

HOST SPECIALISATION IN CHONDRILLA FUNGI ^{1/}

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30 - Saint-Christol (France)

^{1/} Presented at the 2nd International Symposium on Biological Control of Weeds. Rome, Italy. Oct. 4-7, 1971

INTRODUCTION

There are many levels of host specialisation in plant fungi, ranging from the highest degree of specificity when only one strain of fungus attacks only one form of the host plant to the apparently polyphagous fungi which attack many plants belonging to different families.

These two extremes of specificity have been particularly important in the study as biological control agents of fungi attacking Chondrilla juncea L. In particular, the work on Puccinia chondrillina Bubak & Syd. and Erysiphe cichoracearum DC. will be used as an illustration.

Skeleton weed, C. juncea, is an important weed of wheat/fallow cultivations in South-East Australia. Before its transport by man the plant occurred from the Mediterranean to Southern Russia. It is a triploid apomict and exists in a large number of geographically restricted forms which are often morphologically distinguishable from each other (Groves, personal communication). Chondrilla is a relatively isolated genus of the tribe Crepidinae, sub-family Cichoriaceae (Compositae). Only one cultivated plant, Lactuca sativa L. (lettuce), is closely related to it. The majority of the Crepidinae are wild plants or weeds, e.g. Taraxacum, Sonchus, Crepis, Hieracium, etc.

PUCCINIA CHONDRILLINA BUBAK & SYD.

This rust fungus is an example of the most extreme specificity. At the beginning of the investigation it was found that certain European strains of the fungus would not attack the Australian forms of C. juncea and that strains of the rust from one part of the Mediterranean were reluctant to attack C. juncea forms from other parts of the plant's range. So great was this specificity that, on occasions, strains of the rust collected only fifty kilometres apart were quite different in their behaviour on the various C. juncea forms.

This extreme specificity has meant that much of the work on the rust was oriented to discovering strains which would attack the Australian forms of C. juncea with sufficient virulence. Such strains have been found in S.E. Italy (Vieste) and in Greece.

High specificity of strains of several Puccinia species to particular forms of their hosts is well known, particularly for the cereal rusts but in this case it is almost certainly increased by the occurrence of apomictic clones of the plant that are very effectively separated geographically.

Although more than sixty crop plants have been exposed experimentally to the Chondrilla rust no infection has occurred. This testing is, in retrospect, scarcely necessary for a fungus with such extreme specificity. P. chondrillina belongs to a group of morphologically very similar macrocyclic monoecious rusts which attack Cichoriaceae such as Taraxacum, Hieracium, Crepis, etc. Some of these, particularly P. hieracii, have an extremely large host range. This rust has been recorded on at least 56 plants, all Cichoriaceae. Others are regarded as very specific, P. chondrillina itself being a good example (Arthur, 1934). Under these circumstances it is evident that Cichoraceous plants would be at much

greater risk to P. chondrillina than would more distantly related plants and the exposure of various Cichoriaceae to P. chondrillina should serve as confirmation of the rust's specificity. Such exposures have been done and all of the following Cichoraceous plants were found to be immune : Cichorium intybus L., Urospermum dalechampii Desf., Crepis taraxicifolia Thuill., C. foetida L., Hypochaeris radicata L., Hieracium pilosella L., Sonchus asper All., S. oleraceus L., Taraxacum officinale Wiggers. There can therefore be little doubt about the specificity of P. chondrillina to C. juncea.

ERYSIPHE CICHORACEARUM DC.

The problems posed by this powdery mildew are quite different from that of P. chondrillina. E. cichoracearum has a host range which includes many different plants in a large number of families. In particular, many of the cultivated plants of the families Compositae, Solanaceae, Leguminosae, Cucurbitaceae and Umbelliferae are recorded as hosts for this mildew. However, Schmitt (1955) was able to show that the strain of this mildew which attacks Phlox sp. was limited to that genus, that which attacked Cucurbita pepo was restricted to Cucurbitaceae and that the strains from the Composites, Zinnia elegans, Inula helenium and Helianthus annuus, and from the Boraginaceous plant, Cerithe major, were the same and restricted to certain Composites and a few Boraginaceae. Moreover, although E. cichoracearum is recorded on a number of plants in Australia (Clare, 1964) it has never been observed on C. juncea suggesting strongly the absence of the strain attacking this weed. However, there is not sufficient morphological difference to distinguish one strain from another and the only method of doing so is by cross-inoculation against the known hosts of the mildew. Had it been possible to discover good distinguishing morphological characters these strains would undoubtedly have been described as separate species.

