DEPARTMENT OF BIOLOGY

VOLUME II 1950 NUMBER 12

STUDIES IN AUSTRALIAN ERGOTS

1. *Claviceps pusilla* Cesati

By

R. F. N. LANGDON, M.AGR.SC.
Department of Biology, University of Queensland.

UNIVERSITY OF QUEENSLAND PRESS
BRISBANE

DATE OF PUBLICATION
12th APRIL, 1950

STUDIES IN AUSTRALIAN ERGOTS

1. *Claviceps pusilla* Cesati.

By R. F. N. LANGDON, M.Agr.Sc.,

Department of Botany, University of Queensland.

Various species of the genus *Claviceps* occur in many countries as parasites of the ovaries of grasses and sedges. To these fungi and to the diseases they cause the term " ergot " is applied. The presence of ergot of cereals and grasses in Australia was mentioned by McAlpine (1894), this being the first record of the occurrence of ergot in this country. The fungus, *Claviceps purpurea* (Fr.) Tul., had probably been introduced with imported cereal or grass seed. The only other species of *Claviceps* known to occur in Australia prior to 1940 was *Claviceps paspali* Stev. & Hall. This ergot was apparently introduced not long before 1935, and each summer since 1935 it has caused disease in *Paspalum dilatatum*, often in epiphytotic proportions. In 1940, ergot of many native grasses in Queensland was observed, and the presence of several indigenous species of *Claviceps* was established (Langdon 1941, 1942A). One of these, *Claviceps pusilla* Ces., had been described many years before on *Bothriochloa ischaemum* (=*Andropogon ischaemum*) in Italy (Cesati 1861). Although this ergot has been known for a long time, the only record of it between 1861 and 1941 is a mention of its occurrence in Yugoslavia (Ranojevic, 1914).

In south-eastern Queensland, *Claviceps pusilla* is not uncommon in the latter part of the summer and in the autumn on a number of native grasses. During 1940 and 1941, and since 1946, the author has been able to make field and laboratory studies of this fungus and the disease it causes in grasses. The results of this work are recorded in this paper.

MORPHOLOGY.

Claviceps pusilla Cesati. Comment. Soc. Crittog. Ital. 1.64.1861.

Sclerotia dark brown to black, cylindrical, tapering slightly and rounded at the ends ; surface minutely wrinkled, with several shallow longitudinal furrows. Stromata one to several on each sclerotium. Stipes pale straw colour, glabrous, with a waxy appearance, 3-15 mm. long, sometimes reaching 30 mm. in old age ; tufts of white hyphae persistent round the base, but most prominent during early stages of development of the stromata. Capitula globose, dark straw colour, prominently papillate at maturity, 0.5-1.0 mm. diameter ; a collar-like appendage surrounds the base of the capitulum at its junction with the stipe. Perithecia subglobose, 220-300 × 125-165 μ. Asci cylindrical, rounded at the apex, tapering at the base, hyaline, 55-160 μ. Ascopores 8, filiform, hyaline, almost equalling the ascus in length. Conidia hyaline, granular, sometimes biguttulate, mostly triangular in general outline, some elliptic, 10-15.5 × 5.0-7.5 μ.

The description of *Claviceps pusilla* by Cesati was short and dealt only with characters of the stromata, but his illustrations of the fungus leave no doubt that the ergot from Queensland is the same species.

The dimensions of the sclerotia vary according to the size of the spikelets of the host on which they develop. The sclerotia are usually about the length of the spikelets of the host, and rarely protrude very far beyond the ends of the glumes. The diameter of the sclerotia also depends on the species of host. The largest sclerotia observed were those from *Themeda australis* which were up to 8 × 2 mm. Some figures for other hosts are given in Table I.

Some notes on the appearance of germinating sclerotia and an amendment of Cesati's figure for the ascal length of *Claviceps pusilla* have been published previously (Langdon 1942A).

