CONTRIBUTIONS FROM THE ARNOLD ARBORETUM
OF HARVARD UNIVERSITY

XI

TAXONOMY AND
OGRAPHICAL DISTRIBUTION
F THE GENUS UREDINOPSIS

BY

JOSEPH HORACE FAULL

WITH SIX PLATES

PUBLISHED BY
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TAXONOMY AND GEOGRAPHICAL DISTRIBUTION OF THE GENUS UREDINOPSIS

INTRODUCTION

The species of the genus *Uredinopsis* are generally considered to be among the most primitive of the living rust fungi. Their host restrictions to firs and ferns naturally suggest such an opinion and supporting evidence is indicated by the rudimentary characters of their telia and teliospores, the diversified features of their urediospores, and the seemingly basic forms of their spermogonia and aecia. Perhaps to these should be added their entire lack of color, since the species of *Uredinopsis* and those of the closely allied *Milesia* are alone among the Melampsoraceae in not containing at any stage or in any part the least trace of the yellow pigment characteristic of rust fungi in general. But however primitive they may be, they have attained the distinctive specializations of the Uredinales. As a matter of fact, they exhibit the organization and biological behavior of the Order to such an extent that they afford little yet discernible help towards solving the problem of the immediate relationship of the Uredinales to other fungi as we now know them.

My studies on this difficult but fascinating genus have extended over many years and I now present a fairly comprehensive account of its taxonomy and geographical distribution. A companion paper to follow will deal particularly with its biology.

NOMENCLATURE

The nomenclatural history of *Uredinopsis* reveals the fact that mycologists were slow in recognizing the first collected species as rusts. Looked at superficially there was nothing rust-like about them, either in form or color. So it is not surprising that they were variously interpreted. Thus Niessl (42) published the first known European collection under the name *Protomyces* (?) *filicinus*. His suggested reference of the species to *Protomyces* was not pointless if we assume that he saw the embedded teliospores and considered them to be organs of the fungus. At about the same time Peck (44) described a species from America; but as he saw its white, pointed, spindle-shaped, pustule-borne spores only, he called it a *Septoria* (*S. mirabilis*). Later (46) he thought it more correctly belonged in the genus *Gloeosporium;* but Kuntze (36) preferred to place it in the genus *Rhabdospora.* Cooke (9) followed with the description of a species from Africa. Fortuitously he was correct in his choice of genus because, under the impression that the pustular sori were orange-colored at the time of collection, he decided to call the fungus *Uredo macrospermum.* The next interpretation came somewhat more than a decade later in a detailed study by Magnus (39) of Niessl's *Protomyces* (?) *filicinus.* His outstanding contribution was a needed, though wrongly conceived, generic name, *Uredinopsis.* In his survey of this fungus he found the bullate, stalked, pustule-borne spores; these he designated "stylospores". Apparently he did not see the pointed spores. But he did find the "endospores" and was much impressed by them. To him they were organs of a phycomycete, even though he noted that the mycelium to which they were attached was septate. Nevertheless, there was something about the fungus that suggested a rust; so he coined a generic name that means rust-resembling. The new name was immediately accepted and has persisted. But the fallacies of Magnus' arguments in support of his contention that *Uredinopsis filicina* could not be a rust were soon revealed by the experimental demonstrations of Dietel (11); these at once settled the question as to the Order to which *Uredinopsis* really belonged.

Dietel was the first to give a complete description of the diploid phase of *Uredinopsis filicina.* He, too, was the first to see and describe the pointed spores of that species. Moreover, he germinated them and correctly appraised them as urediospores. He also verified Magnus' description of the later appearing "stylospores"; but since he was unsuccessful in germinating them he was uncertain of their nature. He thought that they might possibly be a second type of urediospores; on the other hand he leaned more strongly to the view that they might be stalked teliospores. The most critically valuable part of Dietel's work, however, had to do with the "endospores". These germinated freely after overwintering and produced basidia like those of rust fungi. The "endospores", therefore, were teliospores; hence, *U. filicina* was unquestionably a rust. Likewise, he fully described the diploid phase of *U. Struthiopteridis* Störmer, adding to Störmer's description an account of its pointed urediospores and its teliospores. Finally he described pointed urediospores and embedded teliospores of a supposedly new rust from California under the name *U. Pteridis*, evidently unaware of the fact that this rust, in an African collection, had already been described by Cooke as *Uredo macrospermum.*

Leaving now for a moment the diploid phase and its still puzzling "stylospores", we find that Peck (45) had long since unknowingly found the haploid phase of a *Uredinopsis* on *Abies balsamea.* This he named *Peridermium balsameum.* True, he did not realize that the white peridermia on the balsam fir represent various species of an *Uredinopsis* and *Milesia*, but the peridermia of a *Uredinopsis* are present in the mixture that is accepted as his type material. Eventually Fraser (18) determined by cultures that the haploid phase of the several species of *Uredinopsis* studied by him were passing under the name *Peridermium balsameum* Peck and his findings have been abundantly confirmed by myself and others. Meanwhile, Klebahn (34) demonstrated the haploid phase of *U. Struthiopteridis* Störmer on *Abies alba* in Europe. Almost certainly its peridermia had been included with those of other species under the name *Aecidium pseudocolumnare* Kuehn. His conclusions, too, have been confirmed. Finally, Kamei (31) has quite recently cultured *U. filicina* and several other species of *Uredinopsis* on *Abies* in Japan.

There now only remains for review the nomenclatural history of Magnus' "stylospores". For many years after the publication of Dietel's paper referred to above, the "stylospores" of *Uredinopsis filicina* and other species received various interpretations. Thus, while Dietel interpreted them as stalked teliospores, Arthur (2) thought that they might be aeciospores. Fischer (17) and Magnus (40), on the other hand, maintained that they were surely a second form of urediospores. Both Fischer and Magnus claimed to have found them in sori along with the pointed urediospores belonging to the species they examined and to have observed intergrades between the two kinds. A test that settled the matter in part was eventually made by Klebahn (34). He sowed overwintered "stylospores" of *U. filicina* on new leaves of their fern host in the spring. Infection resulted and the first crop of spores produced were the pointed urediospores. Hence, as the true aeciospores of certain other species of *Uredinopsis* had already been found to occur on *Abies*, he reasonably concluded that the "stylospores" were more properly to be regarded as a second form of urediospores. That his deduction was correct has subsequently been confirmed by studies on the cytological phenomena of these spores and by Kamei's experimental proof that the aeciospores of *U. filicina* are developed in peridermia on *Abies*. To distinguish the second form of urediospores from the other type of urediospores they have been called "amphispores".

With the solution of the amphisporic problem and the working out of the life histories of some of the species of *Uredinopsis* the nomenclatural uncertainties attendant on these fungi were finally clarified. At last the picture of *Uredinopsis* was distinct and its nomenclature brought into harmony with that of other rust fungi.

MORPHOLOGY

(1) **Mycelium**

The mycelium of *Uredinopsis* is typically that of a rust fungus except for its lack of pigment. It is divided into cells and is intercellular in relation to the host tissues. The cells of the haploid phase are uninucleate; those of the diploid phase are binucleate. Haustoria constitute a part of the mycelial system of each phase.

Magnus (39) in his first studies of *Uredinopsis filicina* observed the cellular organization of the diploid phase; but he did not see the haustoria (39, 40). Adams (1) and Hunter (25) recorded uninucleate cells as characteristic for the haploid phase. The former also asserted that pairs of these cells at the base of the aecial primordium fuse to initiate the binucleate cells of the diploid generation. And the latter, in studies as yet unpublished, has discovered that haustoria occur abundantly in the haploid phase of the four or five species in which she has looked for them. Moss (41), similarly, has shown that binucleate cells and haustoria characterize the diploid phase.

(2) **Spermogonium**

The spermogonia of *Uredinopsis* are readily distinguished from those of all other genera of the Melampsoraceae, except *Milesia*, by their gross form and lack of color. They are hemispherical, immersed, almost plane at the leaf surface, of subcuticular or subepidermal origin and aparaphysate. Their spermatiophores are simple and their spermatia are catenulately produced and uninucleate.

For the main part the spermogonia of the Melampsoraceae have been either disregarded by systematists or too briefly and inadequately described. Hence, we are under obligations to Bell (7) for calling attention to their taxonomic importance. Referring to various genera of the Pucciniastreae he remarked — "but even the studies reported herewith indicate that the pycnia are very important diagnostic structures". He then marshalled comparative examples and strikingly illustrated them with convincing photomicrographs. Hunter (25, 26) followed with painstaking, detailed studies, ranging throughout the Melampsoraceae; and as part of her undertaking she included several species of *Uredinopsis*. From her work it is certain that spermogonia are important aids in distinguishing genera and even some species. As an appropriate example of Hunter's findings, it may be noted here that her examination of what is supposed to be Peck's type material of *Peridermium balsameum* revealed the fact that this material is a mixture of *Milesia intermedia* Faull and one or more undetermined and possibly indeterminable species of *Uredinopsis*. Moreover, Hunter (26) has made clear that certainty in the description of the spermogonia of some species as subcuticular or subepidermal is possible only after examining the early stages of their development.

(3) **Aecium**

So far as is known the aecia of *Uredinopsis* are restricted to *Abies*. They are pure white in color; but morphologically they are of typical, pucciniastraceous, peridermial structure in every essential respect. Unfortunately, those that have been described are so similar, one species with another, that there has been little incentive to make comparative studies. In some species, however, these organs do show differences in such features as spore size, peridia and length of formative period. So it is possible that comparative studies, such as those made for the spermogonia, might yield useful information. At present many species of *Uredinopsis* cannot be determined from the haploid phase alone. The same thing applies to most other genera of the Melampsoraceae. What has been learned about the spermogonia has helped considerably, especially in the recognition of genera; but that is not sufficient. A practical key to the Melampsoraceae based on haploid characters would, indeed, be a boon to students of that family.

Adams (1) seems to have been the only one to have studied the development of the aecium of any species of *Uredinopsis.* His observations were made on what he called *Peridermium balsameum* Peck, but which, judging from its recorded field associations, was probably either *Uredinopsis Osmundae* or *U. mirabilis.* Adams found that the ontogeny of the species studied followed the regular pattern for a peridermium of the Pucciniastreae.

(4) **Uredium**

Taxonomically, the uredia are the most important organs of *Uredinopsis* in distinguishing species. The telia, indeed, are often essential at the outset in fixing the genus; but beyond that they are, with few exceptions, of no help in the recognition of species. On the other hand, a complete key to *Uredinopsis* can be based solely on the uredia. At the outset the species fall into two groups, one characterized by a single type of urediospore, the other by two types. Then, within these groups, the species are separable through distinctive spore and peridial features.

Many species of *Uredinopsis,* as just indicated, are characterized by two types of urediospores. While this is a rare phenomenon in the Uredinales it is not unknown outside the genus *Uredinopsis.* Thus it occurs in *Hyalopsora* for the Melampsoraceae and in a few species of *Puccinia* and *Uromyces* for the Pucciniaceae. To distinguish these spores, Arthur (4) uses the terms "ordinary urediospores" and "amphispores" (of Carleton). The corresponding uredia he calls "ordinary uredia" and "amphisporic uredia" respectively. For lack of better terms I shall use Arthur's nomenclature, except in the minor detail of designative symbols. That is, instead of his "II" and "II^x", respectively, I shall employ "II", just as Arthur does, in its conventional sense; but when two types of uredia and urediospores are known for a given species and these are to be distinguished, I shall use the symbols "II^1" and "II^2", respectively.

Perhaps it would be well at this point to emphasize the fact that amphispores have never been recorded for certain species of *Uredinopsis.* However, I am convinced that in some of these at least they are never formed. That is true, for example, of *U. Osmundae* and *U. Phegopteridis,* specimens of which I have examined in large numbers from the greater part of their known range. Likewise, it is true of *U. macrosperma,* specimens of which I have examined from many widely separated regions of its almost world-wide range. This naturally suggests the question of the evolutionary history of the amphispores. Have they been inherited from the stock from which *Uredinopsis* sprang and then by reduction omitted from some of the more recently evolved species; or have they originated within the genus? In seeking an answer we are bound to turn to *Milesia* and *Hyalopsora*, the two existing genera most closely resembling *Uredinopsis*. *Milesia* may be dismissed at once, because in it amphispores are unknown. They do occur, however, in *Hyalopsora*, a "yellow" rust, the teliospores of which are similar to those of *Milesia*. Have amphispores then originated independently within the genera *Uredinopsis* and *Hyalopsora;* or has this spore type been derived from a common ancestor? As consideration of these questions leads to questions regarding the natural relationships of the three genera mentioned and the phenomenon of lack of pigment in two of them, discussion is deferred to the section on "phylogeny".

However the amphispores may have originated, the amphisporic uredium of *Uredinopsis* is similar to that of the ordinary uredium. Both occur on the same lesions, both are pustulate, both are hypophyllous, both have a peridium of like development and organization and both produce stalked spores. They differ, however, in several respects. The ordinary uredia are always the first to appear, they dehisce promptly at maturity, their peridial cells and their spores are usually thinner-walled, the stalk cell of their spores is very short, not more than a few microns long at most, their spores, one species with another, show a wider range of form and markings and they are immediately viable at maturity. On the other hand, the amphisporic uredia are later in appearing, they dehisce mostly only after overwintering, their peridial cells and spores are usually thicker-walled, the stalk cell of the spores may attain a length of 20 to 40 microns, the spores do not show as great differences in form and markings and they germinate freely only after a winter of rest.

The uredium of *Uredinopsis*, as in all of the Pucciniastreae, is characterized by a peridium. Magnus (39) described and figured it for the amphisporic uredium of *U. filicina* and Dietel (11) for the ordinary uredium of the same species. It has been found in all other species described. As for illustrations of the peridium, Bell's depictions (7) are of outstanding merit. He examined the ordinary uredia of several species of *Uredinopsis* from microtome sections of suitably prepared materials and then selected median vertical sections of an immature and a mature uredium of *U. Phegopteridis* as representative subjects for drawings. These drawings were so faithfully and beautifully executed that they stand as almost perfect depictions of the ordinary uredium in vertical section. They correctly represent the peridium as a single layer of binucleate cells forming a continuous dome over the sorus and closely adherent to the overlying epidermis.

The homology of the uredial peridium of the Pucciniastreae long remained the subject of opinion unsupported by investigation. Possibly most weight was attached to the view expressed by Dietel (11) that it consisted of adhering peripheral paraphyses. Moss (41) cleared up the matter by carefully following its development. He found that the uredial peridium of the Pucciniastreae, including *Uredinopsis*, consists of the laterally adhering terminal cells of "three-celled columns which arise in the young sorus". Basal connection of the terminal cell of each column is soon lost by the disintegration of the middle cell. The basal cells then continue, by a repeated process of budding, to form stalked spores. He concluded, therefore, that the peridial cells are modified potential spores and that the evanescent middle cells of the primordial columns represent their stalks.

The ordinary urediospores of *Uredinopsis* are remarkable for their morphological diversity. The commonest form is of very striking appearance — a comparatively narrow, fusiform, mucronate spore, smooth except for two opposed vertical rows of cogs. Next in frequency are amucronate, ellipsoid to subspheroid, smooth, warted or spinulose spores; these are quite like those of a *Milesia* or a *Hyalopsora.* Lastly, as described here for the first time, there are two species in which the ordinary urediospores are mucronate, smooth and entirely encased in a thick, gelatin-like capsule.

So far no one seems to have offered a correct explanation of the "mucro". A study of spore development, however, shows that it is the upper, enucleate portion of the spore cell. The young spore of the mucronate form is almost linear at first. At an early stage the mucro is cut off from the rest of the spore by a constriction or a septum and it undergoes little further change. The lower part of the young spore cell contains the two nuclei and it continues to develop until the mature form is attained.

The amphispores do not show as much diversity of form as do the ordinary urediospores. They are usually irregular and frequently they are polyhedral. They are nearly always described as being closely, uniformly and finely warted. But comparing them, in one species with another, they show considerable differences. They may be smooth and quite regular or they may exhibit specific differences in shape, size and markings. Little use has heretofore been made of the amphispores in taxonomy aside from recognition of their presence or absence in a given species. But from my studies it is apparent that their features are often specifically distinctive. So I have made free use of them in formulating a key for the genus.

There have been two conflicting views regarding the way in which the urediospores of the Pucciniastreae are borne. Some have held that they are always singly produced and that they are stalked. Magnus (40a) and Liro (38), on the other hand, have maintained that while that is the case in most of the genera, yet in *Melampsorella* and *Pucciniastrum* they are borne catenulately. Bell (7), erroneously interpreting basal and stalk cells as young spores, thought that the ordinary urediospores of *Uredinopsis* also are catenulately produced. The admirable studies by Moss (41) in six genera of the Pucciniastreae, including *Uredinopsis*, have determined once for all that the urediospores of *Uredinopsis* and of all the other genera examined are produced singly and are stalked. He summarized as follows — "This investigation shows, however, that the uredospores are pedicellate throughout, and that they bud out singly from a layer of sporogenous cells at the base of the sorus. This mode of spore development is not unlike that reported for the Pucciniaceae and certain other members of the Uredinales. Conjugate nuclear division associated with spore formation resembles that described for other rusts."

(5) **Telium**

If the term "telium" is to be included in the nomenclature of *Uredinopsis*, it must be in a modified sense because the teliospores of this genus are not grouped in defined sori. They are diffusely scattered immediately under the epidermis, and if they are aggregate it is in crusts of indefinite extent, each consisting of a single layer of a few to many spores. Yet "telium" is such a convenient term that I have retained it, thinking of it in the sense of "diffuse telium", each comprising all the teliospores found under the same epidermis in a given spacial unit (an intercostal area or leaf islet) of the lesion.

The teliospores of *Uredinopsis* are typically subglobose to broadly ellipsoid. They are usually 2- to 8-celled, though a few single-celled spores can be found in almost any telium. For two of the species I have not seen more than two cells to a spore; in several other species the number is not greater than four; in still other species spores up to 8-celled are more or less frequent. The 4-celled, cruciate spore is by far the commonest in the genus as a whole. The septa in the spores are anticlinal or oblique to the leaf surface, a condition that makes it possible for the basidia to grow directly out. Each spore cell has a single germ pore in its outer wall.

Earlier observers of *Uredinopsis* were not clear as to the location of the teliospores. Thus Magnus (40), Dietel (11), Fischer (17) and Grove (21) have described them as being produced singly or in small aggregates in intercellular spaces throughout the mesophyll. Grove even imagined that they are liberated prior to germination in the spring by a supposed rotting of the leaf tissues. However, Magnus (40) and Dietel (12) did comment on their subepidermal location in certain species. Bell (7) was the first to satisfactorily demonstrate the fact that normally the teliospores of *Uredinopsis* are strictly subepidermal. He examined properly prepared materials of three species and his excellent photomicrographs leave no doubt as to the correctness of his assertions. True, teliospores are occasionally found in intercellular spaces of the spongy parenchyma, but similar irregularities occur in many rust fungi. Bell's findings have been confirmed by Faull (15), Pady (43) and Arthur (5). Moreover, I find no species of *Uredinopsis* exhibiting a deviation from the common habit. In the genus throughout, the teliospores are normally located in intercellular spaces under the epidermis and they are by far most abundant under the lower epidermis.

Regarding the time of formation of teliospores in *Uredinopsis*, the misconception prevails that their production is postponed to the end of the growing season (cf. Pady, 43). The time, however, seems not to be governed by the seasonal period; more likely it is determined by a nutritional influence in the lesions. However that may be, I have often found them before midsummer has arrived. It may be added that in a few species the tendency to form teliospores is so pronounced that not only is their formation active by midsummer, but that comparatively few or even no uredia may occur on the lesions. In all cases, of course, teliospore formation is completed by the end of the growing season and the spores overwinter in the dead host leaves.

The origin of the teliospores in *Uredinopsis* is extremely simple. Sydow (52) saw them as being developed terminally on short lateral branches of the mycelium. Pady (43) defined their origin more exactly as follows — "The tip of a hyphal strand comes to lie immediately below the epidermal cell, and applied closely to it. A septum is laid down, cutting off the tip, which contains two nuclei and considerable cytoplasm". This terminal cell, he found, develops directly into a teliospore, the nuclei dividing conjugately so that at maturity each cell of the spore contains a pair of nuclei.

(6) **Basidium**

The teliospores, as stated above, are overwintered in the dead infected fronds. They are not viable, however, until they have had the winter rest. In the spring following their production they germinate promptly under suitable conditions of warmth and moisture. A basidium quickly grows out from each cell through the epidermis. The aerial portion divides into four uninucleate cells, each of which produces a single, uninucleate basidiospore. The cytological phenomena involved in these processes follow the regular sequence characteristic of rust fungi.

HOSTS

All successful life history research pertaining to *Uredinopsis* has shown that its species are heteroecious and that their haploid phase occurs exclusively on *Abies*. The aecia of this phase had long been collected and named before their relationships were determined. In Europe they passed under the composite specific name *Aecidium pseudocolumnare* Kuehn (in part) and in America mostly under the name *Peridermium balsameum* Peck (in part). So far, sixteen life histories have been worked out. Of the sixteen species recorded in Table 1, the aecia of fifteen of them are found on fir needles of the current season only. *Uredinopsis macrosperma* differs from all of the others, in that its aecia mature on needles of the second to the fifth season.

To what extent there is a specific host restriction within the genus *Abies* we do not know. But such incidental data as are available indicate that there is no close limitation. In other words, it would appear that any one of several species of *Abies* may serve as host for many, if not all, species of *Uredinopsis;* and conversely, that any one species of *Uredinopsis* may pass to many, if not all, species of *Abies.* Thus Kamei (23) has cultured nine species of *Uredinopsis* on *Abies Mayriana.* Fraser (19) and Faull (15) have cultured seven species on *Abies balsamea.* And *U. Struthiopteridis* has been cultured in America, Europe and Japan on a different species of *Abies* in each instance. Incidentally, it should be noted that in Manuals such as those of Arthur (5) and Hiratsuka (23) various species of *Abies* may be listed as hosts of a given species of *Uredinopsis*, but without distinction as to whether or not the determination has been based on experiment. Since in many of these instances no relevant experiments have been made, those lists can at best be accepted with caution. But more certainly, the rust names attached to the specimens from which such lists have been assembled are subject to error.

The complete list of species of *Uredinopsis* known to occur on *Abies* is presented in Table 1. All of these have been cultured.

TABLE 1

SPECIES OF UREDINOPSIS AND THEIR RESPECTIVE ABIES HOSTS, AS DETERMINED FROM CULTURE EXPERIMENTS.

1. *Uredinopsis Adianti* on *Abies Mayriana.* (Japan)
2. " *Athyrii* on *A. Mayriana.* (Japan)
3. " *Atkinsonii* on *A. balsamea.* (North America)
4. " *ceratophora* on *A. balsamea.* (North America)
5. " *filicina* on *A. Mayriana.* (Japan)
6. " *hirosakiensis* on *A. Mayriana.* (Japan)
7. " *intermedia* on *A. Mayriana.* (Japan)
8. " *Kameiana* on *A. Mayriana.* (Japan)
9. " *longimucronata* on *A. balsamea.* (North America)
10. " *macrosperma* on *A. grandis.* (North America)
11. " *mirabilis* on *A. balsamea.* (North America)
12. " *Osmundae* on *A. balsamea.* (North America)
13. " *ossaeiformis* on *A. firma, A. Mayriana, A. sachalinensis.* (Japan)
14. " *Phegopteridis* on *A. balsamea.* (North America)
15. " *Struthiopteridis* on *A. alba* (Europe), *A. balsamea* (North America), *A. Mayriana.* (Japan)
16. " *Woodsiae* on *A. Mayriana.* (Japan)

The uredial and telial hosts of all species of *Uredinopsis* are members of the Filicales. True, a fungus found on dead epicarps of *Juglans nigra* was hesitatingly referred to *Uredinopsis* by Saccardo (Syll. Fung. **16**: 272. 1902); but Sydow (52), with good reason, not only excludes it from that genus, but also regards it as not even being a rust. Within the Filicales, one species occurs on members of the Osmundaceae; all the others occur on members of the Polypodiaceae. The distribution of *Uredinopsis* among the fern host genera is recorded in Table 2.

TABLE 2

DISTRIBUTION OF UREDINOPSIS WITHIN THE FILICALES

A. Family POLYPODIACEAE

Subfamily	*Genus*	*No. of species of Uredinopsis*
Woodsieae	Cystopteris	2
	Matteuccia	1
	Onoclea	1
	Woodsia	1
Aspidieae	Dryopteris	5
Oleandreae	———	–
Davallieae	———	–
Asplenieae	Athyrium	5
	Blechnum	1
	Woodwardia	1
Pterideae	Adiantum	2
	Cheilanthes	1
	Pellaea	1
	Pteridium	5
Vittarieae	———	–
Polypodieae	———	–
Acrosticheae	———	–

B. Family OSMUNDACEAE

	Osmunda	1

With regard to filicinian host restriction, it is certain that some species of *Uredinopsis* may infect more than one species of a given fern genus. Thus, *U. Osmundae* has been passed from one to the other of three species of *Osmunda;* and Kamei's experiments with *U. intermedia* indicate a choice of host species within the genus *Athyrium.* The probability is, however, that most species of *Uredinopsis* are restricted to one fern species. Indeed, even for *U. Osmundae,* as I shall show in a later paper, it appears from culture experiments that a degree of specific host restriction exists, indicating that *U. Osmundae* comprises at least two physiological strains. All three specific hosts are susceptible to one of them, but not equally so; and *Osmunda cinnamomea* is immune to a second one.

Turning to the question of generic fern host restriction it is evident that the answer depends not only on experimental data but also, in a very large degree, on accepted morphological definitions of the species. An excellent illustration of lack of agreement on such definitions is afforded by *Uredinopsis Struthiopteridis* Störmer. Thus Arthur (2), Sydow (52) and Hiratsuka (23), according to their conception of this species, find it on hosts belonging to two fern genera; Arthur (5), on the other hand, in his recent Manual refers it to no fewer than five fern genera. According to my own studies, as presented in the taxonomic part of this paper, the *U. Struthiopteridis* of the first-named authors comprises two distinct species, while that of Arthur's later publication comprises six species. In this connection reference might also be made to the disposition of *U. Struthiopteridis* made by Rhoads, Hedgcock, Bethel and Hartley (47). They reduce it to synonymy under *U. mirabilis* (Peck) Magnus; and they refer that species to hosts distributed among nine fern genera. But according to my definition of *U. mirabilis* it is restricted to a single species of the one genus. In explanation of such differences in interpretation it is fair to state that these and similar taxonomic confusions in the genus *Uredinopsis* have been due mainly to a lack of comparative studies.

So far as experimental data on the problem are concerned, no published accounts exist. Some explicit results, however, obtained in the course of my own experimental studies on the subject, will be presented in a subsequent paper.

In conclusion, one other topic appropriately finds a place for discussion here, namely, the ways in which species of *Uredinopsis* are carried over from one year to the next. Except for *U. macrosperma* and perchance such other as yet uninvestigated species as may likewise be characterized by the continuance of the rust mycelium in fir needles for more than one year, the perpetuation of the rust to a second year is effected by spores formed on the fern hosts. As for that, it is to be borne in mind that the fronds of all fern species that serve as hosts to species of *Uredinopsis* cannot be regarded as anything more than annual. That is, they do not overwinter in a living condition. Hence, in the North

Temperate Zone at least, where there is a well-marked winter season, the rust must be carried forward in dead fronds or by already discharged spores to the next growing season. Reference has already been made to the overcarry by teliospores. These become viable in the spring following their production; they germinate then *in situ*, and the resulting basidiospores are at once capable of infecting new fir needles. It has also been established that the overcarry can be effected through the agency of amphispores. These also first become viable in the spring and are then capable of causing the infection of new fronds. As for species without amphispores the overcarry by teliospores is obvious if there are firs in the neighborhood. It is also readily understood for those species in tropical regions in which living susceptible fronds are not lacking for any considerable period of time. But just how the overcarry of non-amphisporic species in temperate zone areas takes place except through the intermediate Abies host — and that in some instances seems to happen — is not clear. Under such circumstances two explanations are suggested — (1) that some of the ordinary urediospores may overwinter in a viable condition; (2) that a physiological differentiation in the urediospores exists, some of them being short-lived, while others, presumably those formed later in the season, partake of the nature of amphispores though showing no evident morphological differences from ordinary urediospores.

GEOGRAPHICAL DISTRIBUTION

Species of *Uredinopsis* are known to occur in all the major regions of the world with the exception of Australasia. *Thirteen* species have been collected in the Western Hemisphere north of Mexico, *four* in the Western Hemisphere south of the United States, *three* native and *one* introduced species in Europe, *twelve* in Asia and *one* in Africa. Details have been assembled for each species and they are recorded in Table 3.

TABLE 3

GEOGRAPHICAL DISTRIBUTION OF SPECIES OF UREDINOPSIS

A. United States, Canada, Newfoundland, Bermuda and Hawaii

U. Arthurii (II^1, II^2, III) — Alabama, Connecticut, Indiana, Massachusetts, Michigan, New York, Vermont; Quebec; Bermuda.

U. Arthurii var. *maculata* (II^1, II^2, III) — Alabama, Delaware, Maine, Maryland, New Jersey, New York, Rhode Island.

U. aspera (II, III) — California; Hawaii; British Columbia.

U. Atkinsonii (O, I, II^1, II^2, III) — Connecticut, Delaware, Indiana, Maine, Massachusetts, Michigan, Mississippi, Montana, Nebraska, New Hampshire, New York, North Dakota, Virginia (?), Wisconsin; Nova Scotia, Ontario; Bermuda.

U. ceratophora (O, I, II^1, II^2, III) — Indiana, New York, Wisconsin; Ontario.

U. Copelandi (II^1, II^2, III) — California.

U. glabra (II^1, II^2, III) — New Mexico.

U. longimucronata (O, I, II^1, II^2, III) — Connecticut, Massachusetts, Maine, New Hampshire, New York, Pennsylvania, Rhode Island, Vermont, Wisconsin; New Brunswick, Nova Scotia, Ontario, Quebec.

U. longimucronata forma *cyclosora* (II^1, II^2, III) — California, Idaho, Montana, Oregon, Washington; Alberta, British Columbia.

U. longimucronata var. *acrostichoides* (II^1, II^2, III) — New Hampshire, New York, Wisconsin.

U. macrosperma (O, I, II, III) — California, Florida, Georgia, Idaho, Montana, New Mexico, Oregon, Washington; British Columbia; Bermuda.

U. mirabilis (O, I, II^1, II^2, III) — Connecticut, Delaware, Illinois, Indiana, Maine, Maryland, Massachusetts, Michigan, Nebraska, New Hampshire, New Jersey, New York, North Carolina, Pennsylvania, Vermont, Virginia, West Virginia, Wisconsin; New Brunswick, Nova Scotia, Ontario, Prince Edward Island, Quebec; Newfoundland.

U. Osmundae (O, I, II, III) — Connecticut, Florida, Maine, Massachusetts, Minnesota, New Hampshire, New York, Pennsylvania, Rhode Island, Vermont, Wisconsin; New Brunswick, Nova Scotia, Ontario, Quebec.

U. Phegopteridis (O, I, II, III) — Maine, New Hampshire, Wisconsin; Alberta, New Brunswick, Nova Scotia, Ontario, Quebec.

U. Struthiopteridis (O, I, II^1, II^2, III) — New York, Vermont, Wisconsin; Alberta, Manitoba, Nova Scotia, Ontario, Prince Edward Island, Quebec; Newfoundland.

U. virginiana (II^1, II^2, III) — Arkansas, Georgia, Kentucky, Maryland, Mississippi, New Jersey, New York, North Carolina, South Carolina, Tennessee, Texas, Virginia.

B. **Mexico, Central America, West Indies and South America**

U. glabra (II^1, II^2, III) — Mexico.

U. investita (II) — Guatemala.

U. macrosperma (II, III) — Brazil, Colombia, Cuba, Guatemala, Honduras, Jamaica, Mexico, Panama, Venezuela.

U. Mayoriana (II) — Colombia.

C. **Europe**

U. filicina (II^1, II^2, III) — Austria, Czechoslovakia, Finland, France, Germany, Great Britain, Hungary, Italy, Norway, Poland, Roumania, Russia (Eu.), Sweden, Switzerland.

U. macrosperma (II) — Russia (Eu.).
U. mirabilis (II^1, III) — England (on introduced plants).
U. Struthiopteridis (O, I, II^1, II^2, III) — Denmark, Germany, Norway, Poland, Roumania, Russia (Eu.), Caucasus.

D. **Asia**

U. Adianti (O, I, II, III) — Japan, Siberia.
U. Athyrii (O, I, II, III) — Japan.
U. daisenensis (II^1, II^2, III) — Japan.
U. filicina (O, I, II^1, II^2, III) — Japan, Siberia.
U. Hashiokai (II, III) — Formosa.
U. hirosakiensis (O, I, II, III) — Japan, Siberia.
U. intermedia (O, I, II^1, II^2, III) — Japan, Siberia.
U. Kameiana (O, I, II^1, II^2, III) — China, Japan, Siberia.
U. macrosperma (II, III) — China, Japan, Manchuria, Mongolia, Siberia.
U. ossaeiformis (O, I, II, III) — Japan, Siberia.
U. Struthiopteridis (O, I, II^1, II^2, III) — Japan, Siberia.
U. Woodsiae (O, I, II^1, II^2, III) — Japan.

E. **Africa**

U. macrosperma (II, III) — Belgian Congo, Natal.

Reference to the foregoing table shows that two species are listed as occurring in both the eastern and the western hemispheres, namely, *Uredinopsis Struthiopteridis* and *U. macrosperma.* The former is amphisporic and the latter is non-amphisporic. *Uredinopsis Struthiopteridis,* conformable to the distribution of its fern host, *Matteuccia Struthiopteris,* is found throughout a northerly zone of the northern hemisphere. *Uredinopsis macrosperma* is almost cosmopolitan, though for some reason it does not follow its bracken fern hosts into certain extensive regions from which neither physical nor climatic factors would prevent its entrance.

The distribution of *U. macrosperma* is, indeed, puzzling. Thus, it occurs in America throughout the western part of Canada, the contiguous parts of the western United States and southward, Florida, Georgia, Mexico, Central America, the West Indies and South America. But it has not been found in eastern Canada nor in the United States east of a north and south line connecting Montana and New Mexico except for Florida and Georgia. In the eastern hemisphere it has been recorded from two widely separated areas in the southern half of Africa, but not northward from there into Asia until beyond the Caucasian and the Himalayan mountains. Nor has it been found in Europe outside of the Province of Perm in Russia. Yet in large parts of these regions from which it is almost certainly absent there is an abundance of bracken ferns. The one obvious explanation of this conundrum in distribution is that, parallel with the existence of forms and varieties of *Pteridium aquilinum*, there is a marked restriction in the infective capacity of the rust. Conversely, it surely must be that some of the forms and varieties of the bracken fern are susceptible and that others are immune to this rust. A very striking illustration of what I mean is afforded by the situation as it exists in the eastern United States. There, from the Gulf of Mexico up to about the "Mason and Dixon" line, that is, up to southern Pennsylvania and slightly northward, occurs a prevalent form of bracken fern sufficiently distinctive for recognition by the pteridologist Maxon. He deems it worthy of taxonomic ranking, namely, as *Pteridium latiusculum* var. *pseudocaudatum* (Clute) Maxon. This form is free from *U. macrosperma.* True, it is commonly infected with another *Uredinopsis*, but that species is amphisporic and I anticipate that its haploid phase, when discovered, will be found on fir needles of the current season only and not on older needles as is the case with *U. macrosperma.* Again, north of the area occupied by this form of the bracken fern, the bracken fern is abundant almost everywhere. Yet on it no rust of any kind has ever been found. Incidentally, these phenomena lend support to Maxon's contention that *Pteridium latiusculum* var. *pseudocaudatum* is different from the bracken fern of the northern United States and eastern Canada. But more significant still to the uredinologist, it indicates a close specialization in the infective capacity of *Uredinopsis macrosperma* with reference to *Pteridium aquilinum* and its various forms, varieties and marginal species.

Looking over the distribution map of *Uredinopsis* there are still other features that arrest attention. The first of these has to do with the existence of but two known species southward beyond the areas occupied by *Abies*. They are the *U. Mayoriana* of Colombia and the widely distributed *U. macrosperma.* So, within the tropics, the representation of *Uredinopsis* is very meager as compared with the frequency of Milesian rusts and the large number of diverse fern hosts parasitized by them. Turning to the Abies regions of the world, one surprising fact is the paucity of species in Europe. Even such comprehensive fern species, known to be susceptible in North America, as

Osmunda regalis, *Athyrium Filix-femina*, *Dryopteris Linnaeana* and *Dryopteris Thelypteris*, are free from Uredinopsis rusts in Europe. By contrast, there is a relative abundance of species in North America and in northeastern Asia. Indeed, it would seem as though the evolution of *Uredinopsis* had been much more active in those regions than in any other parts of the world.

But one of the most arresting phenomena of all is the distribution of the two most peculiar species of *Uredinopsis*, namely, *U. Adianti* and *U. investita*. Characterized alone among the known species of *Uredinopsis* by urediospores with a thick investing capsule, they also closely resemble each other in various other respects, such as, possession of mucronate urediospores, lack of amphispores, and occurrence on *Adiantum*. Yet one is known only from northeastern Asia and the other from a mountainous region in Guatemala. Truly this phenomenon excites conjectures — conjectures as to the antiquity of *Uredinopsis*, as to parallel evolutions, or as to the possibility of an earlier, more extensive and more continuous distribution. Certainly it is a stimulus to further search for materials in the intervening areas.

Before leaving the general topic of geographical distribution comment should be made on the existence of *Uredinopsis Mayoriana* in a region far beyond the range of *Abies*. A similar subject was discussed in my monograph on *Milesia* (16). There it was maintained that evolution of tropical Milesian species might well have been based solely on the diploid phase, or else that the distribution of *Abies* was once much wider than at present. With reference to the Colombian *U. Mayoriana*, I have only to add that I have looked for it without success in Central America. Isolated as it appears to be, yet it seems reasonably certain that if it is potentially capable of having a haploid phase, that phase in actuality would occur on *Abies*.

PHYLOGENY

The assumption that *Uredinopsis* is a primitive genus, possibly occupying the lowest position in the phylogenetic scale of existing rust fungi, by no means excludes the recognition of some of its characters as evolutionary developments at the inception of or within the genus. This might, indeed, apply to its lack of pigment and to specialization of its urediospores.

