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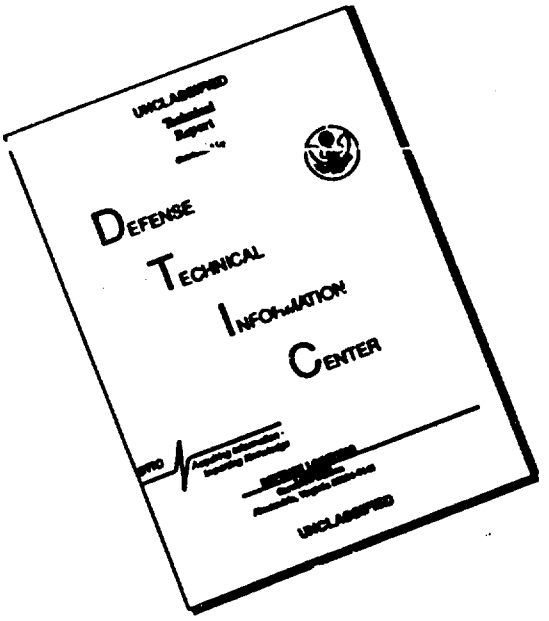

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THE HIBERNATION OF RUSTS

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THE HIBERNATION OF RUSTS

Alviero Dionigi

Rivista Parassit Vegetal
27(9-10): 275-279, 1937 (5 pp)

(Note 1)

Although the problem, and therefore its conclusions, are of a general nature, I refer to the typical wheat rusts: Puccinia glumarum, P. triticina, P. graminis.

Their propagation through time has been attributed to spores of the winter type -- teleutospores; and their propagation in space was believed to be carried out by spores of the summer type -- urediospores. The teleutospores are not capable of infecting directly the wheat since they have to go through an intermediate host that in many cases is not available. Since it is apparent from the numerous control experiments that the infection can not be transmitted by means of the seed (mycoplasm according to Eriksson -- mycelium according to Zukal), even the urediospores have then been regarded as organs capable of transmitting the infection from year to year. Specifically according to some investigators the urediospores, by utilizing the spontaneous weeds as temporary hosts are responsible for infecting the new crop in the fall; or according to other investigators, in the period of spring receptivity.

Because of the general nature of this concept, I shall not bother to report the names of the investigators or their research; I shall instead point out its biological basis and its explicatory value.

With this concept the possibility of the hibernation of the urediospores is considered as a secondary vital function tightly connected to circumstances of incidental nature. (1)

With the above concept one cannot explain the preservation in climates where all the wild graminaceous plants dry out during the summer.

The above reasons made me doubt the accuracy of this explanation given for the hibernation of rusts. I am convinced that the explanation is to be found in the functionality of the urediospores, but as the result of a mechanism harmonizing with the fundamental biological laws.

First of all, why should the teleutospores be regarded as organs of winter procreation and the urediospores as organs of summer multiplication? Why would this organism resort to a display of shapes and functionalities in order to defend itself against the two extremes of the same element which all other organisms fight with the simplest mechanism?

It is more logical to think that the differentiation of the organs of multiplication is related only to the sexual phenomenon and that the nature of winter resistance of the teleutospores is only secondary. It is the result of the need for the fungus to link its vital cycle with that of an intermediate plant-host: Teleutospores "equal" seeds: Urediospores equal agamic propagulums: The same methods of a single vital system.

Then it is also logical to think of an analogous behavior between high and low plants; as a matter of fact of an analogous behavior of all the organisms, plants or animals, which being in direct contact with the environment, must protect themselves from its extremes by exploiting the common properties of all the living matter.

As it is evident from my report in Archivio Botanico (Botanical Archives)[1], the best protection against the adversities of the environment, for the organisms in direct contact with it, is lethargy; its beginning, duration and end, being regulated by the environment itself.[2]

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[1] The adjustment of the organism to the environment -- Notes 1 and 2. Arch. Botanico, f. 2, 1937.

[2] Organisms with more than a biological cycle for every environmental cycle. (see, mentioned notes)

To summarize, four different stages of vitality can be distinguished:

1) The organism is capable of active vitality.

2) The organism under the influence of the environment becomes lethargic.

3) The organism under the influence of the environment regains the ability of living actively.

4) The organism utilizes the most favorable conditions of the environment to display again its maximum activity.

By applying the same principle to the urediospores we have the following stages:

1) During the spring-summer period they are ready to germinate and to spread the infection.

2) After falling on the ground, or on the plant itself, later in the season, under the effect of the summer temperatures they will become lethargic.

3) Under the effect of the winter temperatures they will be able to regain their capacity to germinate.

4) Upon the green organs of the wheat they will develop more or less vigorously according to the temperature, humidity and susceptibility of the host.

Thus are eliminated the objections related to the intervention of the spontaneous grasses; the specific biological phenomenon becomes part of the general harmony.

But I also wish to report some direct experiments:

Susceptible wheat allowed to grow continuously from year to year (through successive sowings), at some time during the summer becomes infected. However, this infection will tend to decrease until eventually it disappears (very early for Puccinia glumarum, somewhat later for P. triticina and P. graminis). The graminaceous plants of various species, do not develop the infection even though they live in close contact with wheat.

Wheat plants sowed in the field and transferred to a place where they are protected from exposure to spores, will become diseased at the usual time and only at that time.

Before coming to a close I wish to point out cases of abnormality that, of necessity, must take place during the process of germination: There will be a certain percentage of spores, certainly very small, that, just as it occurs with the seeds, will avoid lethargy (because of incomplete maturation, exceptional environment, special behavior of the host) by infecting some wheat plants or some wild graminaceous plants: it will always be a question of a few sporadic cases.

As far as the experiments on artificial germination, I can repeat what I stated for the seeds: "The stimuli ordinarily and arbitrarily chosen, believed to be the most favorable for the germination, only exceptionally correspond to the natural ones. Very often they are the very same stimuli from which the organism must defend itself in natural conditions, in order not to be stirred before the right time. In short they are stimuli that least of all will encourage a germinative reaction." In our case, some of the spores not yet turned lethargic will indeed germinate, but later, only in abnormal cases will they manifest themselves, giving us the false impression of a natural law.

From the Royal Experimental Station of Wheat Cultivation

"Nazareno Strampelli" in Rieti

It can no longer be doubted that the perpetuation from one year to the next of the wheat rusts can take place without the necessary passage through the ecidiosporic form.

Either the urediospore, through passages from one graminaceous host to another, maintains its identity and infects the new sowings, or else the very same urediospore grown on the wheat in the late spring keeps its viability for several months, and is successful in infecting the new wheat.

As far as the longevity of the urediospores, asserted by some investigators but not observed by others, Dionigi offers a new explanation; he believes that because of the action of definite external conditions the urediospores tend to become lethargic (dormant life). The main characteristic of dormant life should be a greater resistance to the action of time and of certain external factors (especially temperature and humidity): If further observations in this general direction will confirm the hypothesis here presented, one cay say that a major step in the study of the perpetuation and the diffusion of the rusts has been taken.

l.m.