Uredo Eichhorniae, a Potential Biocontrol Agent for Waterhyacinth[1]

by
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Uredo eichhorniae Gonz.-Frag. & Cif. a rust pathogen of waterhyacinth, *Eichhornia crassipes* (Mart.) Solms was discovered in 1927 in the Dominican Republic (Ciferri & Fragoso, 1927). We have found this rust in several locations in Argentina, Uruguay and southeastern Brazil, but could not find it in Venezuela, Puerto Rico, the Dominican Republic and the southeastern U. S. A. *Uredo eichhorniae* has been found only in its uredosporic stage (Charudattan & Conway, 1975), and apparently only in the Western Hemisphere. In South America, the rust is very localized in its occurrence in observed locations. The paucity of information on rusts in the Pontederiaceae has prompted basic studies on the biology and pathology of *U. eichhorniae*.

Symptoms and host damage. Rust-infected waterhyacinths are conspicuous in the field. Pronounced yellowing of leaves along with typical "rusting" are characteristic symptoms incited by this pathogen. Extensive host damage due to *U. eichhorniae* has been observed in some locations in Argentina. However, in the absence of adequate data, it is premature to state the effects of this rust on host populations.

Seasonal occurrence. The occurrence of *U. eichhorniae* in Argentina from July 1975 to June 1976 was monitored monthly for stages other than uredia on waterhyacinth. Two areas, Campana (ca. 60 km northwest of Buenos Aires) and Arroyo Baltazar in Entre Rios province (ca. 50 km north of Campana) were selected as sites. The former, a lagoon off the Río Paraná, is approximately 2 ha in area while the latter, a wayside overflow from a rivulet, is about 200 m². At both sites the waterhyacinth populations have persisted for a number of years.

During the observational period no spermatia, aecia or telia developed on waterhyacinth at these sites. The rust was found in its uredial stage throughout the year in Campana and through July October (winter) and April to June (fall) Arroyo Baltazar.

Relation of rust incidence to climatic conditions. Temperature, relative humidity and precipitation data for 1975-76 from a station of the Fuerza Aerea Argentina, ca. 70 km from the survey sites, were compared with rust incidence. The incidence of *U. eichhorniae* was expressed in terms of the number of rust pustules on infected leaves, averaged from at least 10-20 leaves.

At both sites combined, higher incidences of the rust were seen in July and November of 1975 and in April through June 1976, which represent, respectively, early winter, middle spring and the entire fall. Temperature ranges for these months were as follows: July '75—mean maximum (m. max.) 13.4 C; mean minimum (m. min.) 3.5 C; absolute maximum (a. max.) 21.5 C; absolute minimum (a. min.) −3.0 C. November '75—m. max. 26.0 C; m. min. 11.2 C; a. max. 32.0 C; a. min. 4.8 C. April through June '76—m. max. 21.8 C; m. min. 8.5 C; a. max. 27.0 C; a. min. −4.0 C (Figure 1). The highest rust incidence was recorded in May 1976 for both sites at mean temperatures of 19.5 C (day) and 6.5 C (night) and absolute temperatures of 25.5 C and −0.6 C. The rust incidence was low or absent in summer even though the mean and absolute temperature maxima were lower than those recorded in December (late spring).

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During the observational period, the atmospheric relative humidity (RH) for these sample sites ranged between 68 to 88% (24 h, monthly averages), January or the beginning of summer having had the lowest RH. It should be noted that surrounding waterhyacinth, the RH will be higher than the atmospheric RH, due to closeness of water surface. However, the combination of lower RH and higher mean temperatures in December and January (70 and 68% RH and m. max. temperatures of 30.0 C and 28.2 C, respectively) seemed unfavorable for the rust, because there were sharp declines in pustule numbers at both sites in December, 1975 (Figure 1).

No definite relationship between higher levels of precipitation and rust incidence was evident, even though higher precipitation levels may be expected to favor the rust through an increase in RH.

The fact that *U. eichhorniae* occurs only in its uredial stage on waterhyacinth through most of the year points to the cyclic nature of its uredospore infections. The predominant source of inocolum for infections would have to be the uredia. Maximum incidence of *U. eichhorniae* occurred in the fall under cooler temperatures and average RH above 75%.