In the case of the strain of this mildew found on C. juncea the problem has not been to find strains adapted to the Australian forms of C. juncea because most of the European and all of the Australian forms of the plant are readily attacked by the same form of the mildew. Instead the problem has been to demonstrate that the C. juncea strain is so restricted in host range that it will not attack any of the known cultivated hosts of E. cichoracearum. For this purpose a very large testing programme has been undertaken in which three varieties of all the known hosts of the mildew are to be exposed to the strain from C. juncea. In addition a series of cultivated plants not known to be hosts are also to be tested. A total of 111 plants (species and varieties) has been selected.

The work by Schmitt (1955) indicates that the plants that would be most likely to be infected by the Chondrilla strain of E. cichoracearum would be members of the Cichoriaceae and other cultivated Compositae. The failure of this mildew strain to attack a group of wild Cichoriaceae as well as Lactuca sativa and Cichorium endivia in addition to several cultivated Compositae is therefore a very persuasive demonstration of the specificity of the Chondrilla strain.

The testing programme against the other cultivated plants is well underway with every indication that the specificity of the Chondrilla form of E. cichoracearum will be confirmed (Hasan, this meeting).

OTHER CHONDRILLA FUNGI

Other fungi which have been observed to produce damaging infestations on C. juncea pose problems similar to those of E. cichoracearum. The other powdery mildew (Hasan, this meeting), Leveillula taurica Arnaud, is also known from a large number of cultivated hosts. The existence of specialised strains of this mildew which attack restricted groups of plants has been recognised for a long time and their apparent distinctiveness has led certain authors to describe them as separate species of Leveillula (Golovin, 1956). The existence of different host-adapted strains of this fungus has been confirmed by similar cross-inoculation experiments (Ciccarone 1951, Doustard 1959) and, like E. cichoracearum, L. taurica is recorded on a number of plants in Australia (Clare, 1964) but the strain attacking C. juncea is unknown there.

The two Fusarium species, F. moniliforme Sheld and F. oxysporum Schlecht., found invading and destroying the roots of C. juncea also belong to species known to exist as separate host-adapted races (Mas et al 1969, Matta et al 1969, Risser et al 1969). The Chondrilla strains of all these fungal pathogens will have to be tested against a wide variety of cultivated plants before their specificity can be established.

Finally an Alternaria species is frequently found producing large lesions on the leaves of C. juncea. The demonstration of the specificity of this fungus may pose even greater problems although host-adapted forms are known. The additional problems may arise because certain Alternaria species are able to live as parasites as well as on dead plant material (Joly, 1964).

DISCUSSION

The above account of the types of host specialisation found in the fungi attacking C. juncea shows that only one, P. chondrillina, was considered to be specific at the beginning of the work. This species also showed high specificity to various forms of C. juncea and the demonstration of its specificity to Chondrilla posed no great problems.

All the rest (6) belong to species which apparently have large host ranges, within which there is the possible existence of strains more or less specific to restricted groups of plants. Sometimes the specificity of these strains is sufficient to limit them to one genus or to a few closely related genera.

If it proves possible by some of the newer methods to show that the fungal strains that are highly specific to a particular plant, consistently differ also in other ways, these strains should presumably be assigned individual specific status. Such an advance would greatly ease the problems of using fungi for the biological control of weeds.

ACKNOWLEDGMENTS

The work described here was supported by the Australian Wheat Industry Research Council.

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DISCUSSION

GERLING What do you think chances would be of turning the specificity of the fungi. I am referring to the necessity for development of fungus resistant varieties of wheat in Canada. Plant pathologists and agronomists have been raising fungus resistant wheat varieties, but because of continuous genetic changes in the fungi they have to change the varieties from time to time. How would this reflect in your work.

HASAN C. juncea is an apomict and genetic mutations will change the plant clone. There may be some resistance of the host to the rust but this seems to be of minor importance because in Europe we find that C. juncea populations are maintained at a relatively low level in the presence of the rust.

ROBERTS Can you comment on the joint action of these fungi, or their interactions? Are you a believer in the multi-species approach to introductions for biological control or have you any evidence to support the group that believe in this approach?

HASAN Yes, our experience in the field is that most of these fungi can act together in reducing plant populations. For example in Vieste (southeast Italy) we found Puccinia, Erysiphe, Fusarium, and Leveillula taurica acting together. I don't think that the interference among these fungi is as important as the damage they cause when acting together.

END OF DISCUSSION

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