The all but universal possession of a yellow pigment by rusts is one of their most remarkable phenomena. This substance, so characteristic of these fungi, remains puzzling both as to its origin and its possible function. That it was acquired somewhere in the course of evolution goes without saying; but whether it came from a fungal or algal ancestor, or originated within the Uredinales can only be surmised. Of course, if pigmentation originated within the Uredinales the temptation would be strong to regard its absence in *Uredinopsis* and *Milesia* as primitive. If this were the case, then we would look to the next most closely allied genus with yellow pigment as the starting point for that character. That genus would be *Hyalopsora*, a genus in which the pigment is both typical and abundant. However, as a deterrent to hasty assumption that lack of color in *Uredinopsis* is primitive, I cannot refrain from recording a suggestive happening in my cultures of *Hyalopsora Polypodii* on *Cystopteris fragilis*. In cultures of that rust maintained for several years in my laboratory greenhouse, a pure white form made its appearance about three years ago. Whatever the significance of this phenomenon might be, it led me to wonder whether or not both *Uredinopsis* and *Milesia* might have originated as colorless mutants. That such might have happened is indicated by the experiences and demonstrations of Johnson and Newton (28) with colorless mutants of *Puccinia graminis Tritici*. They report that not only have colorless mutants of that rust been observed in their cultures from time to time, but also that they have experimentally proved that lack of pigment in these mutants is a pure heritable character. In other words they have bred white races of stem wheat rust that carry no trace of the yellow color character. If, then, *Uredinopsis* originated as a colorless mutant, my supposition is that it sprang from a yellow stock common to both *Uredinopsis* and *Hyalopsora*. Since there are species of *Uredinopsis* with urediospores morphologically like those of species of *Hyalopsora* this supposition requires little stretch of the imagination.

That there has been a marked evolutionary play on the urediospores of *Uredinopsis* is evident. Thus, comparing the ordinary urediospores of the genus throughout, it will be observed that at one end of their range there are simple, subspheroid to ellipsoid or obovoid spores, smooth or warted, and at the other end there are mucronate spores, smooth except for two opposing vertical rows of cogs; and there are also two species with mucronate, capsulate spores. Then, in addition, there is a second type of urediospores, the amphispores. These are found in certain species along with very simple ordinary urediospores, and in various other species along with the highly specialized, mucronate spores. But, as we have seen, amphispores are lacking in some species of *Uredinopsis*. Is their absence in such species a primitive or a reduced feature; and what bearing has the answer on speculations as to the phylogeny of the fir-fern rusts?

Comparing *Uredinopsis* with the apparently quite closely related genus *Hyalopsora*, in which amphispores also occur, an obvious, though not necessarily correct hypothesis is that the amphispores of the two genera have been inherited from a common stock, and that their absence in certain species represents a reduction. Accepting that explanation and bearing in mind the possibility that lack of pigment in *Uredinopsis* represents a genetic loss of color, then the phylogeny of the fir-fern rusts would seem to have been one in which *Uredinopsis* and *Hyalopsora* have sprung independently from a common ancestry and that this ancestry was characterized by a yellow pigment and amphispores. Under such circumstances, *Uredinopsis* would have originated through loss of color, and *Hyalopsora* through a change from intercellular to intracellular teliospores. As for *Milesia* it might be nothing more than an offset from a non-amphisporic *Hyalopsora*, originating simply as a colorless mutant. Of course, underlying the hypothetical common stock of *Uredinopsis* and *Hyalopsora*, going further back along the evolutionary road, it would seem that there must have been a yellow-pigmented, non-amphisporic ancestry with simple Uredinopsis-like teliospores. From such basal stock the Pucciniastrum complex of genera could have had their origin.

TAXONOMY

Professor Arthur in his Plant Rusts (4, p. 109) defines a species as a "variable quantity composed of groups of individuals, races and varieties of greater or less morphologic and physiologic resemblance". This impresses upon the systematist the care to be taken and the judgment to be exercised in determining the limits of the "variable quantity". As applied to preparations for the descriptions that follow, the undertaking began with a study of the types. Fortunately the types of all the species or supposed species heretofore described were available. Then, so as to have authentic materials of haploid phases, specimens obtained by culturing were assembled. Some of these were secured in the course of my own experimental project; others were most generously provided by Dr. S. Kamei of Japan and Professor W. P. Fraser of Canada. Next, these materials were supplemented from cultures made to determine the fern host restrictions of certain closely allied species. There remained the exacting task of appreciating what might be designated a norm for each species. This involved an examination of a wide range of specimens and exhaustive measurements, particularly of the more "variable" quantities. So, for example, for each specimen of uredial material studied, forty or more ordinary urediospores taken from tendrils or extruded masses* were measured and averaged; the same was done for the amphispores where such occur. Averages were also taken of these averages for each species. Some weight was given to host restrictions, but never to the exclusion of the morphological factor. The results indicate that at present we can recognize *twenty-five species* of *Uredinopsis.* To these, pending experimental studies, are added *two varieties* and *one form.* Teliospores are described for all except the two species *U. Mayoriana* and *U. investita.*

UREDINOPSIS P. Magnus

in Atti del Congresso Botanico Internazionale
Genova, **1892**: 167 (1893).

Mycelium colorless, intercellular, with haustoria, septate, the haploid phase on needles of *Abies*, the diploid phase on fronds of ferns.

Spermogonia minute, round, hyaline, hypophyllous, rarely amphigenous, immersed, subcuticular, described as subepidermal in two oriental species, flattened hemispherical to subglobose in vertical section, plane to slightly convex at leaf surface, ostiolate, without ostiolar filaments. Spermatiophores septate, usually simple. Spermatia hyaline, entire, ellipsoid, catenulately produced.

Aecia on needles of current season or in one species on needles

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*In making choice of ordinary urediospores for measurements and descriptions, care was taken to choose extruded spores from vigorous sori. The reason for this was that the ordinary urediospores in sori on old lesions are often greatly reduced in size and altered in proportions. Likewise the lineal rows of cogs, normally one cog each in width for spores characterized by them, are frequently replaced in the spores of sori on old lesions by bands of closely set cogs up to as many as four cogs in a transverse plane of each band.

of second to fifth season, in two rows, hypophyllous, rarely amphigenous, erumpent, peridermial, cylindric, white. Peridium colorless, rupturing irregularly at apex or sometimes also laterally; peridial cells vertically elongate, irregularly polygonal, more or less overlapping, outer walls thin and smooth, inner walls thick and coarsely to finely verrucose or in one species finely and closely reticulate. Aeciospores white, catenulate, with intercalary cells, globose to broadly ovoid or ellipsoid, verrucose.

Uredia of one or of two kinds (ordinary and amphisporic, respectively), hypophyllous, subepidermal, pustular. Peridium colorless, convex, a single layer of isodiametrically to irregularly polygonal cells adherent to the overlying epidermis, the combined membrane rupturing apically by a pore or irregular slit, or rarely by an irregular, subbasal, lateral slit. Spores white. (a) *Ordinary uredium.* Peridium promptly dehiscent; peridial cells thin-walled. Ordinary urediospores with a very short stalk cell, almost sessile; in some species the spores are subspheroid to broadly or narrowly ellipsoid, smooth, warted or spinulose; in many species the spores are narrow and fusiform, ellipsoid or obovoid, with two opposed germ pores near each end, smooth and with or without capsule, but usually non-capsulate and smooth except for two opposed vertical straight or subspiral rows of cogs, apiculate or more commonly with a filamentous, cell-like enucleate mucro. (b) *Amphisporic uredium.* Peridium mostly firmer and tardily dehiscent; peridial cells thicker-walled. Amphispores with a long stalk cell, more or less irregular in form, frequently polyhedral, with or without ridges, fins and horns; smooth or more usually finely and closely warted.

Telia diffuse. Teliospores overwintering in dead fronds, colorless, amphigenous, mostly hypophyllous, subepidermal, intercellular, scattered, or aggregate in crusts of indefinite extent, each a single layer of a few to many spores; teliospores subglobose to broadly ellipsoid, smooth, thin-walled, mostly 4-celled, cruciate, but varying from 1–8-celled, a maximum of 2, 4 or 8 cells according to the species; septa anticlinal or oblique to the leaf surface; spore walls with a single germ pore in the outer wall of each cell.

Basidia formed in the spring, perforating the epidermis overlying the teliospores, colorless, 4-celled; sporidia delicate, white, smooth, thin-walled, entire, subglobose to ellipsoid.

Type species, *Uredinopsis filicina* (Niessl) Magnus (II^1, II^2 and

III), on *Dryopteris Phegopteris* (L.) C. Chr. in Rabenhorst Fg. Eur. 1659.

Two analytic keys to the species of *Uredinopsis* are presented, namely, No. 1 — a comprehensive key based solely on their distinctive morphological characters, and No. 2 — a key in which the species are differentiated under their respective host genera.

KEY TO THE SPECIES OF UREDINOPSIS. No. 1

- A. Amphisporic uredia not present
  - I. Urediospores capsulate
    - a. Mucro formed, but for the most part not evident at maturity, averaging about 14 μ long....1. *U. Adianti* p. 32
    - a. Mucro persistent, averaging about 29 μ...2. *U. investita* p. 35
  - I. Urediospores not capsulate
    - a. Mucro present
      - b. Mucro short, averaging about 4 μ...8. *U. Mayoriana* p. 51
      - b. Mucro of medium length, averaging about 12 μ.................................15. *U. Osmundae* p. 68
      - b. Mucro long, averaging about 20 μ...17. *U. Phegopteridis* p. 77
    - a. Mucro absent
      - b. Spores commonly apiculate, rarely submucronate................................ 21. *U. macrosperma* p. 85
      - b. Spores not commonly apiculate
        - c. Spores smooth, or almost so
          - d. Spores quite symmetrical, ellipsoid to obovate, not irregularly swollen at apex...3. *U. Athyrii* p. 37
          - d. Spores mostly asymmetrical, often more or less swollen near apex........13. *U. ossaeiformis* p. 62
        - c. Spores spinulose or warted
          - d. Spores broadly ellipsoid to obovate
            - e. Spores averaging about 16×23 μ.............................12. *U. hirosakiensis* p. 61
            - e. Spores much larger, averaging about 20×32 μ......................18. *U. aspera* p. 79
          - d. Spores narrowly ellipsoid to obovate, averaging about 17×43 μ...........19. *U. Hashiokai* p. 81
- A. Amphisporic uredia present
  - I. Mucro present
    - a. Amphispores smooth, quite symmetrical. Teliospores not more than 2-celled..................10. *U. glabra* p. 55
    - a. Amphispores finely and uniformly warted
      - b. Ordinary urediospores with conical, broadly based mucro. Amphispores not conspicuously ridged. Teliospores not more than 2-celled....16. *U. filicina* p. 73

- b. Ordinary urediospores with narrowly based filamentous mucro. Teliospores up to 4-celled or more
  - c. Mucro averaging less than 5 μ long
    - d. Amphispores ridged and often with fins...... ....25a. *U. Arthurii* var. *maculata* p. 103
    - d. Amphispores more or less polyhedral but rarely with fins
      - e. Spores smaller, averaging about 16×26 μ. On *Onoclea sensibilis*......14. *U. mirabilis* p. 64
      - e. Spores robust, averaging about 18×28 μ. On *Woodwardia virginica*..25. *U. Arthurii* p. 101
  - c. Mucro averaging 5–10 μ
    - d. Amphispores not strongly polyhedral, ordinarily not finned, averaging about 18×26 μ. On *Athyrium thelypteroides*................ .....7b. *U. longimucronata* var. *acrostichoides* p. 50
    - d. Amphispores strongly polyhedral, often with fins and horns, averaging about 16×26 μ. Ordinary urediospores averaging about 12×34 μ. On *Dryopteris Thelypteris* var. *pubescens* ....11. *U. Atkinsonii* p. 57
    - d. Amphispores strongly polyhedral, occasionally with fins, averaging about 18×28 μ. Ordinary urediospores averaging about 13×37 μ. On *Matteuccia Struthiopteris*................ ....23. *U. Struthiopteridis* p. 96
  - c. Mucro averaging more than 10 μ long
    - d. Amphispores robust, strongly finned and horned, averaging about 19×29 μ. Ordinary urediospores averaging about 15 μ broad. Mucro averaging about 16 μ long. On *Cystopteris bulbifera* ....9. *U. ceratophora* p. 52
    - d. Amphispores not strongly horned. Ordinary urediospores averaging about 13 μ broad. Mucro averaging about 13 μ long
      - e. Amphispores robust, often with fins, averaging about 18×27 μ. On *Athyrium cyclosorum* ....7a. *U. longimucronata* forma *cyclosora* p. 48
      - e. Amphispores smaller, rarely finned, averaging about 16×24 μ. On *Athyrium angustum*................7. *U. longimucronata* p. 44

I. Mucro absent or nearly so
- a. Ordinary urediospores more or less apiculate, rarely submucronate
  - b. Ordinary urediospores with two to four vertical lines of cogs and diffusely scattered warts. Amphispores robust, averaging about 20×26 μ...4. *U. Copelandi* p. 39

- b. Ordinary urediospores with only two opposed vertical lines of cogs, otherwise smooth
    - c. Ordinary urediospores prevalent. Amphispores much rarer, shorter, averaging about 17×24 μ. . . . . 22. *U. virginiana* p. 92
    - c. Ordinary urediospores much rarer. Amphispores prevalent, longer, averaging about 17×28 μ. . . . . 20. *U. Kameiana* p. 82
- a. Ordinary urediospores not apiculate
    - b. Ordinary urediospores quite regular. Amphispores larger, more or less polyhedral
        - c. Amphispores smooth or almost so. . . . . 5. *U. daisenensis* p. 40
        - c. Amphispores finely warted. . . . . . 24. *U. Woodsiae* p. 100
    - b. Ordinary urediospores more or less asymmetrical, frequently irregularly swollen, especially near apex. Amphispores small, fairly regular, almost smooth. . . . . 6. *U. intermedia* p. 42

KEY TO THE SPECIES OF UREDINOPSIS. No. 2

Species on *Adiantum*

- a. Capsulate. Mucro formed, but for the most part not evident at maturity, averaging about 14 μ long
    - 1. *U. Adianti* (on *A. pedatum*). . . . . p. 32
- a. Capsulate. Mucro persistent, averaging about 29 μ long
    - 2. *U. investita* (on *A. andicola*). . . . . p. 35

Species on *Athyrium*

- a. Mucro absent or nearly so
    - b. Amphisporic uredia absent
        - 3. *U. Athyrii* (on *A. melanolepis, A. otophorum, A. rigescens, A. Vidalii*). . . . . . p. 37
    - b. Amphisporic uredia present
        - c. Ordinary urediospores quite regular, often apiculate and with vertical lines of cogs
            - d. Amphispores robust, averaging about 20×26 μ, polyhedral, finely and uniformly warted
                - 4. *U. Copelandi* (on *A. cyclosorum*). . . . . p. 39
            - d. Amphispores smaller, averaging about 15×22 μ, smooth or almost so
                - 5. *U. daisenensis* (on *A. multifidum*). . . . . . . p. 40
        - c. Ordinary urediospores more or less asymmetrical, frequently irregularly swollen, especially near apex, smooth
            - 6. *U. intermedia* (on *A. thelypteroides, A. pterorachis*). . . . p. 42
- a. Mucro present
    - b. Mucro averaging less than 10 μ long
        - 7b. *U. longimucronata* var. *acrostichoides* (on *A. thelypteroides*). . . . p. 50

- b. Mucro averaging more than 10 µ long
  - c. Amphispores robust, often with fins, averaging about 18×27 µ
    - 7a. *U. longimucronata* forma *cyclosora* (on *A. cyclosorum*).... p. 48
  - c. Amphispores smaller, rarely finned, averaging about 16×24 µ
    - 7. *U. longimucronata* (on *A. angustum*).... p. 44

Species on *Blechnum*

- 8. *U. Mayoriana* (on *B. unilaterale*)...... p. 51

Species on *Cheilanthes*

- 10. *U. glabra* (on *C. pyramidalis*)......... p. 55

Species on *Cystopteris*

- a. Amphispores smooth, quite symmetrical, small, averaging about 14×22 µ. Teliospores 1–2-celled
  - 10. *U. glabra* (on *C. fragilis*)............. p. 55
- a. Amphispores robust, finely and closely warted, strongly marked with ridges, horns and fins, averaging about 19×29 µ. Teliospores 1–6-celled
  - 9. *U. ceratophora* (on *C. bulbifera*)....... p. 52

Species on *Dryopteris*

- a. Amphispores present
  - b. Mucro conical, broadly based
    - 16. *U. filicina* (on *D. Phegopteris*)........ p. 73
  - b. Mucro filamentous, narrowly based
    - 11. *U. Atkinsonii* (on *D. Thelypteris* var. *pubescens*).... p. 57
- a. Amphispores absent
  - b. Mucro present
    - 17. *U. Phegopteridis* (on *D. Linnaeana*).... p. 77
  - b. Mucro absent
    - c. Urediospores spinulose
      - 12. *U. hirosakiensis* (on *D. Thelypteris* var. *pubescens*).... p. 61
    - c. Urediospores smooth
      - 13. *U. ossaeiformis* (on *D. amurensis*, *D. dilatata* var. *oblonga*, *D. monticola*).... p. 62

Species on *Matteuccia*

- 23. *U. Struthiopteridis* (on *M. Struthiopteris*) p. 96

Species on *Onoclea*

- 14. *U. mirabilis* (on *O. sensibilis*)......... p. 64

Species on *Osmunda*

- 15. *U. Osmundae* (on *O. cinnamomea*, *O. Claytoniana*, *O. regalis* var. *spectabilis*).... p. 68

Species on *Pellaea*

- 10. *U. glabra* (on *P. cordata*)............. p. 55

Species on *Pteridium*

a. Amphispores absent

b. Urediospores commonly apiculate, smooth except for two opposed vertical rows of cogs

21. *U. macrosperma* (on *P. aquilinum* and vars.) p. 85

b. Urediospores rounded at apex, spinulose

c. Urediospores broadly ellipsoid to obovate, averaging about 20×32 μ

18. *U. aspera* (on *P. aquilinum* var. *lanuginosum*) p. 79

c. Urediospores narrowly ellipsoid to obovate, averaging about 17×43 μ

19. *U. Hashiokai* (on *P. aquilinum*) .... p. 81

b. Amphispores present

c. Ordinary urediospores prevalent. Amphispores much more infrequent, shorter, averaging about 17×24 μ

22. *U. virginiana* (on *P. aquilinum* var. *pseudocaudatum*) .... p. 92

c. Ordinary urediospores much more infrequent. Amphispores prevalent, longer, averaging about 17×28 μ

20. *U. Kameiana* (on *P. aquilinum*, *P. aquilinum* var. *japonicum*) .... p. 82

Species on *Woodsia*

24. *U. Woodsiae* (on *W. polystichoides* vars. *nudiuscula* and *Veitchii*) .... p. 100

Species on *Woodwardia*

a. Amphispores ridged and often with fins, walls thin

25a. *U. Arthurii* var. *maculata* (on *W. areolata*) p. 103

a. Amphispores more robust, polyhedral but rarely with fins, walls thick

25. *U. Arthurii* (on *W. virginica*) .... p. 101

1. **Uredinopsis Adianti** Komarov in Jaczewski, Komarov and Tranzschel, Fungi Rossiae, no. 278 (1899). (III).

O, I, II and III.

O. "Spermogonia on needles of current season, amphigenous, chiefly hypophyllous, minute, inconspicuous, numerous, irregularly scattered on more or less discoloured areas, isolated or confluent, subcuticular, subconoidal to hemispherical, 70–165 μ wide, 66–77 μ high; spermatiophores unbranched; spermatia oblong, 4.8–6.4×1.6–2 μ, colourless, smooth." (23)

I. Aecia (peridermia) hypophyllous on needles of current season, in two rows, one on each side of midrib, white, cylindrical, 0.15–0.25 mm. in diameter and up to 1.2 mm. in height; peridium colorless, rather firm, rupturing at the apex; peridial cells in a single layer, overlapping, polygonal, 17–24×17–27 μ, outer walls smooth, about 1 μ thick, inner walls closely and rather coarsely verrucose, 2–3 μ thick; aeciospores subglobose to ellipsoid, colorless, closely and rather finely verrucose, one side partly smooth, tubercles somewhat deciduous, 15–20×17–26 μ, averaging about 18×22 μ; spore wall colorless, thin, about 1 μ thick.

II. Uredia hypophyllous, subepidermal, scattered on yellowish areas of indefinite extent or on elongate strips between parallel lateral veins, pustular, round, 0.1–0.3 mm. in diameter, covered by yellowish to dark brown epidermis; peridium hemispheric, colorless, delicate; peridial cells isodiametrically to irregularly polygonal, 7–14×10–22 μ, with walls less than 1 μ thick; urediospores hyaline, white in mass, abundant, extruded in tendrils, very short-stalked, ellipsoid, ovoid, obovoid or fusiform, 8–15×19–54 μ, averaging about 11×36 μ, with a filamentous, enucleate mucro 0–27 μ long, averaging about 14 μ; spore and mucro invested with a persistent, continuous, thick, hyaline, gelatin-like capsule, marked by very delicate, radiating lines; mucro not evident in the mature spore except for traces of its basal portion; spore wall colorless, smooth, up to 1 μ thick, with two germ pores near each end.

III. Telia diffuse, amphigenous, mostly hypophyllous; teliospores subepidermal, intercellular, scattered or loosely aggregate in a single layer, colorless, subspheroid to ellipsoid, 1–8-celled, mostly 4-celled, 14–25×18–38 μ; spore walls hyaline, smooth, about 1 μ thick.

HOSTS AND DISTRIBUTION:

O and I. *Abies Mayriana* Miyabe and Kudô, in Japan (*cultures*).

II and III. *Adiantum pedatum* L., in Manchuria, Japan, Siberia.

TYPE LOCALITY: Mountain forests of Dschai-guan-zailin, between Omoso and Kirin, Manchuria, on *Adiantum pedatum.* II and III.

ILLUSTRATIONS: Pl. I, figs. 1 a-b. — Hiratsuka in Jour. Jap. Bot. **10**: 472, fig. 10 (1934).

EXSICCATI: Jacz. Kom. Tranzsch. Fg. Ross. 278.

SPECIMENS EXAMINED. —

O and I. On *Abies Mayriana.*

JAPAN: Sapporo, June 1925; CULTURES by *S. Kamei.*

II and III. On *Adiantum pedatum.*

JAPAN: Mt. Teine, Ishikari, Sept. 28, 1924, *S. Kamei.* — Awanomura, Echizen, Oct. 17, 1931, *N. Hiratsuka* 884.

MANCHURIA: Prov. Kirin, Aug. 20, 1896, *V. L. Komarov*, Fg. Ross. 278; *type.*

SIBERIA: Coast Prov., Distr. Vladivostok, Aug. 9, 1929, *W. Tranzschel* (II). — Distr. Vladivostok, Aug. 19, 1929, *W. Tranzschel.* — Distr. Vladivostok, Sept. 14, 1929, *W. Tranzschel.*

Uredinopsis Adianti is one of the most remarkable species of the genus. It was discovered by Komarov in the Province of Kirin in Manchuria and has since been collected by Tranzschel in the Coast Province of Siberia and by Hiratsuka and Kamei in Japan. Hiratsuka states that "it is rather common in Japan". Komarov described the species from its teliospores only, but both Sydow and Hiratsuka found overripe uredia and a few urediospores in the original material and I have met with similar success. The more recent collections, however, show an abundance of urediospores, some of them being freely discharged in white tendrils. Fortunately, Kamei (30) included this species in his culture studies and his efforts were rewarded by successful infections on *Abies.* He generously shared part of his cultures with me, thus affording me the opportunity to study the haploid phase at first hand. My observations confirm his own. So all stages of the life history are now known and all of its spore forms found. These do not include amphispores; apparently *U. Adianti* is one of those species of *Uredinopsis* in which they do not occur.

All of the sori of *U. Adianti* conform to the patterns for the genus, and the only spores that exhibit unusual features are the urediospores. The urediospores were briefly described by Sydow (52), their first observer, as being thin-walled, ovate-fusiform to fusiform and varying in size from 12–18 μ wide and 28–38 μ long. Hiratsuka (23) extended the description by noting that "beaks" (mucros) were "very short or quite lacking", that the spores varied from 10–18 μ wide and 27–45 μ long and that the epispore was "minutely echinulate or nearly smooth except for a longitudinal line of minute papillae". My own observations are in agreement as to spore shape and almost so as to size. I am convinced, however, that the spore walls are smooth; certainly I find nothing that I could interpret as a longitudinal line of minute papillae. But more significant still I find a mucro up to 27 μ long, with an average of about 14 μ, and also a soft, thick, hyaline capsule that completely invests the spore, including the mucro.

As my studies were made on dried herbarium specimens solely, it was necessary to revive the uredia and their spores. This was done by the application of lactic acid or Amann's fluid. From such preparations it is evident that the urediospore initials are filamentous, that in the course of their development a mucro is differentiated and that prior to maturity the spore with its mucro becomes capsulate. The unstained capsule appears structureless, but if treated with Amann's acid fuchsin and then Amann's light green there can be faintly detected many fine radiating lines and generally diffused particles. The spore contents in these preparations are red and granular. The mucro, at full maturity of the spores, seems to have disappeared except for a very short basal portion, just as though it had been absorbed; its part of the capsule, however, remains intact. By pressure on the cover glass of mounts like those described, the spores are easily pressed out of the capsule, leaving the latter intact but empty. The following are measures in microns of ten representative urediospores, their measures including the capsules and in parentheses the corresponding measures without the capsules: 14 (10)×43 (37), 15 (10)×47 (38), 16 (11)×45 (38), 16 (11)×41 (33), 16 (12)×59 (32), 16 (11)×44 (30), 16 (8)×47 (33), 19 (11)×51 (36), 19 (12)×60 (38), 19 (14)×55 (26). The difference between the two long measures for a given spore represents approximately the length of its mucro.

Discovery of a capsule completely investing the urediospore reveals a surprising and distinctive character hitherto unknown in the genus *Uredinopsis*, if not, indeed, in the Uredinales. Certainly it sets *U. Adianti* widely apart from other species of *Uredinopsis*, except for a new species I recently found on a Cupressus-forested mountain in Guatemala — a species, also on *Adiantum*, and described below under the name *U. investita*. Yet the systematic relationship of *U. Adianti* is unquestionable, because its structural features and its biology are in every essential respect those of a *Uredinopsis*.

The average measures of the urediospores of *U. Adianti*, exclusive of the capsules and the mucros, range from 10–12× 32–38 μ.

2. **Uredinopsis investita** Faull, sp. nov. II.

Pycnidia et aecidia ignota. Sori uredosporiferi hypophylli, epidermide tecti, sparsi, pustulati, rotundati, 0.1–0.3 mm. diam., peridio ex cellulis hyalinis irregulariter polygonalibus composito cincti; cellulae peridii 7–16×8–19 μ, pariete 1–4 μ crasso; uredosporae ellipsoideae, obovoideae vel fusiformes, subsessiles, hyalinae, 8–14×27–43 μ, plus minusve 11×35 μ, mucrone 14–43 μ longo, plus minusve proxime 29 μ; spora et mucro theca hyalina, gelatinosa cincti; paries sporae hyalinus, levis, tenuis.

Hab. in foliis *Adianti andicolae* in Guatemala.

O and I. Spermogonia and aecia unknown.

II. Uredia hypophyllous, subepidermal, scattered on purplish brown areas of indefinite extent, pustular, round to elliptical, 0.1–0.3 mm. in diameter; peridium hemispheric, colorless, firm; peridial cells isodiametrically to irregularly polygonal, 7–16×8–19 μ, with walls 1–4 μ thick; urediospores hyaline, abundant, extruded in white masses or tendrils, very short-stalked, ellipsoid, obovoid or fusiform, 8–14×27–43 μ, averaging about 11×35 μ, with a filamentous, persistent, enucleate mucro 14–43 μ long, averaging about 29 μ; spore and mucro invested with a persistent, continuous, hyaline, gelatin-like capsule, 1.5 to many microns thick; spore wall colorless, smooth, up to 1 μ thick, with two germ pores near each end.

III. Telia unknown.

Hosts and Distribution:
O and I. Unknown.
II. *Adiantum andicola* Liebm., in Guatemala.
III. Unknown.

Type Locality: Tecpam, Guatemala, on *Adiantum andicola*. II.

Illustrations: Pl. I, figs. 2 a-b.

Specimens Examined. —

Guatemala: Forest of *Cupressus lusitanica* Miller, elev. 10,000 ft., Tecpam, Dec. 22, 1936, *J. H. Faull* 12983 (II); *type.*

Uredinopsis investita was found by the writer in a moist, isolated forest of *Cupressus lusitanica* Mill. that covered the top of a mountain near Tecpam, Guatemala. Both the host and the rust were abundant. Although the urediospores only have been seen so far, they are so similar to those of *U. Adianti* that no reasonable doubt exists as to the generic position of the fungus. By treatment of the spores with Amann's methyl blue a pair of nuclei is clearly differentiated in each spore; the capsule also is well defined and the persistent mucro is evident. The capsule seems to be homogeneous; at least I have not been able to detect lines or granules in it, such as were observed in the urediospore capsules of *U. Adianti.* Naturally, the existence of two such characteristic and similar species on *Adiantum,* as *U. Adianti* and *U. investita,* so widely separated geographically, arouses curiosity as to both present and past distribution of *Uredinopsis.* Further collecting northward from Guatemala may well yield interesting finds.

3. **Uredinopsis Athyrii** Kamei in Trans. Sapporo Nat. His. Soc. **12:** 163 (1932). (O, I, II and III). O, I, II and III.

O. Spermogonia on needles of current season the affected portions of which are discolored and distorted, amphigenous, mostly hypophyllous, inconspicuous, slightly elevated to slightly depressed, round, colorless, immersed, applanate-conoidal to hemispheric in vertical section, subcuticular, 74–137 μ broad and 37–77 μ deep; spermatiophores unbranched, obclavate, septate; spermatia ellipsoid, hyaline, smooth, 1.6–2.4×4.8–6.4 μ. (Measures according to Kamei, 30).

I. Aecia (peridermia) on needles of current season, hypophyllous, in two rows, white, cylindrical, 0.2–0.3 mm. in diameter and up to 2 mm. high; peridium colorless, rupturing at the apex; peridial cells in a single layer, polygonal, elongate vertically, overlapping, 13–25×25–48 μ, outer wall smooth, 1.0–2.0 μ thick, inner wall closely and coarsely verrucose, 2.0–4.0 μ thick; aeciospores broadly ellipsoid, ovoid or subspheroid, white, 15–19×18–24 μ, averaging about 17×20 μ, closely and rather finely verrucose; wall of aeciospore colorless, 1.0–1.5 μ thick.

II. Uredia hypophyllous, subepidermal, scattered on discolored intercostal spots or on areas of indefinite extent, pustular, round, 0.1–0.3 mm. in diameter; peridium convex, colorless, rather firm; peridial cells isodiametrically to irregularly polygonal, 6–14×8–16 μ, with walls 1–2 μ thick; urediospores hyaline, white in mass, extruded in tendrils, very short-stalked, ellipsoid, obovoid or fusiform, 8–16×19–38 μ, averaging about 12×27 μ, rounded at the apex or slightly apiculate; spore walls up to 1 μ thick, colorless and smooth except for two opposing vertical rows of short, closely set cogs.

III. Telia diffuse, amphigenous, mostly hypophyllous; teliospores subepidermal, intercellular, scattered or loosely aggregate in a single layer, colorless, subspheroid to ellipsoid, usually 4-celled, cruciate, but varying from 1–5-celled, 14–21×16–24 µ; spore walls hyaline, smooth, about 1 µ thick. "Basidiospores subglobose, 7–11 µ across, smooth, colourless" (23).

HOSTS AND DISTRIBUTION:

O and I. *Abies Mayriana* Miyabe and Kudô, in Japan (CULTURES).

II and III. *Athyrium melanolepis* (Franch. and Sav.) Christ, in Japan.

TYPE LOCALITY: Sapporo, Japan on *Athyrium melanolepis*. II and III.

ILLUSTRATIONS: Pl. I, figs. 3 a-b.

SPECIMENS EXAMINED. —

O and I. On *Abies Mayriana*.

JAPAN: Sapporo, June 20, 1923, *S. Kamei;* CULTURES.

II and III. On *Athyrium melanolepis*.

JAPAN: Mt. Makkarinupuri, Prov. Iburi, Aug. 27, 1923, *S. Kamei.* — Mt. Makkarinupuri, Prov. Iburi, Sept. 9, 1925, *S. Kamei.* — Sapporo, Oct. 4, 1932, *S. Kamei; type.*

We owe our knowledge of the life history of *Uredinopsis Athyrii* to Kamei (30) and through his kindness I have been enabled to study the haploid phase obtained in his cultures. Hiratsuka (23) reports this rust from the island of Hokkaidô only, where he states that it occurs rather commonly. Regarding the host assignments of *U. Athyrii* I feel rather in doubt. Its diploid characters are so like those of *U. daisenensis* Hirat. that I question if at present the two species are separable except for the occurrence of amphispores in the latter. It seems to have been this difference only that led Hiratsuka to establish the species *U. daisenensis.* He reports *U. daisenensis* on *Athyrium multifidum* (*A. deltoidofrons*), *A. otophorum, A. rigescens* and *A. Vidalii.* I have seen rusted specimens of all of these hosts except *A. otophorum;* but the material of *A. multifidum* only carries amphispores. As amphispores of several species are somewhat variable in their frequency, the uncertainty persists as to whether amphispores may not eventually be found in *U. Athyrii* on *A. melanolepis.* If such should turn out to be the case then *U. daisenensis* should, in my judgment, be reduced to synonymy under *U. Athyrii.* Tentatively, however, I am accepting Hiratsuka's disposition of these species.

4. **Uredinopsis Copelandi** Sydow in Ann. Mycol. **2**: 30 (1904). (II^1, II^2 and III). II^1, II^2 and III.

Milesia Copelandi (Syd.) Arthur in Résult. Sci. Congr. Internat. Bot. Vienne, 1905, 337 (1906).

Uredinopsis mirabilis (Peck) Magn. ex Rhoads, Hedgcock, Bethel and Hartley in Phytopath. **8**: 333 (1918), in part.

Uredinopsis Struthiopteridis Störmer ex Arthur, Man. Rusts United States Canada, 4 (1934), in part.

Uredinopsis Copelandi Syd. ex Hiratsuka, Monog. Pucciniastreae, 53–56 (1936), in part.

O and I. Spermogonia and aecia unknown.

II^1. Uredia hypophyllous, subepidermal, scattered or aggregate on discolored intercostal spots or on areas of indefinite extent, pustular, round, 0.1–0.5 mm. in diameter; peridium convex, colorless, delicate; peridial cells isodiametrically to irregularly polygonal, 5–13×8–18 μ, with walls up to 1 μ thick; urediospores hyaline, white in mass, abundant, extruded in tendrils, very short-stalked, ellipsoid, obovoid or fusiform, 11–16×27–54 μ, averaging about 14×39 μ, obtuse to apiculate, rarely submucronate; walls of spores 1.0–1.5 μ thick, colorless, with two opposing, vertical rows of short, closely set cogs, often with additional incomplete vertical rows of cogs and with scattered warts.

II^2. Uredia hypophyllous, subepidermal, developing later than the first of the II^1-uredia but on the same lesions, round, 0.1–0.4 mm. in diameter; peridium convex, colorless, rather delicate, tardily dehiscent; peridial cells isodiametrically to irregularly polygonal, 5–13×8–16 μ, with walls up to 1.2 μ thick; lateral peridial cells much elongate radially; urediospores (amphispores) hyaline, white in mass, long-stalked, angularly obovoid or irregularly polyhedral, 15–27×19–38 μ, averaging about 20×26 μ, strongly finned and horned; spore walls hyaline, finely and closely verrucose, 2.0–2.5 μ thick.

III. Telia diffuse, mostly hypophyllous; teliospores subepidermal, intercellular, scattered, colorless, subspheroid to ellipsoid, usually 4-celled, cruciate, but varying from 1–6-celled, 19–27×19–32 μ; spore walls hyaline, smooth, about 1 μ thick.

Hosts and Distribution:

O and I. Unknown.

II^1, II^2 and III. *Athyrium cyclosorum* Rupr., in California.

Type Locality: Sisson, California, on *Athyrium cyclosorum*. II^1, II^2 and III.

Illustrations: Pl. I, figs. 6 a-d.
Exsiccati: Syd. Ured. 1790.
Specimens Examined. —
II¹, II² and III. On *Athyrium cyclosorum.*
California: Sisson, Aug. 13, 1903, *E. B. Copeland; type.* — *W. C. Blasdale,* Herb. B. P. I. Wash. 66727 (II¹, II²). — Humboldt Co., *H. E. Parks* (II¹). — Yosemite Valley, June 23, 1919, *W. C. Blasdale* (II¹, II²). — Requa, Aug. 20, 1929, *G. D. Darker.*

Failure to recognize two easily distinguished species of *Uredinopsis* on *Athyrium cyclosorum* has resulted in much nomenclatural confusion. One of these, the *U. Copelandi* of Sydow, has so far been reported from California only. The other seems to be common throughout the range of its host and the general conception of *U. Copelandi* is apparently based on that species rather than on the type material of *U. Copelandi.* The five collections of *U. Copelandi* studied, one of them the type, closely resemble one another. The ordinary urediospores in all are more robust than those of the second species; they are thicker-walled, differently marked and above all the mucro is entirely absent or very short. Thus the mucro in the five collections referred to averages 0, 0, 0.9, 1.1 and 1.1 µ in length, respectively. Likewise the amphispores are more robust and their measures do not overlap those of the second species. Conversely, in the second species the urediospores of both kinds are more slender, and the mucro of its ordinary urediospores ranges up to 30 µ long, with an average of about 13 µ. That species I have named *U. longimucronata* forma *cyclosora,* a form in most respects similar to a corresponding rust on *Athyrium angustum;* but both are quite distinct from *U. Copelandi* Syd.

The average measures of the ordinary urediospores of *U. Copelandi* range from 13–14×34–42 µ, and the amphispores from 19–21×25–28 µ.

5. **Uredinopsis daisenensis** Hiratsuka f. in Monog. Pucciniastreae, 69 (1936). (II¹, II² and III.) II¹, II² and III.

O and I. Spermogonia and aecia unknown.

II¹. Uredia hypophyllous, subepidermal, scattered on discolored intercostal spots or on areas of indefinite extent, pustular, subround, 0.1–0.3 mm. in diameter; peridium convex, delicate, colorless; peridial cells irregularly polygonal, 6–11×8–16 µ, with walls about 1 μ thick; urediospores hyaline, extruded in white tendrils or masses, very short-stalked, obovoid, ellipsoid or fusiform, rounded at the apex; 11–15×24–43 μ, averaging about 13×29 μ; walls of spores colorless, smooth except for two opposing vertical rows of short, closely set cogs; spore walls 1 μ thick or less.

II². Uredia hypophyllous, subepidermal, developing later than the first of the II¹-uredia but on the same lesions, round, 0.2–0.3 mm. in diameter; peridium convex, colorless, tardily dehiscent; peridial cells isodiametrically to irregularly polygonal, 6–11×8–16 μ, with walls up to 1.5 μ thick; urediospores (amphispores) hyaline, white in mass, with stalks up to 27 μ long, commonly asymmetrical, obovoid to ellipsoid, rounded to somewhat angular, distinctly to imperceptibly marked with low, fine ridges, the ridges more or less roughened to erose, elsewhere smooth or possibly very minutely warted, 11–19×19–27 μ, averaging about 15×22 μ; spore walls hyaline, up to 1.5 μ thick.

