

## The Rust Fungi (Uredinales) of Hawaii<sup>1</sup>

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**ABSTRACT:** The fungi of Hawaii were documented by F. L. Stevens and other workers early in the 1900s. Since about 1925, however, little formal attention has been given Hawaiian rust fungi. This is the first study devoted exclusively to Hawaiian Uredinales as a group. During recent years we have contributed a number of rust specimens to the Herbarium Pacificum, Bernice P. Bishop Museum (BISH), which includes the most complete collection of Hawaiian fungi. Our contributions, together with the earlier deposits, supplemented by the Animal and Plant Health Inspection Service, U.S. Department of Agriculture, reference collection at Honolulu International Airport (HONO) and information from the USDA National Fungus Collections (BPI), provided the basis for this study. The fungus collection of the Department of Botany, University of Hawaii at Manoa (HONO), was also examined. We recognize 74 species, 9 of which are endemic, and an additional 13 occur on native hosts. As with many rusts in tropical areas, most species reported here are less than macrocyclic or are represented only by uredinial and/or telial states and do not utilize alternate hosts.

SINCE THE PUBLICATION OF Hawaiian Fungi by F. L. Stevens in 1925 (Stevens 1925), little attention has been given to the Uredinales of Hawaii. At the time of Stevens' publication, 39 species of rust fungi were recognized from Hawaii, most of which were known to have been recent introductions on crops, ornamentals, or weeds from elsewhere. Stevens noted the relatively scant number of rusts in Hawaii as compared to other insular localities, such as Puerto Rico, with which he was familiar. He attributed this overall scarcity, as well as the scarcity of aecial forms, to the remoteness of the Hawaiian archipelago from continental landmasses.

Stevens concluded that rusts did not come to Hawaii windborne, but primarily had been introduced with their hosts. Introduction of alternate hosts of heteroecious rusts, usually plants totally unrelated to the primary hosts, would be coincidental, and appears not to

have occurred often. In mild climates, rust fungi are capable of surviving indefinitely in the uredinial state and do not require alternate hosts.

Stevens (1925:176) recognized 7 endemic rust species from Hawaii. Each of the following, with one exception (*Puccinia oahuensis*), was reported on an endemic host:

- Puccinia oahuensis* E. & E. on *Syntherisma pruriens* (Trin.) Arth.
- Puccinia velata* (E. & E.) Arth. on *Euphorbia multiformis* H. & A.
- Pucciniastrum wikstroemiae* Arth. in Stevens on *Wikstroemia uva-ursi* Gray
- Uredo hawaiiensis* Arth. in Stevens on *Carex oahuensis* C. A. Mey. ex Hbd.
- Uredo stevensii* Arth. in Stevens on *Euphorbia clusiaefolia* H. & A.
- Uromyces alyxiae* Arth. in Stevens on *Alyxia olivaeformis* Gaud.
- Uromyces koae* Arth. in Stevens on *Acacia koa* Gray

An additional species, *Puccinia polygoni-amphibii* Pers. was also designated endemic. However, this rust is well known elsewhere (Arthur 1962).

Of the above rusts recognized by Stevens as

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endemic, *Puccinia oahuensis* is found only on nonnative *Digitaria* hosts and currently includes other species that have been brought into synonymy. As a result, *P. oahuensis* is widely distributed throughout warmer regions of the world (Cummins 1943).

The status of *Puccinia velata* (= *P. levata* Hennen & Hodges) is questionable since collections of a rust thought to represent this species are known from Mexico (Hennen and Hodges 1981). A reference by Stevens himself to Mexican material of this species described by J. C. Arthur (Stevens 1925: 124) contributes to the uncertainty.

*Pucciniastrum wikstroemiae* [= *Uredo wikstroemiae* (Arth. in Stevens) Hirat.] is now referred to *Melampsora yoshinagai* P. Henn., which also occurs on several species of *Wikstroemia* in Japan, Taiwan, and the Philippines (Gardner 1988b).

Following is a list of additional rusts discovered since Stevens' work and currently considered endemic: *Uredo vulcani* Gardner on *Coprosma rhynchocarpa* Gray (Gardner 1988b), *Puccinia vitata* Hennen & Hodges on *Chamaesyce* (= *Euphorbia*) *olowaluana* Sherff var. *gracilis* (Rock) Sherff (Hennen and Hodges 1981), *Endoraecium acaciae* Hodges & Gardner, and *E. hawaiiense* Hodges & Gardner. The two *Endoraecium* species occur on *Acacia koa* var. *koa* St. John, *A. koa* var. *latifolia* St. John, and *A. koaia* Hbd. (Hodges and Gardner 1984). Although not currently listed as a separate species, a microcyclic form of *Atelocauda digitata* (Wint.) Cumm. & Hirat., described more fully below, is recognized as endemic (Hodges and Gardner 1984). Since this microcyclic form conforms at least in part to the concept of correlated species of rust fungi (Hiratsuka and Sato 1982), it is possible that, while it is not treated as such here, this form may be considered a valid species.

*Puccinia molokaiensis* Cumm. was reported as a new species on an unidentified species of *Carex* (Cummins 1937) on the island of Molokai. Although Cummins did not directly designate *P. molokaiensis* as an endemic species in his description, the binomial implies it to be endemic to Molokai. To our knowledge, no other collections or observations of *P. molokaiensis* have been made.

With the above deletions and additions, the following 9 rust species, all limited to endemic hosts, are currently recognized as endemic (Gardner 1987b):

*Atelocauda* (= *Uromyces*) *koa*  
*Endoraecium acaciae*  
*Endoraecium hawaiiense*  
*Puccinia molokaiensis*  
*Puccinia vitata*  
*Uredo hawaiiensis*  
*Uredo stevensii*  
*Uredo vulcani*  
*Uromyces alyxiae*

In addition to the above, the following 13 nonendemic rusts occur on native (endemic or indigenous) hosts:

*Atelocauda digitata*  
*Kuehneola uredinis*  
*Melampsora yoshinagai*  
*Puccinia absinthii*  
*Puccinia heterospora*  
*Puccinia levata*  
*Puccinia leveillei*  
*Puccinia malvacearum*  
*Puccinia versicolor*  
*Pucciniastrum vacinii*  
*Uromyces lineolatus*  
*Uromyces rhynchosporae*  
*Xenostepe* sp.

Our observation of the general scarcity of rust fungi in Hawaii, which is particularly true of those occurring on endemic hosts, agrees with that of Stevens. It is remarkable that rusts are known to occur on only about 20 of the approximately 1400 recognized endemic plant species. A few genera such as *Acacia*, *Geranium*, and *Chamaesyce* (= *Euphorbia*) are disproportionately represented among these hosts.