The number of stromata produced by a sclerotium of *Claviceps* varies, and in general it may be said that there is a correlation between the size of a sclerotium and the number of stromata produced. Barger (1931) states that the sclerotia of *Claviceps purpurea*, which are on the average 14.6 mm. long and up to 6.5 mm. in diameter, often produce 15 and sometimes as many as 60 stromata. During her studies of the ergot of *Zizania*, Fyles (1916) observed up to 48 stromata and rarely less than 20 stromata on the sclerotia. She did not mention the size of the sclerotia from *Zizania*, but the illustrations in her paper show that they were similar to the sclerotia of *Claviceps purpurea* mentioned above. With *Claviceps pusilla* the sclerotia vary in size according to the host on which they are formed. The volume of individual sclerotia varies considerably, and as might be expected, the sclerotia with the greatest volume, as a group, produce the largest number of stromata. Table I. shows the number of stromata produced by sclerotia from several hosts, and the dimensions of the sclerotia produced by those hosts.

TABLE I.

No. of stromata per sclerotium	No. of sclerotia observed			
	Bothriochloa biloba 1948	Bothriochloa intermedia 1941	Bothriochloa intermedia 1947	Heteropogon contortus 1941
1	17	74	21	5
2	33	28	3	1
3	51	11	—	—
4	48	5	—	—
5	25	1	—	—
6	13	—	—	—
7	7	—	—	—
8	2	—	—	—
Totals	196	119	24	6
Dimensions of Sclerotia (in mm.)	5.0-7.0 × 1.5-2.0	4.0-5.5 × 1.0-1.2		5.0-6·4 × 0.7-0.85

Several abnormalities in the stromata have been observed, including fusion of capitula borne on separate stipes, the development of amorphous masses of tissue with scattered perithecia, the production of secondary stromata on an injured stroma, and splitting of a section of the stipe into several branches.

Three cases have been observed where capitula coming in contact when near maturity have undergone complete fusion where they touched one another. In each case perithecia were developed except at the point of contact of capitula.

Twice, failure of the stroma to differentiate into stipe and capitulum at an early stage has been observed. These stromata continued to enlarge until large subglobose masses of tissue had formed. After some time a few perithecia developed on the distal portion. A somewhat similar occurrence has been observed in *Claviceps purpurea* by Wilson (1875) who observed that "sometimes an amorphous mass grows up without stalk or head." The cause of this type of abnormal development is not known.

The production of three secondary stromata on a stroma (which is thought to have been injured by mites) is a phenomenon which has not been recorded previously. Development of this stroma was suspended for about 10 days at the stage when differentiation into stipe and capitulum was about to begin. Later this stroma elongated, but did not produce a terminal capitulum. Instead a secondary stroma which did bear a capitulum grew out from the top of the primary stroma, while two other secondary stromata developed about 5 mm. lower down on the primary stroma. All three capitula matured normally.

Another stroma was observed in which the stipe split into three branches, each rounded and smooth like a normal stipe. These branches fused again further up, and bore a normal capitulum.

THE HOSTS OF *CLAVICEPS PUSILLA*.

Claviceps pusilla has been recorded on the following hosts in various localities :

Italy :	*Bothriochloa ischaemum* (L.) Keng.
Yugoslavia :	*Bothriochloa ischaemum* (L.) Keng.
Queensland :	*Dichanthium sericeum* (R.Br.) A. Camus.
	Dichanthium sp. aff. *D. tenue* (R.Br.) A. Camus.
	Dichanthium annulatum (Forsk.) Stapf.
	Bothriochloa intermedia (R.Br.) A. Camus.
	Bothriochloa decipiens (Hack.) C. E. Hubbard.
	Bothriochloa biloba S. T. Blake.
	Bothriochloa ambigua S. T. Blake.
	Bothriochloa erianthoides (F.Muell.) C. E. Hubbard.
	Capillipedium spicigerum (Benth.) S. T. Blake.
	Themeda australis (R.Br.) Stapf.
	Themeda avenacea (F.Muell.) Dur. & Jacks.
	Cymbopogon refractus (R.Br.) A. Camus.
	Heteropogon contortus (L.) Beauv. ex. R. & S.
	Vetiveria filipes (Benth.) C. E. Hubbard.
New South Wales :	*Dichanthium sericeum* (R.Br.) A. Camus.
	Bothriochloa decipiens (Hack.) C. E. Hubbard.
	Bothriochloa ambigua S. T. Blake.
	Bothriochloa intermedia (R.Br.) A. Camus.
New Guinea :	*Themeda australis* (R.Br.) Stapf.
	Capillipedium parviflorum (R.Br.) Stapf.
	Capillipedium sp.