III. Telia diffuse, amphigenous, mostly hypophyllous; teliospores subepidermal, intercellular, scattered or loosely aggregate in a single layer, colorless, subspheroid to ellipsoid, 2–4-celled, rarely 1-celled, 16–20×16–24 μ; spore walls hyaline, smooth, about 1 μ thick.

HOSTS AND DISTRIBUTION:
O and I. Unknown.
II¹, II² and III. *Athyrium multifidum* Rosenst. (*A. deltoidofrons* Mak.), in Japan.
Athyrium otophorum (Miq.) Koidz., in Japan.
Athyrium rigescens Mak., in Japan.
Athyrium Vidalii (Franch. and Sav.) Nakai, in Japan.

TYPE LOCALITY: Yamanaka-machi, Prov. Kaga, Japan on *Athyrium multifidum*. II¹, II² and III.

ILLUSTRATIONS: Pl. I, figs. 4 a-b.

SPECIMENS EXAMINED. —
II¹, II² and III. On *Athyrium multifidum*.
JAPAN: Yamanaka-machi, Prov. Kaga, Oct. 20, 1931, *N. Hiratsuka.*
II¹ and III. On *Athyrium rigescens.*
JAPAN: Daisenji, Prov. Hôki, Aug. 23, 1929, *N. Hiratsuka.*
II¹ and III. On *Athyrium Vidalii.*
JAPAN: Nopporo, Prov. Ishikari, Sept. 7, 1924, *S. Kamei.*

For comments on this species, the reader is referred to the notes under *Uredinopsis Athyrii.*

6. **Uredinopsis intermedia** Kamei in Trans. Sapporo Nat. His. Soc. **12:** 166 (1932). (O, I, II^1, II^2 and III).

O, I, II^1, II^2 and III.

O. Spermogonia on needles of the current season, hypophyllous, inconspicuous, round, colorless, immersed, globose to subglobose in vertical section, subepidermal, 130–209 μ broad and 120–187 μ deep; spermatia ellipsoid, hyaline, smooth, 1.9–2.4× 5.6–6.7 μ. (After Kamei, 30).

I. Aecia (peridermia) on needles of current season, hypophyllous, in two rows, white, cylindrical, 0.2–0.4 mm. in diameter and up to 1.2 mm. high; peridium colorless, rather tough, rupturing irregularly at the apex; peridial cells in a single layer, polygonal, elongate vertically, overlapping, 13–32×22–40 μ, outer wall smooth, 1.0–1.5 μ thick, inner wall finely and closely reticulate, 3.0–4.5 μ thick; aeciospores broadly ellipsoid, ovoid or subspheroid, white, 14–22×16–27 μ, averaging about 17×20 μ, closely and finely verrucose; wall of aeciospore colorless, 1.0–1.5 μ thick.

II^1. Uredia hypophyllous, subepidermal, scattered on discolored intercostal spots or on areas of indefinite extent, pustular, round, up to 0.3 mm. in diameter; peridium convex, colorless, delicate; peridial cells isodiametrically to irregularly polygonal, 6–11×8–17 μ, with walls up to 1 μ thick; urediospores hyaline, white in mass, extruded in tendrils, very short-stalked, subspheroid, cuneate, ellipsoid or obovoid, sometimes regular in form but more often locally protuberant, especially at or near the apex, 11–16×16–30 μ, averaging about 13×21 μ; walls of spores colorless, smooth, up to 1 μ thick.

II^2. Uredia hypophyllous, subepidermal, developing later than the II^1-uredia but on the same lesions, round to slightly elongate 0.2–0.5 mm. in diameter; peridium convex, colorless, rather firm, tardily dehiscent; peridial cells isodiametrically to irregularly polygonal, 6–13×8–16 μ, with walls 1.0–2.5 μ thick; urediospores (amphispores) hyaline, white in mass, long-stalked, obovoid or ellipsoid, and often quite irregularly asymmetrical, 11–16×15–27 μ, averaging about 14×20 μ; spore walls hyaline, sometimes faintly and very finely verrucose at the apex, otherwise smooth, 1.0–1.2 μ thick.

III. Telia diffuse, amphigenous, mostly hypophyllous; teliospores subepidermal, intercellular, scattered or loosely aggregate in a single layer, colorless, subspheroid to ellipsoid, usually 4-celled, cruciate, but varying from 1–8-celled, 15–30×19–34 μ; spore walls hyaline, smooth, about 1 μ thick. According to Kamei (30), the basidiospores are subglobose, hyaline, smooth, 5.5–9.0×7.5–11.0 μ.

HOSTS AND DISTRIBUTION:

O and I. *Abies Mayriana* Miyabe and Kudô, in Japan (*cultures*).

II^1, II^2 and III. *Athyrium pterorachis* Christ, in Japan.

Athyrium thelypteroides (Michx.) Desv., in Japan, Siberia.

TYPE LOCALITY: Sapporo, Japan on *Athyrium pterorachis*. II^1, II^2 and III.

ILLUSTRATIONS: Pl. I, figs. 5 a-d.

SPECIMENS EXAMINED. —

O and I. On *Abies Mayriana*.

JAPAN: Sapporo, June 18 and 25, 1923, *S. Kamei;* CULTURES.

II^1, II^2 and III. On *Athyrium pterorachis*.

JAPAN: Sapporo, Sept. 30, 1922, *S. Kamei; type.* — Morappu, Iburi, Sept. 18, 1931, *S. Kamei.*

II^1, II^2 and III. On *Athyrium thelypteroides*.

JAPAN: Mt. Teine, Ishikari, Sept. 26, 1925, *S. Kamei.*

SIBERIA: Distr. Vladivostok, Sept. 14, 1929, *W. Tranzschel* 1326.

Arranging the species of *Uredinopsis*, in which all spore forms of the genus are represented, with respect to the simplicity of their urediospores, *U. intermedia* would very properly be placed at the bottom of the list. Its urediospores exhibit almost no specialization of form and even the differences between the ordinary urediospores and the amphispores are not great. Conceivably it stands close to the forms from which the genus originated. The simplicity of the spores suggested to Kamei (30) resemblances to *Milesia;* he might equally well have alluded to certain species of *Hyalopsora*. The description of the ordinary urediospores given above calls attention to one irregularity frequently present, that is, the tendency to bulge locally, especially at or near the apex. That feature is manifested by but one other known species, namely, *U. ossaeiformis*, and to such an extent as to indicate close relationship.

Kamei (30) cultured *U. intermedia* and found that it passes to *Abies*. The spermogonia obtained are unusually large and the markings on the peridial cells of the peridermium are exceptional; but both organs are typically those of an *Uredinopsis*. I am grateful to him for sharing this culture material with me. He also obtained infection of one of the fern hosts by inoculating young fronds with overwintered amphispores from the same host species.

7. **Uredinopsis longimucronata** Faull, sp. nov. O, I, II^1, II^2 and III.

Uredinopsis Atkinsonii Magn. ex Arthur in N. Am. Flora, **7**: 117 (1907), in part.
Uredinopsis Copelandi Syd. ex Jackson in Brooklyn Bot. Gard. Mem. **1**: 218 (1918), in part.
Uredinopsis mirabilis (Peck) Magn. ex Rhoads, Hedgcock, Bethel and Hartley in Phytopath. **8**: 333 (1918), in part.
Uredinopsis Struthiopteridis Störmer ex Arthur, Man. Rusts United States Canada, 4 (1934), in part.

Pycnidia hypophylla, inconspicua, hyalina, hemispherica, subcuticularia, 67–123 μ lata×36–51 μ alta, plus minusve 96×48 μ; spermatia ovata vel ellipsoidea, 1.0–3.3×2.5–5.0 μ. Aecidia hypophylla, in seriebus duabus disposita, alba, cylindracea, 0.2–0.4 mm. diam.×0.5.–1.0 mm. alta, ad apicem dehiscentia; cellulae peridii imbricatim positae, 11–27×16–35 μ, pariete exteriore levi 1.0–1.2 μ crasso, interiore 2.5–3.0 μ crasso et dense verrucoso; aecidiosporae late ellipsoideae, ovatae vel subglobosae, dense verrucosae, hyalinae, 16–22×18–27 μ, plus minusve 18×22 μ, episporio 1.2–1.5 μ crasso. Sori uredosporiferi ordinarii hypophylli, epidermide tecti, pustulati, rotundati, 0.1–0.3 mm. diam., peridio ex cellulis hyalinis irregulariter polygonalibus composito cincti; cellulae peridii 5–11×8–16 μ, pariete 0.7–1.0 μ crasso; uredosporae ellipsoideae, obovoideae vel fusiformes, subsessiles, hyalinae, 11–17×22–54 μ, plus minusve 13×35 μ, mucrone 0–24 μ longo, plus minusve 13 μ; paries sporae hyalinus, verrucis in serie verticali in utroque latere dispositis, ceterum levis, 1 μ vel minus crassus. Sori uredosporiferi secondarii hypophylli, epidermide tecti, pustulati, rotundati, 0.1–0.3 mm. diam., peridio ex cellulis hyalinis irregulariter polygonalibus composito cincti; cellulae peridii 5–13×8–14 μ, pariete 1.0–1.8 μ crasso; uredosporae (amphisporae) longe stipitatae, angulariter obovoideae vel irregulariter polyedricae, 11–22×14–35 μ, plus minusve 16×24 μ, plerumque nec alatae nec cornutae; paries sporae hyalinus, dense verruculosus, 1–3 μ crassus. Teleutosporae epidermide tectae, amphigenae, plerumque hypophyllae, subglobosae vel ellipsoideae, 1–7-cellulares, leves, hyalinae, 14–23×16–40 μ.

Hab. in foliis *Abietis balsameae* et *Athyrii angusti* in Canada; United States.

O. Spermogonia on needles of current season, hypophyllous, inconspicuous, colorless, plane, immersed, inverted hemispherical in sectional view, subcuticular, 67–123 μ broad and 36–51 μ deep, averaging 96×48 μ; apical pore lens-shaped or a short slit; spermatiophores unbranched, septate, with large basal cell; spermatia hyaline, catenulately produced, ovoid to ellipsoid, 1.0–3.3×2.5–5.0 μ.

I. Aecia (peridermia) hypophyllous on needles of the current season, in two rows, white, cylindrical, 0.2–0.4 mm. in diameter and 0.5–1.0 mm. high; peridium colorless, fragile, rupturing at the apex; peridial cells in a single layer, polygonal, elongate vertically, overlapping, 11–27×16–35 μ, outer wall smooth, 1.0–1.2 μ thick, inner wall 2.5–3.0 μ thick, closely and rather coarsely verrucose; aeciospores broadly ellipsoid, ovoid or subspheroid, white, 16–22×18–27 μ, averaging about 18×22 μ, closely and rather coarsely verrucose; wall of aeciospore colorless, 1.2–1.5 μ thick.

II^1. Uredia hypophyllous, subepidermal, scattered on discolored intercostal spots or on areas of indefinite extent, pustular, round, 0.1–0.3 mm. in diameter; peridium convex, colorless, delicate; peridial cells isodiametrically to irregularly polygonal, 5–11×8–16 μ, with walls up to 1 μ thick; urediospores hyaline, white in mass, abundant, extruded in tendrils, very short-stalked, ellipsoid, obovoid or fusiform, 11–17×22–54 μ, averaging about 13×35 μ, with a filamentous, enucleate mucro 0–24 μ long, averaging about 13 μ; walls of spores colorless, smooth except for two opposing vertical rows of short (up to 2.0 μ high) closely set cogs; spore wall up to 1 μ thick, with two germ pores near each end.

II^2. Uredia hypophyllous, subepidermal, developing later than the first of the II^1-uredia but on the same lesions, round, 0.1–0.3 mm. in diameter; peridium convex, colorless, rather firm, tardily dehiscent; peridial cells isodiametrically to irregularly polygonal, 5–13×8–14 μ, with walls 1.0–1.8 μ thick; urediospores (amphispores) hyaline, white in mass, long-stalked, angularly obovoid or irregularly polyhedral, 11–22×14–35 μ, averaging about 16×24 μ, thickened and often ridged at the angles, usually without fins or horns, sometimes finned and occasionally with low horns; spore walls hyaline, finely and closely verrucose, 1–3 μ thick, thickest at the angles.

III. Telia diffuse, amphigenous, mostly hypophyllous; teliospores subepidermal, intercellular, scattered or loosely aggregate in a single layer, colorless, subspheroid to ellipsoid, usually 4-celled, cruciate, but varying from 1–7-celled, $14\text{–}23 \times 16\text{–}40\ \mu$, a single pore in the outer wall of each cell; spore walls hyaline, smooth, about $1\ \mu$ thick.

HOSTS AND DISTRIBUTION:

O and I. *Abies balsamea* (L.) Mill., in Ontario (*cultures*).

II^1, II^2 and III. *Athyrium angustum* (Willd.) Presl, in Connecticut, Maine, Massachusetts, New Hampshire, New York, Pennsylvania, Rhode Island, Vermont, Wisconsin; New Brunswick, Nova Scotia, Ontario, Quebec.

TYPE LOCALITY: Timagami, Ontario, on *Abies balsamea* and *Athyrium angustum*. O, I, II^1, II^2 and III.

ILLUSTRATIONS: Pl. II, figs. 7 a-d. — Hiratsuka, Monog. Pucciniastreae, Pl. II, fig. 4. (1936).

EXSICCATI: Reliq. Farl. 283 b, c. — S. and E. Econ. Fg. B7.

SPECIMENS EXAMINED. —

O and I. On *Abies balsamea*.

ONTARIO: Timagami, Aug. 3–10, 1926, *J. H. Faull & E. H. Bensley*, Herb. J. H. Faull 7751–7753; CULTURES. — Timagami, July 9–23, 1927, *J. H. Faull & E. H. Bensley*, Herb. J. H. Faull 8472–8481; CULTURES.

II^1, II^2 and III. On *Athyrium angustum*.

CONNECTICUT: Central Village, Aug. 16, 1910, *J. L. Sheldon*.

MAINE: South Bristol, Aug. 31, 1929, *P. & H. J. Wilson*. — Augusta, Sept. 1, 1933, *J. H. Faull* (II^1, III). — Jackman, Aug. 22, 1935, *J. H. Faull*. — Solon, Aug. 27, 1935, *J. H. Faull* (II^1, III).

MASSACHUSETTS: Magnolia, Aug. 1903, *W. G. Farlow*. — Weston, Sept. 1897, *H. M. Noyes & A. B. Seymour*. — Jamaica Plain, Aug. 6, 1931, *G. D. Darker* (II^1, III). — Mt. Washington, July 13, 1932, *J. H. Faull & K. S. Chester* (II^2, III). — Washington, Aug. 6, 1932, *J. H. Faull* (II^1, III).

NEW HAMPSHIRE: Chocorua, Sept. 27, 1908, *W. G. Farlow*. — Whitefield, Aug. 25 and Sept. 3, 1925, *J. H. Faull*. — Milton, July 4, 1931, *J. H. Faull & K. S. Chester* (II^1, III). — Lake Sunapee, July 6, 1931, *J. H. Faull*.—Keene, Aug. 11, 1932, *J. H. Faull*.— Mt. Monadnock, Aug. 21, 1932, *J. H. Faull*. — Mt. Jefferson, Aug. 31, 1932, *J. H. Faull*. — Mt. Madison, Sept. 1, 1932, *J. H. Faull*.

NEW YORK: Newcomb, Sept. 6, 1932, *D. S. Welch*.

PENNSYLVANIA: Ingleby, July 21, 1931, *H. W. Thurston, Jr.*

RHODE ISLAND: Little Compton, Oct. 6, 1936, *J. H. Faull*.

VERMONT: Barre, Aug. 27, 1914, *H. W. Thurston, Jr.* (II^1). — Sherburne Pass, Aug. 11, 1932, *J. H. Faull* (II^1, III).

WISCONSIN: Nekoosa, July 23, 1919, *J. J. Davis* (II^1, III). — Jump River, Aug. 3, 1920, *J. J. Davis* (II^1, III). — Ogema, Aug. 11, 1925, *J. J. Davis* (II^1, III). — Hollandale, Aug. 15, 1927, *J. J. Davis.*

New Brunswick: St. Andrews, Aug. 29, 1933, *J. H. Faull.* — Fredericton, Aug. 15, 1933, *J. H. Faull.*

Nova Scotia: Pictou, July 23, 1910, *W. P. Fraser* (II^1).

Ontario: Timagami, Aug. 3, 1921, *J. H. Faull; type.* — Timagami, July 29, 1924, Aug. 27, 1924, *J. H. Faull.* — Timagami, Aug. 25, 1925, *E. H. Moss* (II^1, III). — Guelph, Aug. 10, 1931, *J. H. Faull & R. E. Stone.* — cultures of *A. angustum* origin through *Abies balsamea,* at Timagami: (a) Aug. 5, 1925, *J. H. Faull & E. H. Moss* (II^1, III); (b) Aug. 16, 1926, *J. H. Faull & E. H. Bensley* (II^1, III); (c) Aug. 4–13, 1927, *J. H. Faull & E. H. Bensley* (II^1, III).

Quebec: Hudson, July, 1913, *W. P. Fraser* (II^1, III). — Grand Cascapedia R., Aug. 17, 1933, *J. H. Faull* (II^1, III). — Claude, Aug. 24, 1933, *J. H. Faull* (II^1, III).

Uredinopsis longimucronata is one of the commonest species of *Uredinopsis* in North America. Heretofore it has always been regarded as identical with a species on *Dryopteris Thelypteris* var. *pubescens,* a species which Magnus named *U. Atkinsonii;* and with every revision of the nomenclature it has been carried along with the latter. A comparative study of many collections of each, however, shows that, though similar, they are not morphologically identical. The ordinary urediospores of *U. longimucronata* are in general more robust and the mucro is longer; the amphispores are usually shorter than those of *U. Atkinsonii* and they are less frequently marked by fins and sharp ridges. True, the differences are not great; but they exist and from a purely morphological point of view the only question is as to whether or not the differences are sufficiently great to warrant specific recognition. As an aid towards reaching a decision I have done some culturing. *Uredinopsis longimucronata* readily infects *Athyrium angustum;* but all trials on *Dryopteris Thelypteris* var. *pubescens* have resulted negatively. These findings are in harmony with what has been observed frequently under natural conditions where both hosts are present. In some of these localities the one host only is rusted and the other consistently free from rust infection of any kind. All in all, therefore, it seems justifiable to recognize the two as distinct species.

The life history of *U. longimucronata* has been completely elucidated. Beginning with the teliospores on *Athyrium angustum* successful cultures were made on *Abies balsamea.* The resulting aeciospores were sowed on protected plants of *A. angustum* and abundant infections bearing both ordinary urediospores and teliospores resulted.

The average measures of the ordinary urediospores of *U. longimucronata* in the collections studied range from 12–15×30–37 μ, and the mucros from 9–17 μ. The amphispores range from 15–17×23–26 μ.

7a. **Uredinopsis longimucronata** forma **cyclosora*** Faull, forma nov. II¹, II² and III.

Pycnidia et aecidia ignota. Uredosporae ordinariae plus minusve 41 μ longae; mucro plus minusve 13 μ longus. Uredosporae secundariae plus minusve 18×27 μ, plerumque alatae. Teleutosporae 1–6-cellulares, 16–27 μ diam. Aliusmodi speciei similis.

Hab. in foliis *Athyrii cyclosori* in California, Idaho, Montana, Oregon, Washington; Alberta, British Columbia.

O and I. Spermogonia and aecia not known from cultures. Known only from field collections closely associated with rust on the fern host. Description of these is same as for the species.

II¹. Uredia as in species except that the urediospores are somewhat longer; average length of urediospores from 25 collections of the species ranges from 30 to 41 μ with a grand average of 35 μ; average length of forma *cyclosora* ranges from 37 to 47 μ with a grand average of 41 μ; average length of the mucro is about 13 μ.

II². Uredia as in species except that the urediospores (amphispores) are more robust than in the species; average measures of amphispores from 7 collections of the species range from 15–17×23–26 μ, with a grand average of about 16×24 μ; average from 14 collections of forma *cyclosora* ranges from 17–18×25–28 μ, with a grand average of about 18×27 μ; very commonly with fins.

III. Telia as in species; teliospores mostly subspheroid, 4-celled, cruciate, but varying from 1–6-celled, 16–27 μ in diameter.

HOSTS AND DISTRIBUTION:

O and I. *Abies lasiocarpa* (Hook.) Nutt., in Washington (*field collections only*).

II¹, II² and III. *Athyrium cyclosorum* Rupr., in California, Idaho, Montana, Oregon, Washington; Alberta, British Columbia.

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* Synonyms as for the species. Not *Uredinopsis Copelandi* Syd. in Ann. Myc. **2:** 30 (1904).

TYPE LOCALITY: Priest River Experiment Station, on *Athyrium cyclosorum*. II^1, II^2 and III.

ILLUSTRATIONS: Pl. II, figs. 8 a-d.

EXSICCATI: Barth Fg. Columb. 4491.

SPECIMENS EXAMINED. —

O and I. On *Abies lasiocarpa.*

WASHINGTON: Roosevelt Cedar Reservation, Aug. 29, 1931, *J. H. Faull.*

II^1, II^2 and III. On *Athyrium cyclosorum.*

IDAHO: Bovil, Sept. 17, 1920, *C. R. Stillinger.* — Bungalow, Aug. 18, 1921, *C. R. Stillinger.* — Elk Butte, Aug. 3, 1923, *C. R. Stillinger* (II^1, III). — Lime Co., Aug. 23, 1925, *C. R. Stillinger* (II^1, III). — Coolin, Aug. 4, 1931, *G. G. Hedgcock.* — Priest River Expmt. Sta., Aug. 27, 1931, *J. H. Faull; type.*

MONTANA: McDougal Peak, July 30, 1908, *M. E. Jones* (II^1, III); host wrongly determined as *Dryopteris Filix-mas* (L.) Schott. — Glacier Nat. Park, Aug. 22, 1919, *P. C. Standley.* — Tin Cup Canyon, Darby, Aug. 11, 1932, *G. B. Cummins.*

OREGON: Rhododendron, July 16, 1929, *G. D. Darker* (II^1, III).

WASHINGTON: Manette, Oct. 17, 1912, *E. B.* — Bellingham, June 1913, *J. R. Weir* (II^1, III). — Chelan, Aug. 26, 1916, *J. R. Weir.* — Roosevelt Cedar Reserv., Aug. 28, 1931, *J. H. Faull.*

ALBERTA: Watertown Park, Aug. 17 and 20, 1934, *E. H. Moss;* host wrongly determined as *Dryopteris Filix-mas* (L.) Schott.

BRITISH COLUMBIA: Glacier, Aug. 1906, *E. W. D. Holway.* — Stanley Park, Vancouver, Sept. 16, 1929, *G. D. Darker.* — Grouse Mt., Vancouver, Sept. 18, 1929, *G. D. Darker.* — Revelstoke, Sept. 20, 1929, *G. D. Darker.* — Revelstoke, Aug. 8, 1932, *T. W. Childs.*

Uredinopsis longimucronata forma *cyclosora* and *U. Copelandi* Syd., both on *Athyrium cyclosorum,* are easily distinguished from one another. The former, however, does closely resemble *U. longimucronata* on *A. angustum.* Yet, as compared with *U. longimucronata* the averages of the urediospores show appreciable differences. Thus, the ordinary urediospores of the form average more than 6 μ longer, and the amphispores are larger and are commonly marked by fin-like ridges. Just what host restrictions there may be as between *A. cyclosorum* and *A. angustum* has not been tested. If there be none it would be interesting to know how persistent the morphological differences noted might be. Meanwhile the distinctions noted should not be overlooked.

The average measures of the ordinary urediospores of *U. longimucronata* forma *cyclosora* range from 12–14×37–47 μ, and the mucros from 10–16 μ. The amphispores range from 17–18×25–28 μ.

7b. **Uredinopsis longimucronata** var. **acrostichoides** Faull, var. nov. II^1, II^2 and III.

Pycnidia et aecidia ignota. Sori uredosporiferi ordinarii hypophylli, epidermide tecti, pustulati, delicati, rotundati, 0.1–0.3 mm. diam., peridio ex cellulis hyalinis irregulariter polygonalibus composito cincti; cellulae peridii 6–11×8–16 μ, pariete 0.6–0.9 μ crasso; uredosporae ellipsoideae, obovoideae vel fusiformes, subsessiles, hyalinae, 11–16×27–51 μ, plus minusve 12×37 μ, mucrone 0–14 μ longo, plus minusve 7 μ; paries sporae hyalinus, verrucis in serie verticali in utroque latere dispositis, ceterum levis, 1 μ vel minus crassus. Sori uredosporiferi secundarii hypophylli, epidermide tecti, pustulati, rotundati, 0.1–0.3 mm. diam., peridio ex cellulis hyalinis irregulariter polygonalibus composito cincti; cellulae peridii 6–11×8–16 μ, pariete 1.0–1.5 μ crasso; uredosporae (amphisporae) longe stipitatae, angulariter obovoideae vel irregulariter polyedricae, 14–26×19–35 μ, plus minusve 17×26 μ; paries sporae hyalinus, fere levis, 1.5–3.5 μ crassus. Teleutosporae epidermide tectae, subglobosae vel ellipsoideae, 1–4-cellulares, 16–22×16–27 μ.

Hab. in foliis *Athyrii thelypteroidis* in New Hampshire, New York, Wisconsin.

O and I. Spermogonia and aecia unknown.

II^1. Uredia hypophyllous, subepidermal, scattered on discolored intercostal spots or on areas of indefinite extent, pustular, round, 0.1–0.3 mm. in diameter; peridium convex, colorless, very delicate; peridial cells isodiametrically to irregularly polygonal, 6–11×8–16 μ, with walls less than 1 μ thick; urediospores hyaline, white in mass, abundant, extruded in tendrils, very short-stalked, ellipsoid, obovoid or fusiform, 11–16×27–51 μ, averaging about 12×37 μ, with a filamentous, enucleate mucro 0–14 μ long, averaging about 7 μ; walls of spores colorless, smooth except for two opposing vertical rows of short, closely set cogs; spore wall up to 1 μ thick.

II^2. Uredia hypophyllous, subepidermal, developing later than the first of the II^1-uredia but on the same lesions, round, 0.1–0.3 mm. in diameter; peridium convex, colorless, rather firm, tardily dehiscent; peridial cells isodiametrically to irregularly polygonal, 6–11×8–16 μ, with walls up to 1.5 μ thick; urediospores (amphispores) hyaline, white in mass, long-stalked, angularly obovoid or irregularly polyhedral, 14–26×19–35 μ, averaging about

17×26 μ, often ridged at the angles; spore walls hyaline, closely and very finely verrucose to smooth, 1.5–3.5 μ thick.

III. Telia diffuse, mostly hypophyllous; teliospores subepidermal, intercellular, scattered or loosely aggregate in a single layer, colorless, subspheroid to ellipsoid, 1–4-celled, mostly 4-celled, cruciate, 16–22×16–27 μ; spore walls hyaline, smooth, about 1 μ thick.

HOSTS AND DISTRIBUTION:

O and I. Unknown.

II^1, II^2 and III. *Athyrium thelypteroides* (Michx.) Desv., in New Hampshire, New York, Wisconsin.

TYPE LOCALITY: Junius, New York on *Athyrium thelypteroides*.

ILLUSTRATIONS: Pl. II, figs. 9 a-b.

SPECIMENS EXAMINED. —

II^1, II^2 and III. On *Athyrium thelypteroides*.

NEW HAMPSHIRE: Hewes Brook, Hanover, Aug. 28, 1937, *H. H. Whetzel.*

NEW YORK: Junius, Sept. 14, 1904, *H. H. Whetzel & H. S. Jackson*, Myc. Herb. N. Y. State Col. Agr. 8896; *type.*

WISCONSIN: Solon Springs, July 31, 1930, *J. J. Davis.*

The present treatment of this rust cannot be otherwise than tentative because of the limited amount of material available for study. From what has been seen, it is not typical *U. longimucronata.* Thus, the mucro of the ordinary urediospores is much shorter and the amphispores are almost to quite smooth. More and better materials, however, should be carefully examined and culture tests made before the definition of the form can be clarified.

8. **Uredinopsis Mayoriana** Dietel in E. Mayor in Mém. Soc. Sci. Nat. Neuchâtel. **5**: 556 (1913). (II). II.

O and I. Spermogonia and aecia unknown.

II. Uredia hypophyllous, subepidermal, scattered on discolored areas of indefinite extent, pustular, round, 0.2–0.5 mm. in diameter; peridium convex, colorless; peridial cells isodiametrically to irregularly polygonal, 6–12×8–18 μ, with walls 1.0–1.5 μ thick; urediospores hyaline, white in mass, extruded in tendrils, very short-stalked, ellipsoid, obovoid, or fusiform, 9–16×30–46 μ, averaging about 13×37 μ, with a filamentous, enucleate mucro 0–14 μ long, averaging about 4 μ; walls of spores colorless, smooth except for two opposing vertical rows of short, closely set cogs; spore walls about 1 μ thick.

III. Telia unknown.

HOSTS AND DISTRIBUTION:

O and I. Unknown.

II. *Blechnum unilaterale* Sw. [*B. blechnoides* (Lag.) C. Chr.], in Colombia.

III. Unknown.

TYPE LOCALITY: Near Medellín, Colombia. II.

ILLUSTRATIONS: Pl. II, fig. 10. — Dietel in Mayor in Mém. Soc. Sci. Nat. Neuchâtel. **5**: fig. 64 (1913).

SPECIMENS EXAMINED. —

COLOMBIA: Near Medellín, Antioquia, Aug. 14, 1910, *E. Mayor; type.*

9. **Uredinopsis ceratophora** Faull, sp. nov. O, I, II^1, II^2 and III.

Uredinopsis Atkinsonii Magnus ex Davis in Wisconsin Acad. Sci. Arts Letters, **18**: 93 (1915), in part.

Uredinopsis Copelandi Sydow ex Arthur in N. Am. Flora, **7**: 684 (1925), in part.

Uredinopsis Struthiopteridis Störmer ex Arthur, Man. Rusts United States Canada, 4 (1934), in part.

Pycnidia hypophylla, numerosa, inconspicua, hyalina, immersa, hemispherica, 103–143 μ lata×54–58 μ alta, plus minusve 115–120×70–75 μ. Aecidia hypophylla, maculis flavidis insidentia, cylindracea, 0.2–0.3 mm. lata×0.3–1.0 mm. alta, ad apicem dehiscentia; cellulae peridii polygonales, imbricatim positae, 13–24×21–41 μ, pariete exteriore levi, 1.0–1.5 μ crasso, interiore verrucoso et 2.5–3.0 μ crasso; aecidiosporae globosae vel ellipsoideae, dense verruculosae, albae, 13–24×19–28 μ, plus minusve 20×24 μ, episporio 1.0–1.5 μ crasso. Sori uredosporiferi ordinarii hypophylli, epidermide tecti, pustulati, rotundati vel elongati, 0.3–0.7 mm. diam., peridio ex cellulis hyalinis irregulariter polygonalibus composito cincti; cellulae peridii 8–13×8–16 μ, pariete 0.7–0.9 μ crasso; uredosporae albae, ellipsoideae, obovatae vel fusiformes, subsessiles, 12–19×24–49 μ, plus minusve 13×35 μ, mucrone 0–38 μ longo, plus minusve 16 μ; paries sporae hyalinus, verrucis in serie verticali in utroque latere dispositis, ceterum levis, 1 μ vel minus crassus. Sori uredosporiferi secondarii hypophylli, epidermide tecti, rotundati, 0.15×0.3 mm. diam., peridio ex cellulis hyalinis irregulariter polygonalibus composito cincti; cellulae peridii 6–13×8–16 μ, pariete 1–2 μ crasso; uredosporae (amphisporae) longe stipitatae, angulariter obovoideae vel irregulariter polyedricae, alatae, cornutae, 14–30×19–41 μ, plus minusve 19×29 μ; paries sporae hyalinus, dense verruculosus, 1.0–1.5 μ crassus. Teleutosporae epidermide tectae, amphigenae, plerumque hypophyllae, subglobosae vel ellipsoideae, hyalinae, 1–6-cellulares, 14–24×14–40 μ, plus minusve 18–22 μ diam.

Hab. in foliis *Abietis balsameae* et *Cystopteridis bulbiferae* in Indiana, New York, Wisconsin; Ontario.

O. Spermogonia on needles of current season, hypophyllous, numerous, inconspicuous, colorless, immersed, inverted hemispherical in sectional view, covered by external epidermal wall, 103–143 μ broad and 54–86 μ deep, averaging 115–120×70–75 μ.

I. Aecia (peridermia) hypophyllous, on needles of current season, in two rows, on yellowish discolored portions of affected needles, white, cylindrical, 0.2–0.3 mm. in diameter and 0.3–1.0 mm. high; peridium colorless, tough, rupturing at the apex; peridial cells in a single layer, polygonal, elongate vertically, often much overlapping, 13–24×21–41 μ, outer wall smooth, 1.0–1.5 μ thick, inner wall 2.5–3.0 μ thick, closely marked by rather fine warts, scattered or in short lines; aeciospores spheroid to ellipsoid, white, 13–24×19–28 μ, averaging about 20×24 μ, finely and closely warted, with one side partly smooth; wall of aeciospore colorless, 1.0–1.5 μ thick.

II^1. Uredia hypophyllous, subepidermal, scattered on discolored intercostal spots or on areas of indefinite extent, pustular, round to elongate, 0.3–0.7 mm. in diameter; peridium hemispheric, colorless, very delicate; peridial cells isodiametrically to irregularly polygonal, 8–13×8–16 μ, with walls less than 1 μ thick; urediospores hyaline, white in mass, abundant, extruded in tendrils, very short-stalked, ellipsoid, obovoid or fusiform, 12–19×24–49 μ, averaging about 15×35 μ, with a filamentous, enucleate mucro 0–38 μ long, averaging about 16 μ; walls of spores colorless, smooth except for two opposing vertical rows of short, closely set cogs; spore wall up to 1 μ thick, with two germ pores near each end.

II^2. Uredia hypophyllous, subepidermal, developing later than the first of the II^1-uredia but on the same lesions, round, 0.15–0.3 mm. in diameter; peridium hemispheric, colorless, rather firm, tardily dehiscent; peridial cells isodiametrically to irregularly polygonal, 6–13×8–16 μ, with walls 1–2 μ thick; urediospores (amphispores) hyaline, white in mass, long-stalked, angularly obovoid or irregularly polyhedral, 14–30×19–41 μ, averaging about 19×29 μ, with thin ridges or fins up to 4 μ deep and flat horns up to 6 μ long; spore walls hyaline, finely and closely verrucose, 1.0–1.5 μ thick, much thicker at the angles.

III. Telia diffuse, amphigenous, mostly hypophyllous; teliospores subepidermal, intercellular, scattered or loosely aggregate in a single layer, colorless, subspheroid to ellipsoid, 1–6-celled, 14–24×14–40 μ, mostly 4-celled, cruciate, 18–22 μ in diameter, a single pore in the outer wall of each cell; spore walls hyaline, smooth, about 1 μ thick.

HOSTS AND DISTRIBUTION:

O and I. *Abies balsamea* (L.) Mill., in Ontario (*cultures*).

II^1, II^2 and III. *Cystopteris bulbifera* (L.) Bernh., in Indiana, New York, Wisconsin; Ontario.

TYPE LOCALITY: Timagami, Ontario on *Abies balsamea* and Bradford, Ontario on *Cystopteris bulbifera*. O, I, II^1, II^2 and III.

ILLUSTRATIONS: Pl. III, figs. 12 a-d.

EXSICCATI: Barth. N. Am. Ured. 3114.

SPECIMENS EXAMINED. —

O and I. On *Abies balsamea.*

ONTARIO: Timagami, Aug. 15, 1929, *J. H. Faull* 9308; CULTURES.

II^1, II^2 and III. On *Cystopteris bulbifera.*

INDIANA: Pine Creek, Warren Co., Aug. 11, 1918, *H. S. Jackson & F. J. Pipal.*

NEW YORK: Taughannock Ravine, July 30, 1916, *H. H. Whetzel & H. S. Jackson.*

WISCONSIN: Bloomingdale, Aug. 1896, *L. H. Pammel* (II^1). — Bridgeport, Sept. 23, 1913, *J. J. Davis.* — Blue River, Aug. 4, 1921, *J. J. Davis.* — Viroqua, July 16, 1930, *J. J. Davis.* — Glen Haven, Sept. 10, 1930, *J. J. Davis.*

ONTARIO: Bradford, Oct. 16, 1927, *L. M. Hunter*, Herb. J. H. Faull 10564; *type.* — Bradford, Aug. 24, 1927, Oct. 1927, Autumn, 1928, *L. M. Hunter.* — Guelph, Aug. 2 and 4, 1913, *J. Dearness.*

Uredinopsis ceratophora is quite widely distributed and is probably commoner throughout its range than the comparatively few collections made of it would indicate. So far, just as in the case of *U. longimucronata*, it has been regarded as identical with *U. Atkinsonii* Magnus on *Dryopteris Thelypteris* var. *pubescens* and has been carried along with the latter in every revision of the nomenclature. But a comparative study of type specimens shows that it stands by itself as a distinctive, well-marked, heretofore unnamed species. Its haploid phase, as demonstrated by cultures, occurs on *Abies balsamea* and a study of the spermogonia and aecia shows that they, too, are distinctive.

A survey of the differentiating characters of *U. ceratophora* is impressive. Thus, the period of development of the haploid phase on *Abies* is a few weeks longer than for any of the species to which this rust has been referred. Its spermogonia are larger, and instead of being simply subcuticular, they are covered by the entire outer wall of the epidermis and look as if they might have originated intracellularly. The peridium of the aecium is a tough membrane and not friable as in the other species referred to above. As for the characters of the diploid phase, it should be noted that the ordinary urediospores have a longer mucro and are more robust than for the species with which *U. ceratophora* has been confused. Its amphispores, too, are more robust and they are strikingly marked by ridges and horns. Indeed, taken altogether, its characters are so distinctive that there is ample justification for extending to *U. ceratophora* specific recognition.

The average measures of the ordinary urediospores of *U. ceratophora* range from 15–16×33–37 μ, and the mucros from 14–18 μ. The amphispores range from 17–20×27–30 μ.

10. **Uredinopsis glabra** Faull, sp. nov. II^1, II^2 and III.

Pycnidia et aecidia ignota. Sori uredosporiferi ordinarii hypophylli, epidermide tecti, pustulati, rotundati, 0.2–0.5 mm. diam., peridio ex cellulis hyalinis irregulariter polygonalibus composito cincti; cellulae peridii 6–11×8–16 μ, pariete 1.0–1.5 μ crasso; uredosporae albae, subsessiles, ellipsoideae, obovoideae vel fusiformes, 12–15×27–40 μ, plus minusve 13×30 μ, mucrone 8–27 μ longo, plus minusve 13 μ; paries sporae hyalinus, levis, 1.0–1.2 μ crassus. Sori uredosporiferi secundarii hypophylli, epidermide tecti, pustulati, rotundati, 0.1–0.3 mm. diam., peridio ex cellulis hyalinis irregulariter polygonalibus composito cincti; cellulae peridii 6–11×8–15 μ, pariete 2–4 μ crasso; uredosporae (amphisporae) longe stipitatae, obovoideae vel angulatae, 11–19×19–28 μ, plus minusve 14×21 μ; paries sporae hyalinus, levis, 1.0–1.5 μ crassus. Teleutosporae epidermide tectae, subglobosae vel ellipsoideae, 1–2-cellulares, 16–21×16–27 μ.

