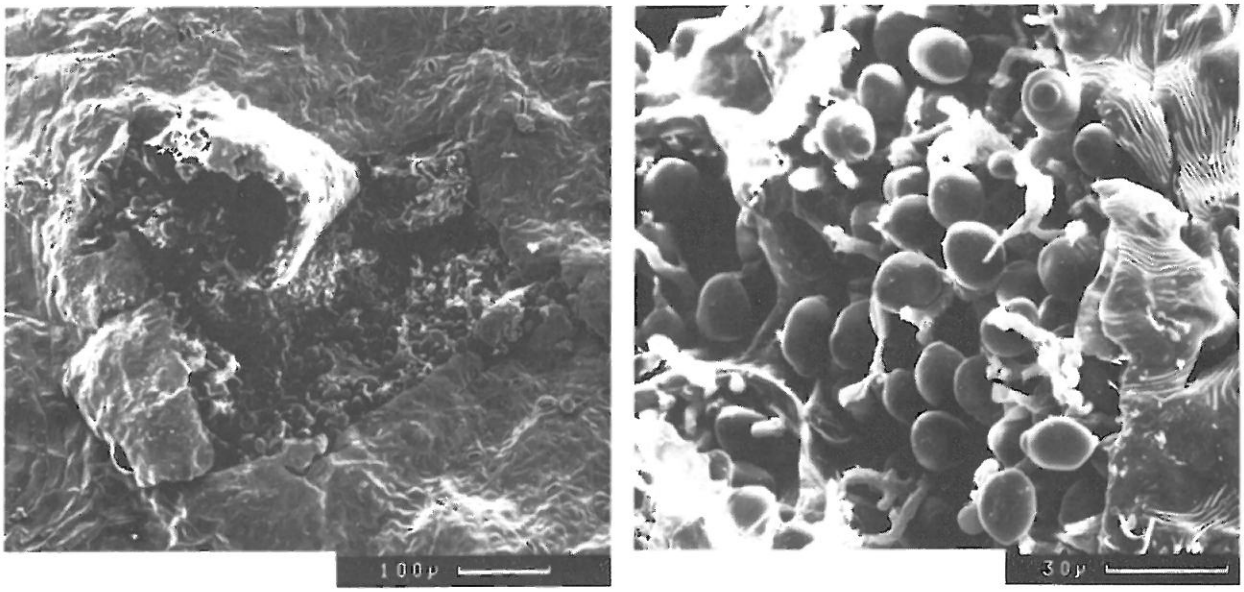
Species 153. *Uromyces trifolii*: aecia and aeciospores.





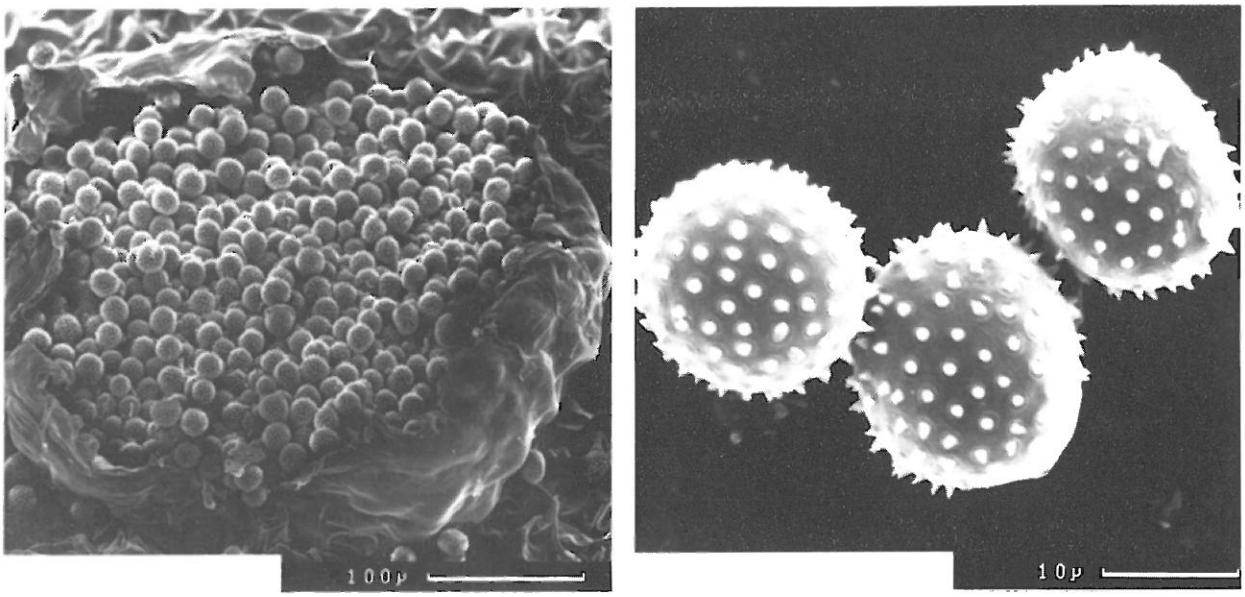
(See caption to photographs of telia and teliospores). Aeciospore surface: verrucose (WH).