Relationship of U. EICHHORNIAE *to other rusts in Pontederiaceae.* Until now, three genera in Pontederiaceae (*Pontederia, Heterantera* and *Eichhornia* (*E. azurea*)) have been reported to be infected by *Uromyces*. The rusts are named, *Uromyces pontederiae* Gerard, *U. heterantherae* Syd. and *U. pontederiae,* respectively (Gerard, 1875, Sydow & Sydow, 1910, and Lindquist & Zoron de Rosengurtt, 1967). The presence of a *Uromyces* sp. on *Eichhornia azurea* (Sw.) Kunth strongly suggests that the rust on *E. crassipes,* (waterhyacinth) would also be a *Uromyces sp.* However, the reclassification of *Uredo eichhorniae* will have to await the discovery of its teliospore.

Spore morphology has been considered a taxonomic tool in rusts. However, the uredospores of the waterhyacinth rust are indistinct from those of *Uromyces pontederiae* (Charudattan & Conway, 1975) or from those of two undescribed rusts on *Reussia* discovered by us (Charudattan & Cordo, unpublished). Comparisons of uredospores and teliospores of rusts in Pontederiaceae for the purpose of their taxonomic separation seem futile because spores of each taxon vary over a range of sizes and shapes. The range of uredospore sizes in this group of rusts is 18.0—39.8 X 18.0—30.6 μm. The uredospore wall thickness varies between 2.0

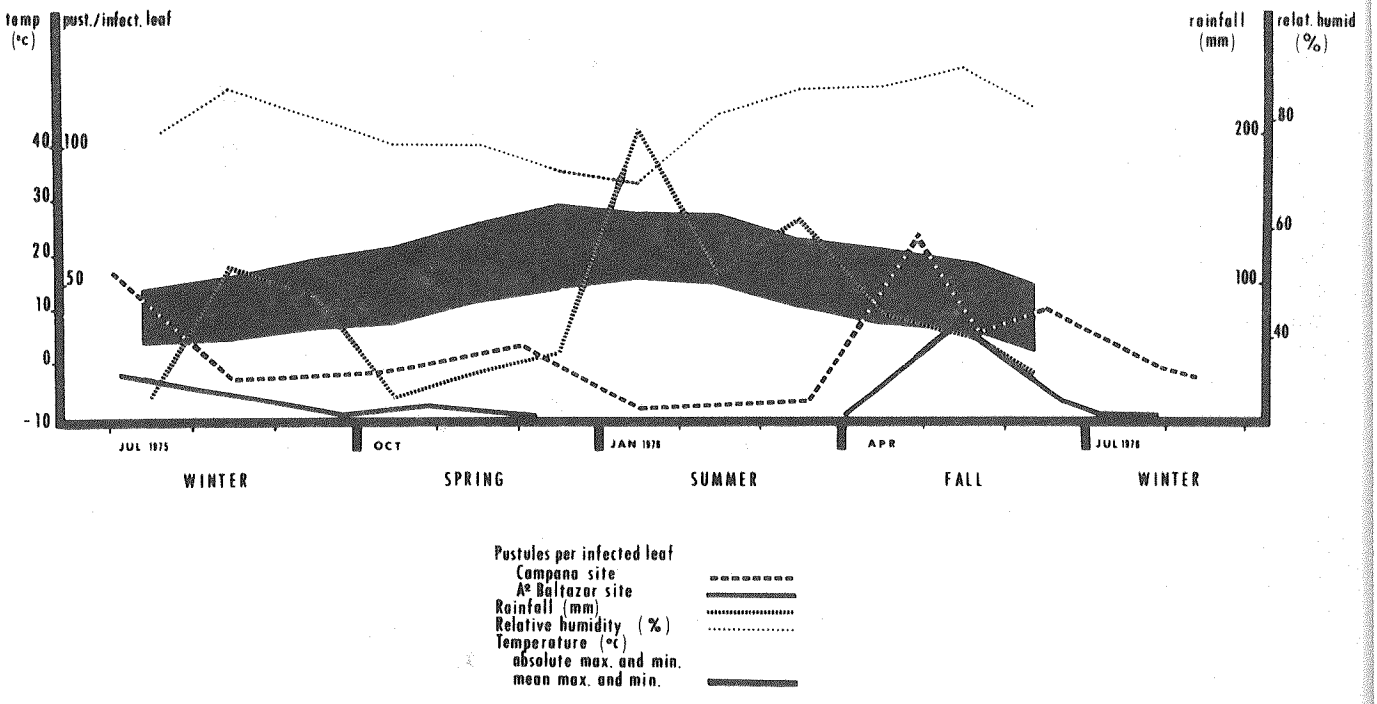

Figure 1. Patterns of temperature, relative humidity and precipitation and the incidence of Uredo eichhorniae on waterhyacinth at two sites in Argentina. Rust incidence was expressed as average number of uredial pustules at sampling sites.

