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A. TIITS

ON THE ETIOLOGY AND PATHOLOGY OF VIRAL PHYLLODIES OF PLANTS.

III. About the red clover phyllody occurring in Latvia

A. TIITS. TAIMEDE VIIRUSLIKE ROHEÕIELISUSTE ETIOLOOGIAST JA PATOLOOGIAST.

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A. ТИИТС. ОБ ЭТИОЛОГИИ И ПАТОЛОГИИ ВИРУСНЫХ ПОЗЕЛЕНЕНИЙ ЛЕПЕСТКОВ РАСТЕНИЙ.

III. О наблюдаемом в Латвии позеленении лепестков красного клевера

Aster yellows type virus [or mycoplasma-like organism (see Doi, Teranaka, Yora, Asuyama, 1967; Maramorosch, Shikata, Granados, 1968; Davis, Whitcomb, Steere, 1968)] is observed only on garden strawberries and on white clover in the Estonian SSR (Тийтс, 1968). In the Latvian SSR this type of pathogene also occurs on corn thistle, dandelion, red clover, crimson clover, garden or paniculate phlox (Ilse Zola and Mara Kilevičs — personal communication) besides the plants mentioned above. Examples of Latvian diseased plants (clovers, phlox) were handed over to the Institute of Experimental Biology of the Academy of Sciences of the Estonian SSR in 1967. The present author has turned his attention especially to the diseased red clover plants, to the rapidly spreading disease in Latvia lately, and has so far made the following observations.

Symptomatology

The normal pinkish red-coloured floral heads of red clover (*Trifolium pratense* L.) were replaced in infected plants by heads which were green and modified in shape. There could be seen four types of flower symptoms.

1. Some floral heads showed excessive proliferation leading to the production of cauliflower-like structures (Fig. 6) such as Grancini observed in Italy (Bos, Grancini, 1965). In this case most of the very little flower buds did not develop to flowers or phylloid formations described below. The cauliflower-like appearance remained for a long time until the flower heads died.

2. Other heads or part of heads had individual flowers whose vexillum became leafy and green. In some cases the carpel, too, became a green leaf-like appendage like the vexillum had (Fig. 1). If it was intermediate between leaf and pod, there could be seen two ovule-like formations on the edge (Fig. 2c).

These vexillum leaves and carpel leaves in phylloid heads were not of the triplet type typical of clover, but they represented a single leaf like the first leaf of the red clover seedlings (Fig. 1). In most cases only the vexillum was phylloid, but the carpel formed a long pistil, a pod, whose ovary only was lengthened and the style and stigma reduced, or there was

trace of them (Fig. 2*b*). In ovules embryos could be seen, only they had "meagre" seed-lobes, i. e., they were lacking in feeding matter (feeding tissue). These ovules died without forming seeds with germinating ability or, continuing development, formed sprouts instead of seeds. This phenomenon is discussed in the present paper as the third symptom type.

3. As mentioned above, one ovule, or in some cases both ovules (embryo) in ovary (pod) began sprouting and seemed to have the appearance of normal seedlings (Fig. 3). If the embryo began sprouting the pod opened and the sprout pressed out (Fig. 2*b* and 4). These sprouts had not roots, but they had a good rooting ability. In soil the roots developed in the place where the "bump" was — a trace of the seed coat on the base of the ovule-sprout (Fig. 5).

4. Another type of sprouting was the common type, the common proliferation, i. e., the development of sprouts from the axils of the floral organs. In many cases these sprouts were similar to the ovule-sprouts described above, only they had no trace of seed coat and the sprout did not grow out from the pod (carpel) edge. There was no pistil at all.

In some cases these sprouts were fruiting-type and had also floral heads, which were also antholysed (Fig. 6).

Identification of Latvian and Estonian pathogene isolates

The pathogene transmitted by grafting from diseased red clover (Latvian) to white clover seedlings. Result in succesful interspecific grafts, stunting, a pronounced witches' broom growth and antholysis appeared on white clover after 3—6 weeks. The symptoms are indistinguishable from Estonian white clover phyllody and from those reported by several authors describing clover phyllody, strawberry green petal, and aster yellows. See for example the effect of aster yellows on clover species as studied by Halisky et al. (1958) or white clover phyllody after natural infection in the Netherlands (Bos, 1959) and in the Roumanian SR (Ploaie, 1966).