As is true of many rusts in warmer areas, most species reported here are represented by abbreviated life cycles (i.e., microcyclic, demicyclic) or are successful in the absence of the alternate host required to complete a long cycle as mentioned above. Thus, most rusts reported here are represented only by uredinial and/or telial states.

Prior to the present study, the Uredinales collection of the Herbarium Pacificum, Bernice P. Bishop Museum (BISH), consisted

mostly of specimens deposited during the early 1900s. The collection had remained essentially static until 1967 when Yrjö Mäkinen, of the Department of Botany, University of Turku, Finland, reviewed the existing specimens and provided current binomials where the originals had been placed in synonymy. Mäkinen apparently contributed few additional specimens, however. Most recently, the senior author has verified the specimens at BISH and further updated the collection by depositing rust fungi collected in Hawaii during the 1980s, along with their current binomials. These additions represent both rusts that have been newly discovered in Hawaii and those that had been reported earlier but for which no specimens had been deposited. With these additions, the BISH collection of Hawaiian Uredinales approaches completion according to both published and unpublished known records. Exceptions are noted in the annotated list below. We acknowledge that lists such as the one presented here are not intended as static or final statements, but are subject to constant updating and revision. Our recent discoveries suggest this to be especially true of the Uredinales of Hawaii. Synonyms are included where a rust fungus was originally deposited under a previous name or was widely known by that binomial until recently.

Present frequency and distribution among the rust species we have not personally observed in the field, but which are represented in BISH, were sometimes difficult to assess. In some instances, only a single, meager specimen was available, with no subsequent record of other occurrences. Thus, the represented species may be rare in Hawaii or may have been overlooked and unreported from other localities. In addition to specimens at BISH, the fungus collections of the Department of Botany, University of Hawaii at Manoa (HONO) and of the Animal and Plant Health Inspection Service, U.S. Department of Agriculture, at Honolulu International Airport (HONOQ) were examined.

Furthermore, printouts of packet notations were available for Hawaiian rusts on deposit at the National Fungus Collections of the U.S. Department of Agriculture [formerly Bureau of Plant Industry (BPI)], Beltsville,

Maryland. The BPI specimen itself of *Xenosteles* sp. was examined, however. Only rusts not already known from BISH or HONOQ, or rare or otherwise significant specimens, were noted from BPI.

Taxonomic treatments of Arthur (1962), including Cummins (1962, 1971), Cummins and Hiratsuka (1983), Rotar (1968), and St. John (1973), were generally followed. The information provided by Raabe et al. (1981) was also useful to this study. The BISH packet (sheet) number is given for each specimen on deposit at BISH. No supplemental records were found at HONO, but those from HONOQ and BPI are so designated. Standard roman numeral designations for the spore states of Uredinales are used: 0 = spermatogonial, I = aecial, II = uredinial, III = telial, IV = basidial. Island names are abbreviated as follows: H = Hawaii, K = Kauai, L = Lanai, M = Maui, Mo = Molokai, O = Oahu, N = Niihau. Endemic rust species are designated (\*), whereas endemic hosts are designated (e) and indigenous hosts (i). Where more than one earlier specimen is available, only a single representative packet is cited, but each island on which the species was found is listed.

The following 74 rusts, represented by the spore states indicated, were examined, with the exceptions noted, and accepted in this study:

*Atelocauda digitata* (Wint.) Cummin. & Hirat., *Illus. Gen. Rust Fungi* p. 81, 1983 (= *Uromyces digitatus* Wint.); 0, I, II, III, IV, on *Acacia koa* var. *koa* (e) and *A. koa* var. *latifolia* (e); II and III on *A. koaia* (e). 510439, II, 1982, O; 510514, 0, I, III, 1986, H. Although the Hawaiian rust fungi on endemic *Acacia* hosts have been transferred from the genus *Uromyces* to *Atelocauda* (Cummins and Hiratsuka 1983), some uncertainty remains whether even this genus is appropriate (Gardner and Hodges 1985). A new genus may be needed to accommodate these rusts. *Atelocauda digitata*, considered indigenous to Hawaii, also occurs on a large number of *Acacia* spp. in Australia, New Zealand, and Java. *Uromyces phyllodium* (Berk. & Broome) McAlp., now a synonym of *A. digitata*, was described as

a demicyclic rust in Australia (McAlpine 1906). This species has been shown to be macrocyclic in Hawaii, however. A separate microcyclic form (0, III) of *A. digitata*, which has not been given distinct taxonomic status, also occurs on *Acacia koa* var. *latifolia* (511352, 1982, H) and is considered endemic to Hawaii (Hodges and Gardner 1984). *Atelocauda digitata* was recently recognized as a distinct species on endemic *Acacia* hosts in Hawaii. Previously, *A. digitata* was confused with *A. koae*, with the original description of *A.* (= *Uromyces*) *koae* (Stevens 1925) including the aecial state of *A. digitata*. Some of the earlier specimens deposited at BISH originally labeled *U. koae* are *A. digitata*. The characteristics, distribution, and hosts are discussed by Hodges and Gardner (1984).

- \**Atelocauda koae* (Arth. in Stevens) Cumm. & Hirat., Illus. Gen. Rust Fungi p. 81, 1983 (= *Uromyces koae* Arth. in Stevens); 0, I, III, on *Acacia koa* var. *koa* (e) and *A. koa* var. *latifolia* (e). 500004 (syntype), 1921, O; H; M; K; 509301-2, 1987, H. *Atelocauda koae* is a demicyclic species considered endemic to Hawaii (Hodges and Gardner 1984). As noted for *A. digitata* above, the life cycle of *A. koae* was only recently demonstrated, necessitating a revision of the original description (see Hodges and Gardner 1984, Stevens 1925).

*Coleosporium paederiae* Diet., Ann. Myc. 7: 355, 1909; II, on *Paederia foetida* (maile pilau). 145787, 1909, O; 1986, O. *Coleosporium paederiae* is common wherever the host occurs, but only the uredinial state is known from Hawaii.

- \**Endoraecium acaciae* Hodges & Gardner, Mycologia 76: 339, 1984; 0, III, on *Acacia koa* var. *koa* (e) and *A. koaia* (e). 510444, 1981, H. *Endoraecium acaciae* was recently recognized as a distinct species from *Atelocauda koae*, with which it was confused in the past. *Endoraecium acaciae* is an endemic, endocyclic species and is considered the most common of

the rusts on *Acacia* spp. in Hawaii (Hodges and Gardner 1984). The characteristics, hosts, and distribution were discussed by Hodges and Gardner (1984) and Gardner and Hodges (1985).