Species 154. *Uromyces valerianae*: telia and teliospores.



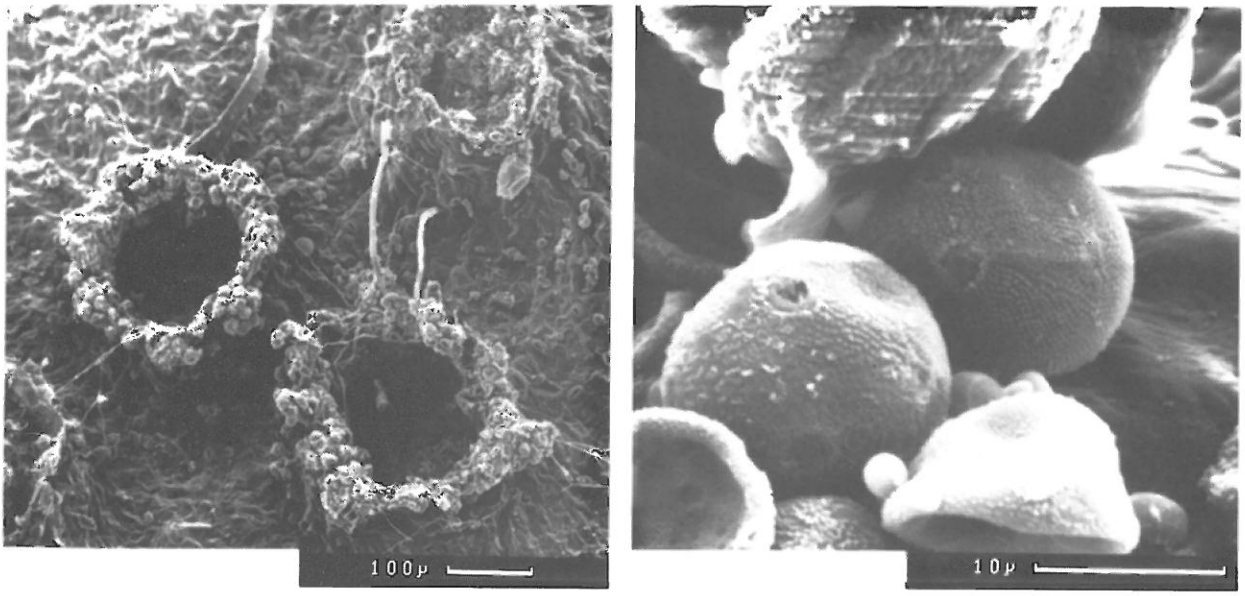
Yorks in B, 201 [AUT] on Valeriana spp. Drawings of U only in WH 348. Descriptions of U and T in EE 444. Teliospore surface: smooth (WH, EE).

Species 154. *Uromyces valerianae*: uredinia and urediniospores.