The record of the ergot from Italy is that of Cesati in 1861, and from Yugoslavia that of Ranojevic (1914).

In New South Wales, *Claviceps pusilla* has been recorded recently on *Dichanthium sericeum* and *Bothriochloa decipiens* by the Biological Branch of the Department of Agriculture (Anon. 1948). *Bothriochloa ambigua* ergotised by *Claviceps pusilla* is known from a collection from near Guyra sent to the author by the Rev. Norman McKie in 1941. *Bothriochloa intermedia* was the host of an ergot collected at Bathurst by Birmingham (1921). Noble *et al.* (1934) listed *Claviceps purpurea* as the ergot of this grass, but the identification was made on the assumption that the ergot on grasses other than species of *Paspalum* was *Claviceps purpurea* (Hynes 1940). This ergot of *Bothriochloa intermedia* was undoubtedly due to *Claviceps pusilla*.

The New Guinea records are based on the author's collections from the Bulolo Valley, in 1943, of the sphacelial stages of ergot on *Themeda* and *Capillipedium*, two genera which are well known as hosts of *Claviceps pusilla* in Australia. From conidial characters, and on a host basis, one can safely identify these sphacelias as *Claviceps pusilla*.

All Queensland records except that of *Dichanthium annulatum* were made from field collections by the author since 1940. *Dichanthium annulatum* grown in the Commonwealth Scientific and Industrial Research Organization's Plant Introduction Garden at Redland Bay, South Queensland, was infected with ergot in 1949. One grass, *Sorghum leiocladum* (Hack.) C. E. Hubbard, which was listed by Langdon (1942A) as a host of *Claviceps pusilla* has been excluded from the present list of hosts. The ergot was found on only one occasion in 1941, and the material on hand is inadequate for any recent check of the identity of the fungus.

GERMINATION OF SCLEROTIA.

The sclerotia of *Claviceps* usually have a resting period before they germinate. McFarland (1922) found that about 8 weeks was the minimum period for sclerotia of *Claviceps purpurea* in America, and that during this period the sclerotia should be stratified in moist sand. Kirchhoff (1929) found that a high proportion of sclerotia of *Claviceps purpurea* germinated after being subjected to low temperatures during the resting period only if they were kept in moist sand during that time. Negligible germination occurred if the sclerotia were kept dry during the winter. If the sclerotia were kept at 0° C., 2°-3° C., or 5°-6° C. for a period of at least 25 days during their dormancy, a high percentage of germination was obtained in the spring, but if sclerotia were kept at 8°-10° C. during the winter, only a few germinated later on. Schwarting and Hiner (1945) found that sclerotia of *Claviceps purpurea* kept at 13° C. in a greenhouse gave only 8% germination, compared with 92% for sclerotia subjected to outdoor winter conditions in Ohio. Also, the sclerotia kept at the higher temperature produced fewer and smaller stromata.

On 6th March, 1941, sclerotia of *Claviceps pusilla* were collected from *Dichanthium sericeum* at Maryvale on the Darling Downs. These sclerotia were used to determine whether low temperatures were necessary during their resting period. The sclerotia, collected in summer, had not been subjected to low temperatures in the field before they were gathered. Sixty-four sclerotia were available. They were kept dry in small glass tubes lightly plugged with cotton wool until September, duplicate groups of 8 sclerotia each being subjected to the following temperatures: (1) room temperature throughout the winter (not less than 10° C.),

(2) room temperature except for a 28 day period of refrigeration (3°-4° C.), (3) room temperature except for a 42 day period of refrigeration (3°-4° C.), (4) room temperature except for a 56 day period of refrigeration (3°-4° C.). All sclerotia were sown on 1st September, 1941, on moist coarse sand in petri dishes with the lids on. The moisture content of the sand was kept at a constant level of 6% by weight. The dishes were kept at room temperature. Germination of sclerotia began on 22nd September, and the experiment was concluded on 22nd October. The results are set out in Table II.