- \**Endoraecium hawaiiense* Hodges & Gardner, Mycologia 76: 343, 1984; 0, III, on *Acacia koa* var. *koa* (e) and *A. koa* var. *waiianaiensis* (e). 494668-9, 1987, O. This rust is an endemic, endocyclic species resembling *E. acaciae* in life-cycle characteristics, but more limited in distribution (Gardner and Hodges 1985, Hodges and Gardner 1984). Differences in witches' broom size and teliospore morphology distinguish these two *Endoraecium* species from one another.

*Kuehneola uredinis* (Lk.) Arth., N. Amer. Flora 7: 186, 1912; 0, I, II, III, on *Rubus argutus* (= *R. penetrans*) (Florida blackberry). 145921-3, 1921, M; 510519, II, III (?), 1982, M; 510520, 0, I, II, III, 1982, K; 510438, II (stem infection), 1987, H. *Kuehneola uredinis* was originally reported from Hawaii on *R. villosus* by Stevens (1925) on Maui. This host is not currently recognized from Hawaii (St. John 1973), but is probably referable to *R. argutus*. *Kuehneola uredinis* also causes foliar infection on the two endemic *Rubus* species, *R. hawaiiensis* (e) (BPI 141513, 1928, K) and *R. macraei* (e) (BPI 141548, 1927, M). Infection of the endemic species is considered infrequent and of minor impact, however (Gardner and Hodges 1983). This rust has been investigated as a potential biocontrol agent for *R. argutus* in Hawaii (Gardner and Hodges 1983). *Kunkelia* (= *Gymniconia*) *nitens* Kern & Thurst., previously reported on *Rubus* sp. from Hawaii (Raabe 1966), is unconfirmed and actually may be *K. uredinis*. Foliar infection by the uredinial state is most common, but stem infection (510438, 1987) also is known from Hawaii Volcanoes National Park, Hawaii Island. The telial state is sometimes associated with uredinia. The spermogonial and aecial states were observed at Kokee, Kauai (510520, 1982).



*Melampsora yoshinagai* P. Henn., Hedwigia 42:108, 1903 [= *Uredo wikstroemiae* (Arth. in Stevens) Hirat.], II, on *Wikstroemia uva-ursi* (akia) (e): 146257 (isotype), 1921, H; 500327 (isotype), 1921, H; and on *W. oahuensis* (akia) (e): 509293, 1987, O; HONQ 37550, 1963, O. Although *U.* (= *Pucciniastrum*) *wikstroemiae* was originally listed by Stevens (1925) as an endemic Hawaiian species, this rust was recently reexamined and referred to *M. yoshinagai*, known already from *Wikstroemia* hosts in East Asia (Gardner 1988b).

*Phakopsora apoda* (Har. & Pat.) Mains, Mycologia 30:45, 1938; II, on *Pennisetum clandestinum* (Kikuyugrass). 509307, 1984, M. The rust is widespread, probably occurring wherever the host occurs. However, no early collections or references to *P. apoda* from Hawaii were available. Only the uredinial state is known from Hawaii (Gardner 1984).

*Phragmidium ?mucronatum* (Pers.) Schlecht., Fl. Berol. 2: 156, 1824 (= *P. disciflorum* Tode ex James); II, on *Rosa odorata* and other *Rosa* spp. (cultivated roses). 486119, 1913, O. Since only the uredinial state was seen, the specific designation is questionable. The uredinial state is difficult to distinguish from those of *Phragmidium* spp. such as *P. speciosum* and *P. rosae-pimpinellifoliae* also reported on *Rosa* hosts from Hawaii.

*Phragmidium rosae-pimpinellifoliae* Diet., Hedwigia 44: 339, 1905 [= *P. subcorticium* (Schrank) Ell. & Ev.]; no spore state given, on *Rosa* sp. BPI 126634, 1895, K. See the annotation for *P. mucronatum* above.

*Physopella tecta* (Jacks. & Holw.) Azb., Nov. Sys. Plant. Non Vasc. 7:224, 1970 (= *Phakopsora tecta* Jacks. & Holw.); II, on *Commelina diffusa* (day flower; hono-hono). 510521, 1987, H. This is probably the rust referred to in previous records as *Uromyces commelinae* (Speg.) Cke. (Raabe et al. 1981). No early voucher specimens of either *P. tecta* or *U. commelinae*

are available, and the existence of *U. commelinae* in Hawaii is questionable (Gardner 1981). *Physopella tecta* is very abundant and widely distributed wherever the host occurs. Since only the uredinial state of *P. tecta* is known from Hawaii and telia have been rarely observed in any location, it has been uncertain whether this rust should be included in the genus *Phakopsora* or *Physopella* (Gardner 1981). The two genera are distinguished from one another by the more linear arrangement of teliospores of *Physopella* and the more random arrangement in *Phakopsora*.

*Puccinia absinthii* (Hedw.f.) DC., Fl. Fr. 6: 56, 1815; II, on *Artemisia australis* (e). BPI 042792, 1928, Mo. Raabe et al. (1981) tentatively reported *P. absinthii* on four species of *Artemisia* (sagebrush) that do not occur in Hawaii (St. John 1973). An apparent misreading of the U.S. Department of Agriculture Index of Plant Diseases (1960) accounts for this ambiguity.

*Puccinia allii* Rud., Linnaea 4: 392, 1829; II (= *P. porri* Wint.); on *Allium cepa* (onion). HONQ 19404, 1958, O. Raabe et al. (1981) also reported this rust on *A. ascalonicum* (shallot) and *A. fistulosum* (green onion).

*Puccinia arachidis* Speg., Anal. Soc. Ci. Argent. 17:90, 1884; II, on *Arachis hypogaea* (peanut). 510445, 1982, O; 515882, 1988, O. *Puccinia arachidis* may occur wherever susceptible host plants are cultivated.

*Puccinia brachypodii* Otth var. *poae-nemoralis* (Otth) Cumm. & H. C. Greene, Mycologia 58:705, 1966; II [= *P. poae-sudeticae* (Westend.), *P. poae-nemoralis* Otth, and *P. epiphylla* (L.) Wettst.]; on *Poa pratensis* (Kentucky bluegrass): 146225, 1940, H; and *Poa annua* (annual bluegrass): 146191-2, 1921, H. *Puccinia epiphylla* has been placed in synonymy with *P. poarum*, which also may attack *Poa* spp. (Arthur 1962) and has been recorded in Hawaii (G. Baker, unpublished files). However, herbarium specimens

contained numerous paraphyses, indicating the material at BISH to be *P. brachypodii* var. *poae-nemoralis* rather than *P. poarum*, in which paraphyses are scarce or lacking (Cummins 1971). Raabe et al. (1981) also reported *P. brachypodii* var. *poae-nemoralis* on *Anthoxanthum odoratum* (sweet vernal grass) from Hawaii, but no voucher specimens were available for this host.

