Some new or poorly known rusts of Brassicaceae

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Received January 21, 1974


New data or amended descriptions are given for Puccinia aberrans, P. arabicola, P. drabae, P. dentariae, P. draboe, P. eutremae, P. oulemaeii, and P. utahensis. P. dentariae var. sublevis var. nov., on Dentaria tenella, and P. drabica sp. nov., on Draba incerta and Draba spp., are named.


[Intitulé du journal]

Introduction

This paper brings together additional host and geographic data and detailed descriptions of several North American rusts of Brassicaceae (Cruciferae). The populations of Puccinia cruciferarum were described by Savile (1964), and Canadian records of the widespread P. holboellii are being presented elsewhere.

All specimens are in DAOM unless otherwise noted. All descriptions are based on mounts in heated lactophenol, and examinations were made with a Carl Zeiss phase-contrast oil-immersion objective. In the citations, Frank., Keew., and Mack. stand for Franklin, Keewatin, and Mackenzie Districts, Northwest Territories.

Taxonomy


Pycnia predominantly epiphyllous, usually small and often lacking on some leaves, perhaps functionless and in process of elimination. Aecia and uredinia lacking. Telia systemic, predominantly hypophyllous, moderately pulverulent. Teliospores (32–)36–61(–67) × 15–32 microns (μ), usually slightly constricted; walls (1.0–)1.2–2.0 μ minimum, 5.5–11(–13) μ maximum at apex, dark yellow-brown or chestnut inside, light yellow to yellow-brown outside, smooth or occasionally faintly rugulose on approximately upper half; pores more or less central under upper cap and more or less septate with small cap; pedicels hyaline, irregularly deciduous but seen to 67 μ long. Mesospores or often teratological three- or four-celled spores seen in several specimens. Incipient germination seen in few specimens.


Smelowskia calycina var. americana reaches a short distance into the B.C. Rockies and somewhat further on the Alberta side. The records suggest that P. aberrans has approximately kept pace with it. This rust resembles P. holboellii in habit and general appearance, but the spores are slightly larger, have irregularly deciduous rather than firm pedicles, are sometimes slightly roughened, and rarely show summer germination.

Puccinia arabicola Ell. & Ev., J. Myc. 6: 119, 1890 [8 Jan. 1891].

This rust, known only from the type specimen taken at Ottawa, Canada, was described as being collected on Arabis sp. by J. Macoun. A presumptive isotype packet in DAOM contains one

1Revised manuscript received March 13, 1974.
leaf with many telia but no aecia. The original label, in Macoun's hand, states the host to be *Arabis confinis*, a name that was evidently applied mainly to *A. divaricata* A. Nels., and the collector to have been Fletcher. Over this fully handwritten label was pasted one of Macoun's printed label forms headed "CANADIAN FUNGI" with the same information and the number "157," written in a different hand. Macoun's printed name as collector was crossed out and "Fletcher" was written below. There is no date on either label. Examination of various specimens bearing the "CANADIAN FUNGI" label shows that the great majority were collected from 1878 to 1881, with a few going back to 1865. The numbers bear no relation to the date of collection.

Arthur and Orton (1921) cite the type as from Ottawa, Canada, on "Arabis sp.," error for *Cardamine douglasi*. James Fletcher was a competent botanist, thoroughly familiar with the Ottawa district flora and most unlikely to have made such an error. Most of his phanerogamic collections are in DAO, but the lack of a date on the rust specimen makes it impossible to associate any phanerogamic voucher positively with it. One sheet of *A. divaricata*, first labelled *A. confinis*, was collected by Fletcher at Ottawa on 19 June 1878 and has basal leaves agreeing well with the rusted leaf. A few other of Fletcher's *Arabis* collections (some made later than 1890) have somewhat similar leaves; but no specimen of *Cardamine douglasi* or other *Cardamine* from the Ottawa district even nearly matches the rusted leaf.

It happens rarely that a flowering stem, taken for identification of adjacent rusted offsets, is actually a different species. I accordingly tried to match the teliospores against other rusts on plants with similar leaves, but with no success. I feel it best to assume that Fletcher's plant was an *Arabis*, and probably *A. divaricata*, taken on 19 June 1878. *P. arabicola* was probably a relict with limited range even before Fletcher collected it. Land clearing and urban development have probably combined to eradicate it. Even before settlement of the Ottawa region, *Arabis* species probably were not common.