—5.0 μm and the number of germ pores varies between 1—8. However, germ pores are consistently equatorial. Teliospores on *Pontederia* spp., *Heteranthera reniformis* and *E. azurea* range from 20.0—45.0 X 13.3—22.0 μm with wall thickness of 1.0—3.0 μm and apical thickening of 4.0—11.0 μm.

Speciation of rusts in Pontederiaceae will seemingly have to be based on evidence other than spore measurements. Perhaps host specialization will be useful in determining speciation. Until now, we have not been able to infect Florida clones of *Pontederia cordata* L. or *P. lanceolata* Nutt. with *U. eichhorniae* from Argentine waterhyacinths. Similarly, Florida isolates of *Uromyces pontederiae* from *Pontederia spp.* would not infect Florida clones of waterhyacinth. Also, as previously noted (Charudattan & Conway, 1975), the apparent absence in Florida of natural cross-infection of waterhyacinth by *Uromyces pontederiae* from *Pontederia* spp. would strongly suggest a pathogenic specialization among rusts on these two genera. Information on the relationship of *U. eichhorniae* to other rusts in Pontederiaceae would be useful in host range testing with this potential biocontrol.

Laboratory experiments on U. EICHHORNIAE. 1. *Spore collection methods.* For our experimentation, uredospores of the waterhyacinth rust were collected from fields in Argentina and Uruguay or obtained from live, rust-infected plants transported to a quarantine greenhouse in Gainesville from these countries. The lack of abundant supplies of uredospores is presently a limiting factor in our research. To obtain viable collections, uredospores have been gathered from freshly open pustules with the aid of a cyclone spore collector. Uredospores must be obtained from open uredosori. Uredia differ in age and not all uredosori on an infected plant are open at the same time. When immature sori were forced open, they did not yield viable spores. Even open pustules yield only a small percentage of apparently mature spores at a given time, leading to low spore germination percentages in our tests.

Uredosori infected with the hyperparasite *Darluca* sp. must be avoided while collecting uredospores because the presence of *Darluca* spores in uredospore collections leads to poor or no subsequent germination of apparently mature uredospores.

2. *Storage.* Freshly collected uredospores lost viability when maintained over desiccants like Drierite[4] or P_2O_5 at temperatures from 0-25 C. Air drying of freshly collected spores and storing them at 70% RH seems to be the best method yet to retain viability H. *eichhorniae.*

3. *Spore germination.* Uredospores of *U. eichhorniae* germinated over a wide range of temperatures (5 - 25 C) in the laboratory. Spores germinated readily in H_2O, 0.05% nonanol and 0.05% octanol. Germination can be seen as early as 6 h after hydration. Initial hydration or leaching of spores for 24 h with water improved subsequent germination of spores on water agar.

4. *Host inoculation.* The shiny surface of waterhyacinth leaf does not seem to retain uredospores easily, especially under high humidity, when water droplets tend to wash away the inoculum applied to leaves. Sticking agents (mineral oil, glycerine, gelatin and plain agar) were tried. Best results were obtained with 10% glycerine sprayed on leaves before dusting with uredospores. High humidity on leaf surfaces is necessary for *U. eichhorniae* infections. Keeping waterhyacinth plants covered with clear plastic bags for 2 to 4 days after inoculation provided high humidity and successful infections.

Inoculations on waterhyacinth were accomplished at 20 C (day) and 8 C (night) temperatures. Plants were maintained in growth cabinets under 12 h light and 12 h darkness. Successful infection and pustule development were obtained with an Argentine isolate of *U. eichhorniae* on a Florida clone of waterhyacinth. This apparent lack of host resistance suggests that it is possible to establish *U. eichhorniae* in Florida.

Summary. Rust are obligate pathogens with the capacity to reduce host populations. Often, they are host-specific to a single host species and are safe as biocontrols. Once established, they are capable of self-dissemination through wind. A rust, *Puccinia chondrillina* Bub. & Syd., has been successfully used as a biocontrol for skeleton weed, *Chondrilla juncea* L. in Australia (Cullen *et al.*, 1973). Considering these facts, *U. eichhorniae* appears to hold promise as a biological control agent for waterhyacinth. We are continuing our evaluation of this pathogen for control of waterhyacinth.

[4] Mention of a trademark or proprietary product does not constitute a guarantee or warranty of the product by the U.S. Department of Agric. and does not imply its approval to the exclusion of other products that may also be suitable.

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