*Puccinia canaliculata* (Schw.) Lagerh., Tromsø Mus. Aarsh. 17: 51, 1894; II, III, on *Cyperus rotundus* (purple nutsedge). 511589, 1987, O. Arthur (1962) reported this rust from Hawaii. This species has been confused with *P. philippinensis*, also on purple nutsedge, which it closely resembles. However, the urediniospores of *P. canaliculata* are somewhat less spherical, slightly larger, have a thinner wall, and are darker in color than are those of *P. philippinensis*. *Puccinia canaliculata* is the more common rust in Hawaii.

*Puccinia cenchri* Diet. & Holw. in Holw., Bot. Gaz. 24: 28, 1897; II, on *Cenchrus echinatus* (sandbur). 146173-5, 1921, O; 510443, 1987, O. The host was originally recorded as *C. echinatus* var. *hillebrandianus*, but this variety is now of doubtful validity (P. O'Connor, personal communication). *Puccinia cenchri* probably can be found wherever the host occurs.

*Puccinia chaetochloae* Arth., Bull. Torr. Bot. Club 34: 585, 1907; on *Paspalum conjugatum* (Hilo grass). BPI 055574, 1970, O. *Puccinia chaetochloae* is perhaps most readily distinguished from *P. paspalina*, which also occurs in Hawaii on *Paspalum* hosts, by the presence of paraphyses associated with uredinia. Teliospore walls of *P. chaetochloae* are chestnut-brown, whereas those of *P. paspalina* are yellowish or golden. Telia of *P. paspalina* were not seen but reportedly contain numerous single-celled spores (Cummins 1971).

*Puccinia chrysanthemi* Roze, Bull. Soc. Myc. Fr. 17: 92, 1900; II, on *Chrysanthemum indicum* and horticultural varieties.

146176, 1913, O; on *Chrysanthemum* sp. HONQ 33483, 1962, H; on *C. morifolium* HONQ 49342, 1966, M.

*Puccinia conoclinii* Seym., Bot. Gaz. 9: 191, 1884; II, on *Ageratum conyzoides* (maile-hohono). 146180, 1909, O. *Puccinia conoclinii* also has been reported previously as *P. compositarum* on Kauai (Stevens 1925).

*Puccinia coronata* Corda, Icon. Fung. 1: 6, 1837; II, III, on *Hordeum vulgare* (barley) and *Holcus lanatus* (velvetgrass). 146183, 1913, O; H; K; M; 510513, 1986, H. *Puccinia coronata* is very common wherever the hosts occur, probably on all islands. *Puccinia coronata* var. *avenae* Fraser & Ledingham [= *P. rhamnii* (Perr.) Wettst.]; II, III, on *Avena sativa* (oats) and *Holcus* (= *Notholcus*) *lanatus*. 146236, 1921, O; H. Although the uredinial state of *P. coronata* closely resembles that of *P. recondita*, also on *Holcus lanatus* in Hawaii, the rusts are readily distinguished by the prominent digitations at the apex of the *P. coronata* teliospore.

*Puccinia cynodontis* Lacroix ex Desm., Pl. Crypt. Ser. III No. 655, 1859; II, III, on *Cynodon dactylon* (= *Capriola dactylon*) (bermudagrass and Tifdwarf; *C. dactylon* × *C. tranvaalensis*). 146178, 1921, O; H; M; 510436, 1987, H; 510437, 1987, O. Telia were scarce and present only in some collections. The uredinial state was common, however (Stevens 1925).

*Puccinia heterospora* Berk. & Curt., J. Linn. Soc. 10: 356, 1868; III (including mesospores), on *Abutilon incanum* (i), *A. menziesii* (e), and *Sida* spp. (i or e) 146195, 1921, M; H; O; N; 510512, 1983, M. This species is common in Hawaii. It is distinguished from *P. malvacearum*, which also occurs on malvaceous hosts, by the abundance of mesospores (unicellular teliospores) in relation to bicellular teliospores, and by the diorchidioid (vertically septate) bicellular teliospores. In some specimens, bicellular teliospores may be absent.

*Puccinia hieracii* (Schum.) Mart., Fl. Mosq. ed. 2: 226, 1817 (= *P. taraxica* Plowr.); II, on *Taraxacum officinale* (dandelion). 146245, 1921, H; 511588, 1987, O. *Puccinia hieracii* var. *hypochaeridis* (no author given) (= *P. hypochaeridis* Oud.); on *Hypochaeris* sp. BPI 076017, 1928, Mo.

*Puccinia hydrocotyles* (Lk.) Cke., Grevillea 9: 14, 1880; II, on *Hydrocotyle verticillata* (marsh pennywort). 146214-5, 1921, O; H; K; Mo.

*Puccinia levata* Hennen & Hodges, Mycologia 73: 1119, 1981 (= *Uredo velata* Ell. & Ever., *Puccinia velata* Arth.); II, on *Chamaesyce* (= *Euphorbia*) *olowaluana* var. *gracilis* (e): 509299-300, 1987, H; and *C. celastroides* (e): 494677, 1987, O. *Puccinia levata* was listed by Stevens (1925) as endemic to Hawaii, but Stevens (1925: 124) also referred to Mexican material of this species. Hennen and Hodges (1981) considered the spermogonial and aecial states of a rust from Mexico to belong to *P. levata*, further suggesting that this rust is not endemic to Hawaii.

*Puccinia leveillei* Mont. in Gay, Fl. Chil. 8: 41, 1852 (= *P. geranii-silvatici* Karst.); III, on *Geranium cuneatum* var. *tridens* (e). 146194, 1921, H; 509296, 1987, M. A rust (146172, 1919) from Maui (Stevens 1925) deposited at BISH as *P. callaquensis* Neg.; II(?), III, on *G. arboreum* (e) is actually *P. leveillei*.

*Puccinia levis* Sacc. & Bizz. var. *tricholaenae* (H. & P. Syd.) Ramachar & Cumm., Mycopath. Mycol. Appl. 25: 44, 1965; II, III, on *Rhynchelytrum repens* (natal red-top grass). 510508, 1986, O. This species is common wherever the host occurs. See the annotation for *P. paspalina* below.

*Puccinia malvacearum* Bert.; Mont. in Gay, Fl. Chil. 8: 43, 1852; III, on *Malva parviflora*, *Abutilon grandifolium*, and *Sida* spp. (Raabe et al. 1981). On *S. fallax* (i) HONQ 8550, 1950, O. See the annotation for *P. heterospora* above.

