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Transactions

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VOL. XLVI.

A NOTE ON THE PATHOLOGICAL MORPHOLOGY OF CINTRACTIA SPINIFICIS (LUDW.) MCALP.

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[Read November 10, 1921.]

PLATE I.

The fungus now known as *Cintractia spinificis* was described, in 1893, by Ludwig from material collected by Mr. J. G. O. Tepper, near Port Adelaide. In the original description the fungus, which was placed in the genus *Ustilago*, was stated to occur on the female inflorescences, destroying the ovaries.

In his monograph on "The Smuts of Australia" (1910) McAlpine redescribed the fungus, transferred it to the genus, *Cintractia*, and gave an account of the method of spore formation and germination.

The purpose of this note is twofold—first, to place on record the presence of the fungus in the male inflorescences; and, second, to describe certain modifications of the host occurring in both male and female inflorescences, due to the presence of the parasite.

Cintractia spinificis was first noted on the male inflorescences of *Spinifex hirsutus*, in February, 1918, at Wright Island, Encounter Bay. The season was then far advanced, and almost all the spores were shed; there was, however, sufficient evidence to determine the fungus provisionally. In subsequent seasons—January, 1919 and 1920—it has been found in abundance at Victor Harbour, occurring on the male as frequently as on the female inflorescences. It has also been found at Grange, not far from the type locality in which

Tepper first collected it on the female. The smut is less conspicuous on the male inflorescences, nor is so large a spore mass formed, which may account for it being overlooked by previous collectors.

PATHOLOGICAL CHANGES IN THE HOST.

The inflorescences of the "spiny rolling grass" are common and conspicuous objects along the coastal dunes of South Australia. The salient features of the normal inflorescences will first be described, then the pathological changes noted.

The normal male inflorescence is a roughly spherical head, about 15 cms. in diameter, borne on a stout upright stem. It consists of an aggregation of stiff secondary axes, each arising in the axil of a bract, upon which the spikelets are borne. Below the terminal head there is usually one, sometimes two, smaller lateral clusters of secondary axes. Each secondary axis is a stout structure about 7 or 8 cms. long, bearing a group of 10 to 20 irregularly spirally arranged spikelets distributed over the middle third of its length. The upper and lower portions of the axis bear no spikelets, the upper part terminating in a stiff tapering spine. The spikelet is composed of two sterile glumes and two flowering glumes, or three sterile and one flowering glume. The flower consists of glume, pale, two broad lodicules, and three stamens. The axis of the flower ends abruptly with the stamens; no ovary rudiment has been seen in the flowers examined.

The smutted male inflorescences are much slenderer and more diffuse (pl. i., fig. 1). The main differences are:—

- (a) Greater elongation of the internodes of the upright stem. In the smutted specimens the average length of internode between the terminal head and the small lateral cluster, next below it, was 9.4 cms. as against 6.7 cms. in healthy specimens.
- (b) Reduction in the number of secondary axes bearing spikelets in the inflorescence; an average of 16 per head in the smutted specimens as against 64 in the healthy specimens.

- (c) The closer aggregation of the spikelets and an increase in their number per secondary axis.

The smutted male spikelets consist of the two sterile glumes and two florets. Each has the fertile glume, pale, and three stamens. No lodicules were seen (text fig. 1), the anthers are about normal length, but contain no pollen, and the filaments do not elongate. No ovary recognizable as such is present, but the axis of the flower elongates above the point of stamen insertion, producing an irregular conical mass

1.7 mm. long. This, in the ripe smut gall, consists of a central core of host tissue coated by the spore mass, which is bounded externally by the usual white skin seen in *Cintractias*.

As is well known, the normal female inflorescence of *Syntherisma hirsutus* is a large globular head, consisting of radiating spines, 40 cms., or even more, in diameter. This is borne, terminally, on a stout erect stem, and below it is one, or sometimes two, small lateral groups of secondary axes, bearing flowers. The head itself is not more than 4 or 5 cms. above the node below, and when ripe is readily detached by snapping off the axis at an absciss region immediately above the node. It then blows away, distributing the fruits as it breaks up. The head is a complicated system of secondary axes, arising in the axils of chaffy bracts, about 8 cms. long. The majority of these axes are long tapering spines, averaging 17 cms. (13.5-20 cms.), which are sterile. They are borne in groups of 6-12 or more, each group representing a branch system with exceedingly short internodes. These spines form the spring-like "legs" of the tumble weed, and are a most characteristic feature of the plant. In each group of sterile spines are a few (1-4) shorter and stouter spines, 10-12 cms. long (text fig. 2). These are the fertile secondary axes, each of which has a single spikelet at its extreme base. The spikelet consists of three sterile glumes (or two sterile and one abortive male flower) and one fertile glume. The flower has glume, pale, three stamens with minute anthers borne on filaments as long as the ripe grain, and an ovary.

The diseased female inflorescence is strikingly different from the normal (pl. i., fig. 2). The main differences are:—

- (a) Elongation of the internode below the terminal head.
- (b) Complete absence of the long sterile spines which are so obvious in the normal inflorescence. A few sterile spines may be present, but these are shorter than the fertile spines, of which the head is largely built up.

- (c) The spikelets are borne 1.5-4 cms. above the base of the fertile secondary axes, which are half as long again as normal, i.e., up to 15 cms.