TABLE II.

Treatment	No. of sclerotia germinated		
	Group 1	Group 2	Total
1. Room temperature throughout winter	6	7	13
2. Room temperature, with 28 days refrigeration	8	7	15
3. Room temperature, with 42 days refrigeration	5	6	11
4. Room temperature, with 56 days refrigeration	8	5	13
Total	27	25	52

These results indicate that low temperatures during the resting period are not essential for sclerotia of *Claviceps pusilla*. Germination of sclerotia kept at temperatures not lower than 10° C. is quite as good as the germination of sclerotia subjected to temperatures of 3°-4° C. for varying periods. The need for stratifying sclerotia of *Claviceps pusilla* in moist sand during the resting period does not exist, for over 80% germination has been obtained with sclerotia kept dry for just under six months. In 1948 this was confirmed when 95% germination was obtained with over 300 sclerotia of *Claviceps pusilla* which had been kept dry from mid-February to mid-September.

The longevity of sclerotia of *Claviceps pusilla* has not been fully investigated. But they do retain their capacity to germinate for more than a year. Two sclerotia collected in May, 1940, failed to germinate in the spring of that year, and were then dried and kept in a glass tube until the following spring. In September, 1941, they were replanted on moist sand, and in the following month they germinated, seventeen months after they had been gathered in the field.

INTER-HOST INFECTION EXPERIMENTS.

With *Claviceps purpurea* a number of physiologic strains which differ in their pathogenicity to various host genera have been found (Stager 1908, 1922; Mastenbroek and Oort 1941; Langdon 1949). To determine whether there are physiologic strains of *Claviceps pusilla* in south-eastern Queensland, a number of inoculations have been made on plants of the host species in a garden in Brisbane.

When testing whether a host is susceptible to ergot, one must ensure that the inoculum is placed in the most favourable position, *i.e.*, close to the ovary. Failure to secure infection cannot be regarded as significant unless this has been accomplished. Before attempts to secure infections with *Claviceps pusilla* were made, the flowering habits of the hosts under test were observed. It was found that some of the hosts held their glumes well apart at anthesis, so that at this time conidial suspensions

TABLE III.

SUMMARY OF INFECTION EXPERIMENTS WITH HOSTS OF *CLAVICEPS PUSILLA*.

Source of Inoculum	Host Species Inoculated	Date	Method of Inoculation	Result of Inoculation	
Conidia from field infection of *Dichanthium sericeum* (Maryvale 6/3/41)	*Bothriochloa intermedia*	9/3/41	Hand spray	Positive	
ditto	*Bothriochloa decipiens*	9/3/41	Hypodermic	Positive	(1) This inoculum was obtained from the plant originally inoculated with conidia from *Dichanthium sericeum*. The supply of this inoculum was maintained by successive inoculations of *Bothriochloa intermedia* with its own conidia.
Conidia from *Bothriochloa intermedia* (1)	*Bothriochloa ambigua*	26/4/41	Hand spray	Positive	
ditto	*Dichanthium sericeum*	26/4/41	Hypodermic	Positive	
ditto	*Capillipedium spicigerum*	18/5/41	Hand spray	Positive	
ditto	*Heteropogon contortus*	18/5/41	Hypodermic	Positive	
ditto	*Cymbopogon refractus*	20/5/41	Hand spray	Positive	
Conidia from dried sphacelial stage on *Bothriochloa intermedia* (2)	*Bothriochloa intermedia*	7/9/41	Hand spray	Positive	(2) This inoculum was from the plant mentioned in (1) above.
Conidia from *Bothriochloa intermedia* (3)	*Dichanthium* sp. aff. *D. tenue*	24/10/41	Hypodermic	Positive	(3) This supply of inoculum was maintained by successive inoculations of the host with the sphacelia produced from inoculation with (2)
ditto	*Themeda australis*	1/11/41	Hypodermic	Positive	
Conidia from *Bothriochloa intermedia* (Maryvale 23/2/48)	*Bothriochloa biloba*	16/3/48	Hand spray	Positive	
ditto	*Bothriochloa erianthoides*	2/4/48	Hypodermic	Positive	
Ascospores from germinating sclerotium of *Dichanthium sericeum* (sclerotia from *Aratula*, 5/4/47)	*Themeda avenacea*	9/11/47	Hypodermic	Positive	

could be sprayed in from a squeeze-bulb hand spray, ensuring the deposition of inoculum around the ovary. Other hosts could not be treated in this way because they were never observed to open their glumes wide. These plants were inoculated by means of a hypodermic syringe with a fine needle, a method used with success in Europe by Stager (1923).