*Puccinia melanocephala* H. & P. Syd. in Syd. & Butler, Ann. Mycol. 5: 500, 1907; II,

III (= *P. erianthi* Padw. et A. Khan); on *Saccharum officinarum* (sugar cane). 510506, 1987, O. *Puccinia melanocephala* was discovered in Hawaii in 1982 and is now widely distributed on susceptible sugar cane varieties throughout the islands, necessitating the development of resistant varieties. The telial state, previously unknown from Hawaii, was found in a greenhouse during the present study. Its occurrence in the field in Hawaii has not yet been documented.

\* *Puccinia molokaiensis* Cumm., Bull. Torr. Bot. Club 64: 43, 1937; II, III, on *Carex* sp. (Cummins 1937). This rust is currently considered endemic to Hawaii; however, it is rare and known only from original herbarium material, no specimens of which are at BISH. The holotype specimen at Arthur Herbarium (PUR F5559, 1928, Mo) was examined. Another specimen (BPI 086600, 1928, Mo) is known. Future collections and critical comparison of *P. molokaiensis* with other tropical *Carex* rusts, a group in need of more research attention, may lead to eventual revisions (J. Hennen, personal communication).

*Puccinia nakanishikii* Diet., Bot. Jahrb. 34: 585, 1905; II, III, on *Cymbopogon citratus* (lemongrass). 509305, 1986, O. *Puccinia nakanishikii*, known from several locations on Oahu and Maui, is probably found throughout the islands wherever the host occurs (Gardner 1985). Lemongrass may become severely and conspicuously rusted.

*Puccinia oahuensis* Ell. & Ever., Bull. Torr. Bot. Club 22: 435, 1895; II, III, on *Digitaria* spp. 146219, 1921, H; O; 510510, 1987, O. *Puccinia oahuensis* was originally designated an endemic Hawaiian species (Stevens 1925), as the binomial implies. However, *P. oahuensis* appears to be an introduced species first described from Hawaii but not belonging to the endemic flora. Cummins (1943) combined species from other localities with *P. oahuensis*, redefining its range. As cur-

rently defined, *P. oahuensis* is circumglobal throughout warmer regions (Cummins 1971). *Puccinia oahuensis* is common on *Digitaria* spp. throughout Hawaii.

*Puccinia oxalidis* Diet. & Ell. in Diet., Hedwigia 34:291, 1895; II, III (rare), on *Oxalis martiana* (pink wood sorrel) and *O. regnellii* (white wood sorrel). 509304, 1986, O; 510446, 1987, O. *Puccinia oxalidis* has been misidentified in Hawaii as the aecial state of *P. sorghi* (Raabe et al. 1981), and possibly that of *P. purpurea*, both of which are known to occur on *Oxalis* spp. elsewhere (Cummins 1971). However, examination of rust material has shown the uredinial state to be present rather than the aecial, and teliospores, although rare, also have been observed associated with the urediniospores (Gardner 1986). Thus, the aecial states of neither *P. sorghi* nor *P. purpurea* have been confirmed to occur in Hawaii.

*Puccinia paspalina* Cummin., Bull. Torr. Bot. Club 72:211, 1945; II. Early collections of this rust on *Paspalum orbiculare* at BISH were originally labeled *P. huberi*, but were later revised to *P. paspalina* (146208-12, O; H). Arthur (Arthur 1962) placed *P. huberi* in synonymy with *P. levis*, but Cummins (1971) later recognized both *P. huberi* and *P. paspalina* as valid species, with the latter occurring on *Paspalum* hosts and the former on *Panicum* spp. Since the telial state, which would provide conclusive morphological distinctions, was not available, the host affinities specified by Cummins (1971) suggest *P. paspalina* as the probable species on *Paspalum orbiculare*. No verifiable record is currently known for *P. huberi* from Hawaii.

*Puccinia pelargonii-zonalis* Doidge, Bothalia 2(1a):98, 1927; II, on *Pelargonium hortorum* (garden geranium). 510507, 1987, O. *Puccinia pelargonii-zonalis* was first reported from Hawaii in 1967 (McCain and Trujillo 1967). The telial state has not been observed, but the uredinial

state is known from several locations on Oahu and Hawaii. The rust is probably widespread throughout the islands. A specimen at HONQ (051521, 1980, O) recorded on *Begonia* sp. is questionable due to the unusual host for this species.

*Puccinia philippinensis* P. & H. Syd., Philip. J. Sci. 8:266, 1913; II, III, on *Cyperus rotundus* (purple nutsedge). 511590, 1986, O. *Puccinia philippinensis* is here newly reported from Hawaii. This species possibly has been confused in the past with *P. canaliculata*, which it closely resembles and which also occurs on *C. rotundus* in Hawaii (Arthur 1962). See the annotation for *P. canaliculata* above.

*Puccinia phyllostachydis* S. Kusano, Bull. Coll. Agric. Tokyo Imp. Univ. 8:2, 1908; II, on *Phyllostachys* sp. (bamboo). HONQ 10414, 1952, H. The uredinial state of *P. phyllostachydis* is distinguished from that of *Stereostromium corticioides*, also on bamboo in Hawaii, by the presence of paraphyses, which are lacking in *S. corticioides* (Cummins 1971).

*Puccinia polygoni-amphibii* Pers., Syn. Fung. p. 227, 1801; II, III, on *Polygonum punctatum* var. *parviflorum*. 146226, 1921, H; Mo; 511350, 1979, H. Species of *Geranium* are the reported aecial hosts of *Puccinia polygoni-amphibii* (Arthur 1962), but no record is available of spermatogonial or aecial states of *P. polygoni-amphibii* on *Geranium* from Hawaii.

*Puccinia polysora* Underw., Bull. Torr. Bot. Club 24:86, 1897; II, III, on *Zea mays* (corn). 510511, 1984, O. *Puccinia polysora* has no known alternate host (Cummins 1971). The teliospores are characteristically irregularly angular and highly variable in form, with single-celled spores often abundant. This species may be readily distinguished from *P. sorghi*, which also occurs on corn, by the more uniform, symmetrical teliospores of the latter.

*Puccinia purpurea* Cke., Grevillea 5:15, 1876; II, III, on *Sorghum halepense*

(Johnsongrass) and *S. vulgare* (sorghum). 146229-31, 1921, O; 510523, 1985, O. *Puccinia purpurea* is common throughout Hawaii, causing conspicuous infection on its host, a roadside weed. Both uredinial and telial spore states are readily produced, but *P. purpurea* is not known to produce spermogonia and aecia on *Oxalis* spp. in Hawaii, as reported elsewhere (Cummins 1971).