Hab. in foliis *Cystopteridis fragilis*, *Pellaeae cordatae* et *Cheilanthis pyramidalis*, in New Mexico; Mexico.

O and I. Spermogonia and aecia unknown.

II^1. Uredia hypophyllous, subepidermal, scattered on discolored areas of indefinite extent, pustular, round, 0.2–0.5 mm.

in diameter; peridium hemispheric, colorless, rather firm; peridial cells isodiametrically to irregularly polygonal, 6–11×8–16 μ, with walls 1.0–1.5 μ thick; urediospores hyaline, very short-stalked, ellipsoid, obovoid or fusiform, 12–15×27–40 μ, averaging about 13×30 μ, with a filamentous, enucleate mucro 8–27 μ long, averaging about 13 μ; walls of spores colorless, smooth, 1.0–1.2 μ thick, with two germ pores near each end.

II^2. Uredia hypophyllous, subepidermal, borne on the same lesions as the II^1-uredia, round, 0.1–0.3 mm. in diameter; peridium hemispheric, colorless, firm, tardily dehiscent; peridial cells isodiametrically to irregularly polyhedral, 6–11×8–16 μ, with walls 2–4 μ thick; urediospores (amphispores) hyaline, white in mass, stalks up to 40 μ long, rounded to angularly obovoid or polyhedral, without ridges, fins or horns, 11–19×19–28 μ, averaging about 14×21 μ; spore wall hyaline, smooth, 1.0–1.5 μ thick.

III. Telia diffuse, amphigenous, mostly hypophyllous; teliospores subepidermal, intercellular, scattered or loosely aggregate in a single layer, colorless, subspherical to ellipsoid, 1–2-celled, 16–21×16–27 μ; spore walls hyaline, smooth, about 1 μ thick.

HOSTS AND DISTRIBUTION:
O and I. Unknown.
II^1, II^2 and III. *Cystopteris fragilis* (L.) Bernh., in New Mexico; Mexico.
II^1 and III. *Pellaea cordata* (Cav.) J. Sm., in Mexico.
II^1, II^2 and III. *Cheilanthes pyramidalis* Fée, in Mexico.
TYPE LOCALITY: Ajusco, D. F., Mexico on *Cystopteris fragilis*. II^1, II^2 and III.
ILLUSTRATIONS: Pl. II, figs. 11 a-e.
SPECIMENS EXAMINED. —
II^1, II^2 and III. On *Cystopteris fragilis*.
NEW MEXICO: Cloudcroft, Sacramento Mts., Nov. 20, 1936, *I. H. Crowell*. — Tularosa Canyon, Otero Co., Aug. 28, 1937, *I. H. Crowell*.
MEXICO: Ajusco, D. F., Nov. 23, 1937, *J. H. Faull*. — Ajusco, D. F., Nov. 25, 1937, *J. H. Faull* 13125; *type*.
II^1 and III. On *Pellaea cordata* (Cav.) J. Sm.
MEXICO: Ajusco, D. F., Nov. 23 and 25, 1937, *J. H. Faull*.
II^1, II^2 and III. On *Cheilanthes pyramidalis*.
MEXICO: Uruapan, Michoacan, Nov. 28, 1937, *J. H. Faull*. — Between Quiroga and Paracho, Michoacan, Nov. 27, 1937, *J. H. Faull*.

Uredinopsis glabra more closely resembles *U. filicina* than it does any other known species of the genus. Like the latter its ordinary urediospores are mucronate and without vertical rows of cogs, its amphispores are relatively regular, and most significant of all, its teliospores are never more than 2-celled. That the haploid phase occurs on *Abies* is almost certain. In that connection, Dr. Ivan H. Crowell, the first collector of this rust, informs me that in early August of 1937, he found white peridermia on the youngest needles of *Abies concolor* at Tularosa Canyon, New Mexico and that field associations clearly indicated that they were the aecia of *U. glabra.* He sowed some of the aeciospores on healthy fronds of *Cystopteris fragilis* and infection resulted; but he did not have the opportunity to complete the experiment.

11. **Uredinopsis Atkinsonii** Magnus in Hedwigia, **43:** 123 (1904). (II^1, II^2 and III.) O, I, II^1, II^2 and III.

Milesia Atkinsonii (Magn.) Arthur in Résult. Sci. Congr. Bot. Vienne, 337 (1906).

Uredinopsis Atkinsonii Magn. ex Arthur in N. Am. Flora, **7:** 117 (1907), in part. II^1, II^2 and III.

Uredinopsis Copelandi Syd. ex Jackson in Brooklyn Bot. Gard. Mem. **1:** 218 (1918), in part.

Uredinopsis mirabilis (Peck) Magn. ex Rhoads, Hedgcock, Bethel and Hartley in Phytopath. **8:** 333 (1918), in part.

Uredinopsis Struthiopteridis Störmer ex Arthur, Man. Rusts United States Canada, 4 (1934), in part.

O. Spermogonia on needles of the current season, hypophyllous, round, rarely confluent, colorless, immersed, inverted hemispherical in vertical section, plane at leaf surface, subcuticular, covered by the combined cuticle and intermediate layer of outer epidermal wall, 62–135 μ broad and 35–57 μ deep, averaging about 105×50 μ; apical opening a short slit; spermatiophores unbranched, septate, with large basal cell.

I. Aecia (peridermia) hypophyllous, on needles of current season, in two rows, white, cylindrical, 0.2–0.3 mm. in diameter and up to 1 μ high; peridium colorless, fragile, rupturing laterally or at apex; peridial cells in a single layer, polygonal, elongate vertically, overlapping, 11–22×24–40 μ, outer wall smooth, 1.2–1.5 μ thick, inner wall closely and rather coarsely verrucose, 2.5–3.0 μ thick; aeciospores broadly ellipsoid, ovoid or subspheroid, white, 15–22×19–26 μ, averaging about 18×22μ, closely and rather coarsely verrucose; wall of aeciospore colorless, 1.0–1.5 μ thick.

II¹. Uredia hypophyllous, subepidermal, scattered on discolored intercostal spots or on areas of indefinite extent, pustular, round to slightly elongate, 0.1–0.4 mm. in diameter; peridium convex, colorless, delicate; peridial cells isodiametrically to irregularly polygonal, 6–13×8–17 μ, with walls up to 1 μ thick; urediospores hyaline, white in mass, abundant, extruded in tendrils, very short-stalked, ellipsoid, obovoid or fusiform, 8–15×23–49 μ, averaging about 12×34 μ, with a filamentous, enucleate mucro 0–19 μ, averaging about 9 μ; walls of spores colorless, smooth, except for two opposing vertical rows of short, closely set cogs; spore walls up to 1 μ thick, with two germ pores near each end.

II². Uredia hypophyllous, subepidermal, developing later than the first of the II¹-uredia but on the same lesions, round, 0.1–0.3 mm. in diameter; peridium convex, colorless, delicate, tardily dehiscent; peridial cells isodiametrically to irregularly polygonal, 6–12×8–16 μ, with walls up to 1 μ thick; urediospores (amphispores) hyaline, white in mass, long-stalked, angularly obovoid or irregularly polyhedral, 11–24×19–43 μ, averaging about 16×26 μ, rounded to ridged at the angles, frequently with low fins and horns; spore walls hyaline, finely and closely verrucose, 1.0–2.2 μ thick, thickest at the angles.

III. Telia diffuse, amphigenous, mostly hypophyllous; teliospores subepidermal, intercellular, scattered or loosely aggregate in a single layer, colorless, subspheroid to ellipsoid, mostly 4-celled, cruciate, but varying from 1–4-celled and in occasional collections up to 8-celled, 14–24×16–30 μ, a single pore in the outer wall of each cell; spore walls hyaline, smooth, about 1 μ thick.

HOSTS AND DISTRIBUTION:

O and I. *Abies balsamea* (L.) Mill., in Nova Scotia (*cultures*).

II¹, II² and III. *Dryopteris Thelypteris* var. *pubescens* (Lawson) A. R. Prince, in Connecticut, Delaware, Indiana, Maine, Massachusetts, Michigan, Mississippi, Montana, Nebraska, New Hampshire, New York, North Dakota, Virginia (?), Wisconsin; Nova Scotia, Ontario; Bermuda.

TYPE LOCALITY: Ithaca, N. Y., on *Dryopteris Thelypteris* var. *pubescens*. II¹, II² and III.

ILLUSTRATIONS: Pl. III, figs. 13 a-e. — Magnus in Hedwigia, **43**: pl. 2, figs. 1–7 (1904).

Exsiccati: Barth. Fg. Columb. 3087, 4085. — Barth, N. Am. Ured. 879, 1089. — Whetzel Berm. Fg. 86. — Reliq. Farl. 283a. — Syd. Ured. 2447.

Specimens Examined. —

O and I. On *Abies balsamea.*

Nova Scotia: Pictou, July 1912, *W. P. Fraser;* adjacent to rusted fern host.

II^1, II^2 and III. On *Dryopteris Thelypteris* var. *pubescens.*

Connecticut: West Goshen, Sept. 4–14, 1896, *L. M. Underwood.*

Indiana: Winona Lake, Aug. 30, 1916, *H. S. Jackson & Hoffer.*

Maine: Solon, Aug. 27, 1935, *J. H. Faull* (II^1, III).

Massachusetts: Newton, Sept. 1879 (?), *W. G. Farlow.* — Granville, Aug. 13, 1883, *A. B. Seymour.*

Michigan: Leland, Aug. 20, 1913, *J. C. Arthur & H. C. Travelbee* (II^1, III). — Whitmore, July 26, 1914, *E. B. Mains.*

Mississippi: Ocean Springs, July 9, 1920, *G. E. Miles* (315).

Nebraska: Kennedy, Aug. 21, 1912, *J. M. Bates.*

New Hampshire: Shelburne, Sept. 1891, *W. G. Farlow* (II^1, III).

New York: Ithaca, Aug. 1896, *G. F. Atkinson; type.* — Michigan Hollow, near Ithaca, Sept. 1, 1908, *M. F. Barrus.*

North Dakota: Anselm, Aug. 29, 1920, *Brenckle & Stevens.*

Wisconsin: Wind Lake, Aug. 24, 1902, *J. J. Davis.* — Oconto Co., July 22, 1909, *J. J. Davis.*

Nova Scotia: Pictou, Summer 1912, *W. P. Fraser* (II^1, III); culture. — Oakfield, Aug. 13, 1910, *W. P. Fraser* (II^1, III).

Ontario: Point Albino, Aug. 1906, *L. M. Underwood.* — London, Aug. 18, 1911, *J. Dearness.* — Weston, Sept. 10, 1935, *G. D. Darker.* — Evelyn, Sept. 20, 1898, *J. Dearness.*

Bermuda: Pembroke Marsh, Feb. 5, 1926, *H. H. Whetzel.*

Uredinopsis Atkinsonii was described by Magnus (40) from specimens collected at Ithaca, N. Y., by Professor G. F. Atkinson. Its distribution ranges from Montana and Nebraska eastward to the northeastern United States, eastern Canada and Bermuda; and to this is added a collection from Mississippi. While it is of frequent occurrence yet it seems to be much less common than several other species of *Uredinopsis.* Thus I have found that it is lacking in many localities where its host abounds but where such rusts as *U. longimucronata* on *Athyrium angustum, U. Struthiopteridis* on *Matteuccia Struthiopteris* and *U. mirabilis* on *Onoclea sensibilis* are abundant. This phenomenon by itself would suggest that *U. Atkinsonii* might, indeed, be distinct from all of the rusts just named, though it has, at one time or another, been judged synonymous with each of them. That it really is different is confirmed by morphological distinctions and by failure in culturing these rusts from their respective hosts to *Dryopteris Thelypteris* var. *pubescens.*

With regard to the nomenclature of *U. Atkinsonii* Magnus the view prevails, as categorically expressed by Hiratsuka (23), that it is synonymous with *U. Copelandi* Syd. A comparative study of the types of *U. Atkinsonii* and *U. Copelandi,* however, reveals that these rusts show such marked morphological differences that no question remains as to their being distinct species. The recognition of these species as one and the same has been ascribed to Jackson (27). But it is to be noted that Jackson based his conclusion on a rust with predominantly long-mucronate ordinary urediospores found on *Athyrium cyclosorum,* a rust which I have described in this paper under the name *U. longimucronata* forma *cyclosora.* His materials of the latter came from Oregon and it is doubtful if he had before him any of Sydow's *U. Copelandi,* a rust so far not recorded outside California. It is with *U. longimucronata* and its varieties and not with *U. Copelandi* that *U. Atkinsonii* shows close resemblances. A rust on *Cystopteris bulbifera* (here named *U. ceratophora*) has also been placed along with *U. Atkinsonii;* but it likewise stands so far apart from *U. Atkinsonii* morphologically as to fully justify specific recognition.

Fraser (19) surmised from field associations that *Abies balsamea* serves as alternate host for *U. Atkinsonii.* Aeciospores from rusted firs growing in the close neighborhood of rusted *Dryopteris Thelypteris* var. *pubescens* were sown on experimental plants of this fern and some infections of typical *U. Atkinsonii* resulted. So, although the culturing has not been as complete as it should be, it seems certain that *Abies balsamea* carries the haploid phase of *U. Atkinsonii.*

The average measures of the ordinary urediospores of *Uredinopsis Atkinsonii* in the collections studied ranges from 11–12×30–37 μ, and the mucros from 7–11 μ. The amphispores range from 15–17×24–29 μ.

A note should be added with reference to the only collection of rusted *Dryopteris Thelypteris* var. *pubescens* so far made from Indiana. I have referred the rust to *Uredinopsis Atkinsonii;* but it differs from that species as seen in all other materials examined in that the ordinary urediospores are mostly amucronate. The mucros vary from 0–7 μ, but with an average of only 0.6 μ. Perhaps the collection should tentatively be designated *U. Atkinsonii* forma *amucronata;* but it seems best to let it stand as treated above until further collections have been made. The ordinary urediospores taken from a tendril vary from 9–12×23–41 μ, averaging about 11×31 μ. These measures are well within the range for the species. The amphispores likewise correspond quite closely to those of typical *U. Atkinsonii.*

12. **Uredinopsis hirosakiensis** Kamei and Hiratsuka in Kamei in Trans. Sapporo Nat. His. Soc. **12:** 164 (1932). (O, I, II and III). O, I, II and III.

O. Spermogonia on needles of current season, the affected portions of which are discolored and distorted, amphigenous, mostly hypophyllous, slightly elevated to slightly depressed, round, honey-colored, immersed, inverted conoidal to almost hemispherical in vertical section, subcuticular, 74–137 μ broad and 37–93 μ deep; spermatia ellipsoid, 1.6–2.7×4.8–6.4 μ, hyaline, smooth. (After Kamei, 30).

I. Aecia (peridermia) hypophyllous, rarely amphigenous, on needles of current season, in two rows, white, cylindrical, 0.2–0.3 mm. in diameter and up to 1.2 mm. high; peridium colorless, fragile, rupturing at the apex; peridial cells in a single layer, polygonal, elongate vertically, scarcely overlapping, 10–22×20–48 μ, outer wall smooth, 1.0–1.3 μ thick, inner wall closely and finely verrucose, 2.0–4.0 μ thick; aeciospores broadly ellipsoid, ovoid or subspheroid, white, 14–19×16–22 μ, averaging about 16×19 μ, closely and finely verrucose; wall of aeciospore colorless, 1.0–1.5 μ thick.

II. Uredia hypophyllous, subepidermal, scattered on discolored intercostal spots or on areas of indefinite extent, pustular, round to elliptical, 0.1–0.5 mm. in longest axis; peridium convex, colorless, firm; peridial cells isodiametrically to irregularly polygonal, 6–13×8–18 μ, with walls 1.5–3.0 μ thick; urediospores hyaline, white in mass, abundant, extruded through an apical pore or slit, very short-stalked, broadly ellipsoid or obovoid, 14–22×19–30 μ, averaging about 16×23 μ; walls of spores colorless, finely and closely spinulose; 1–2 μ thick.

III. Telia diffuse, amphigenous, mostly hypophyllous; teliospores subepidermal, intercellular, scattered or aggregate in a single layer, at times much crowded, subspheroid to broadly ellipsoid, usually 4-celled, cruciate, but varying from 1–8-celled, 13–24×13–27 μ; spore walls hyaline, smooth, about 1 μ thick.

HOSTS AND DISTRIBUTION:

O and I. *Abies Mayriana* Miyabe and Kudô, in Japan (*cultures*).

II and III. *Dryopteris Thelypteris* var. *pubescens* (Lawson) A. R. Prince, in Japan, Siberia.

TYPE LOCALITY: Kotoni, near Sapporo, Japan on *Dryopteris Thelypteris* var. *pubescens.* II and III.

ILLUSTRATIONS: Pl. III, figs. 14 a-b. — Hiratsuka in Monog. Pucciniastreae, pl. II, fig. 5 (1936).

SPECIMENS EXAMINED. —

O and I. On *Abies Mayriana.*

JAPAN: Sapporo, July 1, 1925, *S. Kamei;* CULTURES.

II and III. On *Dryopteris Thelypteris* var. *pubescens.*

JAPAN: Kotoni, near Sapporo, Oct. 1, 1921, *S. Kamei; type.* — Mt. Nioji, Prov. Echigo, Oct. 10, 1924, *Y. Homma.* — Akan, Kuchiro, Sept. 13, 1925, *N. Hiratsuka.* — Chitose, Prov. Iburi, Sept. 19, 1926, *N. Hiratsuka.* — Mt. Komagatake (Kiso), Shinano, Aug. 22, 1932, *N. Hiratsuka.*

SIBERIA: Nikolsk-Ussurijskij, Coast Province, Sept. 4, 1927, *W. Tranzschel* 1488. — Okeanskaja, Coast Province, Aug. 8, 1929, *W. Tranzschel* 648.

Kamei (30) was much impressed by *Uredinopsis hirosakiensis* because its urediospores are morphologically similar to those of a *Pucciniastrum.* When, however, all of the known species of *Uredinopsis* are assembled, we see that it is just one of several in which the urediospores show no indication of a mucro and in which the spore form is simple. Kamei (30) repeatedly cultured this rust on *Abies Mayriana.* Through his courtesy I have had the opportunity to examine some of the haploid materials so obtained and I can confirm his assertions that the spermogonia and the aecia are typically those of an *Uredinopsis.* Kamei (32) reports that this rust may cause considerable injury to seedlings of *Abies Mayriana* in nurseries.

13. **Uredinopsis ossaeiformis** Kamei in Trans. Sapporo Nat. His. Soc. **12**: 167 (1932). (O, I, II and III). O, I, II and III.

O. Spermogonia on needles of the current season, hypophyllous, round, colorless, immersed, deeply seated, subglobose in vertical section, subepidermal, 154–270 μ broad and 110 to 241 μ deep; spermatiophores simple or branched, obclavate, septate; spermatia ellipsoid, hyaline, smooth, 1.2–2.3×3.6–6.6 μ. (After Kamei, 30).

I. Aecia (peridermia) on needles of current season, hypophyllous, in two rows, white, cylindrical, 0.2–0.5 mm. in diameter and up to 1.1 mm. high; peridium colorless, rupturing at the apex; peridial cells in a single layer, polygonal, elongate, scarcely overlapping, 8–27×19–40 μ, outer wall smooth, about 1 μ thick, inner wall rather finely verrucose, the warts mostly in short lineal rows, 3.0–4.0 μ thick; aeciospores broadly ellipsoid, ovoid or subspheroid, white, 16–22×16–27 μ, averaging about 18×22 μ, closely and rather finely verrucose; wall of aeciospore colorless, 1.0–1.7 μ thick.

II. Uredia hypophyllous, subepidermal, scattered on discolored intercostal spots or on areas of indefinite extent, pustular, round, 0.1–0.3 mm. in diameter; peridium convex, colorless, delicate; peridial cells isodiametrically to irregularly polygonal, 6–13×8–16 μ, with walls up to 1 μ thick; urediospores hyaline, white in mass, extruded in tendrils, very short-stalked, subcylindric, cuneate, obovoid or ellipsoid, straight to curved, symmetrical to asymmetrical, regular to laterally protuberant at the apex, somewhat as in the upper part of a femoral bone, 11–19×22–43 μ averaging about 14×30 μ; walls of spores colorless, smooth, up to 1 μ thick.

III. Telia diffuse, amphigenous, mostly hypophyllous; teliospores subepidermal, intercellular, scattered or loosely aggregate in a single layer, colorless, subspheroid to ellipsoid, 2–4-celled, rarely 1-celled, 14–25×19–35 μ; spore walls hyaline, smooth, about 1 μ thick.

HOSTS AND DISTRIBUTION:

O and I. *Abies Mayriana* Miyabe and Kudô, in Japan (*cultures*).
Abies firma Sieb. and Zucc., in Japan (*cultures*).
Abies sachalinensis (Schm.) Mast., in Japan (*cultures*).
II and III. *Dryopteris amurensis* (Milde) Christ, in Siberia.
Dryopteris dilatata var. *oblonga* Takeda, in Japan.
Dryopteris monticola (Mak.) C. Chr., in Japan.

TYPE LOCALITY: Mt. Makkarinupuri, Iburi, Japan on *Dryopteris dilatata* var. *oblonga*. II and III.

ILLUSTRATIONS: Pl. III, figs. 15 a-b.

SPECIMENS EXAMINED. —

O. and I. On *Abies Mayriana.*
JAPAN: Sapporo, June 11, 1923, *S. Kamei;* CULTURES.
II and III. On *Dryopteris amurensis.*
SIBERIA: Distr. Vladivostok, Sept. 15, 1929, *W. Tranzschel.*
II and III. On *Dryopteris dilatata* var. *oblonga.*

JAPAN: Mt. Makkarinupuri, Iburi, Aug. 27, 1923, *S. Kamei; type.*
II and III. On *Dryopteris monticola.*
JAPAN: Nopporo, near Sapporo, Sept. 29, 1923, *S. Kamei.* — Nopporo, Oct. 25, 1925, *S. Kamei.* — Nopporo, Oct. 25, 1931, *S. Kamei.*

The ossiform character suggested by the specific name of *Uredinopsis ossaeiformis* has reference to the peculiar shape of many of the urediospores. From their knobbed apices and more slender shanks they truly bear, as Kamei fancied, a resemblance to the upper part of a femur bone. Similar spores are found in *U. intermedia.* It would seem that these species are closely related, a conclusion strengthened by the further resemblance of their unusually large spermogonia.

Kamei (30) cultured this rust from *Dryopteris dilatata* (var. *oblonga* Takeda, according to Hiratsuka, 23) and *D. monticola* on three species of *Abies* and found that each serves as host for the haploid phase. Through his kindness I have been privileged to examine the results of these cultures.

14. **Uredinopsis mirabilis** (Peck) Magnus in Hedwigia, **43**: 121 (1904). (II¹, II² and III). O, I, II¹, II², III.

Septoria mirabilis Peck in Report New York State Mus. Nat. His. **25**: 87 (1873). II¹.
Gloeosporium mirabile Peck in Report New York State Mus. Nat. His. **39**: 57 (1887). II¹.
Rhabdospora mirabilis (Peck) O. Kuntze, Rev. Gen. Pl. **3²**: 512 (1898). II¹.
Uredinopsis americana Sydow in Ann. Mycol. **1**: 325 (1903). II¹, II² and III.
Milesia mirabilis (Peck) Arthur in Résult. Sci. Congr. Vienne, 337 (1906).

O. Spermogonia on needles of the current season, hypophyllous, inconspicuous, round, rarely confluent, colorless, immersed, inverted hemispherical in vertical section, nearly plane at the leaf surface, subcuticular, covered by the combined cuticle and intermediate layer of outer cell wall, 58–123 µ broad and 35–54 µ deep, averaging about 89×44 µ; apical opening a pore or short slit; spermatiophores unbranched, 1–2-septate, the basal cell large; spermatia hyaline, catenulately produced, ovoid, 1.5–2.0×3.5–4.2 µ. (After Hunter, 26).

I. Aecia (peridermia) hypophyllous, on needles of current season, in two rows, white, cylindrical, 0.2–0.3 mm. in diameter and 0.5–1.0 mm. high; peridium colorless, fragile, rupturing at the apex; peridial cells in a single layer, polygonal, elongate vertically, overlapping, 11–22×22–46 μ, outer wall smooth, 1.0–1.2 μ thick, inner wall closely and rather coarsely verrucose, 2.5–3.0 μ thick, other walls 2–13 μ thick; aeciospores broadly ellipsoid, ovoid or subspheroid, white, 15–19×16–24 μ, averaging about 17×21 μ, closely and rather coarsely verrucose; wall of aeciospore colorless, 1.5–2.0 μ thick.

II^1. Uredia hypophyllous, subepidermal, scattered on discolored intercostal spots or on areas of indefinite extent, pustular, round, 0.1–0.2 mm. in diameter; peridium convex, colorless, delicate; peridial cells isodiametrically to irregularly polygonal, 6–13×8–16 μ, with walls 0.5–1.0 μ thick; urediospores hyaline, white in mass, abundant, extruded in tendrils, very short-stalked ellipsoid, obovoid or fusiform, 8–14×24–67 μ, averaging about 11×40 μ, with a filamentous, enucleate mucro 0–19 μ, averaging about 4 μ; walls of spores colorless, smooth except for two opposing vertical rows of short closely set cogs; spore walls 0.5–1.0 μ thick, with two germ pores near each end.

II^2. Uredia hypophyllous, subepidermal, developing later than the first of the II^1-uredia but scattered or aggregate on the same lesions, round, 0.1–0.3 mm. in diameter; peridium convex, colorless, delicate, tardily dehiscent; peridial cells isodiametrically to irregularly polygonal, 5–13×8–16 μ, with walls up to 1 μ thick; urediospores (amphispores) hyaline, white in mass, long-stalked, angularly obovoid or irregularly polyhedral, 11–22×19–39 μ, averaging about 16×24 μ, rounded at the angles to ridged or finned; spore walls hyaline, finely and closely verrucose, 0.5–1.5 μ thick.

III. Telia diffuse, amphigenous, mostly hypophyllous; teliospores subepidermal, intercellular, scattered or loosely aggregate in a single layer, colorless, subspheroid to ellipsoid, usually 4-celled, cruciate, 20–25 μ in diameter, but varying from 1–8-celled, 12–25×12–29 μ, a single pore in the outer wall of each cell; spore walls hyaline, smooth, about 1 μ thick.

HOSTS AND DISTRIBUTION:

O and I. *Abies balsamea* (L.) Mill., in Nova Scotia (*cultures*), Ontario (*cultures*).

II^1, II^2 and III. *Onoclea sensibilis* L., in Connecticut, Delaware, Illinois, Indiana, Maine, Maryland, Massachusetts, Michigan, Nebraska, New Hampshire, New Jersey, New York, North Carolina, Pennsylvania, Vermont, Virginia, West Virginia, Wisconsin; New Brunswick, Nova Scotia, Ontario, Prince Edward Island, Quebec; Newfoundland; England (introduced host).

II^1, II^2 and III. *Onoclea sensibilis* forma *obtusilobata* (Schk.) Gilbert, in Vermont; Nova Scotia.

Type Locality: Sand Lake, N. Y., on *Onoclea sensibilis* L. II^1, II^2 and III.

Illustrations: Pl. V, figs. 22 a-d. — Arthur, Man. Rusts United States Canada, fig. 3 (1934). — Bell in Bot. Gaz. **77**: figs. 25, 26 (1924). — Hunter in Jour. Arnold Arb. **17**: fig. 35 (1936). — Magnus in Hedwigia, **43**: pl. I, figs. 1–13 (1904).

Exsiccati: Barth. N. Am. Ured. 880. — Barth. E. and E. Fg. Col. 1987. — Barth. Fg. Col. 4086. — Ellis N. Am. Fg. 532. — E. and E. Fg. Col. 1158. — E. and E. N. Am. Fg. 3559. — Reliq. Farl. 282 a, b, c. — Rav. Fg. Carol. IV, 97. — S. and E. Econ. Fg. B8. — Syd. Ured. 2446.

Specimens Examined. —

O and I. On *Abies balsamea.*

Ontario: Timagami, July 21–Aug. 10, 1926, *J. H. Faull & E. H. Bensley*, Herb. J. H. Faull 7696–7706; cultures.

II^1, II^2 and III. On *Onoclea sensibilis.*

Connecticut: Woodmont, Sept. 1888, *R. Thaxter* (II^2, III). — Unionville, Aug. 26, 1902, *G. P. Clinton* (II^1, III). — Monroe, Aug. 22, 1920, *E. H. Eames*, Gray Herb.

Delaware: Newark, Oct. 1907, *H. S. Jackson* (II^2, III).

Illinois: Mt. Carmel, Sept. 27, 1889, *M. B. Waite* (II^2, III).

Indiana: Shelby, Oct. 14, 1920, *H. S. Jackson* (II^2, III).

Maine: Calais, Aug. 31, 1933, *J. H. Faull* (II^1, III).

Maryland: Chevy Chase Circle, Aug. 14, 1896, *E. S. Steele*, Gray Herb. — Glen Echo, Oct. 30, 1919, *J. K. Charles & W. W. Diehl.*

Massachusetts: Newton, Sept. 1879, Farlow Herb. — Weston, Sept. 1891, *Miss H. M. Noyes & A. B. Seymour.* — Weston, Sept. 1897, *A. B. Seymour.* — Magnolia, Aug. 1903, *W. G. Farlow.* — Canton, Oct. 3, 1931, *I. H. Crowell* (II^1, III). — Washington, Aug. 6, 1932, *J. H. Faull* (II^1, II^2). — Worthington, Aug. 21, 1912, *B. L. Robinson*, Gray Herb.

Michigan: Lansing, 1892 (?), *G. H. Hicks*, Herb. B. P. I. 60991 (II^2, III). — Leland, Sept. 7, 1908, *J. C. Arthur & F. D. Kern* (II^1, III).

Nebraska: Kennedy, Aug. 29, 1912, *J. M. Bates.*

New Hampshire: Shelburne, Sept. 1891, *W. G. Farlow* (II^1, III). — East Alstead, Sept. 8, 1903, *A. B. Seymour* (II^2, III). — Whitefield, Sept. 1 and 3, 1925, *J. H. Faull.*

New Jersey: Elizabethtown, Aug. 1847, *J. Carey*, Gray Herb.

New York: Sand Lake, Sept. 1871, *C. H. Peck; type.* — Verona, issued 1881, *C. H. Peck*, Ellis N. Am. Fg. 532. — Cold Spring

Harbor, Sept. 7, 1912, *F. D. Fromme.* — Lyndonville, July 16, 1913, *Bartholomew & Fairman* (II^1, II^2). — Shelter Id., Sept. 1914, *W. G. Farlow.* — South Bay, Madison Co., Sept. 16, 1919, *H. D. House.* — Newcomb, June 8, 1922, *H. D. House.* — Ithaca, Aug. 8, 1931, *J. H. Faull.* — Newcomb, Sept. 9, 1932, *D. S. Welch.*

North Carolina: Biltmore, Sept. 30, 1897, Bilt. Herb. 683 in Gray Herb.

Pennsylvania: Ex Pennsylvania misit Michener, Rav. Fg. Carol. Fasc. IV, no. 97 (1855). — West Chester, Farl. Herb.

Vermont: Winhall, Oct. 6, 1931, *P. Spaulding & G. H. Hepting* (II^1, III). — Willoughby, July 31, 1894, *E. F. Williams*, Gray Herb. — Manchester, Aug. 20, 1898, *H. C. Day*, Gray Herb. — Dorset, 1915, *E. H. Terry*, Gray Herb.; on forma *obtusilobata.*

Virginia: Mountain Lake, Sept. 12, 1915, *F. D. Fromme.* — Camp Lee, Aug. 13, 1918, *J. F. Adams* (II^1, III).

West Virginia: Randolph Co., Oct. 1, 1932, *C. R. Orton & P. D. Strausbough* (II^2, III). — Uppington, Oct. 8, 1932, *B. Streth.*

Wisconsin: Tomahawk Lake, June 29, 1903, *L. S. Cheney* (II^1, III). — Danbury, Aug. 28, 1916, *J. J. Davis.* — Plover, Aug. 25, 1917, *J. J. Davis.* — Spooner, Sept. 1, 1924, *J. J. Davis* (II^1, III). — Arena, Aug. 1, 1927, *J. J. Davis.* — LaValle, Sept. 7, 1927, *J. J. Davis.*

New Brunswick: Speerville, Aug. 17, 1933, *J. H. Faull* (II^1, III). — St. Andrews, Aug. 29, 1933, *J. H. Faull* (II^1, III).

Nova Scotia: Truro (origin), July 1912, *W. P. Fraser* (II^1); culture. — Pictou, Aug. 17, 1909, *W. P. Fraser* (II^1). — Truro, Aug. 19, 1932, I. H. Crowell (II^1, III). — Tusket Lake, Aug. 20, 1920, *M. L. Fernald et al*, Gray Herb.; on forma *obtusilobata.*

Ontario: London, Sept. 1896, *J. Dearness* (II^2, III). — London, Aug. 2, 1911, *J. Dearness* (II^1, III). — Timagami, Aug. 1 and 17, 1921, *J. H. Faull* (II^1, III). — Timagami, Sept. 8, 1921, *H. P. Bell* (II^1, III). — St. Williams, Aug. 8, 1929, *J. H. Faull* (II^1, II^2). — Guelph, Aug. 10, 1931, *R. E. Stone & J. H. Faull* (II^1, III). — Timagami, July 28–Aug. 13, 1926, *J. H. Faull & E. H. Bensley*, Herb. J. H. Faull 7707–7712 (II^1); cultures.

Prince Edward Island: Brookside, Aug. 31, 1912, *M. L. Fernald, B. Long & H. St. John*, Gray Herb.

Quebec: Hudson, 1913, *W. P. Fraser* (II^1). — Lake Kenogami, Aug. 26, 1923, *J. H. Faull* (II^1). — Claude, Sept. 18, 1928, *J. H. Faull* (II^1, III).

Newfoundland: Whitbourne, Aug. 14, 1894, *B. L. Robinson & H. Schrenk*, Gray Herb.

England: A garden near London, Autumn 1933, *L. M. Hunter* (II^1, III).

Uredinopsis mirabilis is abundant throughout the range of its host and especially so in those regions in which *Abies balsamea* is present. The occurrence of white peridermia on firs in Nova

Scotia near rusted *Onoclea sensibilis* led Fraser (18, 19, 20) to undertake experiments to find out whether or not the two rusts were connected. He carried out many tests during the summers of 1912–13, both from the fern to fir and in the reverse direction. His efforts were uniformly successful. Thus, Fraser was the first to discover that the haploid phase of a species of *Uredinopsis* has *Abies* as its host. He recognized this phase as Peck's *Peridermium balsameum.* Likewise, judging from field associations he concluded that the haploid phases of other species of *Uredinopsis* were also included under *P. balsameum;* this conclusion he shortly verified by experiments. In that connection he made the interesting observation that the field aeciospores of the *P. balsameum* he found earlier in the season were smaller than those found later. Some of them he stated "averaged about 8 μ smaller". Fraser never determined what that might mean. From my own culture experiments, however, it seems quite likely that the aecia with larger aeciospores were those of a *Milesia.* Thus, while the aeciospores of *U. mirabilis* average about 17×21 μ and those of the other species of the same genus studied by Fraser are approximately the same size, the aeciospores of *Milesia intermedia* average about 21×27 μ and those of *M. marginalis* about 24×28 μ. Both of these rusts, not then known, almost surely occur in the region in which he collected.

As part of my own experimental undertakings, *U. mirabilis* has been cultured many times on *Abies balsamea* from *Onoclea sensibilis;* and the aeciospores so obtained, when sown on *O. sensibilis*, produced *U. mirabilis* on that host. I can also confirm Fraser's finding that *U. mirabilis* is restricted to the one fern host, *O. sensibilis.* That is, my inoculations of *U. mirabilis* on various other fern hosts have always resulted negatively.

The average measures of the ordinary urediospores of *U. mirabilis* range from 11–12×36–47 μ, and the mucros from 2–8 μ. The amphispores range from 14–16×25–27 μ.

15. **Uredinopsis Osmundae** Magnus in Hedwigia, **43:** 123 (1904). (II and III). O, I, II and III.

Milesia Osmundae (Magn.) Arthur in Résult. Sc. Congr. Bot. Vienne, p. 337 (1906).
Uredinopsis mirabilis (Peck) Magn. ex Rhoads, Hedgcock, Bethel and Hartley in Phytopath. **8:** 333 (1918), in part.

O. Spermogonia on needles of the current season, hypophyllous, inconspicuous, round, colorless, immersed, inverted hemispherical in vertical section, plane at leaf surface, subcuticular, covered by the combined cuticle and intermediate layer of outer epidermal wall, 71–134 μ broad and 40–57 μ deep, averaging about 104×51 μ; apical opening a short slit; spermatiophores unbranched, septate, with large basal cell; spermatia hyaline, catenulately produced, about 2×4 μ. (After Hunter, 25).

I. Aecia (peridermia) hypophyllous, on needles of current season, in two rows, white, cylindrical, conspicuously small and very numerous, often in closely set lineal series, 0.1–0.25 mm. in diameter and up to 0.5 mm. high; peridium colorless, very fragile, rupturing at the apex; peridial cells in a single layer, polygonal, elongate vertically, overlapping, 11–24×24–41 μ, outer wall smooth, 1.2–1.5 μ thick, inner wall rather coarsely verrucose, 2.5–3.0 μ thick; aeciospores broadly ellipsoid, ovoid or subspheroid, 16–22×19–28 μ, averaging about 19×22 μ, closely and rather coarsely verrucose; wall of aeciospore colorless, 1–2 μ thick.

II. Uredia hypophyllous, subepidermal, scattered on discolored intercostal spots or on areas of indefinite extent, pustular, round, dehiscent by central rupture, 0.2–0.5 mm. in diameter; peridium convex, colorless, delicate; peridial cells isodiametrically to irregularly polygonal, 6–13×8–18 μ, with walls up to 1 μ thick; urediospores white in mass, abundant, extruded in tendrils, very short-stalked, ellipsoid, obovoid or fusiform, 8–19×24–65 μ, averaging about 13×41 μ, with a filamentous, enucleate mucro 0–38 μ, averaging 11–13 μ; walls of spores colorless, smooth, except for two opposing vertical rows of short (up to 3 μ high), closely set cogs; spore walls up to 1 μ thick, with two germ pores near each end.

III. Telia diffuse, amphigenous, mostly hypophyllous; teliospores subepidermal, intercellular, very abundant, scattered or aggregate in a single layer, subspheroid to ellipsoid, usually 4-celled, cruciate, but varying from 1–8-celled, in some collections 5–8-celled spores frequent, 16–24×16–32 μ, a single pore in the outer wall of each cell; spore walls hyaline, smooth, about 1 μ thick.

