

EVIDENCE OF THE SEED CARRIAGE OF THE EUPHORBIA RUSTS,  
UROMYCES PROEMINENS AND U. DICTOSPERMA.<sup>1</sup>

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As part of the investigations of the life cycles of rusts being carried on by this laboratory, two species of *Uromyces*, *U. proëminens* (DC.) Pass. and *U. dictosperma* Ellis & Ev., have been studied. *U. proëminens* (*U. Euphorbiae* Cooke & Pk.) was studied by Carleton,<sup>2</sup> who showed that this rust was carried by the seed of *Euphorbia dentata* Michx. Arthur<sup>3</sup> showed that this species was autoecious by sowing the aeciospores from aecia on *Euphorbia Preslii* Guss. ("*E. nutans*"), obtaining uredinia and telia on the same host. The writer's attention was attracted to this rust on account of the more or less systemic aecia which persist throughout the season, the heavy production of aecia, uredinia and telia on the fruit, and the evident strains which exist in this rust in the vicinity of Lafayette, Ind. *U. dictosperma* is a species found on *Euphorbia Arkansana* Eng. & Gr. and other species farther west in Nebraska, Kansas, Texas and westward. The life history of this species has been in question, first as to whether the systemic aecia on these hosts belong to this species or to some heteroecious species, and second as to whether uredinia are produced in the life cycle.

*Uromyces proëminens.*

In the fall of 1920, seed was collected from plants of *Euphorbia dentata* which were heavily rusted with telia of this rust. In the field this species does not appear until midsummer, so that by starting the plants in the greenhouse there is no chance for infection from without. The seed was planted the 22d of January and about the time the first leaves were well developed, sixty of the plants were transplanted to a flat. Infection first showed up March 1st, when pycnia appeared upon one capsule of one plant. Following this, other plants showed pycnia or aecia or both. Since there was some variation in the manner of development on the various infected plants, each will be discussed separately.

*Plant 3-4.*

The rust showed on this plant as pycnia upon one of the terminal capsules of the main shoot March 1st. March 27th, two more capsules showed pycnia and both pycnia and aecia appeared on the leaves of the secondary branches arising from the axils of the cotyledons. May 4th, aecia also had appeared on the terminal fruits. No further de-

<sup>1</sup> Contribution from the Botanical Department Purdue University Agricultural Experiment Station.

<sup>2</sup> Carleton, M. A. U. S. Dept. Agri. Bureau Plant Ind. Bull. 63 p. 9-11. 1904.

<sup>3</sup> Arthur, J. C. Bot. Gaz. 29 p. 271. 1900.

velopment of the rust on this plant was noted, the new branches being rust free.

*Plant 3-2.*

This plant showed pycnia April 7th on the secondary branches arising from the axils of the cotyledons. Upon April 19th, pycnia and aecia showed on the secondary branches. Following this throughout the summer up until September 3d, the plant continued to send out new branches most of which were covered with pycnia and aecia. No other stages developed.

*Plant 5-4.*

This plant first showed rust on April 19th, when pycnia appeared covering the capsules and leaves of the two secondary branches. On April 27th, pycnia also appeared upon one capsule of the central shoot and aecia appeared intermixed with the pycnia on the secondary branches. Part of the new branches, as they developed during the summer, showed pycnia and aecia covering the leaves and capsules.

*Plant 6-5.*

On April 19th, pycnia and aecia appeared on the leaves and capsules of the secondary branches, and on May 4th, pycnia showed on the terminal capsules of the main shoot. On May 5th, uredinia appeared scattered over the plant. Shortly afterward, the plant died.

*Plant 9-4.*

On April 19th, pycnia and aecia appeared on the capsules and the leaves of the secondary branches. On April 27th, two of the capsules of the main shoot showed pycnia, followed by aecia May 4th. On May 4th, aecia apparently without pycnia appeared upon the leaves of two new branches. On May 11th, uredinia appeared scattered over the plant. About June 3d, the plant died without showing any further development of the rust.

*Plant 4-4.*

On April 19th, aecia apparently unaccompanied by pycnia appeared on the capsules of the secondary branches. No further development of the rust occurred.

*Plant 4-3.*

On May 11th, this plant showed pycnia on the capsules of the main shoot. On July 3d, several new branches also had pycnia. No further development of the rust occurred.

In all, seven of the sixty plants showed infection either with pycnia or aecia or with both. As indicated above, there was some variation as to the manner in which infection showed and developed. In some cases it appeared first on the terminal capsules of the main shoot, following later on the secondary branches. In some cases the plant outgrew the infection and became rust-free with the dying of the infected branches.

In other cases the infection developed with the plant throughout the season, invading the new branches as they were formed. In general pycnia appeared first, followed shortly by aecia. Occasionally pycnia only appeared and in a few instances apparently only aecia developed.

Aeciospores from the above material were sown on five uninfected plants and uredinia and telia of *U. proëminens* were produced upon the leaves and capsules. Later ten other plants became infected, showing uredinia and telia apparently from the aeciospores and urediniospores of infected plants.

*Uromyces dictosperma.*

Seed from plants of *Euphorbia Arkansana* heavily infested with telia of *U. dictosperma* was collected by Mr. E. Bartholomew at Stockton, Kansas, July 2, 1920, and sent to Dr. J. C. Arthur, who kindly turned the material over to me for this work. This seed was planted August 20, 1920, forty-two plants being obtained. These were transplanted to a flat September 2d, and upon November 12th one plant showed infection, one branch being covered with aecia. This infected branch soon died and all the plants appeared free from rust until the last of March, when a number showed infection. The plant showing aecia in November again showed aecia upon one of its branches. Out of the forty-two plants, eleven showed infection, aecia or pycnia and aecia developing upon one or two branches. Later uredinia and telia appeared on most of the plants apparently from aeciospore infection. The branches infected with aecia soon died without setting seed and the plants finally showed only telia.

Aeciospores from the above described material were sown on uninfected plants and uredinia were produced. The urediniospores in these sori were, however, soon replaced by the characteristic teliospores of *Uromyces dictosperma*. From these cultures it is evident, therefore, that the more or less systemic aecia found on *Euphorbia Arkansana* associated with the teliospores of *U. dictosperma* represent the aecial stage of this rust. Aeciospores from these aecia give rise to uredinia, which, however, as such, exist for only a short time, the urediniospores being replaced by teliospores. *Uromyces dictosperma* in consequence is a full-cycled, autoecious species.

It is considered that the above evidence is sufficient to prove that these two rusts are seed carried. The press of other work has not allowed the question to be investigated as to how this takes place. The investigations of Carleton would indicate that in the case of *Uromyces proëminens* the rust was carried on the surface of the seed since plants from seed treated with corrosive sublimate showed no infection. To explain the production of aecia, it would be necessary to assume, however, that teliospores were carried on the seed and germinated while the plant was still young. In the above experiments the teliospores would have to germinate in the fall without overwintering, while in the field they would germinate in the spring after overwintering. Carleton was not able to obtain germination from the teliospores which were present on the seed at the time of planting. In consequence the manner in which this rust is seed carried will have to be left for future investigations.