The original inoculum used was conidia from a natural infection of *Dichanthium sericeum* at Maryvale collected on 6th March, 1941. With this material successful inoculations were made on *Bothriochloa intermedia*, and the sphacelial stage was maintained on this host, by a series of inoculations, until the end of May. Conidia were kept *in situ* on dried inflorescences of this plant until the following spring, and then were used for infection of the same host, thus providing further supplies of conidia for inoculation of other hosts.

Bothriochloa intermedia was used to maintain a supply of conidia because it is an easy host to work with. By breathing on a young inflorescence held cupped in the hands, one can cause many of the florets to open wide within a quarter of an hour.* Numerous florets can then be inoculated with a conidial suspension by means of a small hand-spray.

The results of various inoculations are set out in Table III. All nine hosts of *Claviceps pusilla* tested in 1941 were readily infected with conidia of common origin. The two hosts infected in 1948 were inoculated with a field collection of the sphacelia on *Bothriochloa intermedia* at Maryvale, *i.e.*, from the same district as the inoculum used in 1941 was obtained. The infection of *Themeda avenacea* was obtained by an inoculation with ascospores, the sclerotium producing the inoculum having been collected from *Dichanthium sericeum* near Aratula in April, 1947. The only Queensland hosts not tested, *Vetiveria filipes* and *Dichanthium annulatum*, were only recently detected as hosts for ergot (May 1949), and there has been no opportunity yet to make inoculations onto them. A heavy infection of *Bothriochloa intermedia* occurred in the area where ergotised *Vetiveria* was collected.

These successful inoculations of all but two of the known hosts of *Claviceps pusilla* offer no suggestion of the existence of more than one strain of the ergot in south-eastern Queensland. The ergot of one host is readily transmitted to each of the other hosts that were tested.

THE DISTRIBUTION OF *CLAVICEPS PUSILLA*.

Until 1940, *Claviceps pusilla* was known only from Italy and Yugoslavia. In the past decade, its occurrence in eastern Australia in coastal and sub-coastal regions from Bowen in Queensland to Bathurst in New South Wales has been demonstrated. There is evidence, based on the present knowledge of the role of *Cerebella* as a saprophyte of sphacelial honey-dew (Langdon 1942B), that the fungus has been present for many years. Bailey (1890) recorded the occurrence of *Cerebella* on *Themeda australis* and *Heteropogon contortus* at Gladstone and Bowen respectively. This indicates that the ergot of these two grasses was present 60 years ago. In the Herbarium of the Plant Pathologist of the Queensland Department of Agriculture and Stock are specimens of *Cymbopogon refractus* and *Bothriochloa decipiens* collected near Brisbane in 1911 and 1912 respectively. The spikelets of both these grasses are

* I am indebted to Mr. G. L. Wilson for making known to me this device for inducing flowering of *Bothriochloa intermedia*.

encrusted with masses of spores of *Cerebella.* Recent collections by the author have been made in the country around the following towns : Mackay, Gympie, Kingaroy, Dalby, Oakey, Toowoomba, Warwick, Beaudesert, Boonah, Ipswich, Fernvale, Gatton, Southport, Brisbane. In New South Wales, *Claviceps pusilla* is known from Guyra and Bathurst.

As indicated earlier in this paper, *Claviceps pusilla* occurs in New Guinea in the Bulolo Valley.