HOSTS AND DISTRIBUTION:

O and I. *Abies balsamea* (L.) Mill., in Ontario (*cultures*).
II and III. *Osmunda cinnamomea* L., in Maine, Massachu-

setts, New Hampshire, New York, Pennsylvania, Rhode Island, Vermont, Wisconsin; New Brunswick, Ontario, Quebec.

Osmunda Claytoniana L., in Connecticut, Maine, Massachusetts, Minnesota, New Hampshire, New York, Pennsylvania, Vermont, Wisconsin; New Brunswick, Nova Scotia, Ontario, Quebec.

Osmunda regalis var. *spectabilis* (Willd.) A. Gray, in Florida, Maine, New Hampshire, New York, Wisconsin; Nova Scotia, Ontario.

TYPE LOCALITY: Malloryville, New York, on *Osmunda cinnamomea.* II and III.

ILLUSTRATIONS: Pl. III, figs. 16 a-d. — Magnus in Hedwigia, **43**: II, figs. 8–16 (1904). — Arthur, Plant Rusts, fig. 26 (C) (1929); Arthur, Man. Rusts United States Canada, fig. 13 (1934). — Hiratsuka, Monog. Pucciniastreae, pl. III, fig. 2. — Bell in Bot. Gaz. **77**: pl. III, fig. 20, pl. IV, figs. 23, 24 (1924). — Moss in Ann. Bot. **40**: text figs. 4–6, 21 (C), pl. XXXIV, figs. 27–29, 41 (1926).

EXSICCATI: Barth. N. Am. Ured. 2981. — Reliq. Farl. 284.

SPECIMENS EXAMINED. —

O and I. On *Abies balsamea.*

ONTARIO: A. Of *Osmunda cinnamomea* origin. Timagami, July 9–24, 1927, *J. H. Faull & E. H. Bensley*, Herb. J. H. Faull 8449–8456; CULTURES. B. Of *Osmunda Claytoniana* origin. Timagami, July 16–Aug. 5, 1926, *J. H. Faull & E. H. Bensley*, Herb. J. H. Faull 7713–7721; CULTURES. — Timagami, July 8 and 10, 1927, *J. H. Faull & E. H. Bensley*, Herb. J. H. Faull 8430–8431; CULTURES. C. Of *Osmunda regalis* var. *spectabilis* origin. Timagami, July 12 and 18, 1927, *J. H. Faull & E. H. Bensley*, Herb. J. H. Faull 8440–8441; CULTURES.

QUEBEC: Of *Osmunda Claytoniana* origin from Nova Scotia. Macdonald College, June 27, 1912, *W. P. Fraser;* CULTURE.

O and I. On *Abies concolor.*

MASSACHUSETTS: Hamilton, July 5, 1931, *G. D. Darker;* adjacent to rusted fern host.

II and III. On *Osmunda cinnamomea.*

MAINE: Wells, Aug. 30, 1859, *J. Blake.* — Scarboro, prior to 1879, *E. C. Boller*, Cooke Herb. in Farl. Herb. — Augusta, Sept. 1, 1933, *J. H. Faull.*

MASSACHUSETTS: Woods Hole, Aug. 18, 1925, *J. H. Faull.* — Hamilton, Aug. 9, 1930, *G. D. Darker.* — Washington, Aug. 6, 1932, *J. H. Faull.*

NEW HAMPSHIRE: Shelburne, Sept. 1893, *W. G. Farlow.* — Whitefield, Sept. 1 and 3, 1925, *J. H. Faull.*

NEW YORK: Malloryville, Aug. 4, 1896, *G. F. Atkinson; type.* — Albany, Sept. 10, 1922, *J. R. Weir.* — Newcomb, Sept. 2, 1932, *D. S. Welch.*

RHODE ISLAND: Little Compton, Oct. 6, 1936, *J. H. Faull.*

WISCONSIN: Haugen, *J. J. Davis.* — Spooner, Sept. 24, 1912, *J. J. Davis.* — Plover, Aug. 24, 1917, *J. J. Davis.* — Bruce, Sept.

4, 1924, *J. J. Davis.* — Weyerhauser, July 28, 1925, *J. J. Davis.* — Tripoli, Aug. 14, 1925, *J. J. Davis.* — Couderay, July 31, 1928, *J. J. Davis.* — Winneboujon, Aug. 8, 1930, *J. J. Davis.*

NEW BRUNSWICK: St. Andrews, Aug. 20, 1933, *J. H. Faull.* — Route 11A, Aug. 27, 1933, *J. H. Faull.*

ONTARIO: *Cultures* of *Osmunda cinnamomea* origin, locally collected, through *Abies balsamea*, and then (a) through *O. cinnamomea*, (b) through *O. Claytoniana*, (c) through *O. regalis*, and then on *O. cinnamomea*, Aug. 9, 23 and 31 respectively, *J. H. Faull & E. H. Bensley*, Herb. J. H. Faull 8457, 8463 and 8467 respectively.

QUEBEC: St. Elie, Aug. 7, 1927, *J. H. Faull.* — North Hatley, Sept. 4, 1932, *D. E. Newton.*

II and III on *Osmunda Claytoniana.*

CONNECTICUT: Central Village, Aug. 24, 1908, *J. L. Sheldon.*

MAINE: Jackman, Aug. 22, 1933, *J. H. Faull.* — Calais, Aug. 31, 1933, *J. H. Faull.* — Augusta, Sept. 1, 1933, *J. H. Faull.*

MASSACHUSETTS: Jamaica Plain, Aug. 6, 1931, *G. D. Darker.* — Washington, Aug. 6, 1932, *J. H. Faull.* — Mt. Greylock, Aug. 7, 1932, *J. H. Faull* (II).

MINNESOTA: Grand Marais, Aug. 1906, *H. L. Lyon.*

NEW HAMPSHIRE: Glen House, Aug. 1889, *L. M. Underwood.* — Alstead, Aug. 17, 1918, *A. B. Seymour.* — Whitefield, Aug. 30 and Sept. 3, 1925, *J. H. Faull.* — Mt. Monadnock, Aug. 21, 1932, *J. H. Faull.* — Mt. Madison, Sept. 1, 1932, *J. H. Faull.*

NEW YORK: Newcomb, July 20, 1922, *H. D. House.* — Newcomb, Sept. 9, 1932, *D. S. Welch.*

VERMONT: Sherburne Pass, Aug. 10, 1932, *J. H. Faull.*

WISCONSIN: Danbury, Aug. 30, 1916, *J. J. Davis.* — Haugen, Aug. 25, 1923, *J. J. Davis.* — Weyerhauser, July 29, 1925, *J. J. Davis.* — Washington Island, Aug. 30, 1929, *J. J. Davis.* — Solon Springs, July 28, 1930, *J. J. Davis.* — Haugen, Aug. 16, 1930, *J. J. Davis.*

NEW BRUNSWICK: Sackville, Aug. 16, 1932, *I. H. Crowell.* — Fredericton, Aug. 15, 1933, *J. H. Faull.* — Route 11A, Aug. 27, 1933, *J. H. Faull.* — St. Andrews, Aug. 29, 1933, *J. H. Faull.*

NOVA SCOTIA: Oakfield, Aug. 13, 1910, *W. P. Fraser.* — Scotburn, Aug. 1916, *W. P. Fraser.* — Truro, Aug. 19, 1932, *I. H. Crowell.*

ONTARIO: Timagami, Aug. 6, 1921, *J. H. Faull.* — Timagami, May 17, 1925, *J. H. Faull* (on dead overwintered leaves). — Timagami, Aug. 5, 1925, *E. H. Moss; culture* of *Osmunda Claytoniana* origin through *Abies balsamea.* — Timagami, Sept. 14, 1927, *G. D. Darker.* — CULTURES of *Osmunda Claytoniana* origin through *Abies balsamea* then (a) on *O. Claytoniana*, (b) on *O. Claytoniana* through *O. Claytoniana*, Timagami, July 27–Aug. 11, 1926, *J. H. Faull & E. H. Bensley*, Herb. J. H. Faull (a) 7722–4, 7731, (b) 7725. — CULTURES of *Osmunda Clay-*

toniana origin through *Abies balsamea*, then (a) on *O. Claytoniana* through *O. Claytoniana*, (b) on *O. Claytoniana* through *O. regalis* var. *spectabilis*, Timagami, Aug. 6–12, 1927, *J. H. Faull & E. H. Bensley*, Herb. J. H. Faull (a) 8434, 8435, (b) 8438, 8439. — CULTURES of *O. regalis* var. *spectabilis* origin through *Abies balsamea*, then (a) on *O. Claytoniana* through *O. regalis* var. *spectabilis*, (b) on *O. Claytoniana* through *O. Claytoniana*, Timagami, Aug. 11–19, 1927, *J. H. Faull & E. H. Bensley*, Herb. J. H. Faull (a) 8444, 8445, (b) 8448. — CULTURES of *O. cinnamomea* origin through *Abies balsamea*, then on *O. Claytoniana* through (a) *O. cinnamomea*, (b) *O. Claytoniana*, (c) *O. regalis* var. *spectabilis*, Timagami, Aug. 19–Sept. 6, 1927, *J. H. Faull & E. H. Bensley*, Herb. J. H. Faull (a) 8458, 8459, (b) 8464, (c) 8470, 8471.

QUEBEC: Lake Kenogami, Aug. 16, 17 and 26, 1923, *J. H. Faull* (II).— Mt. Albert, Shickshocks, Aug. 21, 1933, *J. H. Faull.*

II and III on *Osmunda regalis* var. *spectabilis.*

FLORIDA: Highlands Hammock, March 30, 1937, *C. L. Shear* (1070). — Winter Park, Feb. 17, 1938, *C. L. Shear* (1165).

MAINE: South Bristol, Aug. 31, 1929, *P. & H. J. Wilson.*

NEW HAMPSHIRE: Whitefield, Sept. 3, 1925, *J. H. Faull.*

NEW YORK: Newcomb, Sept. 3 and 10, 1932, *D. S. Welch.*

WISCONSIN: Glen Brook, July 26, 1902, *J. J. Davis.*

NOVA SCOTIA: Oakfield, Aug. 13, 1910, *W. P. Fraser.*

ONTARIO: CULTURES of *Osmunda regalis* var. *spectabilis* origin, locally collected, through *Abies balsamea*, then (a) to *O. regalis* var. *spectabilis*, (b) to *O. regalis* var. *spectabilis* through *O. Claytoniana*, Timagami, Aug. 16 and 17, 1926, *J. H. Faull & E. H. Bensley*, Herb. J. H. Faull (a) 7726–7728, (b) 7729, 7730. — CULTURES of *O. regalis* var. *spectabilis* origin, locally collected, through *Abies balsamea*, then (a) to *O. regalis* var. *spectabilis* through *O. regalis* var. *spectabilis*, (b) to *O. regalis* var. *spectabilis* through *O. Claytoniana*, Timagami, Aug. 11–23, 1927, *J. H. Faull & E. H. Bensley*, Herb. J. H. Faull (a) 8442, 8443, (b) 8446, 8447. — CULTURES of *O. Claytoniana* origin through *Abies balsamea*, then (a) on *O. regalis* var. *spectabilis*, (b) on *O. regalis* var. *spectabilis* through *O. Claytoniana*, (c) on *O. regalis* var. *spectabilis* through *O. regalis* var. *spectabilis*, Timagami, July 24–Aug. 13, 1927, *J. H. Faull & E. H. Bensley*, Herb. *J. H. Faull* (a) 8432, 8433, (b) 8436, 8437, (c) 8439. — CULTURES of *O. cinnamomea* origin through *Abies balsamea*, then to *O. regalis* var. *spectabilis* through (a) *O. cinnamomea*, (b) *O. Claytoniana*, (c) *O. regalis* var. *spectabilis*, Timagami, Aug. 12–Sept. 1, 1927, *J. H. Faull & E. H. Bensley*, Herb. J. H. Faull (a) 8460–1, (b) 8465, (c) 8468–9.

Uredinopsis Osmundae is a very common rust, especially on *Osmunda Claytoniana* and *O. cinnamomea*, in those parts of its range in which *Abies balsamea* abounds. This rust soon spoils the appearance of its fern hosts, to such an extent, indeed, that in some localities their value as ornamentals is lost in settings adjacent to firs.

Fraser (19) was successful in culturing *U. Osmundae* from *Osmunda Claytoniana* on *Abies balsamea.* In the course of my own experimental undertakings this rust has been cultured many times from each of its fern host species on the balsam fir and then, using the aeciospores so obtained, cultured back on the respective species of *Osmunda.* Also considerable cross-culturing was carried out. A detailed account will be presented in a later paper. It may be noted here, however, that according to our experiences, the rust occurring so abundantly in nature on *O. Claytoniana* will infect *O. regalis* var. *spectabilis* but not *O. cinnamomea*, that the rust on *O. regalis* var. *spectabilis* will infect *O. Claytoniana* but not *O. cinnamomea*, and that the rust on *O. cinnamomea* will infect both *O. regalis* var. *spectabilis* and *O. Claytoniana.* Thus there seem to be two biological strains of *U. Osmundae* and to one of them *O. cinnamomea* is immune. I have not, however, been able to separate them satisfactorily on the basis of morphological characters. It should be noted that the spore measures in the description of the aecia given above are taken from culture material of *U. Osmundae* of *O. cinnamomea* origin.

The average measures of the urediospores of *U. Osmundae* on *O. Claytoniana* range from 12–14×39–44 μ and their mucros 10–20 μ, those on *O. cinnamomea* 13–15×37–43 μ and their mucros 6–19 μ, those on *O. regalis* var. *spectabilis* 13–14×38–47 μ and their mucros 7–14 μ.

16. **Uredinopsis filicina** (Niessl) Magnus in Atti Congr. Bot. Internat. Genova (1892), 167 (1893). (II^1, II^2 and III).
O, I, II^1, II^2 and III.

Protomyces (?) *filicinus* Niessl in Rabenhorst's Fg. Eur. 1659 (1873). II^1.
Gloeosporium Phegopteridis Pass. in Rev. Myc. **2**: 36 (1880). II^1.
Gloeosporium Phegopteridis Frank, Krank. Pflanz. 611 (1880). II^1.
Uredo Polypodii Pers. forma *Phegopteris* Winter in Pilze Deutsch. **1**: 253 (1881). II^1.
Gloeosporium Frankii Allescher in Pilze Deutsch. 494 (1901).

O. "Spermogonia on needles of current season, amphigenous, mostly hypophyllous, closely aggregated on discoloured areas, minute, numerous, inconspicuous, mostly isolated or often confluent, in section subcuticular, slightly convex, sometimes conoidal, 73–118.5 μ broad, 37–64.5 μ high; spermatiophores unbranched; spermatia oblong, 4.8–6.4×1.9–2.4 μ, colourless, smooth." (23).

I. Aecia (peridermia) hypophyllous, on needles of current season, in two rows, white, cylindrical, 0.2–0.5 mm. in diameter and up to 1.3 mm. high; peridium colorless, fragile, rupturing laterally or at apex; peridial cells in a single layer, elongate vertically, slightly overlapping, 11–27×19–40 μ, outer wall smooth, 1.0–1.2 μ thick, inner wall closely and rather coarsely verrucose, 3–6 μ thick; aeciospores broadly ellipsoid, ovoid or subspheroid, white, 16–22×19–24 μ, averaging about 17×21 μ, closely and rather coarsely verrucose; wall of aeciospore colorless, 1.2–2.0 μ thick.

II¹. Uredia hypophyllous, subepidermal, scattered on discolored intercostal spots or on lesions of indefinite extent, pustular, round, 0.1–0.3 mm. in diameter; peridium convex, colorless, delicate; peridial cells isodiametrically to irregularly polygonal, 6–11×8–14 μ, with walls less than 1 μ thick; urediospores hyaline, white in mass, abundant, extruded in tendrils, very short-stalked, ellipsoid, obovoid or fusiform, 8–13×24–46 μ, averaging about 10×31 μ, with a narrowly conical, broadly based, filamentous, enucleate mucro, 0–22 μ long, averaging about 12 μ; walls of spores colorless, smooth except for a few, low, scattered, hyaline warts; spore walls less than 1 μ thick, except that in many spores the lateral wall at the base is abruptly thickened and may measure as much as 3 μ thick.

II². Uredia hypophyllous, subepidermal, developing later than the first of the II¹-uredia but on the same lesions, round, 0.1–0.4 mm. in diameter; peridium convex, colorless, rather delicate, tardily dehiscent; peridial cells isodiametrically to irregularly polygonal, 6–13×8–18 μ, with walls about 1 μ thick; urediospores (amphispores) hyaline, white in mass, long-stalked, obovoid to irregularly polyhedral, 8–22×14–30 μ, averaging about 13×21 μ, rounded to faintly angled and without fins or horns; spore walls hyaline, finely and closely verrucose, 1.0–1.5 μ thick.

III. Telia diffuse, amphigenous, mostly hypophyllous; teliospores subepidermal, intercellular, scattered or loosely aggregate in a single layer, subspheroid to ellipsoid, usually 2-celled, but varying from 1–2-celled, 14–22 μ in diameter; spore wall hyaline, smooth, about 1 μ thick.

HOSTS AND DISTRIBUTION:

O and I. *Abies Mayriana* Miyabe and Kudô, in Japan (*cultures*).

II¹, II² and III. *Dryopteris Phegopteris* (L.) C. Chr. (*Phegopteris polypodioides* Fée), in Austria, Czechoslovakia, Finland, France, Germany, Great Britain, Hungary, Italy, Norway, Poland, Roumania, Russia (Europe), Sweden, Switzerland; Japan, Siberia.

TYPE LOCALITY: Gratz, Austria, on *Dryopteris Phegopteris*. II¹, II² and III.

ILLUSTRATIONS: Pl. V, figs. 23 a-e. — Bubák in Rostpilze Böhmens, p. 192 (1908). — Dietel in Ber. Deutsch. Bot. Ges. **13**: pl. 26, figs. 1–4 (1895), in Engler und Prantl, Nat. Pflanzenfam. **1**, 1 Abt.**: fig. 30 (F. G.) (1900), in ditto, **2**, Aufl. 6: fig. 26 (F. G.) (1928). — Fischer in Ured. der Schweiz, figs. 310 and 311 (1904). — Fragoso, Fl. Ibér. Ured. fig. 136 (1925). — Grove, Brit. Rust Fungi, fig. 284 (1913). — Hariot, Les Urédinées, p. 255 (1908). — Hiratsuka in Jour. Jap. Bot. **10**: 473, fig. 12 (1934), Monog. Pucciniastreae, pl. II, fig. 1 (1936). — Klebahn in Kryptogamenflora Mark Brandenbr. p. 856, fig. U, 1 (I–VI) (1912–14). — Magnus in Atti d. Congr. Bot. Internat. Genova, pl. 9, figs. 1–13 (1892). — Migula in Krypt.-Fl. **3**¹: pl. 10, E, fig. 6 (1910). — Trotter in Fl. Ital. Crypt. Ured. figs. 33 and 99 (1908–14).

EXSICCATI: Eichhorn and Poeverlein Ured. Süddeutsch. 81. — Jaap Fg. Sel. 819. — Krieger Fg. Saxon. 886. — Krypt. Vindob. Fg. Kryptog. 936. — Migula Kryptog. Germ., Austr. and Helvet. 366. — Petrak Fl. Bohem. and Morav. 1980. — Petrak Fg. Polon. 275. — Rabenh. Fg. Eur. 1659. — Smarods Fg. Latvici 468. — Speg. Myc. Ital. 63. — Syd. Myc. Germ. 60, 312, 1864, 1865. — Syd. Ured. 949, 1197, 1285, 2194. — Vestergren Microm. Rar. Sel. 272. — Weese Eumycetes Sel. 386, 474, 521. — Wrób. and Siem. Fg. Polon. Sel. 14.

SPECIMENS EXAMINED.—

O and I. On *Abies Mayriana*.

JAPAN: Sapporo, June 18, 1923, *S. Kamei;* CULTURES.

II¹, II² and III. On *Dryopteris Phegopteris*.

AUSTRIA: Gratz, 1873 (?), *G. Niessl; type.* — Voralberg, July 26, 1898 (II¹). — "Gnadenwald" pr. Hall, Aug. 8, 1898, *P. Sydow.* — Bad Gastein, Aug. 14, 1890, *P. Magnus.*

CZECHOSLOVAKIA. Kralóvany, Slovakia, July 27, 1932, *G. D. Darker.*— Reichenberg, 1867, *W. Siegismond.*

GERMANY: Utterwaldergrund, Sept. 1887, July 1888, June 1890, July 1892, *W. Krieger.* — Natzehungtal bei Olbernhau in Erzgebirge, Aug. 11, 1903, *P. Dietel* (II¹, III). — Schmilka, Aug. 21, 1903, *H. & P. Sydow.* — Braunlage, Harz, Sept. 6, 1904, *P. Sydow.* — Zell a. See, July 21, 1909, *P. Dietel.* —

Flinsberg, Silesia, Aug. 2, 1910, *P. Dietel.* — Karlsbrunn, July 1911, *G. Niessl-Mayendorf.* — Partenkirchen, July 23, 1917, *O. Jaap.* — Oberhof, Aug. 1, 1921, *H. Sydow.* — Heinchen, July 16, 1922, *A. Ludwig.* — Garmisch, Aug. 15, 1928, *E. Eichhorn.* — Ohragrund, Aug. 29, 1928, *W. Migula.* — Schmilka, Aug., *P. Magnus.* — Garbel, 1930, *J. Weese.*

ITALY: Consiglio, Aug. 1879, *P. Spegazzini* (II^1, II^2).

LATVIA: Karli, July 28, 1934, *A. Kirulis.*

NORWAY: Vedä in Bruvik, Hordaland, Aug. 16, 1926, *I. Jörstad* (II^2, III). — Strengen in Lunde, Telemark, Sept. 22, 1927, *I. Jörstad* (II^2, III). — Bergen, Sept. 19–20, 1932, *G. D. Darker.* — Reimgrend, Sept. 17, 1932, *G. D. Darker.*

POLAND: Howerla, Aug. 1913, *A. Wróblewski* (II^2, III). — Mikuliczyn, July 5, 1914, *A. Wróblewski* (II^1, III). — Chonnirtz, July 19, 1918, *F. Petrak.* — Czarnohora, Aug. 1923, *W. Siemaszko.* — Ojców, June 24, 1924, *W. Konopacka* (II^1).

ROUMANIA: Madein, Moldavia, July 1903, *I. C. Constantineanu.* — Hochgesenke, July 1924, *R. Picbauer.*

RUSSIA (Europe): Lewaschewo, Prov. Leningrad, July 26, Aug. 8, 1902, *W. Tranzschel.* — Lewaschewo, Prov. Leningrad, Aug. 12–24, 1902, *W. Tranzschel* (II^2, III). — Kama R., Distr. Omutnin, Aug. 26, 1924, *M. Chochrjakov* (II^2, III).

SWEDEN: Falun, Aug. 20, 1895, *O. Juel.* — Falun, July 10, 1897, *O. Juel* (II^1). — Läter, Aug. 1907, *G. Lagerheim.* — Dullaberget, Aug. 16, 1929, *J. A. Nannfeldt.*

SWITZERLAND: Ebnit, Sept. 3, 1906, *E. Fischer.* — Between Triente and Gueuroz, Valois, July 30, 1915, *E. Mayor.* — Iseltwald, Berner Oberland, Aug. 15, 1925, *E. Fischer* (II^2, III).

JAPAN: Mt. Makkarinupuri, Iburi, Aug. 27, 1923, *S. Kamei.* — Mt. Meakin, Kushiro, Sept. 14, 1925, *N. Hiratsuka* (II^2, III). — Mt. Yatsugatake, July 22, 1930, *N. Hiratsuka.*

SIBERIA: Maj-he R., Distr. Vladivostok, Aug. 1–3, 1927, *W. Tranzschel* (II^2, III).

Uredinopsis filicina, distributed widely throughout the northern part of the eastern hemisphere, has so far not been reported from the western hemisphere, although its host, *Dryopteris Phegopteris*, occurs abundantly in the northern regions of that hemisphere. The diploid phase of this rust shows several distinctive features. Thus, its ordinary urediospores are capped by a conical, broadly based mucro instead of a filamentous, narrowly based mucro like that of other species with mucronate spores. Moreover, the basal part of many of the urediospores has very abruptly thick walls, often so thick as to reduce the lumen to capillary dimensions. The teliospores are exceptional in that they are never more than 2-celled, a feature shared only by *U. glabra.*

Kamei (31) has successfully cultured *U. filicina* from *Dryopteris Phegopteris* on *Abies Mayriana.* Through his courtesy I have had the opportunity to study the haploid phase. Both spermogonia and aecia are typically those of an *Uredinopsis.*

The average measures of the ordinary urediospores of *U. filicina* range from 9–11×29–34 μ and the mucros from 8–15 μ. The amphispores range from 12–14×20–24 μ.

17. **Uredinopsis Phegopteridis** Arthur in N. Am. Flora, **7:** 117 (1907) (II and III). O, I, II and III.

> *Uredinopsis mirabilis* (Peck) Magn. ex Rhoads, Hedgcock, Bethel and Hartley in Phytopath. **8:** 333 (1918), in part.

O. Spermogonia on needles of the current season, hypophyllous, inconspicuous, round, colorless, immersed, inverted hemispherical in vertical section, plane at leaf surface, subcuticular, covered by the combined cuticle and intermediate layer of outer epidermal wall, 56–125 μ broad and 34–58 μ deep, averaging about 93×48 μ; apical opening a pore or short slit; spermatiophores unbranched, septate, with large basal cell; spermatia hyaline, catenulately produced, ovoid, 1.5–2.0×3.3–4.1 μ (After Hunter, 26).

I. Aecia (peridermia) hypophyllous, on needles of current season, in two rows, white, cylindrical, 0.2–0.3 mm. in diameter, 0.5–1.0 mm. high; peridium colorless, fragile, rupturing at the apex; peridial cells in a single layer, polygonal, elongate vertically, overlapping, 13–24×22–35 μ, outer wall smooth, 2.0–2.5 μ thick, inner wall rather coarsely verrucose, 3–4 μ thick; aeciospores broadly ellipsoid, ovoid or subspheroid, 16–24×19–35 μ, averaging about 19×24 μ, closely and rather coarsely verrucose; wall of aeciospore colorless, 1–2 μ thick.

II. Uredia hypophyllous, subepidermal, scattered on discolored intercostal spots or on areas of indefinite extent, pustular, round, mostly very small, but varying from 0.1–0.3 mm. in diameter; peridium convex, colorless, delicate; peridial cells isodiametrically to irregularly polygonal, 6–11×8–14 μ, with walls up to 1 μ thick; urediospores white in mass, extruded in tendrils by apical rupture, very short-stalked, ellipsoid, obovoid or fusiform, 10–16×27–51 μ, averaging about 12×36 μ, with a filamentous, enucleate mucro 0–46 μ, averaging about 19 μ; walls of spores colorless, smooth, except for two opposing vertical rows of short, closely set cogs; spore walls 0.5–1.0 μ thick, with two germ pores near each end.

III. Telia diffuse, amphigenous, mostly hypophyllous; teliospores subepidermal, intercellular, scattered or loosely aggregate in a single layer, subspheroid to ellipsoid, usually 4-celled, but varying from 1–4-celled, 11–21×16–27 μ, a single pore in the outer wall of each cell; spore walls hyaline, smooth, about 1 μ thick.

Hosts and Distribution:

O and I. *Abies balsamea* (L.) Mill., in Nova Scotia, Ontario, Quebec; *cultures* and field.

II and III. *Dryopteris Linnaeana* C. Chr. [*Phegopteris Dryopteris* (L.) Fée], in Maine, New Hampshire, Wisconsin; Alberta, New Brunswick, Nova Scotia, Ontario, Quebec.

Type Locality: Vilas Co., Wisconsin on *Dryopteris Linnaeana*. II and III.

Illustrations: Pl. V, figs. 26 a-d. — Arthur, Man. Rusts United States Canada, fig. 5 (1934). — Bell in Bot. Gaz. **77**: text figs. 3–10; pl. I, fig. 1; pl. II, figs. 1–12 (1924).

Exsiccati: Fg. Wiscon. 140.

Specimens Examined. —

O and I. On *Abies balsamea*.

Nova Scotia: New Glasgow, Aug. 14, 1911, *W. P. Fraser;* adjacent to rusted fern host.

Ontario: Timagami, July 22, 1911, *J. H. Faull;* adjacent to rusted fern host. — Timagami, July 27, 1926, *J. H. Faull & E. H. Bensley*, Herb. J. H. Faull 7748; culture. — Timagami, July 11–19, 1927, *J. H. Faull & E. H. Bensley*, Herb. J. H. Faull 8488–8493; cultures.

Quebec: Macdonald College, June 22, 1912, *W. P. Fraser;* culture (telia from Pictou, N. S.). — Claude L., Sept. 8, 1928, *J. H. Faull;* adjacent to rusted fern host.

II and III. On *Dryopteris Linnaeana*.

Maine: Jackman, Aug. 22, 1935, *J. H. Faull.*

New Hampshire: Mt. Jefferson, Aug. 31, 1932, *J. H. Faull.*

Wisconsin: Vilas Co., July 28, 1902, *J. J. Davis; type.* — Weyerhauser, July 31, 1925, *J. J. Davis.*

Alberta: Slave Lake on Lesser Slave L., Aug. 10, 1931, *E. H. Moss.* — Slave Lake on Lesser Slave L., July 21, 1934, *E. H. Moss.*

New Brunswick: Fredericton, Aug. 15, 1933, *J. H. Faull.* — St. Andrews, Aug. 29, 1933, *J. H. Faull.*

Nova Scotia: Pictou, Sept. 15, 1910, *W. P. Fraser.*

Ontario: Timagami, July 19 and 23, 1919, *J. H. Faull.* — Timagami, Aug. 17, 1921, *J. H. Faull.* — Timagami, Aug. 5, 6 and 15, 1925, *E. H. Moss.* — Timagami, Sept. 10, 1926, *J. H. Faull & G. D. Darker.* — Timagami, Aug. 2, and 11, 1926, *J. H. Faull & E. H. Bensley*, Herb. J. H. Faull 7749 and 7750; cultures.

QUEBEC: Claude L., Sept. 8, 1928, *J. H. Faull.* — Claude, Sept. 18, 1928, J. H. Faull. — Grand Cascapedia R., Aug. 17 and 19, 1933, *J. H. Faull.* — Claude, Aug. 24, 1933, *J. H. Faull.*

Uredinopsis Phegopteridis was successfully cultured by Fraser (19) from *Dryopteris Linnaeana* to *Abies balsamea.* In connection with my own experimental work Fraser's results have been repeatedly confirmed. In addition, with the aeciospores thus obtained the rust has been carried back to its fern host.

The average measures of the urediospores of *U. Phegopteridis* range from 12–13×33–38 μ and their mucros from 18–24 μ.

18. **Uredinopsis aspera** Faull, sp. nov. II and III.

Uredo Pteridis D. and H. in Erythea, **2**: 127 (1894). II.
Milesia Pteridis (D. and H.) Arthur in Résult. Sci. Congr. Bot. Vienne, 337 (1906), in part.
Uredinopsis Pteridis (D. and H.) Arthur in N. Am. Flora **7**: 116 (1907), in part.
Milesina Pteridis (D. and H.) Sydow, Monog. Ured. **3**: 481 (1915). II.
Uredinopsis macrosperma (Cooke) Magnus ex Arthur, Man. Rusts United States Canada, 5 (1934), in part.

Pycnidia et aecidia ignota. Sori uredosporiferi hypophylli, epidermide tecti, pustulati, rotundati, elliptici vel lineales, 0.3–2.5 mm. longi, peridio ex cellulis hyalinis irregulariter polygonalibus composito cincti; celluli peridii 5–16×8–19 μ, pariete 2–4 μ crasso; uredosporae albae, subsessiles, obovoideae vel late ellipsoideae, 14–30×24–46 μ, plus minusve 20×32 μ; paries sporae hyalinus, dense spinulosus, 1.5–2.0 μ crassus. Teleutosporae epidermide tectae, subglobosae, 1–5-cellulares, 15–27 μ diam.

Hab. in foliis *Pteridii aquilini lanuginosi* in California; Hawaii; British Columbia.

O and I. Spermogonia and aecia unknown.

II. Uredia hypophyllous, subepidermal, on brownish discolored intercostal spots and on areas of indefinite extent, one to a few on an intercostal lesion, pustular, round to linear, 0.3–2.5 mm. in longest axis; peridium convex, colorless, firm, laterally dehiscent at base; peridial cells isodiametrically to irregularly polygonal, 5–16×8–19 μ, mostly with walls 2–4 μ thick; urediospores hyaline, white in mass, abundant, extruded in bulky masses or in tendrils, very short-stalked, obovoid to broadly ellipsoid, 14–30×24–46 μ, averaging about 20×32 μ; walls of spores colorless, closely and finely spinulose; spore wall 1.5–2.0 µ thick, with two germ pores near each end.

III. Telia diffuse, amphigenous, mostly hypophyllous; teliospores subepidermal, intercellular, scattered or loosely aggregate in a single layer, colorless, subspheroid, 1–5-celled, mostly 4-celled, cruciate, 15–27 µ in diameter, a single pore in the outer wall of each cell; spore walls hyaline, smooth, about 1 µ thick; cells of spores occasionally separating from one another.

HOSTS AND DISTRIBUTION:
O and I. Unknown.
II and III. *Pteridium aquilinum* var. *lanuginosum* (Bong.) Fernald, in California; Hawaii; British Columbia.

TYPE LOCALITY: Pasadena, California on *Pteridium aquilinum* var. *lanuginosum*. II and III.

ILLUSTRATIONS: Pl. IV, figs. 18 a-b.

EXSICCATI: Barth. Fg. Columb. 2988, 4087, 4787. — Barth. N. Am. Ured. 881, 1682.

SPECIMENS EXAMINED. —
II and III. On *Pteridium aquilinum* var. *lanuginosum*.

CALIFORNIA: Pasadena, Jan. 25, 1893, *A. J. McClatchie; type*. — Dec. 1885, *Dr. Anderson*, Farlow Herb. (II). — Eureka, June 4, 1896, *W. C. Blasdale*. — Monterey Co., Aug. 5, 1908, *W. T. Swingle* (II). — July 1900, *R. M. Horner* (II). — San Francisco, Aug. 11, 1915, *E. Bartholomew* (II). — Long Beach, Aug. 15, 1916, *E. Bethel* (II). — Carmel, Sept. 10, 1919, *Mrs. J. Clemens*. — Mt. Tamalpais, Oct. 1925, *H. E. Parks* (II). — Tennessee Point, Marin Co., Sept. 9, 1925, *W. C. Blasdale* (II). — Fort Ross, July 27, 1930, *W. W. Diehl*.

HAWAII: Makawoa, Maui Id., July, 1909, *H. L. Lyon* (II).

BRITISH COLUMBIA: Victoria, Sept. 5, 1912, *Mr. & Mrs. E. B.*

Uredo Pteridis Diet. and Holw. (1894) has been confused with *Uredinopsis Pteridis* Diet. and Holw. (1895). But, as Sydow (52) insisted, they are entirely distinct species; the latter has with the former "nicht zu tun". Sydow, of course was in error when he transferred *Uredo Pteridis* to the genus *Milesina*. Not knowing anything of its teliospores he thought its urediospores must surely be those of a *Milesia*. So far no one has advanced a valid reason for correcting Sydow's error. Naturally this rests on the character of the teliospores, and as yet no one seems to have observed the teliospores of this rust. They occur, however, in the type material and I have found them in several other collections. They are of the regular Uredinopsis type. So, unquestionably, *Uredo Pteridis* belongs in the genus *Uredinopsis*. One might now raise the question as to the possibility of the spinulose urediospores of *Uredo Pteridis* being the amphispores of the much commoner species *Uredinopsis macrosperma* (*Uredinopsis Pteridis* Diet. and Holw.). Of this there is not the slightest evidence. The spinulose urediospores of *Uredo Pteridis* and the apiculate, non-spinulose urediospores of *Uredinopsis macrosperma* have never been found associated. Moreover, the urediospores of both of these species are like those of the ordinary kind in that they are almost sessile; they are similarly pored; they are the only urediospores found on a given infection; and they are promptly discharged at maturity in the same way. Both species, so far as is known, are without amphispores. Now, with the transfer of *Uredo Pteridis* to *Uredinopsis*, a new specific name must be coined because the use of "*Pteridis*" is pre-empted. So I have called it *Uredinopsis aspera*. It is especially interesting that Hiratsuka (23) has described a comparable, though readily distinguishable species, *U. Hashiokai*, from Formosa.

The average measures of the urediospores of *U. aspera* range from 19–22×30–36 μ.

19. **Uredinopsis Hashiokai** Hiratsuka, Monog. Pucciniastreae, 82 (1936). (II and III). II and III.

O and I. Spermogonia and aecia unknown.

II. Uredia hypophyllous, subepidermal, scattered on discolored intercostal spots or on areas of indefinite extent, pustular, round to elongate, 0.2–1.0 mm. in major axis, peridium convex, colorless, firm; peridial cells isodiametrically to irregularly polygonal, 6–13×8–16 μ, with walls 2.0–3.5 μ thick; urediospores hyaline, white in mass, abundant, freely extruded in masses, very short-stalked, oblong or clavate, 16–20×30–58 μ, averaging about 17×43 μ; walls of spores colorless, marked by low, usually pointed, broad-based, subclosely and rather uniformly scattered small warts or echinulations; spore walls hyaline, about 1 μ thick.

III. Telia "on fronds of current season, amphigenous, causing brown discoloration"; teliospores "intercellular, solitary or irregularly grouped under the epidermis, often in a single layer, occasionally scattered within the mesophyll, subglobose or ellipsoidal, 2–4-celled (rarely one or more than 4), with vertical septa, 15–30 μ broad, 14–27 μ high; epispore uniformly thin, about 1 μ thick, smooth, colourless". (Hiratsuka, 23).

HOSTS AND DISTRIBUTION:

O and I. Unknown.

II and III. *Pteridium aquilinum* (L.) Kuhn, in Formosa.

TYPE LOCALITY: Mt. Arisan, Tainan, Formosa on *Pteridium aquilinum*. II and III.

ILLUSTRATIONS: Pl. IV, figs. 17 a-b. — Hiratsuka, Monog. Pucciniastreae pl. III, fig. 3 (1936).

SPECIMENS EXAMINED. —

II and III. On *Pteridium aquilinum*.

FORMOSA: Mt. Arisan, Tainan, Nov. 6, 1932, *Y. Hashioka* (II, III); *type*.

Uredinopsis Hashiokai resembles *U. aspera* with respect to its ellipsoid, echinulate urediospores and its thick-walled cells of the uredial peridium and both occur on the bracken fern. But it is readily distinguishable from *U. aspera* in that its urediospores are much more elongate, quite commonly club-shaped, thinner-walled and less strongly spinulose. I have not seen the telia of *U. Hashiokai* and so have quoted Professor Hiratsuka's description of them.