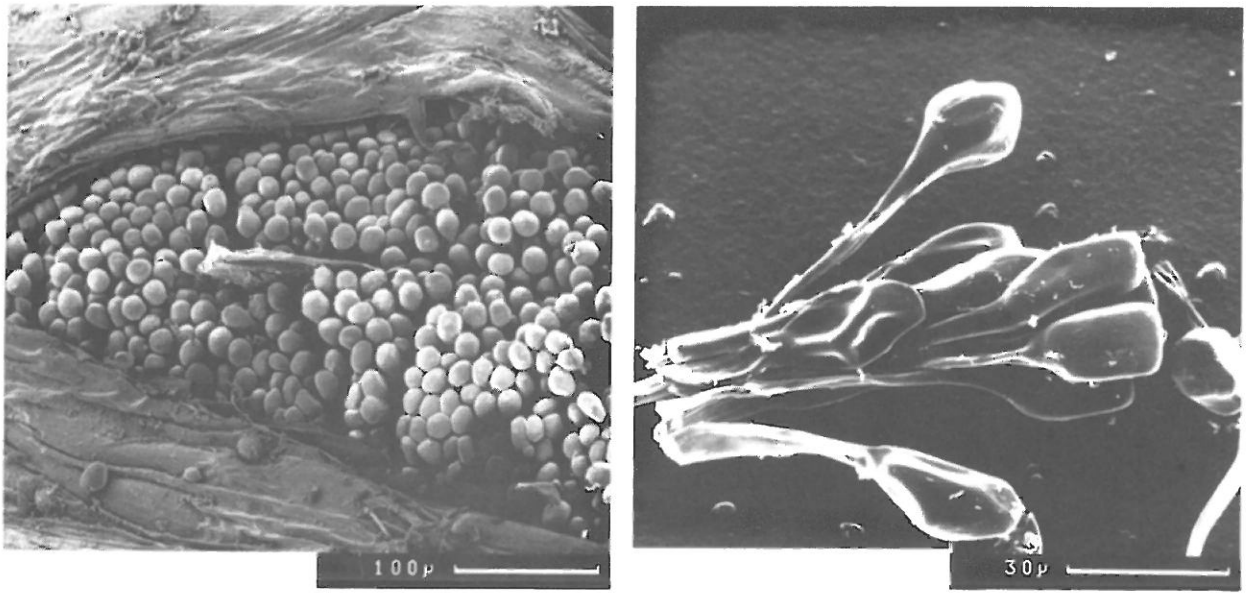
(See caption to photographs of telia and teliospores). Urediniospore surface: verrucose-echinulate (WH), echinulate (EE).

Species 154. *Uromyes valerianae*: aecia and aeciospores.



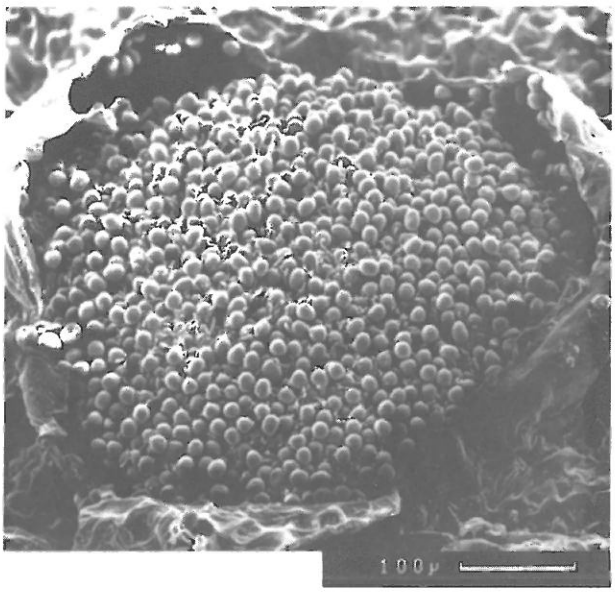
(See caption to photographs of telia and teliospores). Aeciospore surface: covered with minute crowded warts (WH).

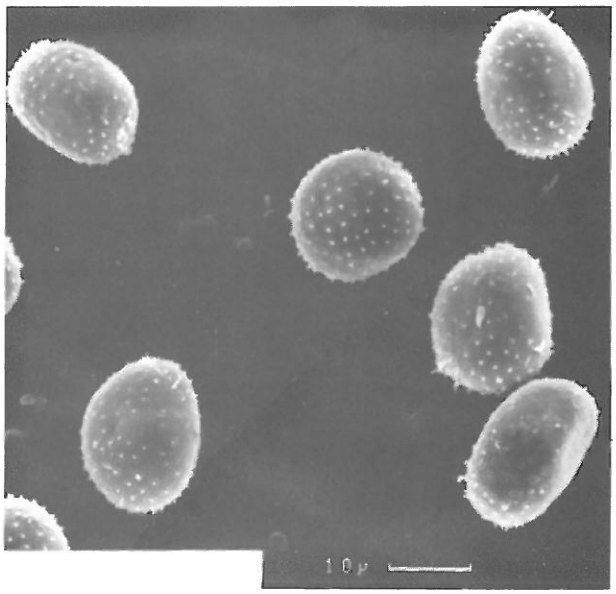
Species 155. *Uromyces viciae-fabae*: telia and teliospores.