Ajrekar (1926) referred to a sphacelia occurring in India on *Dichanthium nodosum* (=*Andropogon caricosus* var. *mollicomus*), the conidia of which were " somewhat triangular in shape." Thirumalacher (1945) recorded the sphacelial stage of an ergot of *Bothriochloa pertusa* (=*Amphilophis pertusa*) in India, the conidia being described as " distinctly triangular, somewhat rounded at the ends, 8.8-11.4 × 6.3-7.7 μ." These conidia, from the description and a drawing by Thirumalacher, might well be those of *Claviceps pusilla.* There is no justification for Thirumalacher's claim in his paper that the type of triangular spores that he saw " is at variance with the *Claviceps* species recorded both on members of the Gramineae and Cyperaceae." Such conidia have been mentioned by Ajrekar (*loc. cit.*) and Langdon (1941). Thomas, Ramakrishman and Srinivasan (1945) have recorded ergot from India on *Heteropogon contortus*, *Cymbopogon polyneuros* and *Chrysopogon zeylanicus*, the conidia being " mostly triangular, 10.4-14.6 × 4.9-6.6 μ." In Australia, *Heteropogon contortus*, five species of *Bothriochloa*, two species of *Dichanthium*, a species of *Cymbopogon* and a species of *Vetiveria*, a genus closely allied to *Chrysopogon*, are hosts of *Claviceps pusilla.* That the same or allied genera and species in India should be ergotised by a fungus characterised by conidia of the same size and unusual shape as those of *Claviceps pusilla* is strong evidence supporting the suggestion put forward some years ago by Langdon (1942A) that *Claviceps pusilla* may occur in India. That *Claviceps pusilla* is in Asia is suggested by a host index of parsitic fungi of Szechwan, China, published recently by Lee Ling (1948). A number of grasses subject to ergot are mentioned, including *Bothriochloa pertusa*, *Capillipedium parviflorum* and *Themeda triandra.* *Claviceps purpurea* is recorded as the fungus attacking these grasses, but it is evident from the accompanying account of the conditions under which the survey was made during the Sino-Japanese war that identification of the ergot was quite arbitrary. Since the three host genera are known hosts of *Claviceps pusilla* in Australia, it is quite possible that this fungus, and not *Claviceps purpurea*, is the cause of ergot disease in these grasses in China.

A number of smuts and rusts of the Gramineae in India are known to occur in Australia also (Herbert and Langdon 1941). This similarity of the fungi parasitic on grasses in the two countries further supports the evidence for the occurrence of *Claviceps pusilla* in Asia.

INCIDENCE IN THE FIELD.

Observations on the incidence of ergot disease due to *Claviceps pusilla* in south-eastern Queensland show that the disease occurs wherever the host plants are found. Early in the summer the disease is absent from some localities where later on a high percentage of infected plants is found. This may be attributed in part to the somewhat sporadic nature of the storm rains which precede germination of sclerotia in the spring. Where the storm rains are early (October), there may be a considerable amount of secondary infection by January. Other areas, not receiving any heavy rain until early December or later, might be relatively free of the disease until well into summer. Saprophytes in ergot honey-dew, by preventing formation of sclerotia, may be partly responsible for the disparity in the degree of infection in different areas. It is known that where *Cerebella* is abundant, sclerotia are rarely found, and in the following spring the effects of the saprophyte may be shown by the rare occurrence of the ergot. At Lawes in the autumn and early winter of 1940, *Cerebella* was found on the majority of ergotised plants. In late January, 1941, although there had been good storm rains in the spring and early summer, no plants infected with *Claviceps pusilla* were found. By early March, however, the ergot had appeared on *Bothriochloa intermedia* and *Dichanthium sericeum*. By mid-April the disease had spread to a number of other hosts, and a high percentage of infected individuals of the susceptible host species was found. The apparent absence of the disease early in the season suggests that very few sclerotia germinated in that area, and that the number of individual plants with a primary infection was few. From infected plants secondary infections of other plants would build up gradually the heavy infections of early autumn. The spread of the disease after midsummer may have been assisted by the introduction of inoculum from neighbouring districts, *e.g.*, the eastern Darling Downs where the disease was widespread at the end of February.

Mature sclerotia were difficult to find on the majority of the hosts in most districts. Some that form fall to the ground as soon as they mature, the inflorescences of many hosts breaking up readily at maturity. But the saprophyte *Cerebella* was the main cause of the absence of large numbers of sclerotia. This fungus, living in honey-dew, has two effects : one, to reduce the amount of conidial inoculum available for secondary infections in the immediate season ; the other, to inhibit the formation of sclerotia and in that way reduce the amount of inoculum available for primary infections in the following season.