20. **Uredinopsis Kameiana** Faull, sp. nov.

O, I, II^1, II^2 and III.

Uredinopsis Pteridis D. and H. ex Sydow, Monog. Uredinearum, **3**: 490–1 (1915), in part.

Uredinopsis macrosperma (Cooke) Magnus ex Arthur, Man. Rusts United States Canada, 5 (1934), in part.

Pycnidia amphigena, plerumque hypophylla, numerosa, subcuticularia, immersa, 66–132 μ lata et 37–66 μ alta; spermatia 1.6–2.8 μ lata et 4.5–6.7 μ longa. Aecidia amphigena, plerumque hypophylla, alba, cylindracea, 0.3–0.5 mm. diam. et 1.0–1.5 mm. alta, ad apicem dehiscentia; cellulae peridii parum imbricatim positae, 11–19×19–38 μ, pariete exteriore levi, 1.0–1.2 μ crasso, interiore 2.2–2.5 μ crasso et dense verrucoso; aeciosporae albae, subglobosae vel late ellipsoideae, 14–19×16–22 μ, plus minusve 15×19 μ, episporio 1.0–1.2 μ crasso. Sori uredosporiferi ordinarii pauci, hypophylli, epidermide tecti, pustulati, rotundati, elliptici vel lineales, 0.2–1.0 mm. longi, peridio ex cellulis hyalinis irregulariter polygonalibus composito cincti; cellulae peridii 6–12×8–16 μ, pariete 0.6–0.9 μ crasso; uredosporae albae, obtusatae vel apiculatae, subsessiles, ellipsoideae, obovoideae vel fusiformes, 12–16×27–54 μ, plus minusve 12×37 μ; paries sporae hyalinus, verrucis in serie verticali in utroque latere dispositis, ceterum levis, 1 μ vel minus crassus. Sori uredosporiferi secundarii numerosi, hypophylli, epidermide tecti, pustulati, rotundati, elliptici vel lineales, 0.2–1.5 mm. longi, peridio ex cellulis hyalinis irregulariter polygonalibus composito cincti; cellulae peridii 6–12×8–16 μ, pariete 1.0–1.5 μ crasso; uredosporae (amphisporae) longe stipitatae, angulariter obovoideae vel irregulariter polyedricae, 14–23×22–43 μ, plus minusve 17×28 μ; paries sporae hyalinus, dense verruculosus, 1.5–4.0 μ crassus. Teleutosporae numerosae, epidermide tectae, hypophyllae, leves, hyalinae, subglobosae vel late ellipsoideae, 1–4-cellulares, 18–25× 20–30 μ.

Hab. in foliis *Abietis Mayrianae* et *Pteridii aquilini* et *P. aquilini* var. *japonici* in China, Japan, Siberia.

O. "Spermogonia amphigenous, mostly hypophyllous, on discolored areas, minute, numerous, punctate, irregularly and closely aggregated or scattered, usually isolated, at times confluent, honey-yellow at first, becoming later reddish-brown, subcuticular, lenticular to subconoidal in shape, 66–132 μ broad, 37–66 μ high; spermatiophores obclavate, septate; spermatia oblong or oblong-ovate, 1.6–2.8 μ broad, 4.5–6.7 μ long." (29).

I. Aecia (peridermia) amphigenous, mostly hypophyllous, in two rows on yellowish discolored portions of affected needles, white, cylindrical, 0.3–0.5 mm. in diameter, 1.0–1.5 mm. high; peridium colorless, delicate, rupturing at the apex; peridial cells in a single layer, polygonal, elongate vertically, slightly overlapping, 11–19×19–38 μ, outer walls smooth, 1.0–1.2 μ thick, inner walls 2.2–2.5 μ thick, closely and rather coarsely verrucose; aeciospores subspheroid to broadly ellipsoid, colorless 14–19×16–22 μ, averaging about 15×19 μ, finely and rather coarsely verrucose; wall of aeciospore colorless, 1.0–1.2 μ thick.

II^1. Uredia hypophyllous, subepidermal, scattered on discolored intercostal spots or on areas of indefinite extent, infrequent, pustular, round to linear, 0.2–1.0 mm. in longest axis; peridium convex, colorless, very delicate; peridial cells isodiametrically to irregularly polygonal, 6–12×8–16 μ, with walls less than 1 μ thick; urediospores hyaline, white in mass, very short-stalked, ellipsoid, obovoid or fusiform, occasionally with a long, narrow base, 12–16×27–54 μ, averaging about 12×37 μ, obtuse to apiculate; walls of spores colorless, smooth except for two opposing vertical rows of short, closely set cogs; spore wall up to 1 μ thick.

II^2. Uredia hypophyllous, subepidermal, abundant, scattered to aggregate, round to linear, 0.2–1.5 mm. in longest axis; peridium convex, colorless, delicate, tardily dehiscent; peridial cells isodiametrically to irregularly polygonal, 6–12×8–16 μ, with walls up to 1.5 μ thick; urediospores (amphispores) hyaline, white in mass, long-stalked, angularly obovoid or irregularly polyhedral, 14–23×22–43 μ, averaging about 17×28 μ; spore walls colorless, finely and closely verrucose, 1.5–4.0 μ thick.

III. Telia diffuse, hypophyllous, abundant; teliospores subepidermal, intercellular, scattered or loosely aggregate in a single layer, colorless, subspheroid to broadly ellipsoid, 2–4-celled, rarely 1-celled, 18–25×20–30 μ, with vertical septa; spore walls hyaline, smooth, about 1 μ thick; cells of spores occasionally separating from one another.

HOSTS AND DISTRIBUTION:

O and I. *Abies Mayriana* Miyabe and Kudô, in Japan (*cultures*).

II^1, II^2 and III. *Pteridium aquilinum* (L.) Kuhn and *P. aquilinum* var. *japonicum* Nakai, in China, Japan, Siberia.

TYPE LOCALITY: Kaributo, Hokkaidô, Japan on *Pteridium aquilinum* var. *japonicum.* II^1, II^2 and III.

ILLUSTRATIONS: Pl. IV, figs. 20 a-d. — Sydow, Monog. Ured. 3: pl. 22, fig. 166 (1915). — Kamei in Ann. Phytopath. Soc. Japan, **2**: figs. 1–5, 7–8 (1930).

EXSICCATI: Sydow Fg. Exotici 224.

SPECIMENS EXAMINED. —

O and I. On *Abies Mayriana.*

JAPAN: Sapporo, Jun. 1928 and Jun. 1931, *S. Kamei;* CULTURES.

II^1, II^2 and III. On *Pteridium aquilinum* and *P. aquilinum* var. *japonicum.*

CHINA: Hwa Yang Chioo, Nov. 3, 1932, *S. Y. Chio.*

JAPAN: Kawanye-mura, Prov. Mino, Nov. 20, 1911, *K. Hara.* — Kaributo, Nov. 17, 1925, *S. Kamei.* — Nopporo, Nov. 24, 1925, *S. Kamei.* — Nopporo, July 24, 1927, *N. Hiratsuka.* — Enoki-toge, Nov. 4, 1929, *N. Hiratsuka.* — Tottori, Sept. 29, 1932, *N. Hiratsuka.*

SIBERIA: "Oriens extremus", Aug. 6–19, 1913, *W. Komarov.*

Sydow (53) seems to be the first one to make reference in the literature to the rust here described under the name *Uredinopsis Kameiana.* He places it along with a rust on bracken ferns described by Dietel and Holway from the western United States under the name *Uredinopsis Pteridis.* Sydow cites California, Washington, Perm (Russia) and Japan as the regions in which

U. Pteridis had been collected. As an example of *U. Pteridis* he lists Sydow's Fg. Exot. 224, a rust collected on a bracken fern in Japan. Hiratsuka (23) has essentially followed Sydow. A comparative study, however, reveals the fact that Sydow was dealing with two distinct species. Thus, the type of *Uredinopsis Pteridis* D. and H. (collected in California) carries abundant ordinary urediospores and teliospores; there are no amphispores. In this respect it is like all other collections of rusts on bracken ferns from western North America; none of them have amphispores. Indeed, I cannot find any characters that would separate *Uredinopsis Pteridis* D. and H. from the previously described *Uredinopsis macrosperma* (Cooke) Magnus. On the other hand, the rust in Sydow's Fg. Exot. 224 contains abundant amphispores as well as teliospores and some ordinary urediospores. In this respect it is like many other collections from bracken ferns in northeastern Asia. Moreover, as indicated below, there are significant differences between the haploid phases of the two rusts. Unquestionably Sydow has included two distinct species under the one name *Uredinopsis Pteridis* D. and H. So, to the Asiatic one a name, in honor of S. Kamei, is now given for the first time. I have described a similar species from eastern North America under the name *Uredinopsis virginiana.*

Kamei (29) successfully cultured *U. Kameiana* on *Abies Mayriana.* He found that the peridermia develop in late spring, about one month after inoculation, on needles of the current season and on them only. His description and illustrations show clearly the striking differences between the haploid phase of this species and that of *U. macrosperma.* Through Dr. Kamei's courtesy I have had the opportunity of studying his culture materials. My observations confirm his own.

The average measures of the ordinary urediospores of *U. Kameiana* in the collections studied range from 12–13×34–39 μ, and the amphispores from 16–18×26–32 μ.

21. **Uredinopsis macrosperma** (Cooke) Magnus in Hedwigia, **43**: 122 (1904) (II). O, I, II and III.

Uredo macrospermum Cooke in Grevillea, **8**: 71 (1879). II.
Uredo macrosperma Cooke ex Saccardo, Syll. Fung. **7**: 853 (1888).
Uredinopsis Pteridis D. and H. ex Dietel in Ber. Deutsch. Bot. Ges. **13**: 331 (1895). II and III.

Aecidium pseudo-balsameum D. and H. ex Holway in Erythea, **7**: 98 (1899). I.

Peridermium pseudo-balsameum (D. and H.) Arthur and Kern in Bull. Tor. Bot. Club, **33**: 430 (1906). O and I.

Milesia Pteridis (D. and H.) Arthur ex Arthur in Résult. Sci. Congr. Bot. Vienne, 337 (1906), in part. II and III.

Uredinopsis Pteridis D. and H. var. *congensis* P. Henn. in De Wildeman, Études sur la Flora du Bas et Moyen-Congo, **2**: 8 (1907). II.

Uredinopsis Pteridis D. and H. ex Arthur in N. Am. Flora, **7**: 116 (1907). II and III.

Uredinopsis Pteridis D. and H. ex Sydow, Monog. Uredinearum, **3**: 490–1 (1915), in part.

Uredinopsis mirabilis (Peck) Magnus ex Rhoads, Hedgcock, Bethel and Hartley in Phytopath. **8**: 333 (1918), in part.

Uredinopsis macrosperma (Cooke) Magnus ex Arthur, Man. Rusts United States Canada, 5 (1934), in part. O, I, II and III.

Uredinopsis Pteridis D. and H. ex Hiratsuka, Monog. Pucciniastreae, 61–66 (1936), in part. II and III.

Uredinopsis macrosperma (Cooke) Magnus ex Hiratsuka, Monog. Pucciniastreae, 77 (1936).

O. Spermogonia on needles of the second to fifth year, hypophyllous, numerous, subcircular, colorless, immersed, inverted hemispherical in vertical section, plane at leaf surface, subcuticular, covered by the combined cuticle and intermediate layer of outer epidermal wall, 100–159 μ broad and 85–110 μ high, averaging about 127×98 μ; apical opening a short slit; spermatiophores septate. [Measures after Hunter's studies (25) of type material of *Peridermium pseudo-balsameum*].

I. Aecia (peridermia) hypophyllous, on needles of the second to fifth year, in two rows, white, cylindrical, 0.2–0.5 mm. in diameter and up to 2 mm. high; peridium colorless, fragile, rupturing at the apex; peridial cells in a single layer, polygonal, elongate vertically, more or less overlapping, 13–27×27–54 μ, outer wall smooth, 1.2–1.5 μ thick, inner wall more or less closely and very coarsely warted, 7–13 μ thick; aeciospores broadly ellipsoid, ovoid or subspheroid, white, 14–21×16–27 μ, averaging about 17–18×21–23 μ, closely and rather coarsely verrucose; wall of aeciospore colorless, 1.2–2.0 μ thick; spore-like bodies with small, more or less eccentric lumen and thick walls, suggesting modified peridial cells, frequent to abundant in some collections.

II. Uredia hypophyllous, subepidermal, scattered on discolored intercostal spots or on areas of indefinite extent, pustular, mostly round and 0.1–0.5 mm. in diameter, occasionally elongate and up to 1 mm. in major axis; peridium convex, colorless, rather firm, usually laterally dehiscent; peridial cells isodiametrically to irregularly polygonal, 6–12×8–19 μ, with walls 1.0–1.5 μ thick; urediospores hyaline, white in mass, abundant, extruded in bulky masses or in tendrils, very short-stalked, ellipsoid, obovoid or fusiform, 8–21×22–70 μ, averaging about 13×40 μ, but very variable, averages in different collections ranging from 11–17×30–50 μ, apex rounded to mucronate, rarely bristle-tipped or with a short mucro; walls of spores colorless, smooth except for two opposing, vertical rows of short, closely set cogs; spore walls 0.7–1.2 μ thick, with two germ pores near each end.

III. Telia diffuse, amphigenous, mostly hypophyllous; teliospores subepidermal, intercellular, scattered or loosely aggregate in a single layer, colorless, subspheroid to ellipsoid, mostly 4-celled, but varying from 1–4-celled and in some collections up to 8-celled, 16–27×19–35 μ; spore walls hyaline, smooth, about 1 μ thick; cells of spores occasionally separating from one another.

HOSTS AND DISTRIBUTION:

O and I. *Abies amabilis* (Dougl.) Forb., in Oregon, Washington.

Abies concolor Lindl. and Gord., in California.

Abies grandis Lindl., in California, Idaho, Oregon, Washington.

Abies venusta (Dougl.) Koch, in California. (?)

II and III. *Pteridium aquilinum* (L.) Kuhn, varieties and marginal species* in California, Florida, Georgia, Idaho, Montana, New Mexico, Oregon, Washington; British Columbia; Bermuda; Brazil, Colombia, Cuba, Guatemala, Honduras, Ja-

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* The genus *Pteridium* still awaits modern revision. Hence, host determination within this group cannot here be considered as final. The difficulty is accentuated by the fact that as a rule the specimens in a mycological herbarium are fragmentary from the standpoint of a pteridologist. I am under deep obligations to Mr. C. A. Weatherby of the Gray Herbarium, Harvard University, for carefully examining all my rusted Pteridium materials. As a result, the following detailed list of hosts bearing *Uredinopsis macrosperma* (Cooke) Magnus and their distribution is offered:

Pteridium aquilinum (L.) Kuhn, in China, Japan, Manchuria, Perm (Eu. Russia), Siberia.
Pteridium aquilinum var. *centrali-africanum* Hieron., in Belgian Congo.
Pteridium aquilinum var. *japonicum* Nakai, in Japan.
Pteridium aquilinum var. *lanuginosum* (Bong.) Fernald, in California, Idaho, Montana, New Mexico, Oregon, Washington; British Columbia.
Pteridium aquilinum var. *pseudocaudatum* Clute, in Florida, Georgia; Bermuda.
Pteridium arachnoideum (Kaulf.) Maxon, in Brazil, Jamaica, Panama.
Pteridium capense (Thunb.) Krasser, in Belgian Congo, Natal.
Pteridium caudatum (L.) Maxon, in Florida; Colombia, Cuba, Guatemala, Jamaica, Mexico, Panama.
Pteridium Feei (Schaffn.) Maxon, in Guatemala, Mexico, Venezuela.
Pteridium psittacinum (Presl) Maxon, in Colombia, Honduras.

maica, Mexico, Panama, Venezuela; Belgian Congo, Natal; China, Japan, Manchuria, Mongolia, Siberia.

TYPE LOCALITY: Natal, South Africa on *Pteridium aquilinum.* II.

ILLUSTRATIONS: Pl. IV, figs. 19 a-f. — Hiratsuka, Monog. Pucciniastreae pl. II, fig. 2; pl. III, fig. 1 (1936). — Hunter in Bot. Gaz. **83**: text fig. 2 (1927). — Weir and Hubert in Am. Jour. Bot. **4**: 329, 331, figs. 1–2 (1917).

EXSICCATI: Barth. Fg. Columb. 4492. — Barth. N. Am. Ured. 1383, 1485. — Jacz., Kom. and Tranzs. Fg. Ross. 277. — Sydow Fg. Exot. 782.

SPECIMENS EXAMINED. —

O and I. On *Abies amabilis.*

OREGON: Rhododendron, July 16, 1929, *G. D. Darker.*

WASHINGTON: Buck Creek, Snohomish Co., June 24, 1922, *J. S. Boyce.*

O and I. On *Abies concolor.*

CALIFORNIA: Weaverville, Trinity Co., June 22, 1914, *J. S. Boyce.*

NEW MEXICO: Eagle Creek, Lincoln Co., May 15, 1937, *I. H. Crowell.*

O and I. On *Abies grandis.*

CALIFORNIA: Eureka, June 4, 1896, *M. A. Howe; type* of *Peridermium pseudo-balsameum* (D. and H.) Arthur and Kern. — Eureka, Jun. 1923, *J. P. Tracy.*

IDAHO: Priest River, June 17, 1916, *J. R. Weir; part of material used for successful infection of Pteridium aquilinum* var. *lanuginosum.* — Harvard, Latah Co., July 3, 1928, *J. S. Boyce.* — Priest River, June 16, 19, 24, 1929, *G. D. Darker.* — Santa, July 3, 1929, *G. D. Darker.* — Long Meadow, Clearwater Co., Aug. 22, 1931, *J. S. Boyce.*

OREGON: Corvallis, Summer, 1910, *H. S. Jackson.* — Sutherlin, Douglas Co., May 13, 1924, *J. S. Boyce.* — Zig Zag Mt. Trail, July 9, 1929, *G. D. Darker;* 2nd to 5th yr. needles. — Prospect, Aug. 8, 1929, *G. D. Darker.* — Drain, Douglas Co., Aug. 25, 1930, *J. S. Boyce.* — Redsides Cabin, Lane Co., Aug. 24, 1930, *J. S. Boyce.*

WASHINGTON: Trout Lake, Klickitat Co., May 31, 1920, *J. S. Boyce.*— Carson, Skamania Co., July 1, 1920, *J. S. Boyce.*

O and I. On *Abies venusta.*

CALIFORNIA: Pick Creek, Monterey Co., Jan. 6, 1926, *H. G. Lackmund.*

II and III. On *Pteridium aquilinum* (including varieties and marginal species).

CALIFORNIA: Sisson, July 28, 1894, *W. C. Blasdale; type* of *Uredinopsis Pteridis* D. and H.

FLORIDA: Tallahassee, Nov. 1891, Farlow Herb. — Jacksonville, Nov. 1891, Farlow Herb. — Lake City, Feb. 10, 1892, *P. H. Rolfs.* — Palma Sola, May 2, 1900, *S. M. Tracy;* overwintered.

GEORGIA: Tifton, July 28, 1919, *C. A. Ludwig* (II).

IDAHO: Weippe, Aug. 26, 1921, *C. R. Stillinger* (II). — Stocking Meadows, Aug. 18, 1923, *C. R. Stillinger.* — Upper Priest River, July 29, 1924, *C. R. Stillinger* (II). — Lookout Mt., July 26, 1925, *C. R. Stillinger* (II). — Steamboat Creek, Aug. 14, 1926, *C. R. Stillinger.* — Coolin, Aug. 4, 1931, *G. G. Hedgcock.* — Long Meadow, Clearwater Co., Aug. 22, 1931, *J. S. Boyce.* — Priest River, Aug. 27, 1931, *J. H. Faull.*

MONTANA: Schultz's Cabin, July 29, 1908, *J. Clemens.* — Missoula, July 25, 1916, *J. R. Weir;* CULTURES, using aeciospores collected from *Abies grandis* at Priest River, Idaho.

NEW MEXICO: Brazos Canyon, Rio Arriba Co., Aug. 21, 1914, *P. C. Standley & H. C. Bollman.* — Eagle Creek, Lincoln Co., May 15, 1937, *I. H. Crowell.*

OREGON: Portland, Aug. 24, 1915, *E. B.* — Williams, Sept. 24, 1919, *C. R. Stillinger.* — Woodburn, July 19, 1921, *Mrs. Jos. Clemens.* — Oak Ridge, Lane Co., Aug. 23, 1920, *J. S. Boyce.* — Portland Heights, Sept. 27, 1920, *J. S. Boyce.* — Marcola, July 21 and 26, 1921, *J. S. Boyce.* — Wendling, Sept. 16, 1924, *J. S. Boyce.* — Prospect, Aug. 8, 1929, *G. D. Darker.* — Ashland, Aug. 2, 1929, *G. D. Darker.*

WASHINGTON: Mt. Tacoma, Aug. 27, 1901, *E. W. D. Holway.* — Lucern, Aug. 24, 1911, *J. R. Weir.* — Port Orchard, July 23, 1912, *E. B.* — Chelan Lake, Aug. 23, 1916, *J. R. Weir.* — Piedmont, July 14, 1920, *J. R. Weir* (II). — Piedmont, July 15, 1920, *J. S. Boyce.* — Elk, Pierce Co., July 27, 1921, *J. S. Boyce.* — Lummi Island, Aug. 8, 1922, *C. R. Stillinger* (II).

BERMUDA: Paget Marsh, Aug. 14, 1921, *H. H. Whetzel.* — Devonshire Marsh, Mar. 14, 1922, *H. H. Whetzel.*

BRITISH COLUMBIA: Nelson, Sept. 25, 1922, *J. S. Boyce.* — Vancouver, Sept. 16 and 18, 1929, *G. D. Darker.* — Revelstoke, Sept. 20, 1929, *G. D. Darker.* — Revelstoke, Aug. 6, 1932, *T. W. Childs.*

BRAZIL: Tijuco, Rio de Janeiro, Aug. 19, 1921, *E. W. D. Holway & Mary Holway* (II).

COLOMBIA: Angelopolis, Aug. 19 and 22, 1910, *E. Mayor.*

CUBA: Trinidad Mts., Dec. 22, 1935, *J. H. Faull* (II).

GUATEMALA: Zaragoza, Dec. 31, 1936, *J. H. Faull.* — Cumbre del Aire, Dec. 30 and 31, 1936, *J. H. Faull.* — Cobán, Jan. 7, 1937, *J. H. Faull.* — Alameda, May 25, 1937, *J. R. Johnston* 712 (II).

HONDURAS: Siguatepeque, Comayagua, Dec. 14–27, 1928, *P. C. Standley* (II).

JAMAICA: Whitfield Hall, Surrey Co., Dec. 25 and 30, 1933, *J. H. Faull.* — Cinchona, Jan. 5, 1934, *J. H. Faull.* — Gordontown, Jan. 7, 1934, *J. H. Faull.* — Gordontown, Feb. 15, 1935, *J. H. Faull.* — Blue Mt. Peak, Feb. 17, 1935, *J. H. Faull.* — St. Peter's P. O., Mar. 1, 1935, *J. H. Faull.* — Catherine Peak, Mar. 1, 1935, *J. H. Faull.* — Christiana, Jan. 13, 1936, *J. H. Faull.* — Morse's Gap, Jan. 21, 1936, *J. H. Faull.*

MEXICO: El Chico, Hidalgo, Nov. 24, 1937, *J. H. Faull* (II). — Uruapan, Michoacan, Nov. 28, 1937, *J. H. Faull* (II). — Cuernavaca, Morelos, Dec. 8, 1937, *J. H. Faull* (II).

PANAMA: Boquete, Jan. 19–21, 1934, *J. H. Faull.*

VENEZUELA: El Limón, Jan. 9, 1928, *H. Sydow*.

BELGIAN CONGO: Kindu [!], Jun. 1906, *H. Vanderyst*, no. B 64 (type of *U. Pteridis* var. *congensis* P. Henn.) — Mayidi, 1907, *H. Vanderyst*.

SOUTH AFRICA: Natal, *J. M. Wood*, Herb. Myc. Cooke 1885, no. 61; *type*.

CHINA: Loh Hob Tsuen, Ling Yuin Hsien, Kwangsi, Jun. 15, 1933, *S. Y. Cheo* (II). — Ta Tseh Shan, Yung Hsien, Kwangsi, Aug. 10, 1933, *S. Y. Cheo* (II). — Ling Wang Shan, San Kiang Hsien, Kwangsi, Sept. 16, 1933, *S. Y. Cheo* (II).

JAPAN: Maruyama, Ishikari, Sept. 23, 1923, *N. Hiratsuka*. — Daisenji, Hôki, Aug. 19, 1930, *N. Hiratsuka* (II).

MANCHURIA: Vanfangoo, Liaotung Penin., July 21 and Aug. 2, 1902, *D. Litvinov & W. Tranzschel* (II).

MONGOLIA: Mt. Tigerek, Altai Mts., July 31 and Aug. 1, 1912, *A. Ivanickaja & W. Tranzschel*. — Kolyvanskoje, Altai Mts., Aug. 12–24, 1912, *A. Ivanickaja & W. Tranzschel*.

SIBERIA: Near Paschkova, July 28 and Aug. 9, 1895, *V. L. Komarov*. — Okeanskaja, Distr. Vladivostok, Aug. 24, 1927, *W. Tranzschel*.— Nikolsk-Ussurijskij, Distr. Sujfun, Sept. 4, 1927, *W. Tranzschel*. — Okeanskaja, Distr. Vladivostok, Aug. 6, 1929, *W. Tranzschel*.

RUSSIA (Europe): Iljinskoje, Perm, Ural Gebiet, July 1898, *P. V. Siuzev* (II).

The urediospores of *Uredinopsis macrosperma* afford an interesting statistical study with respect to size. A comparison of the ranges and averages of the measures from respective uredia in a given collection shows relative constancy. But a comparison of the ranges, and especially of the averages from the various collections studied shows great diversity and an unbroken gradation between the extremes. Any attempt, as made by Sydow, to give specific or varietal recognition (cf. Sydow, 52, p. 491) based on the diversities seems hopeless because of the close intergradations and because they do not appear to be related to fixed factors, such as host varieties or geographical distribution. A few examples will suffice; in all cases the spores measured were taken from extruded masses and the averages are computed on the measures of 40 spores taken at random from a single mount in each instance. Thus, among 25 collections from western United States and western Canada, the following extreme averages occur: 11×50 μ; 11×44 μ; 17×43 μ; 17×30 μ. The grand average for the 25 collections is 13×42 μ. Among 8 collections from Asia, the extreme averages are: 11×37 μ; 12×35 μ; 13×42 μ. The grand average for the 8 collections is 12×39 μ. Among 15 collections from other parts of the world, the extreme averages are

11×46 μ; 13×35 μ; 15×39 μ. The grand average for the 15 collections is 13×40 μ. The grand average for all collections is 13×40 μ.

Besides the diversity in the measures of the urediospores as indicated above, there is also considerable diversity in the forms of their apices. Typically, the urediospores of *U. macrosperma* are acute to apiculate. But in a few collections their apices are obtuse to rounded and in a few others the acute apices of many of the spores are tipped with meager bristle-like continuations. These were never found to average more than 4 μ long. They may be vestigial mucros, but rarely is there any indication that they are cut off from the main spore proper by a septum.

The teliospores of *U. macrosperma* are of peculiar interest, in that multicellular teliospores tend to split partially or completely into their cellular units. The first split is in the primary septum and it begins at the outer side of the spore. The secondary septa may then split and in many instances the original teliospore is represented by a nest of one-celled spores. This phenomenon occurs occasionally in *U. aspera* and I have seen it rarely in a few other species.

Weir and Hubert (55) appear to be the only ones to have made any experimental contribution towards an elucidation of the life history of *U. macrosperma.* On June 19, 1916 they sowed aeciospores from the second year needles of *Abies grandis* on the fronds of two plants of *Pteridium aquilinum* var. *lanuginosum.* "On July 25, 1916, a medium infection of uredinia was found on one of the plants while the other bore no results." Kamei (29) could not harmonize these results with those of his own on a bracken fern rust in Japan; but Kamei did not appreciate the fact that he was working with quite another species, a species to which I have given the name *U. Kameiana.* Indeed, Weir and Hubert's results, slender as they were, are exactly those indicated by field associations.

Weir and Hubert, however, failed to recognize the haploid phase of the rust that supplied the inoculum for their experiments as *Peridermium pseudo-balsameum* (D. and H.) Arth. and Kern. Fortunately, through the courtesy of the Herbarium of the United States Bureau of Plant Industry, I have had the opportunity to study part of the material from which Weir and Hubert's inoculum was taken, and also part of their cultures on the bracken fern. These I have compared with the types of *P. pseudo-balsameum,* *Uredinopsis Pteridis* D. and H. and *Uredo macrospermum* Cooke. Weir and Hubert reported that they found no spermogonia on their inoculum material. But their specimens carry them and they are precisely those of *P. pseudo-balsameum.* They are subglobular, deeply immersed, almost plane at the leaf surface and vary in size from 111–165 μ wide and 78–111 μ deep. Hunter's measures (25) for the spermogonia of *P. pseudo-balsameum* are 100–159 μ wide and 85–100 μ deep. Moreover, the aecia and their measures correspond almost exactly with those of *P. pseudo-balsameum.* Unquestionably the rust of Weir and Hubert's experiments is *Uredinopsis macrosperma* (Cooke) Magnus (*Uredinopsis Pteridis* D. and H.) and its haploid phase is *Peridermium pseudo-balsameum* (D. and H.) Arth. and Kern. It is almost needless to add that Weir and Hubert were in error in interpreting *P. pseudo-balsameum* (D. and H.) Arth. and Kern as being synonymous with *P. balsameum* Peck.

22. **Uredinopsis virginiana** Faull, sp. nov. II^1, II^2 and III.

Uredinopsis macrosperma (Cooke) Magnus ex Arthur in N. Am. Flora, **7**: 684 (1925), in part.
Uredinopsis Pteridis D. and H. ex Hiratsuka, Monog. Pucciniastreae, 61–6 (1936), in part.

Pycnidia et aecidia ignota. Sori uredosporiferi ordinarii numerosi, hypophylli, epidermide tecti, pustulati, rotundati vel elliptici, 0.2–1.0 mm. longi, peridio ex cellulis hyalinis irregulariter polygonalibus composito cincti; cellulae peridii 6–11×8–16 μ, pariete 0.5–1.0 μ crasso; uredosporae albae, obtusatae vel apiculatae, subsessiles, ellipsoideae, obovoideae vel fusiformes, 11–16×27–57 μ, plus minusve 13×39 μ; paries sporae hyalinus, verrucis in serie verticali in utroque latere dispositis, ceterum levis, 0.6–0.9 μ crassus. Sori uredosporiferi secundarii pauci, hypophylli, epidermide tecti, pustulati, rotundati vel elongati, 0.2–0.7 mm. longi, peridio ex cellulis hyalinis irregulariter polygonalibus composito cincti; cellulae peridii 6–11×8–16 μ, pariete 1.0–1.5 μ crasso; uredosporae (amphisporae) longe stipitatae, angulariter obovoideae vel irregulariter polyedricae, 14–22×18–35 μ, plus minusve 17×23 μ; paries sporae hyalinus, dense verruculosus, 1–2 μ crassus. Teleutosporae paucae, hypophyllae epidermide tectae subglobosae vel late ellipsoideae, 1–4-cellulares, leves, hyalinae, 16–22×19–27 μ, plus minusve 20–21×23–24 μ.

Hab. in foliis *Pteridii aquilini pseudocaudati* in Arkansas, Georgia, Kentucky, Maryland, Mississippi, New Jersey, New York, North Carolina, South Carolina, Tennessee, Texas, Virginia.

O and I. Spermogonia and aecia unknown.

II^1. Uredia hypophyllous, subepidermal, scattered to loosely aggregate on brownish intercostal spots and on areas of indefinite extent, abundant, pustular, round to elongate, 0.2–1.0 mm. in longest axis; peridium convex, colorless, very delicate, laterally dehiscent at base or occasionally at apex by a slit; peridial cells isodiametrically to irregularly polygonal, 6–11×8–16 μ, with walls up to 1 μ thick; urediospores hyaline, white in mass, abundant, extruded in tendrils, very short-stalked, ellipsoid, obovoid or fusiform, often with a long narrow base, 11–16×27–57 μ, averaging about 13×39 μ, obtuse to apiculate; walls of spores colorless, smooth except for two opposing vertical rows of short, closely set cogs; spore wall less than 1 μ thick, with two germ pores near each end.

II^2. Uredia hypophyllous, subepidermal, developing much later than the first of the II^1-uredia but on the same lesions, scattered to somewhat aggregate, round to elongate, 0.2–0.7 mm. in longest axis; peridium hemispheric, colorless, rather firm, tardily dehiscent; peridial cells isodiametrically to irregularly polygonal, 6–11×8–16 μ, with walls 1.0–1.5 μ thick; urediospores (amphispores) hyaline, white in mass, long-stalked, angularly obovoid or irregularly polyhedral, 14–22×18–35 μ, averaging about 17×23 μ; spore walls hyaline, finely and closely verrucose, 1–2 μ thick.

III. Telia diffuse, hypophyllous, scarce; teliospores subepidermal, intercellular, scattered or loosely aggregate in a single layer, colorless, subspheroid to broadly ellipsoid, 1–4-celled, mostly 2–4-celled, 16–22×19–27 μ, averaging about 20–21×23–24 μ; spore walls hyaline, smooth, about 1 μ thick.

HOSTS AND DISTRIBUTION:

O and I. Unknown.

II^1, II^2 and III. *Pteridium aquilinum* var. *pseudocaudatum* Clute, in Arkansas, Georgia, Kentucky, Maryland, Mississippi, New Jersey, New York, North Carolina, South Carolina, Tennessee, Texas, Virginia.

TYPE LOCALITY: Virginia Highlands, Arlington Co., Virginia on *Pteridium aquilinum* var. *pseudocaudatum*. II^1, II^2 and III.

ILLUSTRATIONS: Pl. IV, figs. 21 a-d.

EXSICCATI: Barth. N. Am. Ured. 2182, 2383, 2579, 2784, 3179.

SPECIMENS EXAMINED. —

II^1, II^2 and III. On *Pteridium aquilinum* var. *pseudocaudatum.*

ARKANSAS: Mena, Oct. 7, 1921, *E. B.* (II^1, II^2).

GEORGIA: Atlanta, Oct. 9, 1924, *E. B.* (II^1, II^2, III).

KENTUCKY: Cumberland Falls, Sept. 7, 1934, *F. T. McFarland* (II^1, II^2).

MARYLAND: Suitland, July 13, 1922, *W. W. Diehl* (II^1).

MISSISSIPPI: Iuka, Oct. 8, 1920, *E. B.* (II^1, II^2).

NEW JERSEY: Glasboro, Aug. 30, 1922, *C. R. Orton & H. W. Thurston, Jr.,* (II^1, II^2). — Tom's River, July 12, 1928, *W. W. Diehl* (overwintered fronds, II^2, III). — Germania, Aug. 18, 1928, *L. O. Overholts & H. W. Thurston, Jr.* (II^1, II^2).

NEW YORK: Greenport, L. Id., June 15, 1928, *Roy Latham* (II^1, II^2, III).

NORTH CAROLINA: Bryson City, Sept. 20, 1919, *C. A. Ludwig* (II^1, II^2). — Murphy, Oct. 1, 1920, *E. Bartholomew* (II^1, II^2). — Murphy, July 26, 1925, *G. G. Hedgcock* (II^1). — Wilmington, Sept. 24, 1926, *R. W. Davidson* (II^1, II^2).

SOUTH CAROLINA: Seneca, Oct. 14, 1918, *E. B.* (II^1, II^2). — Bonneau, Sept. 16, 1919, *C. A. Ludwig* (II^1, II^2).

TENNESSEE: Blanket Mt. near Elkmont, Fall 1919, *S. H. Essary & Carl Kurtzweil* (II^1, II^2). — Crossville, Nov. 4, 1919, *Carl Kurtzweil* (II^1, II^2, III). — Lookout Mt., Sept. 25, 1920, *E. B.* (II^1, II^2). — Montvale Springs, July 13, 1929, *L. R. Hesler* (II^1). — Le Conte, Aug. 10, 1934, *L. R. Hesler* (II^1, II^2). — Le Conte, July 20, 1934, *L. R. Hesler* (II^1).

TEXAS: Longview, Oct. 1, 1921, *E. Bartholomew* (II^1).

VIRGINIA: Virginia Highlands, July 7, 1922, *J. S. Stevenson & W. W. Diehl* (II^1, II^2, immature). — Fort Humphries, July 20, 1924, *L. C. Cash* (II^1). — Radnor, July 20, 1930, *C. L. Shear* (II^1). — Virginia Highlands, Oct. 27, 1933, *W. W. Diehl & J. H. Faull* (II^1, II^2, III); *type.*

The first record I can find of *Uredinopsis virginiana* is a collection made by Elam Bartholomew in 1918 from the Appalachian region of South Carolina. Since then it has been collected many times in most of the southeastern United States and as far northward as the southeastern tip of New York. Arthur (5) has referred all such collections seen by him to *U. macrosperma* and solely on the basis of their ordinary urediospores. Apparently until now there has been no knowledge of the existence of amphispores or teliospores. Both, however, occur in many of the collections. The ordinary urediospores are conspicuous and very abundant, and they are produced over a comparatively long period of time. The amphispores and teliospores on the other hand are formed in old lesions only and apparently late in the season.

My first field acquaintance with this rust was made possible through the courtesy of Dr. W. W. Diehl who took me to a region in Virginia not far from Washington, D. C., where it abounds. Dr. Diehl was especially interested in the rust and had located teliospores in dead overwintered infected fronds of the bracken fern collected by him some time previously in New Jersey. The bracken ferns in the Virginia region visited were heavily rusted and the fronds bore countless numbers of white tendrils of the ordinary urediospores. A laboratory examination of the older lesions, however, revealed the presence of abundant amphisporic uredia and telia.

A study of this rust shows that it cannot be *U. macrosperma.* Possibly its ordinary urediospores would not suffice to separate it from the extremely variable rust I am recognizing as *U. macrosperma* in this paper. But the latter is entirely without amphispores. Moreover, it is probable that the rust on the bracken fern in the southeastern United States has, just as is true of *U. Kameiana* in northeastern Asia, a haploid phase quite different from that of *U. macrosperma.* The aecia of the latter do not mature on needles of the current season and the spermogonia are relatively large and distinctive. The aecia of *U. Kameiana* develop promptly on needles of the current season and the spermogonia are scarcely to be distinguished from those of most other species of *Uredinopsis.* Unquestionably the rust under consideration is not *U. macrosperma;* nor does it answer to any other named species. So, with some reserve, I have described it under the new name *Uredinopsis virginiana.*

The only question in my mind is that of justification for separating *U. virginiana* and *U. Kameiana.* I am doing so, however, because in the former the ordinary urediospores predominate almost to the exclusion of amphispores and teliospores, while in the latter the opposite is the case. Also the amphispores of *U. Kameiana* are distinctly larger, so much so that the averages do not overlap, and they are thicker-walled. Finally the two species are widely separated geographically. Further differences may come to light when the haploid phase of *U. virginiana* becomes known.