Yorks in B, 201. [AUT] e.g. on *Vicia faba*. Drawings of U and T in WH 323. Description of U and T in EE 447. Photograph of U and T in CMID 60. Teliospore surface: smooth (WH, EE, CMID).

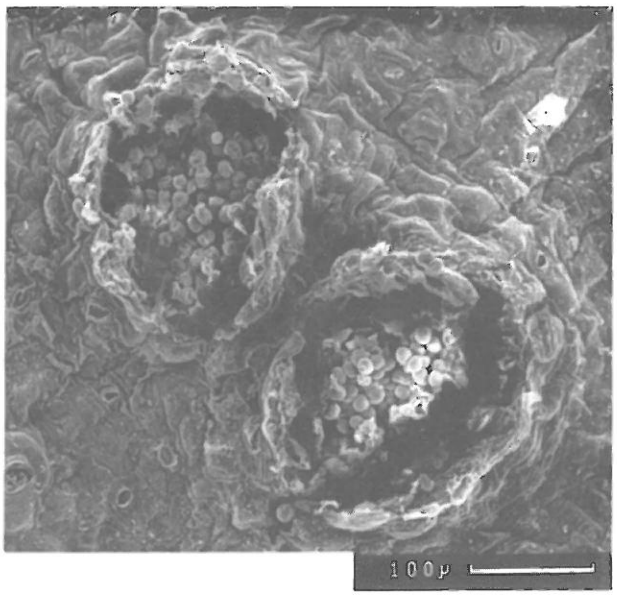
Species 155. *Uromyces viciae-fabae*: uredinia and urediniospores.

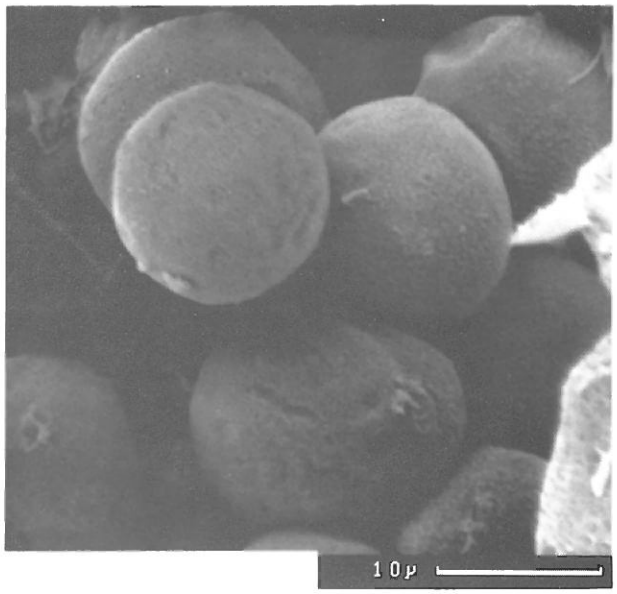




(See caption to photographs of telia and teliospores. Urediniospore surface: distantly echinulate (WH), echinulate (EE), very finely echinulate (CMID).

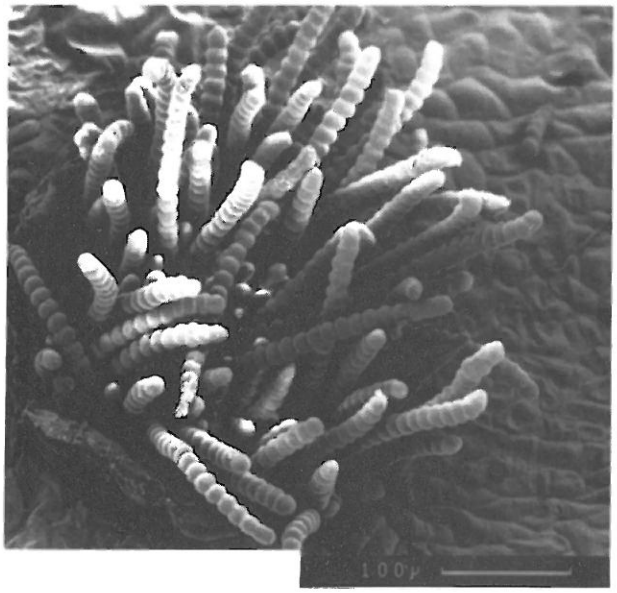
Species 155. *Uromyces viciae-fabae*: aecia and aeciospores.