Discussion

The occurrence of all the symptoms described in one diseased red clover or even in one floral head shows that the plant has not only common physiological processes, but there are also local ones in every part which is changeable. It is in accord with Wardlaw's (1957) theory concerning the floral meristem function as a reaction system with "switch mechanisms" which turn on and turn off the gene-controlled processes involved in producing various appendages. A particular gene only becomes appropriate to its activity, and the changes induced by it in the reaction system (or in the protoplasmic substratum) prepare the way for the action of certain other genes.

In virus-infected (or infected with mycoplasma-like organisms) plants the physiological situation is changed to one or another extent. The hormone balance is also changed (a changed amount or inhibition/promotion of auxins and gibberellins, see Diener, 1963; Будагян, Ложникова, Гольдин, 1967, and other recent reviews and papers), which according to Wittwer and Tolbert (1960) "trigger the switch mechanism", i. e., the cell differentiation in floral meristem can be correlated with particular patterns of chromosomal DNA resulting from hormone action.

Although the question of the initiation and development of embryo



Fig. 1. A single diseased red clover flower whose all parts are phylloid (the calyx is removed). Enlargement 5X.

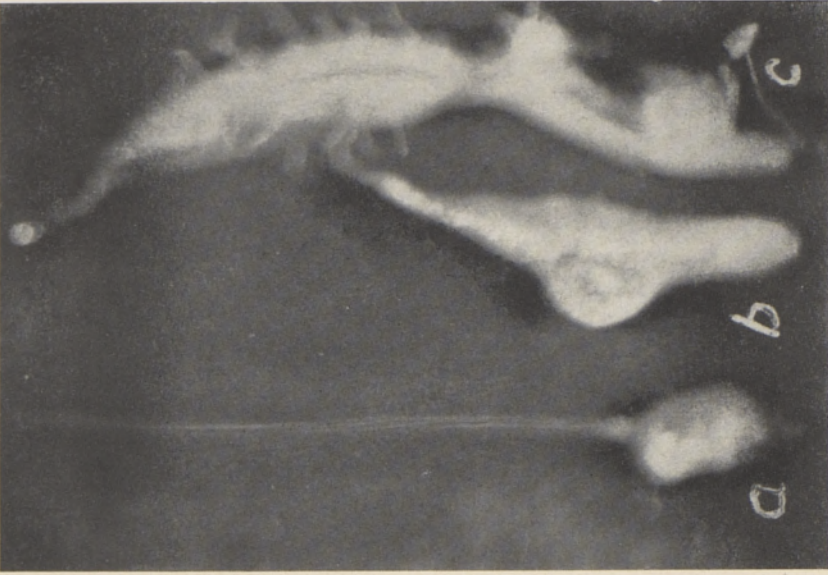


Fig. 2. Normal (a) and changed (b, c) pistils of red clover (c — reverted pistils with the reverted ovules; on the base unite the nearly normal stamen). Enlargement 10X.

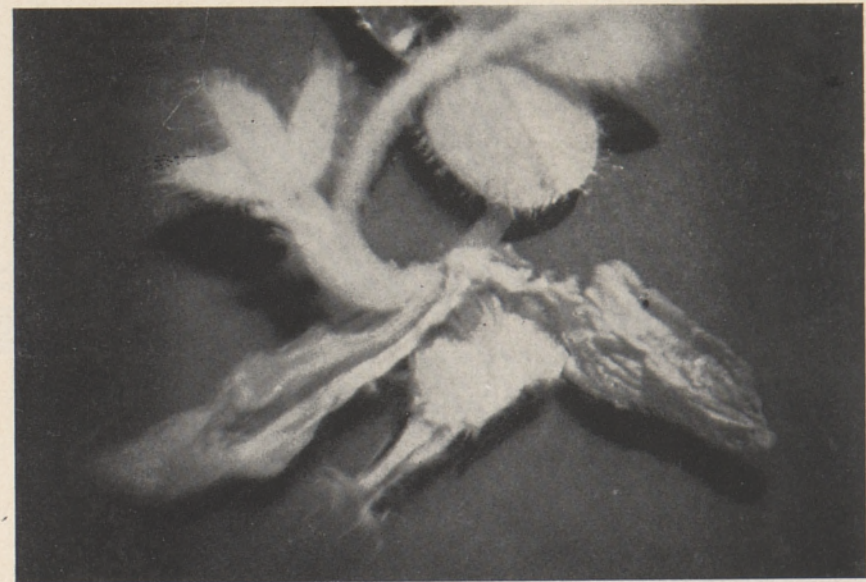


Fig. 3. The ovule-sprout. Enlargement 5 X.