One feature in connection with the distribution of *U. virginiana,* already referred to in this paper, is its entire absence in the northeastern United States. Although the bracken fern occurs almost everywhere in that region it has never been known to carry a rust of any kind. This is a phenomenon of peculiar interest. Perhaps Maxon has given the answer. The form of the bracken fern parasitized by *U. virginiana* has been recognized by him as a variety morphologically distinct from the bracken fern of the northeastern United States and eastern Canada. However that may be it is certain that the latter form is immune to *Uredinopsis.*

The average measures of the ordinary urediospores of *U. virginiana* range from 12–15×33–42 μ. They are commonly apiculate and in the less frequent submucronate spores there is no indication of the short apical appendage being cut off from the spore proper. One feature not found in *U. macrosperma* is the rather common occurrence of spores with slender bases. The averages of the amphispores vary from 15–19×20–26 μ.

23. **Uredinopsis Struthiopteridis** Störmer in Bot. Notiser, 81 (1895). (II^2). O, I, II^1, II^2 and III.

? *Gloeosporium Struthiopteridis* Rostrup in Bot. Tids. **17**: 236 (1889).

Aecidium pseudocolumnare Kuehn ex Klebahn, (1916), in part.

Uredinopsis Struthiopteridis Störmer ex Arthur in N. Am. Flora, **7**: 116–7 (1907), in part.

Uredinopsis mirabilis (Peck) Magnus ex Rhoads, Hedgcock, Bethel and Hartley in Phytopath. **8**: 333 (1918), in part.

Uredinopsis Struthiopteridis Störmer ex Arthur, Man. Rusts United States Canada, 4 (1934), in part.

O. Spermogonia on needles of the current season, hypophyllous, inconspicuous, round, colorless, immersed, inverted hemispherical in vertical section, plane at leaf surface, subcuticular, covered by the combined cuticle and intermediate layer of outer epidermal wall, 71–129 μ broad and 45–58 μ deep, averaging about 94×50 μ; apical opening a short slit; spermatiophores unbranched, septate, with large basal cell; spermatia hyaline, catenulately produced, 1.5–2.0×4.6 μ.

I. Aecia (peridermia) hypophyllous, on needles of current season, in two rows, white, cylindrical, 0.2–0.3 mm. in diameter and up to 1 mm. high; peridium colorless, fragile, rupturing at the apex; peridial cells in a single layer, polygonal, elongate vertically, overlapping, 11–24×24–40 μ, outer wall smooth, 1.2–1.3 μ thick, inner wall closely and rather coarsely verrucose, 3.0–3.5 μ thick; aeciospores broadly ellipsoid, ovoid or subspheroid, white, 15–19×18–24 μ, averaging about 17×21 μ, closely and rather coarsely verrucose; wall of aeciospore colorless, 1.0–1.5 μ thick.

II^1. Uredia hypophyllous, subepidermal, scattered on discolored intercostal spots or on areas of indefinite extent, pustular, round to slightly elongate, 0.1–0.3 mm. in diameter; peridium convex, colorless, delicate; peridial cells isodiametrically to irregularly polygonal, 6–11×8–18 μ, with walls about 1 μ thick; urediospores hyaline, white in mass, abundant, extruded in tendrils, very short-stalked, ellipsoid, obovoid or fusiform, 10–17×27–54 μ, averaging about 13×37 μ, with a filamentous enucleate mucro 0–21 μ long, averaging about 6 μ; walls of spores colorless, smooth, except for two opposing vertical rows of short, closely set cogs; spore walls up to 1 μ thick, with two germ pores near each end.

II^2. Uredia hypophyllous, subepidermal, developing later than the first of the II^1-uredia but on the same lesions, round, 0.1–0.3 mm. in diameter; peridium convex, colorless, rather firm, tardily dehiscent; peridial cells isodiametrically to irregularly polygonal, 6–11×8–16 μ, with walls up to 2.2 μ thick; urediospores (amphispores) hyaline, white in mass, long-stalked, angularly obovoid or irregularly polyhedral, 14–27×18–40 μ, averaging about 18×27 μ, rounded to ridged at the angles, sometimes with low fins and short horns; spore walls hyaline, finely and closely verrucose, 1–4 μ thick, thickest at the angles.

III. Telia diffuse, amphigenous, mostly hypophyllous; teliospores subepidermal, intercellular, scattered or loosely aggregate in a single layer, colorless, subspheroid to ellipsoid, usually 4-celled, cruciate, but varying from 1–4-celled, and in occasional collections 1–7-celled, 14–24×16–25 μ, a single pore in the outer wall of each cell; spore walls hyaline, smooth, about 1 μ thick.

HOSTS AND DISTRIBUTION:

O and I. *Abies balsamea* (L.) Mill., in Ontario (*cultures*), Quebec (*cultures*).

Abies alba Mill., in Germany (*cultures*).

Abies Mayriana Miyabe and Kudô, in Japan (*cultures*).

II^1, II^2 and III. *Matteuccia Struthiopteris* (L.) Todaro, (*Struthiopteris germanica* Willd.), in New York, Vermont, Wisconsin; Alberta, Manitoba, Nova Scotia, Ontario, Prince Edward Island, Quebec; Newfoundland; Denmark, Germany, Norway, Poland, Roumania, Russia, Caucasus; Japan, Siberia.

Type Locality: Merradalen near Oslo, Norway, on *Matteuccia Struthiopteris*. II^1, II^2 and III.

Illustrations: Pl. V, figs. 24 a-d. — Arthur, Man. Rusts United States Canada fig. 4 (1934). — Dietel in Ber. Deutsch. Bot. Ges. **13**: pl. xxvi, figs. 5–9, 12, 13 (1895). — Dietel in Engler and Prantl, Nat. Pflanzenfam. **1**: Abt. 1**: fig. 30 (A); **2**, Aufl.: fig. 26 (A-E). — Hiratsuka in Monog. Pucciniastreae pl. 2, fig. 3 (1936). — Klebahn in Zeitschr. f. Pflanzenkr. 26, text fig. 1 (1916). — Sydow in Monog. Ured. **3**: pl. xxi, fig. 165 (1915).

Exsiccati: Jaap Fg. Sel. 325. — Krieger Fg. Saxon. 887. — Petrak Fg. Polon. 276. — Rabenh.-Pazsche Fg. Eur. et Extraeur. 4332. — Smarods Fg. Latvici 508. — Syd. Myc. Germ. 1160 — Syd. Ured. 1638. — Vestergren Microm. Rar. Sel. 176.

Specimens Examined. —

O and I. On *Abies balsamea*.

Ontario: Timagami, July 21–Aug. 11, 1926, *J. H. Faull & E. H. Bensley*, Herb. J. H. Faull 7732–7743; cultures. — Timagami, July 15, 1927, *J. H. Faull & E. H. Bensley*, Herb. J. H. Faull 8486; culture.

Quebec: MacDonald College, June 18, 1912, *W. P. Fraser;* culture (telial material from Truro, Nova Scotia).

On *Abies Mayriana*.

Japan: Sapporo, July 1926, *S. Kamei;* culture.

II^1, II^2 and III. On *Matteuccia Struthiopteris*.

New York: Junius, Sept. 1904, Myc. Herb. N. Y. State Col. Agr. 18775 (II^2, III). — Whitehall, Aug. 10, 1932, *J. H. Faull.* — Lake Placid, Aug. 10, 1932, *J. H. Faull.* — Newcomb, Sept. 9, 1932, *D. S. Welch* (II^2, III).

Vermont: Sherburne Pass, Aug. 11, 1932, *J. H. Faull* (II^1, III).

Wisconsin: Spooner, Aug. 14, 1911, *J. J. Davis.* — St. Croix Falls, Aug. 25, 1914, *J. J. Davis.* — Cadott, July 24, 1920, *J. J. Davis* (II^1, III). — Herbster, Aug. 8, 1923, *J. J. Davis.* — Haugen, July 19, 1923. — Haugen, Aug. 18, 1930, *J. J. Davis.*

Alberta: Slave Lake, Lesser Slave L., Aug. 10, 1931, *E. H. Moss.*

Manitoba: Winnipeg, July 25, 1921, *W. P. Fraser & J. L. Conners.*

Nova Scotia: Folleigh, Aug. 31, 1909, *W. P. Fraser.* — Pictou, July 30, 1912, *W. P. Fraser* (II^1, III); culture.

Ontario: Timagami, Aug. 31, 1925, *G. D. Darker.* — Timagami, Sept. 14, 1927, *G. D. Darker.* — Timagami, July 28–Aug. 5, 1926, *J. H. Faull & E. H. Bensley*, Herb. J. H. Faull 7744–7747 (II^1); cultures.

Quebec: Hudson, July 1913, *W. P. Fraser.* — Claude, Sept. 18, 1928, *J. H. Faull* (III). — Claude, Aug. 24, 1933, *J. H. Faull* (II^1, III).

Newfoundland: Deer Lake, Bay of Islands, Aug. 1897, *A. C. Waghorne* (II^1, III).

Austria: Zemmtal, Aug. 13, 1906, *P. Magnus.*

Germany: Utterwaldgrunde, Sept. 17, 1887, July 21, 1892, Oct. 1901, Sept. 22, 1912, *W. Krieger.* — Polenztal, Jun. 1, 1892, Sept. 20, 1901, *W. Krieger.*

LATVIA: Kalrene, Sept. 20, 1934, *A. Kirulis.*
NORWAY: Merradalen, near Oslo, Oct. 12, 1894, *C. Störmer* (II^2, III); *type.* — Merradalen, Sept. 1895, *C. Störmer.*
POLAND: Rungury, Kolomea, Sept. 2, 1912, *A. Wróblewski.* — Duhby, Apr. 26, 1917, *F. Petrak.*
RUSSIA: Beresajka, Novgorod, July 6–18, 1897, *W. Tranzschel* (II^1, II^2).
CAUCASUS: Suchum, Sept. 1918, *W. Siemaszko* (II^2, III). — Alchazia, Sept. 25, 1920, *W. Siemaszko.*
JAPAN: Sapporo, Oct. 7, 1894, *K. Miyabe* (II^2, III). — Makomanai, Hokkaidô, Sept. 15 and 24, 1907, *M. Miura.* — Jôzankei, Hokkaidô, Sept. 26, 1926, *I. Tanaka* (II^2, III). — Kotoni, Hokkaidô, *S. Kamei.*
SIBERIA: Distr. Vladivostok, Aug. 10 and Sept. 9, 1929, *W. Tranzschel.*

The life history of *Uredinopsis Struthiopteridis* in America was worked out by Fraser (19). He inoculated *Abies balsamea* with telial material of this rust from *Matteuccia Struthiopteris* and within less than three weeks spermogonia and aecia appeared in abundance. Conversely, infection resulted on the fern host after sowing field-collected aeciospores from the balsam fir. The life history of *U. Struthopteridis* in Europe was worked out by Klebahn (34). He successfully inoculated *Abies alba* with telial material from *M. Struthiopteris* and then, with the aeciospores so obtained, carried the rust back to the fern host. He was also successful in producing infection in the fern by inoculating with overwintered amphispores. Finally, the life history of *U. Struthiopteridis* in Japan was worked out by Kamei (31). From his experiments he proved that the haploid phase can be carried by *Abies Mayriana.*

The average measures of the ordinary urediospores of *U. Struthiopteridis* range from 11–15×32–43 µ, and the mucros 3–12 µ. The amphispores range from 16–20×25–28 µ.

Lind (Arkiv Bot. **7**: 10. 1908) published the name *Uredinopsis Struthiopteridis* (Rostrup) Lind and claimed that *Gloeosporium Struthiopteridis* Rostrup (Myk. Meddel. Bot. Tids. **17**: 236. 1889) and *U. Struthiopteridis* Störmer are synonymous. Through the courtesy of the Botanisk Museum, Copenhagen, I have been enabled to examine all of the specimens in their herbarium of *G. Struthiopteridis* Rostrup. Unfortunately the type was not among them nor could it be located. The specimens sent were collected in Rostrup's time and some of them by himself. These prove to be the same species throughout and apparently are correctly recognized as *Herpobasidium Struthiopteridis* (Rostrup) Lind. Certainly none of them is a rust fungus. On one label there is a note to the effect that *U. Struthiopteridis* (Rostrup) Lind, non Störmer, is a synonym of *H. Struthiopteridis* (Rostrup) Lind. The conclusion is that Lind misinterpreted *G. Struthiopteridis* Rostrup when he referred it to *Uredinopsis.*

24. **Uredinopsis Woodsiae** Kamei in Trans. Sapporo Nat. His. Soc. **12:** 162 (1932). (O, I, II^1, II^2 and III).

O, I, II^1, II^2 and III.

O. Spermogonia on needles of the current season, amphigenous, mostly hypophyllous, colorless, immersed, slightly raised, lenticular to flattened conoidal in vertical section, 92–137 µ broad and 37–67 µ deep; spermatiophores unbranched, obclavate, septate; spermatia ellipsoid, colorless, smooth, 1.6–2.4×4.0–5.6 µ. (After Kamei, 30).

I. Aecia (peridermia) on needles of the current season, amphigenous, mostly hypophyllous, in two rows, white, cylindrical, 0.2–0.4 mm. in diameter and up to 1 mm. high; peridium colorless, rupturing at the apex; peridial cells in a single layer, polygonal, elongate, slightly overlapping, 11–25×19–37 µ, outer wall smooth, about 1 µ thick, inner wall closely and rather finely verrucose, 3.0–4.0 µ thick; aeciospores broadly ellipsoid, ovoid or subspheroid, white, 14–20×18–24 µ, averaging about 17×20 µ, closely and finely verrucose; wall of aeciospores colorless, 1.0–1.5 µ thick.

II^1. Uredia hypophyllous, subepidermal, scattered on discolored intercostal spots or on areas of indefinite extent, pustular, subcircular, 0.2–0.5 mm. in diameter, covered by yellowish to brownish epidermis, rupturing at the apex; peridium convex, colorless; peridial cells irregularly polygonal, 6–11×8–16 µ, with walls less than 1 µ thick; urediospores hyaline, extruded in white masses, short-stalked, obovoid, ellipsoid or fusiform, rounded at the apex, 12–18×24–41 µ, averaging about 15×31 µ; walls of spores colorless, smooth except for two opposing vertical rows of short, closely set cogs; spore walls about 1 µ thick.

II^2. Uredia hypophyllous, subepidermal, developing later than the first of the II^1-uredia but on the same lesions, round, 0.2–0.5 mm. in diameter; peridium convex, colorless, firm, tardily dehiscent; peridial cells isodiametrically to irregularly polygonal, 6–11×8–16 μ, with walls 1.0–2.5 μ thick; urediospores (amphispores) hyaline, white in mass, with stalks up to 18 μ long, ellipsoid, obovoid or subspheroid or subpolyhedral, 11–19×22–38 μ, averaging about 14×28 μ, some spores with one or more usually sublongitudinal fine ridges; spore walls hyaline, finely, closely but faintly verrucose, 1.0–1.2 μ thick.

III. Telia diffuse, amphigenous, mostly hypophyllous; teliospores subepidermal, intercellular, scattered or loosely aggregate in a single layer, colorless, subspheroid to ellipsoid, 2–4-celled, rarely 1-celled, 16–27×18–29 μ; spore walls hyaline, smooth, about 1 μ thick.

HOSTS AND DISTRIBUTION:

O and I. *Abies Mayriana* Miyabe and Kudô, in Japan (*cultures*).

II¹, II² and III. *Woodsia polystichoides* Eat. var. *nudiuscula* Hook. and var. *Veitchii* Hook. and Bak., in Japan.

TYPE LOCALITY: Mt. Teine, Ishikari, Japan on *Woodsia polystichoides* var. *nudiuscula.* II¹, II² and III.

ILLUSTRATIONS: Pl. V, figs. 25 a-d. — Hiratsuka, Monog. Pucciniastreae, pl. II, fig. 6 (1936).

SPECIMENS EXAMINED. —

O and I. On *Abies Mayriana.*

JAPAN: Sapporo, July 19, 1931, *S. Kamei;* CULTURES.

II¹, II² and III. On *Woodsia polystichoides* var. *nudiuscula.*

JAPAN: Jôzankei, Ishikari, Oct. 16, 1924, *N. Hiratsuka.* — Mt. Teine, Ishikari, Oct. 22, 1924, *S. Kamei; type.* — Jôzankei, Ishikari, Sept. 22, 1925, *S. Kamei.*

Kamei (30) cultured *Uredinopsis Woodsiae* on young needles of *Abies Mayriana* by inoculating them with overwintered telial material from the fern host. Through his courtesy I have had the opportunity of studying a part of his cultures and my observations confirm his descriptions.

25. **Uredinopsis Arthurii** Faull, sp. nov. II¹, II² and III.

Uredinopsis Struthiopteridis Störmer ex Arthur in N. Am. Flora, **7**: 116–7 (1907), in part.

Pycnidia et aecidia ignota. Sori uredosporiferi ordinarii hypophylli, epidermide tecti, pustulati, rotundati, 0.2–0.5 mm. diam., peridio ex cellulis hyalinis irregulariter polygonalibus composito cincti; cellulae peridii 8–14×8–19 μ, pariete 0.5–1.0 μ crasso; uredosporae albae, ellipsoideae, obovoideae vel fusiformes, subsessiles, 11–18×24–65 μ, plus minusve 13×40 μ, mucrone debili vel nullo, plus minusve 2.5 μ longo; paries sporae hyalinus, verrucis in serie verticali in utroque latere dispositis, ceterum levis, 1 μ vel minus crassus. Sori uredosporiferi secundarii hypophylli, epidermide tecti, pustulati, rotundati, 0.2–0.5 mm. diam., peridio ex cellulis hyalinis irregulariter polygonalibus composito cincti; cellulae peridii 8–13×8–18 μ, pariete 2.0–3.5 μ crasso; uredosporae (amphisporae) longe stipitatae, angulariter obovoideae vel irregulariter polyedricae, 14–26×19–41 μ, plus minusve 18×28 μ; paries sporae hyalinus, dense veruculosus, 1.5–3.3 μ crassus. Teleutosporae epidermide tectae, amphigenae, plerumque hypophyllae, subglobosae, 1–4-cellulares, leves, hyalinae, 14–27 μ diam.

Hab. in foliis *Woodwardiae virginicae* in Alabama, Connecticut, Indiana, Massachusetts, Michigan, New York, Vermont; Quebec; Bermuda.

O and I. Spermogonia and aecia unknown.

II^1. Uredia hypophyllous, subepidermal, scattered to closely aggregate on discolored intercostal spots and on areas of indefinite extent, pustular, round to somewhat elongate, 0.2–0.5 mm. in diameter; peridium hemispheric, colorless, very delicate; peridial cells isodiametrically to irregularly polygonal, 8–14×8–19 μ, with walls 0.5–1.0 μ thick; urediospores hyaline, white in mass, abundant, extruded in tendrils, very short-stalked, ellipsoid, obovoid or fusiform, 11–18×24–65 μ, averaging about 13×40 μ, with a very weak, short mucro, or very commonly with none, the average being about 2.5 μ long; walls of spores colorless, smooth except for two opposing vertical rows of short, closely set cogs; spore wall up to 1 μ thick, with two germ pores near each end.

II^2. Uredia hypophyllous, subepidermal, developing later than the first of the II^1-uredia but on the same lesions, round, 0.2–0.5 mm. in diameter; peridium hemispheric, colorless, firm, tardily dehiscent; peridial cells isodiametrically to irregularly polygonal, 8–13×8–18 μ, with walls 2.0–3.5 μ thick; urediospores (amphispores) hyaline, white in mass, long-stalked, angularly obovoid or irregularly polyhedral, 14–26×19–41 μ, averaging about 18×28 μ, without conspicuous fins or horns; spore wall hyaline, finely and closely verrucose, 1.5–3.3 μ thick.

III. Telia diffuse, amphigenous, mostly hypophyllous; teliospores subepidermal, intercellular, scattered or loosely aggregate in a single layer, colorless, subspheroid, 1–4-celled, 14–27 μ in diameter, mostly 4-celled, cruciate, 22–27 μ in diameter, a single pore in the outer wall of each cell; spore walls hyaline, smooth, about 1 μ thick.

HOSTS AND DISTRIBUTION:

O and I. Unknown.

II^1, II^2 and III. *Woodwardia virginica* (L.) Sm., in Alabama, Connecticut, Indiana, Massachusetts, Michigan, New York, Vermont; Quebec; Bermuda.

TYPE LOCALITY: Middlesex Fells, Medford, Massachusetts on *Woodwardia virginica.* II^1, II^2 and III.

ILLUSTRATIONS: Pl. VI, figs. 27 a-d.

EXSICCATI: Barth. N. Am. Ured. 3280. — Reliq. Farl. 285. — Whetzel Bermuda Fg. 25.

SPECIMENS EXAMINED. —

II^1, II^2 and III. On *Woodwardia virginica.*

ALABAMA: Tuskaloosa, June 4, 1897, *G. Carver,* Herb. F. S. Earle in Herb. N. Y. Bot. Gard. (host wrongly identified as *Osmunda cinnamomea* L.).

CONNECTICUT: Oxford, Sept. 20, 1896, *Harger & Clinton.*

INDIANA: La Porte Co., Aug. 25, 1920, *C. C. Deam.*

MASSACHUSETTS: Newton, Sept. 1897, *W. G. Farlow.* — Magnolia, July 1903, *W. G. Farlow.* — Medford, Sept. 29, 1935, *G. D. Darker.* — Medford, Oct. 10, 1935, *J. H. Faull* 12728; *type.*

MICHIGAN: Ann Arbor, Aug. 20, 1916, *C. H. Kauffman.*

NEW YORK: Voorheesville, Aug. 30, 1924, *H. D. House.* — Sylvan Beach, Oneida Co., Aug. 12, 1916 and Aug. 29, 1918, *H. D. House.* — Manor, L. Id., Aug., *C. H. Peck.* — Karner, Aug., *C. H. Peck.*

VERMONT: Burlington, Aug. 17, 1898, *W. A. Orton & T. E. Hazen.*

QUEBEC: Berthier, Sept. 1, 1932, *R. Pomerleau.*

BERMUDA: Devonshire Marsh, Aug. 10, 1921, *H. H. Whetzel.*

The average measures of the ordinary urediospores of *Uredinopsis Arthurii* range from 12–13×34–46 μ and the mucros from 1–4 μ. The amphispores range from 17–19×26–30 μ.

25a. **Uredinopsis Arthurii** var. **maculata** Faull, var. nov. II^1, II^2 and III.

Uredinopsis mirabilis (Peck) Magnus ex Arthur in N. Am. Flora, **7**: 115–6 (1907), in part.

Uredinopsis americana Sydow ex Sydow, Monog. Uredinearum, **3**: 486–7 (1915), in part.

Pycnidia et aecidia ignota. Sori uredosporiferi ordinarii hypophylli, epidermide tecti, pustulati, rotundati, 0.2–0.6 mm. diam., peridio ex cellulis hyalinis irregulariter polygonalibus composito cincti; cellulae peridii 8–14×8–19 μ, pariete 0.5–0.9 μ crasso; uredosporae albae, ellipsoideae, obovoideae vel fusiformes, subsessiles, 8–16×27–57 μ, plus minusve 12×40 μ, mucrone debili vel nullo, plus minusve 2.5 μ longo; paries sporae hyalinus, verrucis in serie verticali in utroque latere dispositis, ceterum levis, 1 μ vel minus crassus. Sori uredosporiferi secundarii hypophylli, epidermide tecti, pustulati, rotundati, 0.2–0.5 mm. diam., peridio ex cellulis hyalinis irregulariter polygonalibus composito cincti; cellulae peridii 5–11×8–13 μ, pariete 1 μ vel minus crassus; uredosporae (amphisporae) albae, longe stipitatae, angulariter obovoideae vel irregulariter polyedricae, frequenter alatae, 12–22×19–43 μ, plus minusve 16×29 μ; paries sporae hyalinus, dense verruculosus, 1 μ crassus. Teleutosporae epidermide tectae, amphigenae, plerumque hypophyllae, leves, hyalinae, subglobosae, 1–8-cellulares, 16–24×16–27 μ.

Hab. in foliis *Woodwardiae areolatae* in Alabama, Delaware, Maine, Maryland, New Jersey, New York, Rhode Island.

O and I. Spermogonia and aecia unknown.

II^1. Uredia hypophyllous, subepidermal, scattered to closely aggregate on conspicuous, white to brown, rather large intercostal spots, giving to affected leaves a mottled appearance, and on green to brown areas of indefinite extent, strikingly pustular, somewhat watery-looking, mostly round, 0.2–0.6 mm. in diameter; peridium hemispheric, colorless, very delicate; peridial cells isodiametrically to irregularly polygonal, 8–14×8–19 μ, with walls less than 1 μ thick; urediospores hyaline, white in mass, abundant, extruded in tendrils, very short-stalked, ellipsoid, obovoid or fusiform, 8–16×27–57 μ, averaging about 12×40 μ, with a very weak, short mucro or commonly with none, the average being about 2.5 μ long; walls of spores colorless, smooth except for two opposing vertical rows of short, closely set cogs; spore wall up to 1 μ thick, with two germ pores near each end.

II^2. Uredia hypophyllous, subepidermal, developing later than the first of the II^1-uredia but on the same lesions, round, 0.2–0.5 mm. in diameter; peridium hemispheric, colorless, delicate, tardily dehiscent; peridial cells isodiametrically to irregularly polygonal, 5–11×8–13 μ, with walls up to 1 μ thick; urediospores (amphispores) hyaline, white in mass, long-stalked, angularly obovoid or irregularly polyhedral, 12–22×19–43 μ, averaging about 16×29 μ, commonly with conspicuous thin fins, up to

3.5 μ in depth; spore wall hyaline, almost smooth to very finely and closely verrucose, about 1 μ thick, thicker at the angles.

III. Telia diffuse, amphigenous, mostly hypophyllous; teliospores subepidermal, intercellular, scattered or loosely aggregate in a single layer, colorless, subspheroid, 1–4-celled, rarely up to 8-celled, mostly 4-celled, cruciate, 16–24×16–27 μ, a single pore in the outer wall of each cell; spore walls hyaline, smooth, about 1 μ thick.

HOSTS AND DISTRIBUTION:

O and I. Unknown.

II^1, II^2 and III. *Woodwardia areolata* (L.) Moore, in Alabama. Delaware, Maine, Maryland, New Jersey, New York, Rhode Island.

TYPE LOCALITY: Little Compton, Rhode Island on *Woodwardia areolata*. II^1, II^2 and III.

ILLUSTRATIONS: Pl. VI, figs. 28 a-d.

SPECIMENS EXAMINED. —

II^1, II^2 and III. On *Woodwardia areolata.*

ALABAMA: Tuskegee, Oct. 1933, *G. W. Carver.*

DELAWARE: Selbyville, Oct. 3, 1907, *H. S. Jackson.*

MARYLAND: Suitland Bog, Prince Georges Co., July 13, 1922, *W. W. Diehl* (II^1, II^2). — Suitland Bog, Sept. 20, 1924, *F. P. Schlatter & W. W. Diehl* (II^2, III).

NEW JERSEY: Milltown, Oct. 1898, *F. H. Blodgett* (II^2, III). — Lakehurst, Oct. 3, 1915, *P. Wilson.*

NEW YORK: Woodmere, Long Island, Aug. 9, 1916, *E. W. Olive.* — Woodmere, Sept. 9, 1916, *P. Wilson* (II^2, III). — Valley Stream, Long Island, Oct. 7, 1917, *H. H. Whetzel & P. Wilson.*— Greenport, Sept. 26, 1919, *Roy Latham.*

RHODE ISLAND: Little Compton, Oct. 6, 1936, *J. H. Faull* 12893; *type.* — Little Compton, Oct. 9, 1937, *J. H. Faull.*

SPECIES OF UREDINOPSIS AND THEIR FERN HOSTS

Uredinopsis Adianti Kom.	*Adiantum pedatum*	(O, I) II, III
U. Arthurii Faull	*Woodwardia virginica*	II^1, II^2, III
U. Arthurii var. *maculata* Faull	*Woodwardia areolata*	II^1, II^2, III
U. aspera Faull	*Pteridium aquilinum* var. *lanuginosum*	II, III
U. Athyrii Kamei	*Athyrium melanolepis*	(O, I) II, III
U. Atkinsonii Magn.	*Dryopteris Thelypteris* var. *pubescens*	(O, I) II^1, II^2, III
U. ceratophora Faull	*Cystopteris bulbifera*	(O, I) II^1, II^2, III
U. Copelandi Syd.	*Athyrium cyclosorum*	II^1, II^2, III

U. daisenensis Hirat. f.	*Athyrium multifidum*	II^{1}, II^{2}, III
	Athyrium otophorum	II^{1}, II^{2}, III
	Athyrium rigescens	II^{1}, II^{2}, III
	Athyrium Vidalii	II^{1}, II^{2}, III
U. filicina (Niessl) Magn.	*Dryopteris Phegopteris*	(O, I) II^{1}, II^{2}, III
U. glabra Faull	*Cheilanthes pyramidalis*	II^{1}, II^{2}, III
	Cystopteris fragilis	II^{1}, II^{2}, III
	Pellaea cordata	II^{1}, III
U. Hashiokai Hirat. f.	*Pteridium aquilinum*	II, III
U. hirosakiensis Kamei & Hirat. f.	*Dryopteris Thelypteris* var. *pubescens*	(O, I) II, III
U. intermedia Kamei	*Athyrium thelypteroides*	(O, I) II^{1}, II^{2}, III
	Athyrium pterorachis	(O, I) II^{1}, II^{2}, III
U. investita Faull	*Adiantium andicola*	II
U. Kameiana Faull	*Pteridium aquilinum*	II^{1}, II^{2}, III
	Pteridium aquilinum var. *japonicum*	(O, I) II^{1}, II^{2}, III
U. longimucronata Faull	*Athyrium angustum*	(O, I) II^{1}, II^{2}, III
U. longimucronata var. *acrostichoides* Faull	*Athyrium thelypteroides*	II^{1}, II^{2}, III
U. longimucronata forma *cyclosora* Faull	*Athyrium cyclosorum*	II^{1}, II^{2}, III
U. macrosperma (Cooke) Magn.	*Pteridium aquilinum*	II, III
	Pteridium aquilinum var. *centrali-africanum*	II, III
	Pteridium aquilinum var. *japonicum*	II, III
	Pteridium aquilinum var. *lanuginosum*	(O, I) II, III
	Pteridium aquilinum var. *pseudocaudatum*	II, III
	Pteridium arachnoideum	II, III
	Pteridium capense	II, III
	Pteridium caudatum	II, III
	Pteridium Feei	II, III
	Pteridium psittacinum	II, III
U. Mayoriana Diet.	*Blechnum unilaterale*	II
U. mirabilis (Peck) Magn.	*Onoclea sensibilis*	(O, I) II^{1}, II^{2}, III
	Onoclea sensibilis forma *obtusilobata*	II^{1}, II^{2}, III
U. Osmundae Magn.	*Osmunda cinnamomea*	(O, I) II, III
	Osmunda Claytoniana	(O, I) II, III
	Osmunda regalis var. *spectabilis*	(O, I) II, III

U. ossaeiformis Kamei	*Dryopteris amurensis*	II, III
	Dryopteris dilatata var. *oblonga*	(O, I) II, III
	Dryopteris monticola	(O, I) II, III
U. Phegopteridis Arthur	*Dryopteris Linnaeana*	(O, I) II, III
U. Struthiopteridis Störmer	*Matteuccia Struthiopteris*	(O, I) II^{1}, II^{2}, III
U. virginiana Faull	*Pteridium aquilinum* var. *pseudocaudatum*	II^{1}, II^{2}, III
U. Woodsiae Kamei	*Woodsia polystichoides* var. *nudiuscula*	(O, I) II^{1}, II^{2}, III
	Woodsia polystichoides var. *Veitchii*	II^{1}, II^{2}, III

FERN HOSTS AND THE SPECIES OF UREDINOPSIS THAT OCCUR ON THEM

Adiantum andicola Liebm.	*U. investita*	II
Adiantum pedatum L.	*U. Adianti*	(O, I) II, III
Athyrium angustum (Willd.) Presl [*A. Filix-femina* Am. auct. in part, not Roth]	*U. longimucronata*	(O, I) II^{1}, II^{2}, III
Athyrium cyclosorum Rupr.	*U. Copelandi*	II^{1}, II^{2}, III
	U. longimucronata forma *cyclosora*	II^{1}, II^{2}, III
Athyrium melanolepis (Franch. & Sav.) Christ	*U. Athyrii*	(O, I) II, III
Athyrium multifidum Rosenst. [*A. deltoidofrons* Mak.]	*U. daisenensis*	II^{1}, II^{2}, III
Athyrium otophorum (Miq.) Koidz.	*U. daisenensis*	II^{1}, II^{2}, III
Athyrium pterorachis Christ	*U. intermedia*	(O, I) II^{1}, II^{2}, III
Athyrium rigescens Mak.	*U. daisenensis*	II^{1}, II^{2}, III
Athyrium thelypteroides (Michx.) Desv. [*A. acrostichoides* (Sw.) Diels]	*U. intermedia*	(O, I) II^{1}, II^{2}, III
	U. longimucronata var. *acrostichoides*	II^{1}, II^{2}, III
Athyrium Vidalii (Franch. & Sav.) Nakai	*U. daisenensis*	II^{1}, II^{2}, III
Blechnum unilaterale Sw. [*B. blechnoides* (Lag.) C. Chr.]	*U. Mayoriana*	II
Cheilanthes pyramidalis Fée	*U. glabra*	II^{1}, II^{2}, III
Cystopteris bulbifera (L.) Bernh.	*U. ceratophora*	(O, I) II^{1}, II^{2}, III
Cystopteris fragilis (L.) Bernh.	*U. glabra*	II^{1}, II^{2}, III

Dryopteris amurensis (Milde) Christ	*U. ossaeiformis*	II, III
Dryopteris dilatata var. *oblonga* Takeda	*U. ossaeiformis*	(O, I) II, III
Dryopteris Linnaeana C. Chr. [*Phegopteris Dryopteris* (L.) Fée]	*U. Phegopteridis*	(O, I) II, III
Dryopteris monticola (Mak.) C. Chr.	*U. ossaeiformis*	(O, I) II, III
Dryopteris Phegopteris (L.) C. Chr. [*Phegopteris polypodioides* Fée]	*U. filicina*	(O, I) II^1, II^2, III
Dryopteris Thelypteris var. *pubescens* (Lawson) A. R. Prince	*U. Atkinsonii*	(O, I) II^1, II^2, III
	U. hirosakiensis	(O, I) II, III
Matteuccia Struthiopteris (L.) Todaro [*Struthiopteris germanica* Willd.]	*U. Struthiopteridis*	(O, I) II^1, II^2, III
Onoclea sensibilis L.	*U. mirabilis*	(O, I) II^1, II^2, III
Onoclea sensibilis forma *obtusilobata* (Schkuhr) Gilbert	*U. mirabilis*	II^1, II^2, III
Osmunda cinnamomea L.	*U. Osmundae*	(O, I) II, III
Osmunda Claytoniana L.	*U. Osmundae*	(O, I) II, III
Osmunda regalis var. *spectabilis* (Willd.) A. Gray	*U. Osmundae*	(O, I) II, III
Pellaea cordata (Cav.) J. Sm.	*U. glabra*	II^1, III
Pteridium aquilinum (L.) Kuhn	*U. macrosperma*	II, III
	U. Hashiokai	II, III
	U. Kameiana	II^1, II^2, III
Pteridium aquilinum var. *centrali-africanum* Hieron.	*U. macrosperma*	II, III
Pteridium aquilinum var. *japonicum* Nakai	*U. Kameiana*	(O, I) II^1, II^2, III
	U. macrosperma	II, III
Pteridium aquilinum var. *lanuginosum* (Bong.) Fernald	*U. aspera*	II, III
	U. macrosperma	II, III
Pteridium aquilinum var. *pseudocaudatum* Clute	*U. virginiana*	II^1, II^2, III
	U. macrosperma	II, III
Pteridium arachnoideum (Kaulf.) Maxon	*U. macrosperma*	II, III
Pteridium capense (Thunb.) Krasser	*U. macrosperma*	II, III
Pteridium caudatum (L.) Maxon	*U. macrosperma*	II, III

Pteridium Feei (Schaffn.) Maxon	*U. macrosperma*	II, III
Pteridium psittacinum (Presl) Maxon	*U. macrosperma*	II, III
Woodsia polystichoides var. *nudiuscula* Hook.	*U. Woodsiae*	(O, I) II^1, II^2, III
Woodsia polystichoides var. *Veitchii* Hook. and Bak.	*U. Woodsiae*	II^1, II^2, III
Woodwardia areolata (L.) Moore	*U. Arthurii* var. *maculata*	II^1, II^2, III
Woodwardia virginica (L.) Sm.	*U. Arthurii*	II^1, II^2, III

EXCLUSIONS

Uredinopsis (?) *juglandina* Sacc.

Dryopteris Filix-mas (L.) Schott. Misidentified for *Athyrium cyclosorum* Rupr.

ACKNOWLEDGMENTS

It is with pleasure that I acknowledge help extended by Professor J. C. Arthur, Professor J. S. Boyce, Professor Naohide Hiratsuka, Professor Alfred Rehder, Mr. C. A. Weatherby, Professor G. W. Carver, Dr. George B. Cummins, Dr. I. H. Crowell, Professor W. P. Fraser, Dr. S. Kamei, Dr. W. W. Diehl, Dr. R. Pomerleau, Professor H. H. Whetzel, Dr. E. Mayor, Professor W. C. Blasdale, Professor E. C. Jeffrey, Dr. W. R. Maxon and Professor W. Tranzschel, Farlow Herbarium, Gray Herbarium, New York State Agricultural College, New York State Museum, New York Botanical Garden, University of Wisconsin, University of California, United States Bureau of Plant Industry, the Kungliga Riksmuseum of Stockholm and the Universitetets Botaniske Museum of Copenhagen. For aid in culturing and contribution of specimens I am under obligation to my former students Drs. H. P. Bell, E. H. Bensley, G. D. Darker, L. M. Hunter, E. H. Moss and W. R. Watson. I am also indebted to Dr. S. Kamei and Professor W. P. Fraser for their unstinted generosity in providing me with materials obtained from their cultures of species of *Uredinopsis*. Gratitude is expressed to Dr. G. D. Darker for assistance in preparation of the illustrations.

SUMMARY

1. The genus Uredinopsis was founded by P. Magnus on Niessel's *Protomyces* (?) *filicinus* under the impression that it

might be a phycomycete but rust-resembling. Dietel was the first to observe the germination of the teliospores and thus from the basidia formed to demonstrate that the genus belongs to the Uredinales.

2. Amphispores occur in many of the species. These were variously recognized as stylospores, aeciospores, urediospores and teliospores. Cultures made by Klebahn and others, supplemented by cytological studies, have shown that these are a second type of urediospores which function as "overwintering" spores.