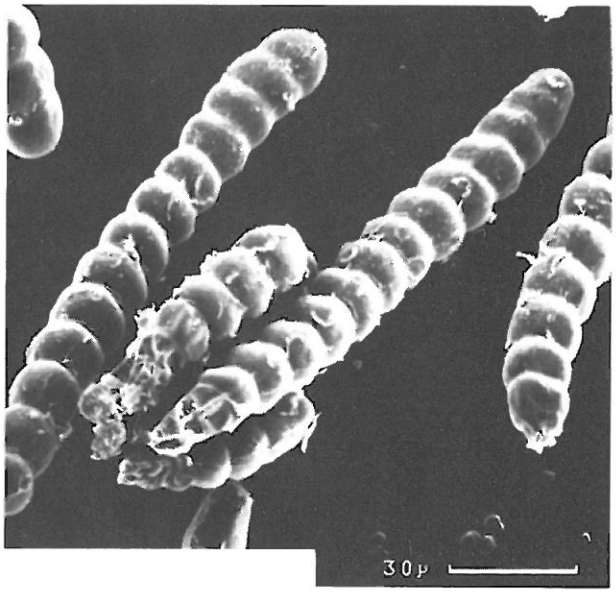




(See caption to photographs of telia and teliospores). Aeciospore surface: densely and minutely verruculose (WH), verrucose (CMID).

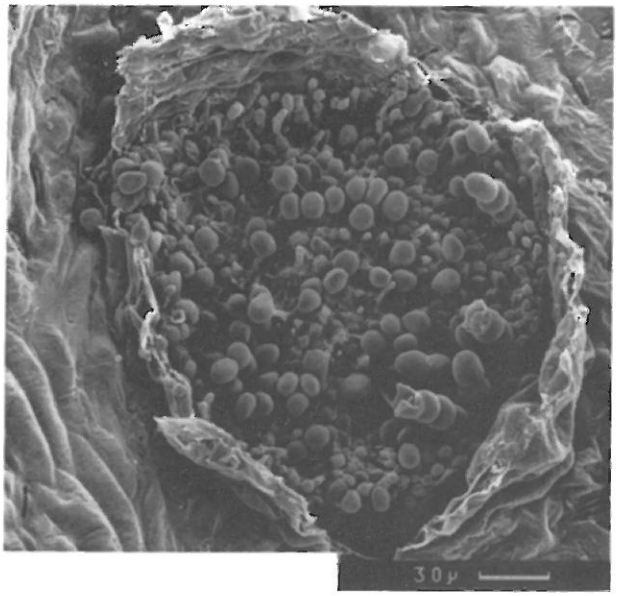
Species 156. *Xenodocus carbonarius*: telia and teliospores.

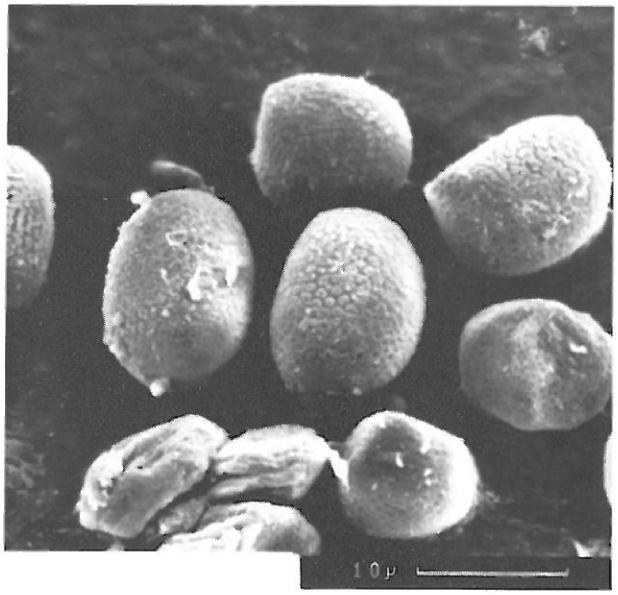




Yorks in B, 201. [AT] on *Sanguisorba officinalis*. Drawings of A and T in WH 110, and of T in EE Fig. 1654. Descriptions in EE 417. Teliospore surface: smooth (EE, WH).

Species 156. *Xenodocus carbonarius*: aecia and aeciospores.





(See caption to photograph of telia and teliospores). Aeciospore surface: densely verruculose (WH), verruculose (EE).

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