Examination of the DAOM material allows a slightly expanded description of the teliospores: 28–44(–46) × 20–27.5(–29) μ, approximately ellipsoid but generally slightly constricted; walls uniformly 1.7–2.3 μ, light chestnut, smooth; germ pores apical (to slightly depressed), and (1/3–)1/2–3/4 depressed, with at most a very small subhyaline cap to 0.5 μ high; pedicels hyaline, deciduous, basal to moderately offset.


≡ *Uredo dentariae* Alb. & Schw., Consp. Fung. 129. 1805.

*Pycnia*; *aecia*, and *uredinia* lacking. Telia localized, amphigenous, and caulicolous, yellow-brown, pulverulent. Teliospores (27.5–)30–50 (–53) × 13–20.5 μ, slightly constricted; walls 1.2–2.3 μ, generally dark yellow-brown inside, grading to light yellow outside, faintly striate with longitudinal ridges about 0.2 μ high × 0.3–0.6 (–0.8) μ wide × 0.8–2.5 μ spacing, occasionally tending to break into warts; germ pores apical with pale yellow cap 1.5–3.5 μ high × 5.5–8 μ wide, and septal (to slightly depressed) with very small cap or none; pedicels hyaline, deciduous, generally basal. Mesospores rare, sometimes teratological.


**Puccinia dentariae** (Alb. & Schw.) Fckl. var. *sublevis* var. nov.

Teliospores (32–)35–54 × 13–19.5 μ, vix (vel modice) constrictae; parietes leves vel pauci costis indistinctissimis diffusisque ca. 0.6–1.5(–2.2) μ lat. × 1.8–6 μ a centro ad centrum.

**ETYMOLOGY:** Nearly smooth, with reference to the spore walls.

**SPECIMEN EXAMINED:** Dentaria tenella Pursh: Hills NW of Corvallis, Oregon, Jackson 1288 (PUR, TYPE).

The ridges, when present, are so faint even under high-contrast phase optics that they must be 0.1 μ or less in height. This rust is appreciably more primitive than var. *dentariae*, suggesting a North American origin for the rust complex and a section of *Dentaria*.

**Puccinia drabae** Rud., Linnaea, 4: 115. 1829.


Pycnia, aecia, and uredinia lacking. Telia from systemic (perennial?) mycelium, on upper flowering stems, pedicels, and siliques, golden brown in bright light. Teliospores (21–23–38–43) × (13–) 14.5–23–(25) μ, (not to) slightly (to moderately) constricted; walls, excluding warts, (1.2–)1.5–2.5 (–2.8) μ (often slightly thicker near pores), distinctly bilaminar with thin dark brown inner layer and thicker yellow to light yellow-brown outer layer; warts nearly hemispherical, about 0.4–0.8–(1.0) μ high × (0.4–)0.6–1.8–(2.0) μ wide, often smallest near septum, occasionally with very delicate connecting ridges; germ pores apical to slightly (~1/3) depressed and (1/2–) 2/3–7/8 depressed (or basal), without distinct cap but often with slight thickening of outer wall; pedicels hyaline, clearly deciduous, basal to slightly (or moderately) offset (Fig. 1). Mesospores occasional in some specimens; three-or four-celled spores occasional in Rimouski Co., Que.


Puccinia drabae was described from near Muggendorf, Bavaria, on Draba aizoides L. (syn. D. iasiocarpa, D. iasiocarpa var. montana, D. montana). European specimens in DAO on D. aizoides (Bavaria, Switzerland, and Hungary), D. hirta L. (Finland), and D. incana L. (Iceland, Finland, and Sweden) fall within range of North American material. Thus there seems to be no important geographic variation. The only appreciable variation noted by me is a tendency to produce small numbers of three- or four-celled spores, seen on D. arabisans, D. aurea, and D. cana near Bic, Rimouski Co., Que., some of the spores being severely teratological. Other, very minor, variants are probably due to inadequate sampling. With localized infection, a spore mont made from several sori generally represents most of the local gene pool; but with systemic infection, all spores in a packet may be genetically identical and not fully representative. There is also no clear indication of host-specialized biotypes in P. drabae. Infection of two or more species at a locality (D. globella and D. lactea at Chesterfield; D. incerta and D. longipes in a col on the Murray Range; D. arabisans, D. aurea, and D. cana near Bic) suggests a relatively broad host range. Systemic infection seems to be universal in P. drabae, all specimens with localized infection proving to be the next species. Systemic infection often has special environmental requirements, and P. drabae seems to be favored by conditions more humid than are typical for some Draba species; for it is found
often in mossy cols or depressions, on late-snow slopes, or on sea cliffs. Thus the xeric high-alpine or high-arctic Drabae perhaps escape infection mainly because of the aridity of their habitats.