The smutted female spikelet consists of two sterile glumes and two fertile. Both the florets are much modified by the fungus (text fig. 4), but the modifications are the same in each flower, i.e., the lower floret, normally an abortive male, behaves like a female. The florets have glume and pale, both longer than usual, the latter being often involved in the smut gall. No stamens have been recognized, the whole of each floral axis above the pale being one elongate, rarely bifurcate, smutty mass (text fig. 5).

GENERAL.

Various observations as to the effect of parasitic fungi upon the flowers of the host are summarized by von Tuben⁽¹⁾.

Owing to the extent of gall formation induced by the fungus, it is not possible to say if ovaries are actually developed in male flowers of *Spinifex hirsutus* (cf. the cases cited by Tuben⁽¹⁾ of *Carex praecox* with *U. caricis*, *Buchloe dactyloides* with *T. buchleana*, and *Andropogon prostratis* with *U. andropogonis*). But in place of the normally abbreviated floral axis a more or less extensive smut gall is developed, resembling that formed in the female flower, except that in the male inflorescences it is usually somewhat smaller. A similar prolongation of the axis is seen in the axil of the third glume of the female spikelet. This glume, it will be remembered, is either sterile or subtends a male flower in the healthy inflorescence.

In a paper on *Tilletia foetens*, Barrus⁽²⁾ cites observations by Adler, Appel, and Miczynski upon wheat affected by stinking smut to the effect that the diseased heads are looser than normal and of greater length, though Barrus' own observations showed that the infected heads were rather shorter. He notes that more grains are found in a smutted ear of wheat than in a normal one of equal length, there being more ovaries per spikelet in the former case. So in *Spinifex hirsutus* two smut masses form per female spikelet, though the healthy flower has but a single ovary.

The most obvious pathological deformation is the complete absence of the long sterile axes or spines of the normal female inflorescence. Thus the smutted head has not the same potentiality for distribution as the healthy one, for it cannot roll about in the same way. It was probably this feature that led to the earlier recognition of the fungus on the female plants. More interesting is the development of structures resembling those formed in female flowers upon the male, which, though they are not so definite as in the case of the smuts, referred to above, yet seem to merit brief description.

DESCRIPTION OF PLATE I.

Fig. 1. Male inflorescence of *Spinifex hirsutus* infected with *Cintractia spinifidis*, showing the reduced number of spikelet-bearing axes and an increase in the number of spikelets above the normal.

Fig. 2. Female inflorescence of *S. hirsutus* with *C. spinifidis*, showing the looser structure, the absence of long, sterile spines, and the spikelets some 2 cms. above the base of the spikelet-bearing axes, abnormalities due to the presence of the fungus.

(1) Tuben⁽¹⁾ and Smith, "Diseases of Plants," 1897, pp. 26-29.

(2) Barrus, M. F., "Observations on the Pathological Morphology of Stinking Smut of Wheat," *Phytopathology*, VI., pp. 21-28, 1916.

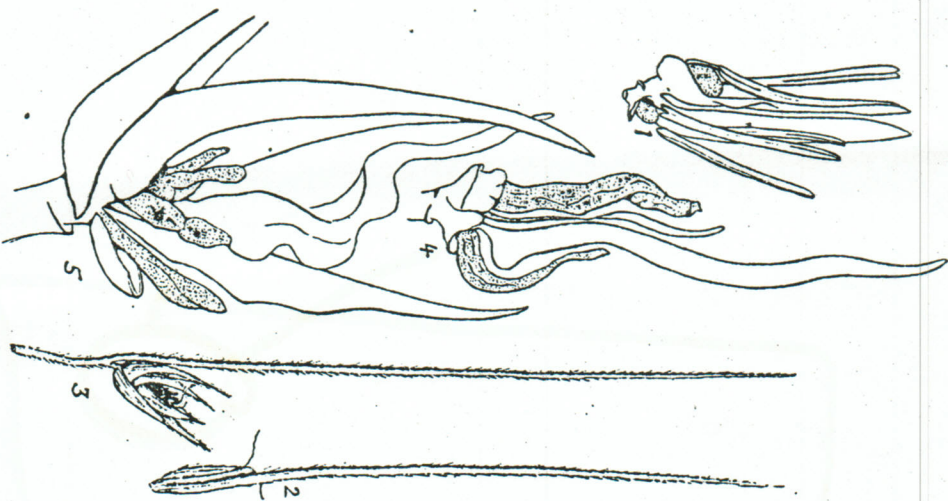


Fig. 1. Smutted male spikelet with two flowers; the glumes are all cut away. The stamens are sterile, the filaments do not elongate, but the anthers are not smutted. A central smut-body has formed (stippled). $\times 5$.

Fig. 2. Normal female secondary axis, with spikelet at its extreme base. About natural size.

Fig. 3. Smutted female secondary axis, of greater length than normal, with the diseased spikelets 2 cms. above the base. About natural size.

Fig. 4. Smutted female spikelet with two flowers, the glumes all being cut away. The pales are left, that of the upper flower being smutted. Note the elongate smut mass that replaces the ovary (stippled). $\times 5$.

Fig. 5. Smutted female spikelet as above. The lower sterile glume is removed and the lower fertile glume is partly cut away. The upper pale is hypertrophied and involved in the smut gall. The galled ovary of this flower is bifurcate. $\times 5$.

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