*Puccinia recondita* Rob. ex Desm., Bull. Soc. Bot. Fr. 4:798, 1857; II, III (= *P. clematidis-secalis* Dupias, *P. clematidis* Lagerh., *P. rubigo-vera* DC.); on *Triticum aestivum* (= *T. vulgare*) (wheat). 146177, 1910, O. Also on *Holcus lanatus* (velvetgrass) 494667, 1987, H. *Puccinia recondita* is treated by Cummins (1971) as a species complex with a large number of synonyms. The uredinial state of *P. recondita* may be confused with that of *P. coronata*, which also occurs on *H. lanatus* in Hawaii (Raabe et al. 1981); however, the two species are readily distinguished by their telial states (see the annotation for *P. coronata* above).

*Puccinia sorghi* Schw., Trans. Amer. Phil. Soc. II 4:295, 1832; II, III, on *Zea mays* (corn). 510505, 1987, O. The spermogonial and aecial states of *P. sorghi* occur on *Oxalis* spp. elsewhere (Cummins 1971), but have not been confirmed on *Oxalis* from Hawaii. The rust on *O. martiana* and *O. regnellii* observed in Hawaii is *P. oxalidis* rather than *P. sorghi*, as has been reported (Raabe et al. 1981). *Puccinia sorghi* is readily distinguished from *P. polysora*, which also occurs on corn, by teliospore morphology (see the annotation for *P. polysora* above). Both corn rusts may seriously impact their host, causing economic losses.

*Puccinia stenotaphri* Cumm., Bull. Torr. Bot. Club 87:40, 1960; II, III, on *Stenotaphrum secundatum* (St. Augustine grass). 510442, 1987, H. McCain and Trujillo (1967) reported a rust on this host as *Uromyces ignobilis* (Syd.) Arth. (= *U. tenuicutis* McAlp.). These authors

did not state whether telia were observed, nor is a voucher specimen available. It is therefore not known whether only the uredinial state was observed and misidentified as *U. ignobilis* in the earlier report, or whether both *P. stenotaphri* and *U. tenuicutis* actually occur on St. Augustine grass in Hawaii. Until additional collections of *U. tenuicutis* can be made, the occurrence of this rust in Hawaii remains questionable.

*Puccinia striiformis* Westend. var. *dactylidis* Manners, Trans. Brit. Mycol. Soc. 43:65, 1960; II, III, on *Dactylis glomerata* (orchardgrass). 511586, 1987, H. The rust on orchardgrass was reported previously as *P. graminis* Pers. (Raabe et al. 1981). Although *P. graminis* ssp. *graminicola* Urban is known to occur on *D. glomerata* elsewhere (Cummins 1971), this species lacks paraphyses. The presence of numerous paraphyses in fresh Hawaiian material and a closer correlation with the published description (Cummins 1971) indicates *P. striiformis* var. *dactylidis* is the common rust on orchardgrass in Hawaii. The occurrence of *P. graminis* in Hawaii is therefore not confirmed.

*Puccinia substriata* Ell. & Barth., Erythea 5:47, 1897; II, on *Setaria verticillata* (bristly foxtail). 511587, 1987, O. *Puccinia substriata* also was reported from Hawaii by Cummins (1971) and McCain and Trujillo (1967). McCain and Trujillo (1967) also reported a *Uredo* sp. on *Setaria* sp. These authors did not indicate whether they had determined the *Uredo* to be distinct from the uredinial state of *P. substriata* as implied by noting both rusts in the same publication. No further attempts to identify or characterize the *Uredo* sp. are known.

*Puccinia thaliae* Diet., Hedwigia 38:250, 1899 [= *P. cannae* (Wint.) P. Henn.]; II, III, on *Canna indica* and its horticultural derivatives. 509306, 1987, O. *Canna* rust disease is conspicuous and widespread throughout Hawaii. Infection may be



sufficiently severe that cultivation of the host becomes impractical (Gardner and Martinez 1985).

*Puccinia versicolor* Diet. & Holw. in Holw., Bot. Gaz. 24: 28, 1897; II, on *Heteropogon contortus* (piligrass) (i). 146246, 1909, O; H. The telial state was not seen, but the urediniospores of *P. versicolor* are characteristic of this species.

\**Puccinia vitata* Hennen & Hodges, Mycologia 73: 1116, 1981; 0, III, on *Euphorbia olowaluana* var. *gracilis* (e). 509303, 1987, H. *Puccinia vitata* was described, and is currently recognized, as an endemic, microcyclic rust causing witches' brooms on its endemic host (Gardner 1988a, Hennen and Hodges 1981).

*Puccinia xanthii* Schw., Schr. Nat. Ges. Leipzig 1: 73, 1822; III, on *Xanthium italicum* (cocklebur). 146249, 1915, O; K. St. John (1973) does not recognize *X. italicum* from Hawaii. Only the telial state of the rust was identified on the specimens examined, in agreement with the description that the uredinia and aecia are wanting (Arthur 1962).

*Puccinia zoysiae* Diet., Bot. Jahrb. 32: 48, 1902; II, III, on *Zoysia matrella* (Manilagrass). HONQ 018623, 1973, O. McCain and Trujillo (1967) also reported *P. zoysiae* on *Z. japonica* and *Z. tenuifolia*.

*Pucciniastrum epilobii* Otth, Mitth. Naturb. Ges. Bern 1861: 72 & 74, 1861; II, on *Fuchsia hybrida* and *F. magellanica* (Gardner 1979). 510522, 1987, H. Some authors continue to recognize *Uredo fuchsiae* Arth. & Holw. as a distinct species from *P. epilobii*, based on morphology of the telia (J. Hennen, personal communication). Raabe et al. (1981) list both binomials. However, telia have rarely been observed and have not been reported from Hawaii (Gardner 1979). For this reason, the rust on *Fuchsia* spp. in Hawaii and elsewhere should perhaps not be referred to *Pucciniastrum* in a strict sense. However, a previous work has assumed the rust to be a *Pucciniastrum*

based on uredinial characteristics (Gardner 1979). Until distinctions are possible, the present binomial (*P. epilobii*) is acceptable for the rust on *Fuchsia* in Hawaii.

*Pucciniastrum vaccinii* (Wint.) Jørst., Skr. Vidensk.—Akad. Oslo I 1951(2): 55, 1952; II, (= *P. myrtilli* Schum.) on *Vaccinium reticulatum* (ohelo) (e). 146256, 1921, H; 509294, 509298, 1986, M. As with *P. epilobii* above, the telial state of *P. vaccinii* is not known from Hawaii. However, based on the similarity of uredinial characteristics to those of *P. vaccinii* elsewhere, the present binomial is accepted for general reference.

*Ravenelia spegazziniana* Lindq., Bol. Soc. Argent. Bot. 1: 300, 1946 (= *R. Siliquae* Long); II, on *Acacia farnesiana* (Gardner and Hodges 1985, Stevens 1925). 146269, 1921, O; 510441, 1982, L.