Taxonomic and nomenclatural confusion has hitherto prevented a realistic listing of the Canadian hosts of *P. drabae*. Mr. G. A. Mulligan has now devised reliable means of distinguishing even seriously abnormal rusted specimens, and has checked all the North American hosts in DAOM.

*M. Puccinia drabicola* sp. nov.

pycnia, acacia urediniae desunt. Telia amphigena, castanea vel atrobrunnea luce vivida. Teliosporae (26–28–39(–42)) × 16–23.5 μ, medice vel valde constrictae; parietes, verrucis exclusis, (1.2–)1.5–2.2 μ, fere uniformiter perflavobrunnei vel castanei; verrucae ca. 0.2–0.5 μ alt. × 0.3–1.0(–1.2) μ lat., plerumque elongatae vel in cristas irregulares sinuatasque cohaerentes, saepe filis subtilibus junctae; pori germinativi apicales vel leniter depressi, et (1/2–)2/3–7/8 depressi vel raro ad basem, papillis distinctis flavidos rugosis 1.0–2.5(–3.0) μ alt. et 6–8 μ lat. instructi; pedicelli hyalini, decidui, prope basem versus septum leniter (modice) locati. Mesosporae rarissimae (Fig. 2).

*ETYMOLOGY:* *Draba* (the host) and *incola* (inhabitant).


The *Draba cruciata* record is from a sheet in DAO bearing 14 plants: one with *P. drabicola* scattered on basal and, sparingly, cauline leaves; one with *P. drabae*; and 12 healthy.

*Puccinia drabicola* is distinguished from *P. drabae* by its localized habit, deeper color of sori under comparable light, greater minimum length and width of spores, more strongly constricted spores, essentially homogeneous rather than bilaminate spore walls, smaller and much more irregular warts on the spore walls, and very distinct caps on the germ pores.

The type collection came from a dry, wind-swept site, much more arid than is usual for *P. drabae*; and such sites are not uncommon for *P. incerta*. *D. cinerea* grows on both arid and mesic sites; but *Cody 1659*, from a gravel stream bank, has no traces of moss in the rosettes and this site thus also seems to have been relatively arid. It is probable that *P. drabicola* tolerates drier sites than does *P. drabae*; but ecological overlap is indicated by the occurrence of both rusts in a single colony of *D. cruciata*. Note that all three hosts of *P. drabicola* also take *P. drabae*.

**Figs. 1-4.** Teliospores, all × 1500. Fig. 1. *Puccinia drabae* in optical section, showing bilaminate wall, and with partial surface view enclosed by broken line. Fig. 2. *P. drabicola*, as in Fig. 1, showing homogeneous wall, definite pore caps, and irregular pattern of warts on surface. Fig. 3. *P. oudemansii* in surface view. Fig. 4. *P. utahensis* in surface view. In Figs. 3 and 4 the markings are drawn exactly for the central part of each cell; but the depth of wall at the septa and spore edges reduces the clarity of the markings under phase contrast and their rendering cannot be fully relied upon.


Pycnia probably lacking. Aecia and uredinia lacking. Telia localized, hypophyllous or amphigenous, petiolicolous and caulicolous, blackish brown, pulverulent, at first covered by epidermis. Teliospores (26–)28–46(-48) \( \times \) (12–)13–19 (–21) \( \mu \), moderately to strongly constricted, the cells often separating easily; walls (1.2–)1.5–1.8 (–2.2) \( \mu \), sometimes thicker in upper than in lower cell, dark yellow-brown to chestnut, longitudinally striate with ridges about 0.3–0.6 \( \mu \) high \( \times \) 0.4–0.8 \( \mu \) wide \( \times \) 0.8–1.8 (–2.2) \( \mu \) spacing, smooth to occasionally slightly fimbriate and rarely tending to break into warts, running over upper pore caps. Germ pores apical to slightly (rarely 1/3) depressed with yellow to yellow-brown cap 1.3–5 \( \mu \) high \( \times \) 5.5–8.5 \( \mu \) wide, and septal to slightly depressed with small cap. Pedicels hyaline, delicate, and generally deciduous, but seen to 50 \( \mu \) long.