3. Consonant with the accepted definition of the genus, *Uredinopsis* is defined in this paper as a genus of white-spored rusts, characterized by immersed hemispherical spermogonia, peridermia, uredia of one or two types (ordinary and amphisporic, respectively) with a peridium and non-catenulate spores, diffuse telia, and simple, few-celled, intercellular, subepidermally located teliospores.

4. The teliospores are formed during the season in which the fern fronds are infected and overwinter in the dead fronds. They germinate promptly in the following spring. They are, with few exceptions, of no diagnostic value in recognizing species; but they are a basic generic criterion.

5. The species of *Uredinopsis* are quite readily separated from one another by their remarkably versatile urediospores.

6. The ordinary urediospores are particularly versatile. In some species they are simple in form, and smooth, warted or spinulose; in others they are much elongate and with or without two, or in one species more than two opposed vertical rows of cogs or warts; in still others they are much elongate, smooth except for two opposed vertical rows of cogs or warts and they are mucronate; in two species they are mucronate and entirely capsulate. The mucro is an apical enucleate portion of a spore cell; it is arrested in its growth at quite an early state in the development of the spore of which it forms a part.

7. Species of *Abies* are the aecial hosts of the sixteen species for which the aecial hosts have been determined experimentally.

8. *Peridermium balsameum* Peck in America and *Aecidium pseudocolumnare* Kuehn in Europe, as generally understood, have included species of *Uredinopsis* as well as of *Milesia*.

9. Species of the Osmundaceae and the Polypodiaceae are the hosts of the uredial and telial stages of species of *Uredinopsis*. Several of the subfamilies of the Polypodiaceae are included in this connection.

10. The aecia, with one exception, are formed on Abies needles of the current season only. *Uredinopsis macrosperma* is exceptional in that its aecia are found on needles of the second to the fifth season.

11. *Uredinopsis* is reported from all of the continents except Australasia. Thirteen species are recognized as occurring in North America north of Mexico, four species in America south of the United States, three native species and one introduced in Europe, twelve in Asia and one in Africa.

12. Two species are recognized as occurring in the Eastern and Western Hemispheres, namely, *Uredinopsis macrosperma* and *U. Struthiopteridis*. The former is almost world-wide in its distribution though showing peculiarities in distribution apparently due to the immunity of certain forms of its host, *Pteridium aquilinum*.

13. Twenty-five *species* of *Uredinopsis*, two *varieties* and one *form* are recognized in this paper. The teliospores of all but two species are known.

14. Eight *species*, two *varieties* and one *form* are described as new, namely, *U. Arthurii*, *U. Arthurii* var. *maculata*, *U. aspera*, *U. ceratophora*, *U. glabra*, *U. investita*, *U. Kameiana*, *U. longimucronata*, *U. longimucronata* var. *acrostichoides*, *U. longimucronata* forma *cyclosora* and *U. virginiana*.

15. Species of *Uredinopsis* are apparently not closely restricted with respect to specific aecial hosts. They are in general closely restricted with respect to specific uredial and telial hosts.

16. *Uredinopsis* is regarded as a primitive genus, perhaps the most primitive of existing Uredinales. At the same time it shows some peculiar, specialized features. Among these are (1) the mucronate and the capsulate urediospores found in some species, and possibly (2) lack of the yellow pigment characteristic of rust fungi.

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BIBLIOGRAPHY

1. ADAMS, J. F. Sexual fusions and development of the sexual organs in the Peridermiums. (Agric. Exp. Sta., Pennsylvania State College Bull. **160**: 31–77. 1918.)
2. ARTHUR, J. C. Uredinales (of North America) — *Uredinopsis*. (North American Flora, **7**: 115–117. 1907. Also **7**: 683–685. 1925.)
3. ——————Fern rusts and their aecia. (Mycol. **16**: 245–251. 1924.)
4. ——————Plant rusts. (Uredinales). 1–446. 1929.
5. ——————Manual of the rusts in United States and Canada. 1–5. 1934.
6. ——————& D. H. KERN. North American species of Peridermium. (Bull. Torr. Bot. Club, **33**: 403–438. 1906.)
7. BELL, H. P. Fern rusts of Abies. (Bot. Gaz. **77**: 1–31. 1924.)
8. BOYCE, J. S. A conspectus of needle rusts on balsam firs in North America. (Phytopath. **18**: 705–708. 1928.)
9. COOKE, M. C. Natal fungi. (Grevillea, **8**: 71. 1879–80.)
10. DIETEL, P. New California Uredineae, II. (Erythea, **2**: 127. 1894.)
11. ——————Zur Kenntniss der Gattung Uredinopsis Magn. (Ber. Deutsch. Bot. Ges. **13**: 326–332. 1895.)
12. ——————In Mayor, E. Contribution à l'étude des Urêdinées de Colombie. (Mém. Soc. Sci. Nat. Neuchâtel. **5**: 442–599. 1913.)
13. ——————Hemibasidii-Uredinopsis (in Engler und Prantl, Nat. Pflanzenfam. **6**: 36–37. 1928.)
14. FARLOW, W. G. Notes on some species of Gymnosporangium and Chrysomyxa of the United States. (Proc. Am. Acad. **20**: 311–323. 1885.)
15. FAULL, J. H. The morphology, biology and phylogeny of the Pucciniastreae. [Proc. Internat. Congr. Plant Sci. Ithaca (1926), **2**: 1735–1745. 1929.]
16. ——————Taxonomy and geographical distribution of the genus Milesia. (Contrib. Arnold Arb. **2**: 1–138. 1932.)
17. FISCHER, EDW. Die Uredineen der Schweiz. Bern. 1904.
18. FRASER, W. P. Cultures of heteroecious rusts. (Mycol. **4**: 175–193. 1912.)
19. ——————Further cultures of heteroecious rusts. (Mycol. **5**: 233–239. 1913.)
20. ——————Notes on Uredinopsis mirabilis and other rusts. (Mycol. **6**: 25–28. 1914.)
21. GROVE, W. B. The British rust fungi. 1913.
22. HEDGCOCK, G. G. Notes on some western Uredineae which attack forest trees. (Mycol. **4**: 146. 1912.)
23. HIRATSUKA, N. A monograph of the Pucciniastreae, 48–86. 1936.
24. HOLWAY, E. W. D. Some California Uredineae. (Erythea, **7**: 98. 1899.)
25. HUNTER, L. M. Comparative study of spermogonia of rusts of Abies. (Bot. Gaz. **83**: 1–23. 1927.)

26. ————Morphology and ontogeny of the spermogonia of the Melampsoraceae. (Jour. Arnold Arb. **17**: 115–152. 1936.)

27. Jackson, H. S. Uredinales of Oregon. (Brooklyn Bot. Gard. Mem. **1**: 218–219. 1918.)

28. Johnson, T. & M. Newton. The origin of abnormal rust characteristics through the inbreeding of physiologic races of Puccinia graminis Tritici. (Canadian Jour. Res. **16**: 38–52. 1938.)

29. Kamei, S. On the life history of Uredinopsis Pteridis with special bearing on its peridermial stage. (Ann. Phytopath. Soc. Japan, **2**: 207–228. 1930.)

30. ————On new species of heteroecious fern rusts. (Trans. Sapporo Nat. His. Soc. **12**: 161–174. 1932.)

31. ————Genetic relation between some Japanese species of the fern rusts and the peridermia on firs. (Abstract) (Jour. Soc. Agric. For. Sapporo, **24**: 364–365. 1933. In Japanese.)

32. ————Identification of a peridermial stage on the seedlings of Abies Mayriana and the injury caused thereby. (Trans. Sapporo Nat. His. Soc. **13**: 153–161. 1934.)

33. Klebahn, H. Kulturversuche mit Rostpilzen, XII. (Zeit. Pflanzenkr. **15**: 65–108. 1905.)

34. ————Kulturversuche mit Rostpilzen, XVI. (Zeit. Pflanzenkr. **26**: 257–277. 1916.)

35. Kuehn, J. Notes on Rabenhorst's Fungi Europaei et Extra-europaei. Cents. 31 and 32. (Hedwigia, **23**: 168. 1884.)

36. Kuntze, O. Rev. Gen. Pl. **3**^{2}: 512. 1898.

37. Lind, J. Sur le dévéloppement et la classification de quelques espèces de Gloeosporium. (Arkiv för Bot. **7**: 1–23. 1908.)

38. Liro (Lindroth), J. Ivar. Uredineae Fennicae. Finlands Rostsvampar. Helsingfors. 1908.

39. Magnus, P. Ueber den Protomyces ? filicinus Niessl. [Atti del Congresso Botanico Internazionale Genova (1892), 167. 1893.]

40. ————Ein weiterer Beitrag zur Kenntniss der Gattung Uredinopsis. (Hedwigia, **43**: 119–125. 1904.)

40a.————Bemerkungen über einige Gattungen der Melampsoreen. (Ber. Deutsch. Bot. Ges. **27**: 322. 1909.)

41. Moss, E. H. The uredo stage of the Pucciniastreae. (Ann. Bot. **40**: 813–847. 1926.)

42. Niessl, G. von. Rabenh. Fg. Eur. no. 1659 (1873).

43. Pady, S. M. Teliospore development in the Pucciniastreae. (Canadian Jour. Res. **9**: 458–485. 1933.)

44. Peck, C. H. Annual report of the State Botanist. (Rep. New York State Mus. Nat. Hist. **25**: 87. 1873.)

45. ————Annual report of the State Botanist. (Rep. New York State Mus. Nat. Hist. **27**: 104. 1875.)

46. ————Annual report of the State Botanist. (Rep. New York State Mus. Nat. Hist. **39**: 57. 1887.)

47. Rhoads, A. S., G. G. Hedgcock, E. Bethel & C. Hartley. Host relationships of the North American rusts other than Gymnosporangiums which attack conifers. (Phytopath. **8**: 309–352. 1918.)
48. Schmitz, H. Preliminary note on the occurrence of Peridermium balsameum in Washington. (Phytopath. **6**: 369. 1916.)
49. Störmer, Carl. Om en art af slaegten Uredinopsis Magn. paa Struthiopteris germanica. (Bot. Not. 81. 1895.)
50. Sydow, P. & H. Neue und kritische Uredineen, I. (Ann. Mycol. **1**: 325. 1903.)
51. ————Neue und kritische Uredineen, II. (Ann. Mycol. **2**: 30. 1904.)
52. ————Monographia Uredinearum, **3**: 482–492. 1915.
53. ————Monographia Uredinearum, **4**: 1. 1923.
54. ————Monographia Uredinearum, **4**: 12. 1923.
55. Weir, J. R. & E. E. Hubert. Observations on forest tree rusts. (Am. Jour. Bot. **4**: 327–335. 1917.)

EXPLANATION OF PLATES*

PLATE I

Fig. 1. *Uredinopsis Adianti* Kom. (a) Urediospore. (b) Urediospore, sectional view.

Fig. 2. *Uredinopsis investita* Faull. (a) Urediospore. (b) Urediospore, sectional view; *average*.

Fig. 3. *Uredinopsis Athyrii* Kamei. (a) Urediospore. (b) Urediospore, sectional view.

Fig. 4. *Uredinopsis daisenensis* Hirat. f. (a) Ordinary urediospore, sectional view. (b) Amphispore.

Fig. 5. *Uredinopsis intermedia* Kamei. (a) Ordinary urediospore, sectional view. (b) Ordinary urediospore. (c) Amphispore, sectional view. (d) Amphispore.

Fig. 6. *Uredinopsis Copelandi* Syd. (a) Ordinary urediospore. (b) Ordinary urediospore, sectional view. (c) Amphispore, sectional view. (d) Amphispore.

PLATE II

Fig. 7. *Uredinopsis longimucronata* Faull. (a) Ordinary urediospore; *average*. (b) Ordinary urediospore, sectional view. (c) Amphispore; *average*. (d) Amphispore, sectional view.

Fig. 8. *Uredinopsis longimucronata* forma *cyclosora* Faull. (a) Ordinary urediospore; *average*. (b) Ordinary urediospore, sectional view. (c) Amphispore; *average*. (d) Amphispore.

Fig. 9. *Uredinopsis longimucronata* var. *acrostichoides* Faull. (a) Ordinary urediospore; *average*. (b) Amphispore.

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*All drawings are made at a magnification of 900 diameters.

Fig. 10. *Uredinopsis Mayoriana* Diet. Urediospore.

Fig. 11. *Uredinopsis glabra* Faull. (a) Ordinary urediospore; *average.* (b) Ordinary urediospore, sectional view. (c) Amphispore, sectional view. (d) Amphispore. (e) Amphispore.

PLATE III

Fig. 12. *Uredinopsis ceratophora* Faull. (a) Ordinary urediospore; *average.* (b) Ordinary urediospore, sectional view. (c) Amphispore; *average.* (d) Amphispore.

Fig. 13. *Uredinopsis Atkinsonii* Magnus. (a) Ordinary urediospore; *average.* (b) Ordinary urediospore, sectional view. (c) Amphispore; *average.* (d) Amphispore; *type.* (e) Ordinary urediospore; from Indiana, Arthur Herb. 4424.

Fig. 14. *Uredinopsis hirosakiensis* Kamei and Hirat. f. (a) Urediospore, sectional view; *average.* (b) Urediospore; *type.*

Fig. 15. *Uredinopsis ossaeiformis* Kamei. (a) Urediospore; *average.* (b) Urediospore, sectional view; *type.*

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Fig. 17. *Uredinopsis Hashiokai* Hirat. f. (a) Urediospore. (b) Urediospore, sectional view.

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Fig. 20. *Uredinopsis Kameiana* Faull. (a) Ordinary urediospore; *average.* (b) Ordinary urediospore, sectional view. (c) Amphispore, sectional view; *average.* (d) Amphispore.

Fig. 21. *Uredinopsis virginiana* Faull. (a) Ordinary urediospore; *average.* (b) Ordinary urediospore, sectional view. (c) Amphispore, sectional view; *average.* (d) Amphispore.

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Fig. 22. *Uredinopsis mirabilis* (Peck) Magnus. (a) Ordinary urediospore; *average.* (b) Ordinary urediospore, sectional view; *type.* (c) Amphispore; *average.* (d) Amphispore, sectional view.

Fig. 23. *Uredinopsis filicina* (Niessl) Magnus. (a) Ordinary urediospore; *average.* (b) Ordinary urediospore, sectional view. (c) Ordinary urediospore, sectional view. (d) Amphispore. (e) Amphispore, sectional view; *average.*

Fig. 24. *Uredinopsis Struthiopteridis* Störmer. (a) Ordinary urediospore; *average.* (b) Ordinary urediospore, sectional view. (c) Amphispore; *average.* (d) Amphispore, sectional view.

Fig. 25. *Uredinopsis Woodsiae* Kamei. (a) Ordinary urediospore. (b) Ordinary urediospore, sectional view. (c) Amphispore; *average.* (d) Amphispore, sectional view.

Fig. 26. *Uredinopsis Phegopteridis* Arthur. (a) Urediospore; *average.* (b) Urediospore, sectional view.

PLATE VI

Fig. 27. *Uredinopsis Arthurii* Faull. (a) Ordinary urediospore; *average.* (b) Ordinary urediospore, sectional view. (c) Amphispore; *average.* (d) Amphispore, sectional view.

Fig. 28. *Uredinopsis Arthurii* var. *maculata* Faull. (a) Ordinary urediospore; *average.* (b) Ordinary urediospore, sectional view. (c) Amphispore; *average.* (d) Amphispore, sectional view.

Fig. 29. *Uredinopsis Adianti* Kom. (a–j) Teliospores, median sectional view in plane parallel to leaf surface.

Fig. 30. *Uredinopsis longimucronata* Faull. (a–c) Teliospores, median sectional view in plane parallel to leaf surface.

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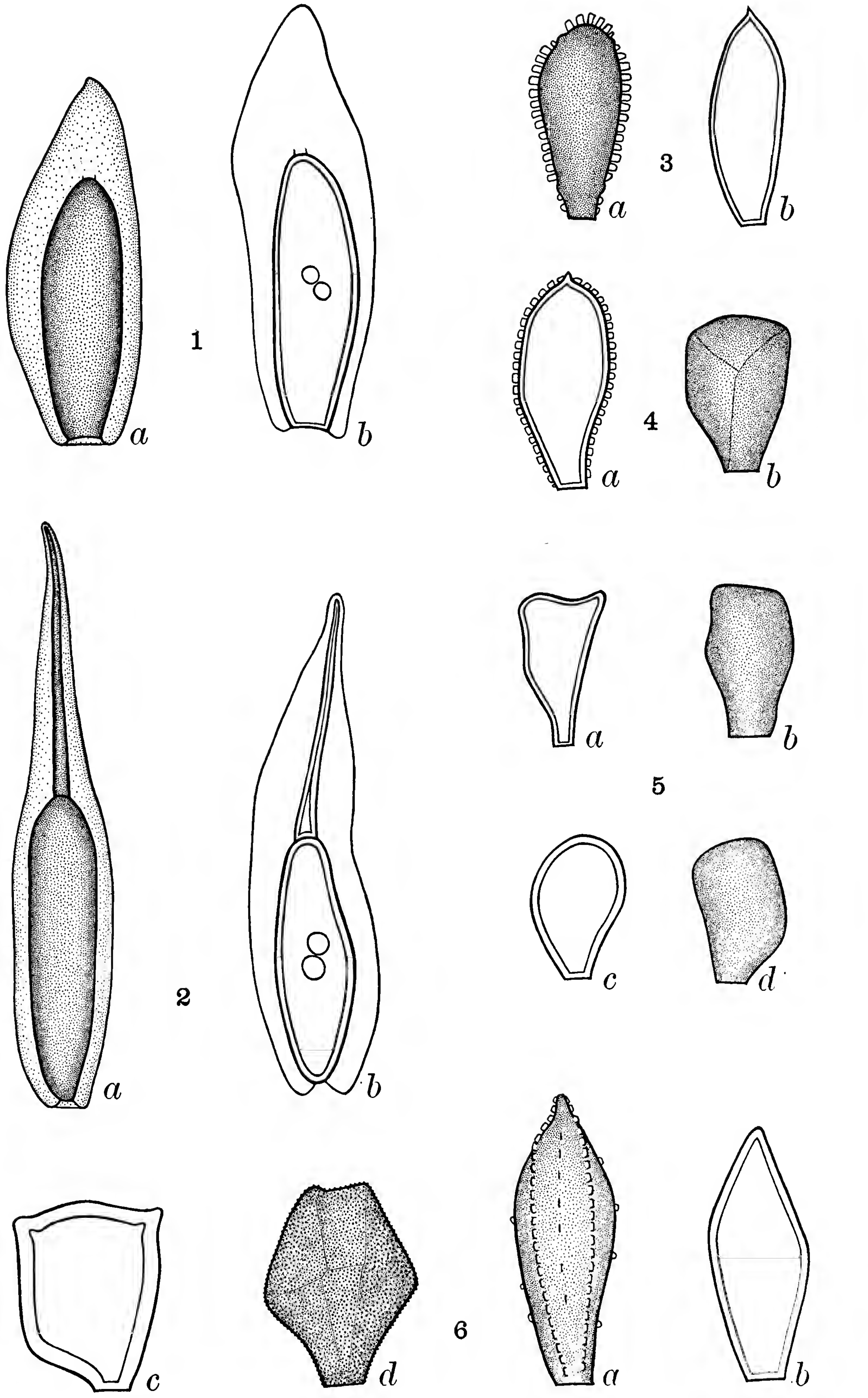
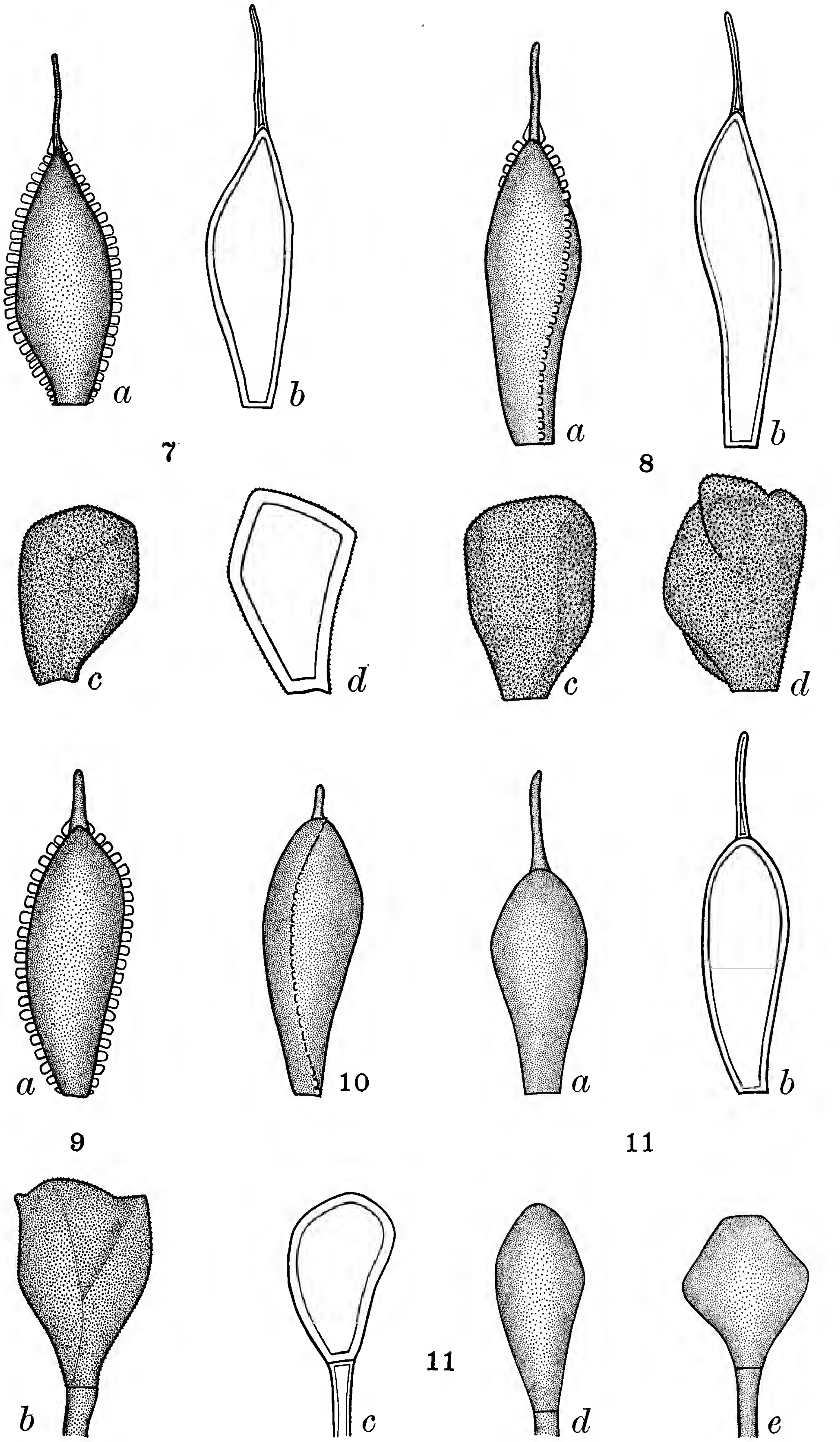
Synonyms are printed in *italics* and new names and new combinations in **bold-face** type



The Genus Uredinopsis

1. U. Adianti
2. U. investita
3. U. Athyrii
4. U. daisenensis
5. U. intermedia
6. U. Copelandi



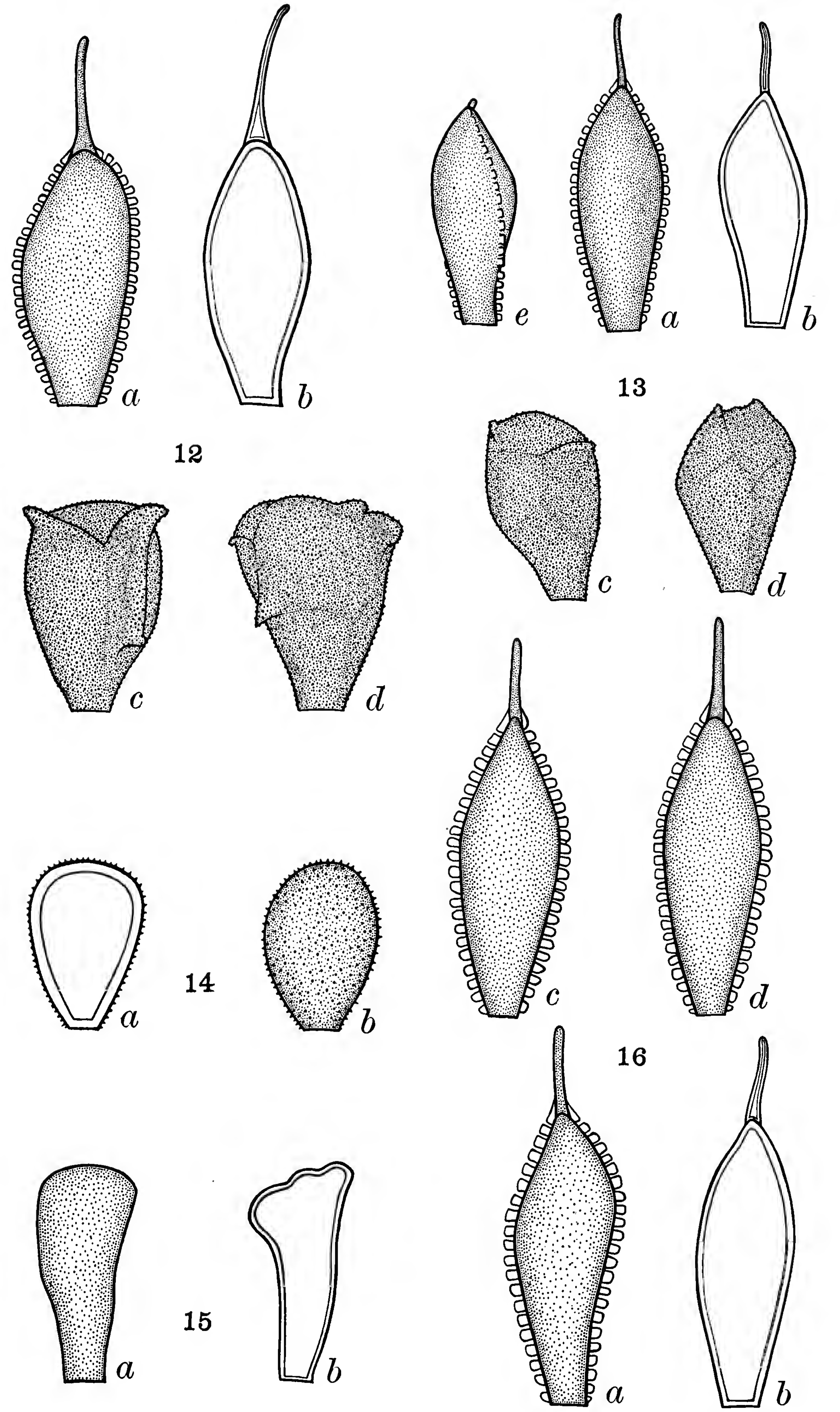
THE GENUS UREDINOPSIS

7. U. longimucronata 8. U. longimucronata f. cyclosora

9. U. longimucronata var. acrostichoides

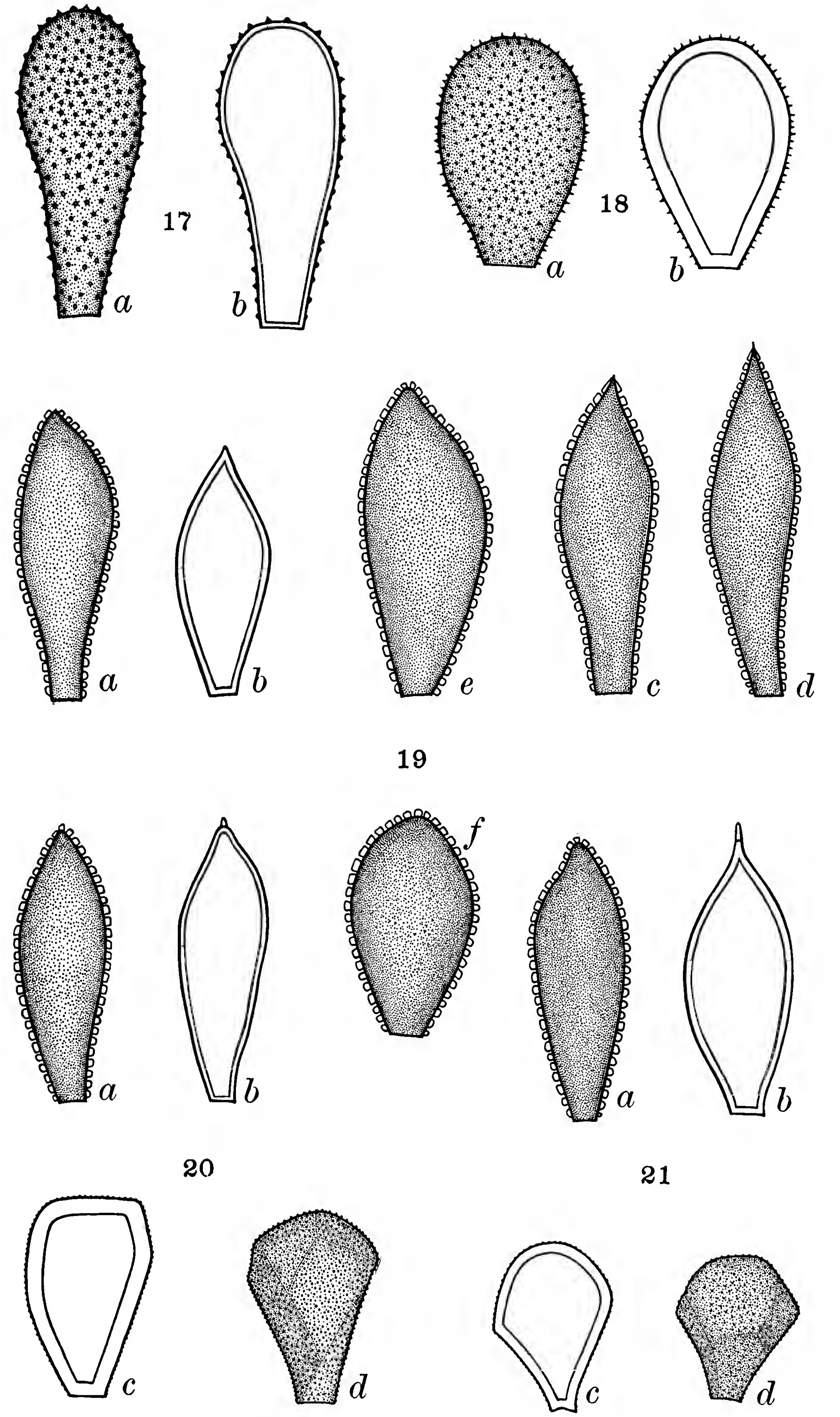
10. U. Mayoriana 11. U. glabra

PLATE III



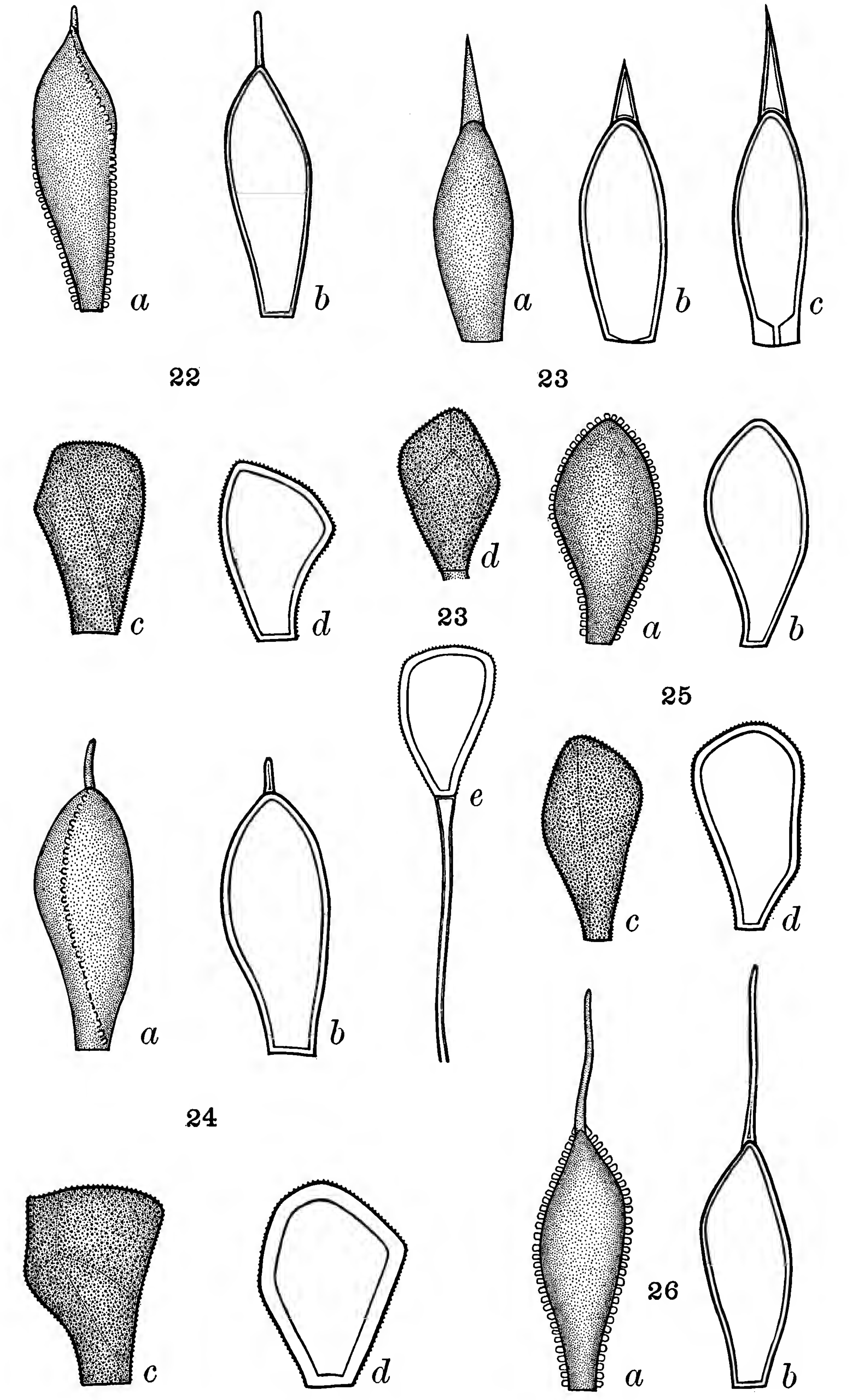
THE GENUS UREDINOPSIS

12. U. ceratophora
13a-d. U. Atkinsonii
13e. U. Atkinsonii "forma amucronata"
14. U. hirosakiensis
15. U. ossaeiformis
16. U. Osmundae



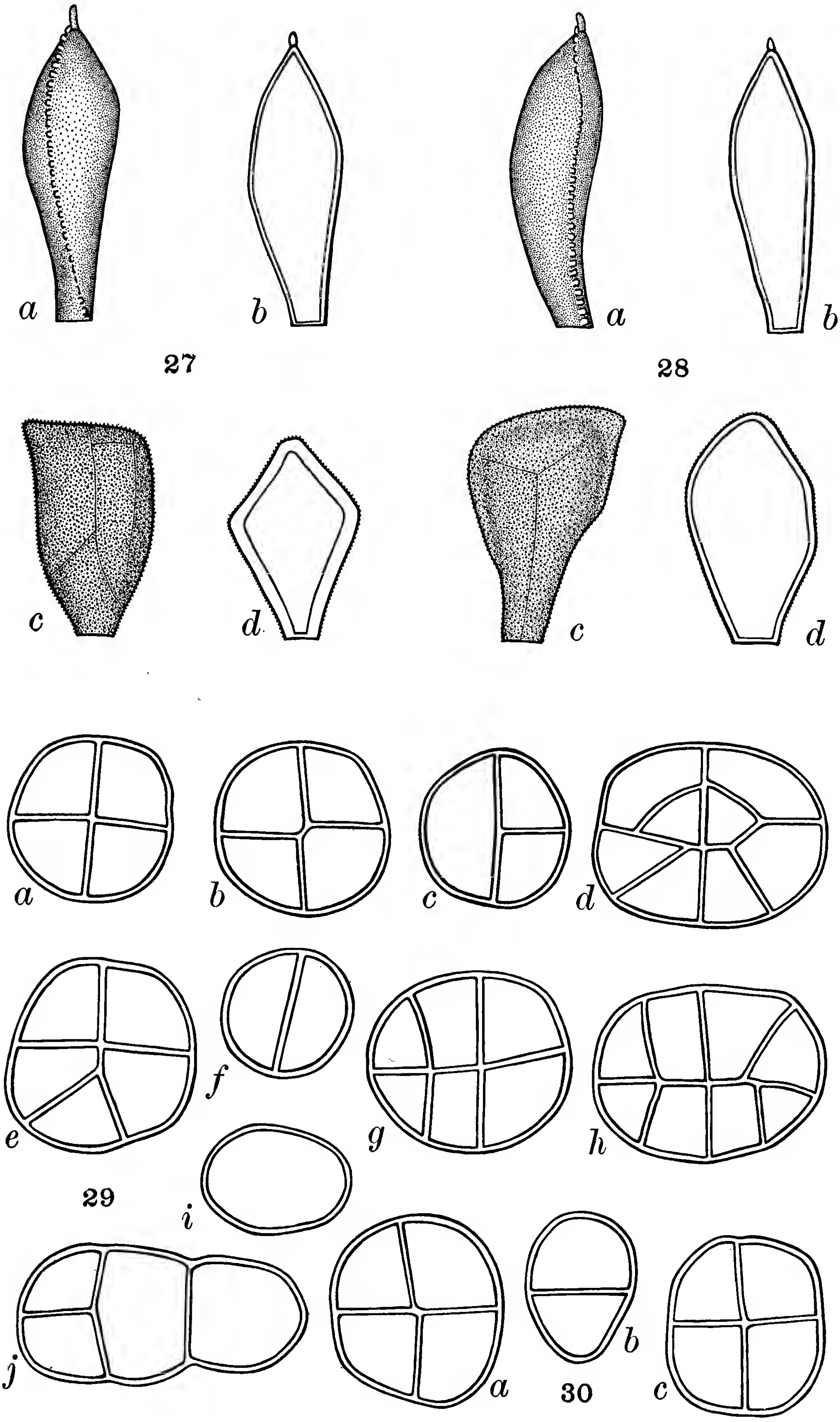
The Genus Uredinopsis

17. U. Hashiokai   18. U. aspera   19. U. macrosperma
20. U. Kameiana   21. U. virginiana



The Genus Uredinopsis

22. U. mirabilis 23. U. filicina 24. U. Struthiopteridis
25. U. Woodsiae 26. U. Phegopteridis



The Genus Uredinopsis

27. U. Arthurii
28. U. Arthurii var. maculata
29. U. Adianti
30. U. longimucronata

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