*Stereostratum corticioides* (Berk. & Br.) Magn., Ber. Deut. Bot. Ges. 17: 181, 1899; II, on *Phyllostachys* (= *Bambusa*) *nigra* (black bamboo). 510517, 1986, O. This species is a recent introduction known only on ornamental plantings in Waikiki, where it was collected in December 1986. It is reported here as a new state record. See also the annotation for *Puccinia phyllostachydis* above.

*Tranzschelia discolor* (Fuckel) Tranz. & Litv., J. Bot. 24: 248, 1939 [= *T. punctata* (Pers.) Arth., *T. pruni-spinosae* (Pers.) Diet.]; II, on *Prunus persica* (peach). 146334, 1908, H; M; K; O; 494629, 1987, H. Also on *Chrysobalanus icaco* (coco plum). 511351, 1982, O. *Tranzschelia discolor* may be found wherever its hosts occur in Hawaii.

*Uredinopsis hashiokai* Hirat. f., Monog. Pucciniastreae p. 82, 1936; II, on *Pteridium aquilinum* (bracken fern) (i). 146399, 1909, M; BPI 039221, 1909, M. The single, scant, uredinial specimen at BISH is labeled *U. pteridis* Diet. & Holw. [= *Hyalospora filicum* Diet.; *U. macrosperma* (Cke.) Magn.]. However, in a discussion of the white-spored rusts of ferns, Ziller

(1959:94, 99–100) distinguished *U. hashiokai* from *U. pteridis* on the basis of the arrangement of the spines on the urediniospore surface: “Urediniospores provided the only reliable criteria by which bracken fern rusts can be identified” ... *U. pteridis* has “two opposed vertical rows of cogs’ on the urediniospores.” *Uredinopsis hashiokai* lacks these and also lacks amphispores. Examination of the BISH specimen revealed urediniospores with scattered, irregularly arranged spines, indicating the material to be of *U. hashiokai*. The binomials *U. pteridis*, *U. hashiokai*, and *U. aspera* Faull have all been used in reference to the fern rust in Hawaii (Raabe et al. 1981), but *U. aspera* has been placed in synonymy with *U. hashiokai* (Ziller 1959). Whereas *U. pteridis* is the more widespread of the two rusts in western North America (Ziller 1959), *U. hashiokai* has previously been reported on *P. aquilinum* var. *lanuginosum* from Hawaii (Faull 1938). No fresh material was seen in the present study, and the rust appears to be rare in Hawaii.

\**Uredo hawaiiensis* Arth. in Stevens, Bull. B. P. Bishop Mus. 19 p. 124, 1925; II, on *Carex wahuensis* (= *C. oahuensis*) (e). 500006 (syntype), 1921, H; 509295, 1987, O. *Uredo hawaiiensis* was originally described (Stevens 1925) and is currently considered endemic to Hawaii, as is *C. wahuensis*.

\**Uredo stevensii* Arth. in Stevens, Bull. B. P. Bishop Mus. 19 p. 124, 1925; II, on *Euphorbia clusiaefolia* (e). 500005 (isotype), 1921, K; BPI 155868, 1928, O. As originally described (Stevens 1925), *U. stevensii* is currently considered endemic to Hawaii. This rust is known currently only from original herbarium material of Stevens’ collection (Hennen and Hodges 1981). The meager isotype at BISH was verified in the present study, however.

\**Uredo vulcani* Gardner, Mycol. 80:747, 1988; II, on *Coprosma rhynchocarpa* (pilo) (e) 509308-9 (istoype), 1986, H. This recently discovered species is cur-

rently considered endemic (Gardner 1988b).

\**Uromyces alyxiae* Arth. in Stevens, Bull. B. P. Bishop Mus. 19p. 117, 1925; III, on *Alyxia olivaeformis* Gaud. (maile) (e). 5158 (type), 1921, K; 509292, 1987, O. *Uromyces alyxiae* was originally described and is currently recognized as an endemic Hawaiian species, as is the host. In his annotation, Stevens (1925) emphasized the scarcity of *U. alyxiae*, but more recent observations (Gardner 1987) have indicated it to be more common in certain localities, such as Hawaii Volcanoes National Park. Only the telial state was originally described, and no other spore states are currently known. Although recent studies (Gardner 1987) were unable to demonstrate the life cycle of *U. alyxiae*, this rust is tentatively considered microcyclic in the absence of an apparent alternate host.

*Uromyces bidenticola* Arth., Mycologia 9:71, 1917; II, on *Bidens pilosa* (Spanish needle). 510509, 1987, O. The uredinal state of *U. bidenticola* is commonly found on this weed, but the telial state has not been reported from Hawaii.

*Uromyces dianthi* (Pers.) Niessl, Verh. Naturf. Ver. Brünn 10:162, 1872 [= *U. caryophyllinus* (Schrank) Wint.]; II, on *Dianthus caryophyllus* (carnation). 146401, 1913, O. A second rust, *Puccinia arenariae* (Schum.) Wint., with which *U. dianthi* may have been confused, also has been reported on carnation from Hawaii (Raabe et al. 1981). Unfortunately, no specimens of *P. arenariae* were available for comparison, however. Specimens examined contained only urediniospores. Since aecia and uredinia of *P. arenariae* are wanting (Arthur 1962), the rust observed in this study was confirmed as *U. dianthi*.

*Uromyces euphorbiae* (Cke.) Pk. in Peck, Ann. Rept. N.Y. State Mus. 25:90, 1873 [= *U. proeminens* (DC.) Pass.]; 0, I, II, III, on *Euphorbia hirta* and *E. prostrata*. 146426, 1921, O; H; M; 510518, 1986; O.

*Uromyces euphorbiae* was first reported from Hawaii by Stevens (1925) on *E. serpyllifolia*, which is not recognized by St. John (1973). This host may be referable to *E. hirta*, however. *Uromyces euphorbiae* is common throughout Hawaii and probably occurs on other weedy euphorbiaceous species as well as those listed above. It is one of the few rust fungi in Hawaii for which all spore states are represented and are readily demonstrated.

*Uromyces graminicola* Burr., Bot. Gaz. 9: 188, 1884; II, III (very scarce), on *Panicum nephelophilum*. 146193, 1921, K. The specimen was originally labeled *Puccinia esclavensis* Diet. & Holw., and was the voucher for Stevens' (1925) report of *P. esclavensis* from Hawaii. Stevens noted that the host had been found only once, on the island of Kauai, but was heavily rusted. The identification of the rust was updated to *U. graminicola* by Y. Mäkinen with the notation that "very scarce" teliospores had been found in the specimen. These presumably had been overlooked by Stevens, who appears to have made the original identification only on the basis of the urediniospores. The existence of *P. esclavensis* in Hawaii is therefore questionable. *Uromyces graminicola* also has been recorded on *Panicum maximum* (Guinea grass) from Hawaii (Raabe et al. 1981), but no specimens were available of *U. graminicola* on this host.