**Specimens examined:** Cochlearia officinalis L. (s. lat.): Mack.: C. Young, 68°56' N 116°56' W, Parmelee 3203. Frank.: 1½ mi NE Longstaff Bluff, Baffin I., about 68°57' N 75°16' W, Parmelee & Seaborn 4146. Keew.: Chesterfield, Savile & Watts 1241; Coral Harbour, Southampton I., CodY 1774A. Extrema edwardsii R. Br.: Frank.: West Foxe I., 64°17' N 75°45' W, Cooch 28; Frobisher Bay, Baffin I., 63°44' N 68°28' W, Swales. Keew.: Chesterfield, Savile & Watts 1016, 1165, 1243, 1259, Savile 1410; Coral Harbour, CodY 1907; Kidney I., Dormer Is., 57°33' N 79°45' W, Morisset 70–244. Que.: Nuvuk, 62°23' N 77°56' W, Gardner; Povungnituk, 59°15' N 77°15' W, Rousseau 159.

The morphological identity of Puccinia cochleariae with *P. extremae* was noted by Jorstad (1932) and Arthur (1934) and is amply confirmed by the study of abundant Canadian material. Spore size varies as much within each host species as between hosts, and other characters are very uniform. The rather sparse occurrence of *Cochlearia*, the habitat of which scarcely overlaps that of Extrema, leaves open the question of whether different biotypes attack the two hosts. *Cochlearia* and *Extrema* seem to be rather closely related within the tribe Synapeae, and it would not be surprising to find that one biotype can attack both plants. *P. extremae* has not been found in the high-arctic islands, although *Extrema* occurs freely and *Cochlearia* sparingly to 82° N.

**Puccinia oudemansii** Tranz. in Syd., Monogr. Ured. 1: 894. 1904.

= Puccinia clementis Garrett, Mycologia, 6: 249. 1914.

*Puccinia oudemansii* was described from Novaya Zemlya and Bering Strait on *Paryya nudicaulis* (L.) Regel (syn. *P. macrocarpa* R. Br., but rendered as *monocarpa* in Sydow). It was also recorded on *P. pinnatifida* Kar. & Kir. in the Kokkamyr Mts. (not located), south of L. Sayram according to Tranzschel (1939) and at 10 000 ft, therefore presumably in Tienshan Range or its outliers (and south rather than north of Kuldja), in Sinkiang, China, near the Kazakhstan border. Garrett later described an apparently identical rust on *Paryya rydbergii* Botsch (*P. platycarpa* Rydb. non Hook. f. & Thomas) from Utah as *Puccinia clementis*. Anderson (1952) recorded *Puccinia oudemansii* from Cape Lisburne, Alaska, on *Parrya nudicaulis* (presumably ssp. *septentrionalis* Hult.). There is also one specimen in DAO on *Parrya nudicaulis* (L.) Regel ssp. *interior* Hult. (Yukon: Moosehide Mtn. near Dawson, Calder & Billard 3107). I have also studied two specimens on *Paryya rydbergii* Botsch from Utah: Bald Mtn., Uinta Mtns., Mrs. Clemens (type of *P. clementis*, PUR); and Mt. Gilbert, 13 000 ft, Uinta Mtns., Summit Co., Maguire et al. 14459 (ex DAO). I find no difference between these specimens except that the upper pore caps in the Yukon specimen tend to be slightly higher than in those from Utah. Only a good series of specimens would show whether this difference is real. *Parrya nudicaulis* should clearly be regarded as the type host; and a lectotype specimen must eventually be selected from whichever of Tranzschel’s cited specimens on this host proves most adequate. In view of the occurrence of three disjunct populations of *Puccinia oudemansii*, the selection of a lectotype may prove to be important.