Fig. 4. Opened by cutting the pod with sprouting-started ovule (see the same whole pod in Fig. 2b). Enlargement 15 X.

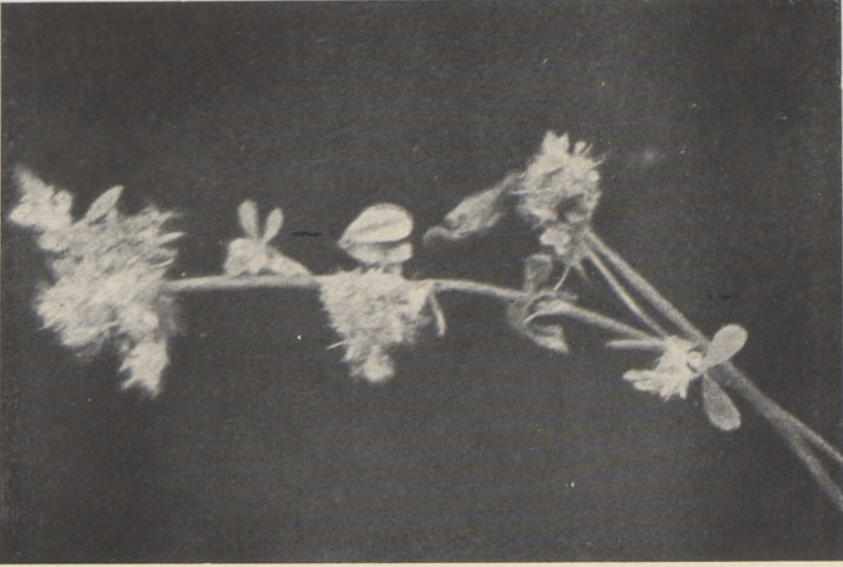


Fig. 6. The "three-storied" floral head of diseased red clover [the most of individual flowers (rudiments) in individual floral heads constitute the "cauliflower"]].

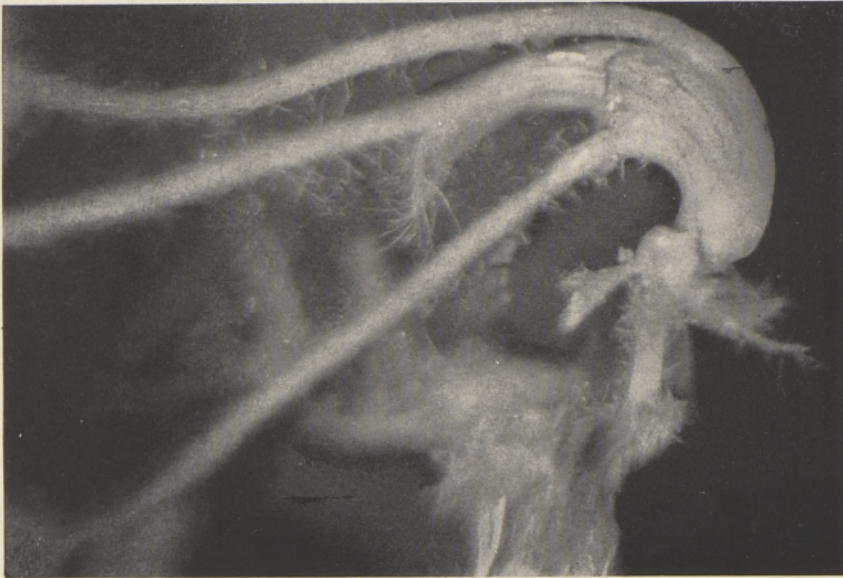


Fig. 5. The ovule-sprout with the trace of seed coat. Enlargement 5 X.

belong to another problem, also in single-celled and multicelled embryo, the chromosomal DNA at specific sites become active under different hormone (auxins, cytokinins and gibberellins) balances, i.e., cell differentiation can be correlated with particular puffing patterns of chromosomal DNA resulting from the hormone action (Torrey, 1966). Only the situation is somewhat more complicated because there operate hormones of flower as well as of embryo.

Another and different answer to the problem of embryogenesis in diseased clover plants is that the pathogene has itself a devastating effect on the megasporogenesis (Caldwell, 1952) or on other processes in the ovule. In that case in pathogene-free ovule or in ovule in which pathogene concentration is low and embryo can develop, only the level of hormones can influence the development to the sprout.

It is interesting to know what kind the flowers of the plants growing from ovule-sprouts will be, phyllod or normal ones, i.e., are the plants free from the virus or not? These and other aspects of the problem are under investigation.

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