*Uromyces lineolatus* (Desm.) Schroet. in Rabh., Fungi Europ. No. 2077, 1876 [= *U. sciripi* (Cart.) Burr.]; II, III, on *Scirpus paludosus* (bulrush) (i). 146438, 1921, O. Only the uredinial state had been noted originally, but examination of the 1921 specimen revealed the telial state as well.

*Uromyces phaseoli* (Pers.) Wint. in Rabh., Krypt. Fl. 1: 157, 1881 [= *U. appendiculatus* (Pers.) Unger]; II, III, on *Vigna catjang* [a host species not recognized from Hawaii (St. John 1973)]. 146425; 1919; O.

*Uromyces phaseoli typica* n. nom., *U. phaseoli* var. *vignae* (Barcl.) Arth., and *U. vignae* Barcl. have variously been recognized either as synonyms of *U. phaseoli* or as separate taxa by individual authors. The rusts of this complex occur on species of *Phaseolus* (bean) and *Vigna* (cow pea, beach pea). Eboh (1986) also recognized *U. appendiculatus* as a separate valid species in Nigeria. In view of the general ambiguity associated with this complex, the bean and cow pea rust in Hawaii is referred, for the present, only to *U. phaseoli* until more definitive observations can be made.

*Uromyces rhynchosporae* Ellis, J. Mycol. 7: 274, 1893; II, on *Rhynchospora lavarum* (e). 146433, 1921, O; Mo.

*Uromyces setaria-italicae* Yosh., Bot. Mag. Tokyo 20: 247, 1906 (= *U. leptodermus* Syd.); II, on *Brachiaria mutica* (= *Panicum barbinode*) (Californiagrass). 146410, 1921, H; O; 510434, 1987, O. The uredinial state of *U. setaria-italicae* is common wherever the host occurs.

*Uromyces striatus medicaginis* (Pass.) Arth., Man. Rusts in U.S. and Can. p. 299, 1962 (= *U. medicaginis* Pass.); II, on *Medicago sativa* (alfalfa). 146420, 1921, O. This rust may be found wherever alfalfa and related species occur.

*Xenosteles* sp.; III, on *Pelea* sp. (e) BPI 123660, 1951, O. This rust found in Makaha Valley is represented only by a meager specimen. The collection had been verified by G. Cummins, with the notation that *Xenosteles* was "a very dubious genus . . . all other spp. of *Xenosteles* occur on Lauraceae." The five species then recognized were listed in the notation. *Xenosteles* is distinguished from *Puccinia* by the presence of a peridium bordering the telia, but observations leading to establishment of the genus may have been erroneous (Cummins 1949, Thirumalachar and Mundkur 1950). The scarcity of material and lack of information on the *Pelea* rust prevent definite con-

clusions. However, the occurrence of this unusual, undescribed rust on an endemic rutaceous host suggests the presence of an additional endemic species that should be further investigated.

The following rust species have been reported from Hawaii but were not seen in the present study and no specimens were available. Since these rusts are well known from other regions, there is little reason to question their occurrence, however. Unfortunately, information on locality, distribution, frequency, and spore state(s) observed was often not reported.

*Phragmidium speciosum* (Fr.) Cke., *Grevillea* 3:171, 1875; on *Rosa* sp. (Raabe et al. 1981). Since both *Phragmidium* species are common on *Rosa* spp. elsewhere, their occurrence in Hawaii is reasonable. However, only the uredinial state of a specimen labeled *P. disciflorum* (= *P. mucronatum*) was seen in this study. See the annotation for *P. mucronatum* above.

*Puccinia antirrhini* Diet. & Holw., *Hedwigia* 36:298, 1897; on *Antirrhinum majus* (snapdragon) (Parris 1940).

*Uredo* sp.; on *Setaria* sp. (McCain and Trujillo 1967). See the annotation for *Puccinia substriata* above. It is presumed that in reporting these rusts in the same publication the authors had reason to accept them as separate species.

The following rust fungi have been reported from Hawaii, but no specimens were available. Based on observations of this study, their occurrence in Hawaii is questionable as noted.

*Kunkelia nitens* (no author given); on *Rubus* sp. (Raabe 1966). See the annotation for *Kuehneola uredinis* above.

*Puccinia arenariae* (Schum.) Wint.; on *Dianthus caryophyllus* (carnation) (Raabe et al. 1981). See the annotation for *Uromyces dianthi* above.

*Puccinia callaquensis* Neg.; on *Geranium arboreum*. See the annotation for *P. leveillei* above.

*Puccinia esclavensis* Diet. & Holw.; on *Panicum nephelophilum*. See the annotation for *Uromyces graminicola* above.

*Puccinia graminis* Pers.; on *Dactylis glomerata* (orchardgrass) (Raabe et al. 1981). See the annotation for *P. striiformis* var. *dactylidis* above.

*Puccinia huberi* P. Henn.; on *Paspalum orbiculare*. See the annotation for *P. paspalina* above.

*Puccinia poarum* Niels. (= *P. epiphylla* Wettst.); on *Poa annua* (annual bluegrass) (G. Baker, unpublished files). See the annotation for *P. brachypodii* var. *poae-nemoralis* above.

*Puccinia sorghi* Schw. The aecial state on *Oxalis* spp. See the annotations for *P. oxalidis* and *P. sorghi* above.

*Puccinia tageticola* Diet. & Holw.; on *Tagetes* sp. (marigold), listed as *P. ?tageticola* (Raabe et al. 1981). Neither the description nor a specimen of this rust was available.

*Uredinopsis pteridis* Diet. & Holw.; on *Pteridium aquilinum*. See the annotation for *U. hashiokai* above.

*Uredo fuchsiae* Arth. & Holw.; on *Fuchsia* spp. (Raabe et al. 1981). See the annotation for *Pucciniastrum epilobii* above.

*Uredo oncidii* P. Henn.; on *Oncidium* sp. (orchid). No local reference is available. The only known report of this rust from Hawaii is from the U.S. Department of Agriculture Index of Plant Diseases (1960), where the binomial is preceded by a question mark. The source of this information is not known.

*Uromyces commelinae* (Speg.) Cke.; on *Commelina diffusa* (day flower) (Raabe et al. 1981). See the annotation for *Phytophthora tecta* above.

*Uromyces tenuicutis* McAlp. [= *U. ignobilis* (Syd.) Arth.]; on *Stenotaphrum secundatum* (St. Augustine grass) (McCain and Trujillo 1967). See the annotation for *Puccinia stenotaphri* above.

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