The following description is based on the three cited specimens. Pycnia unknown, apparently lacking. Aecia and uredinia lacking. Telia amphigenous, blackish brown, pulverulent. Teliospores 27–42 (–44) \( \times \) 14.5–19 (–21) \( \mu \), slightly to moderately constricted; walls (1.0–)1.2–2.0 (–2.2) \( \mu \), yellow-brown to chestnut, distinctly verrucose.
with warts about 0.3–0.5(-0.7) μ high × 0.4–0.7
(-1.0) μ wide × 1.0–1.9 μ spacing, generally
randomly dispersed and round but occasionally
tending to be in longitudinal rows and then often
slightly elongate; germ pores ± apical with
verrucose pale cap 2–3.5(-5) μ high × 6–9 μ
wide, and septal to slightly depressed with
smaller cap; pedicels hyaline, deciduous, basal to
slightly offset. No mesospores seen (Fig. 3).

The distribution patterns of Puccinia oude-
mansii in Asia and North America are curiously
similar, with occurrence on Parrya nudicaulis in
the north and widely disjunct populations on
other host species farther south. The similarity of
the two new-world populations suggests that the
separation dates only from late Pleistocene.

Puccinia utahensis Garrett in Holway, N. Am.
Ured. 1: 46. 1906.

Apparently known only from the type speci-
men, this species is clearly distinct under phase
contrast from Puccinia oudemansii in which
Arthur (1934) submerged it. Examination of the
type, on Thlaspi fendleri A. Gray var. fendleri
(as T. glaucum Nels.), Big Cottonwood Canyon,
Wasatch Mts., Utah, Garrett 779 (PUR 39010),
yields the following description. Telia amphi-
genous, scattered, golden brown to light chestnut.
Teliospores 30–46 × 15–21(-23) μ, (slightly to)
moderately (to strongly) constricted, cells occa-
sionally separating; walls 1.0–2.0 μ excluding
ridges, light yellow-brown, conspicuously rugose
with very irregular, longitudinal, occasionally
broken and somewhat finlike ridges about 0.3–
0.6 μ high × 0.5–1.0 μ diam; germ pores apical
to 1/4 depressed with pale cap 2.0–3.3 μ high ×
6.5–10 μ diam, and septal to 1/4(–1/2) depressed
with smaller cap; pedicels hyaline, (irregularly)
deciduous, basal to slightly offset. Mesospor-
es rare (Fig. 4).

Puccinia utahensis, although apparently related
to P. oudemansii, differs in the markedly paler
spore walls (distinct even in the sors under the
dissecting microscope), somewhat longer spores,
and very different wall markings. It would, in-
deed, have been surprising if two such different
host genera had harbored precisely the same rust.

Discussion

Several of the rusts of Brassicaceae seem to be
related and may be tentatively arranged in an
evolutionary sequence, starting with Puccinia
dentariae var. sublevis (spores smooth or with a
few faint ridges), continuing with P. dentariae
var. dentariae (spores closely but delicately
striate), P. eutremae (spores distinctly striate
with ridges rarely tending to break into warts),
P. utahensis (spores coarsely rugose with ir-
regular ridges), P. oudemansii (spores with mostly
round warts, occasionally elongate), P. drabica-
la (spores with irregular warts), and P. drabae
(spores uniformly with round warts). The last
four species are certainly more advanced than
the preceding ones; but their precise sequence is
doubtful, and they might better be represented as
on separate branches. The sequence also shows
an increasing departure of the germ pores from
the ancestral apical and septal positions. It is
possible that the sequence should be pushed
further back, via Puccinia aberrans, to P. holbo-
ellii and the immediate ancestor of the hetero-
cious P. monoica; but the teliospores of these
rusts are so lacking in distinctive characters that
their relationship to the more modern ones is
doubtful.

Interrelationships of the genera of Brassicaceae
are so doubtful (pessimists have suggested that
only one genus be recognized) that I am loath to
suggest any clues to host relationship from the
meager rust data, which apply to only a few
genera. However, the rust sequence suggests a
relative chronology of the main evolutionary
periods of some genera. Thus it seems clear that
the predominantly arctic-alpine genera Draba
and Parrya underwent very late evolutionary
surges, with many species probably segregating
during the Pleistocene.

Acknowledgments

I thank Dr. J. F. Hennen for the loan of speci-
mens from the Arthur Herbarium; and Mr. G. A.
Mulligan for collecting several specimens, for
checking all rusted Draba specimens, and for end-
less advice on the disposition of other cruciferous
plants.

NOTE ADDED IN PROOF: Under Puccinia drabae
add Draba borealis DC.: Ida.: E. Fork Pahsimera
R., Custer Co., Hitchcock 1572 (ex CAN, issued
as D. praetalia Greene).