It is not unusual to find localised areas where *Cerebella* has not been active, and then abundant sclerotia may be formed. Between Dalby and Bell in May, 1941, near Warwick in 1948, and near Fernvale in 1949, ergotised plants were almost free of *Cerebella*. Such areas may act as reservoirs of inoculum, and the disease may spread from there in the following season, nullifying to some extent the effects of the natural control exercised elsewhere in the previous season by *Cerebella*.

ECONOMIC ASPECTS.

No physiological tests on animals or chemical analyses have yet been made with sclerotia of *Claviceps pusilla*, but by analogy with other species of Claviceps which are known to be poisonous, one might regard *Claviceps pusilla* as a potential cause of stock poisoning.

Some of the hosts of *Claviceps pusilla* are of little value as pasture plants, for example, *Bothriochloa decipiens*, but there are others which are generally regarded as being amongst our best native pasture grasses, for example, *Dichanthium sericeum*, *Bothriochloa intermedia*, *Capillipedium spicigerum*, and *Themeda australis*. Ergot of the latter grasses results in a loss of seed, and several years of heavy infection with ergot might result in pasture deterioration through the failure of the natural re-seeding processes. Unfortunately, certain of the hosts are widespread on road-sides and waste places, and they can act as reservoirs of inoculum which might nullify attempts to control the disease in pastures by appropriate management

The disease must be considered in connection with any programme of pasture plant improvement involving certain native species of grass. Resistant or disease-escaping strains of grass would be required. Here a study of the flowering habits would be useful because cleistogamous strains would possibly be disease-escaping. The possibility of introduced species of merit being susceptible to the disease must also be taken into account.

ACKNOWLEDGMENTS.

I wish to thank Mr. S. T. Blake of the Queensland Herbarium, who has checked the identity of the hosts, and Professor D. A. Herbert of the University of Queensland, whose interest and help in many ways have been invaluable. Financial assistance for this work was granted by the University of Queensland Research Committee administering the Commonwealth Training and Research Projects, to whom the author is grateful.

REFERENCES.

ANON, 1948. Ag. Gaz. N.S.W., lix, 35-36.

AJREKAR, S. L., 1926. J. Indian Bot. Soc., v, 55-61.

BAILEY, F. M., 1890. Syn. Qld. Flora 3rd Supp., p. 123.

BARGER, G., 1931. Ergot and Ergotism. A Monograph. London.

BIRMINGHAM, W. A., 1921. Ag. Gaz. N.S.W., xxxii, 410.

CESATI, V., 1861. Comment Soc. Critt. Ital., i, 64.

FYLES, F., 1916. Phytopath., v, 186-192.

HERBERT, D. A., AND LANGDON, R. F., 1941. Univ. Qld. Papers (Biology), ii, 1, 1-6.

HYNES, H. J., 1940. Private communication.

KIRCHHOFF, H., 1929. Centralbl. Bakt. II. Ab. Bd. 77, 310-369.

LANGDON, R. F., 1942A. Proc. Roy. Soc. Qld., liv, 23-32.

LANGDON, R. F., 1942B. Phytopath, xxxii, 613-617.

LANGDON, R. F., 1949. J. Aust. Inst. Agr. Sci., xv, 39-41.

LEE LING, 1948. Pl. Dis. Rptr. Supp., 173.

MASTENBROEK, C. AND DORT, A. J. P., 1941. Tijdschr. Plziekt., xlvii, 165-185.

MCALPINE, D., 1894. Report on Rust in Wheat Experiments, 1892-3 (Dept. Agr., Victoria).

MCFARLAND, F. T., 1922. Science N.S., lvi, 85.

RANOJEVIC, N., 1914. Annales mycologici xii, 393-421.

SCHWARTING, A. E. AND HINER, L. D., 1945. J. Amer. Pharm. Assoc. (Sci. Ed.), xxxiv, 1, 11-16.

STAGER, R., 1908. Centralbl. Bakt. II. Ab. Bd., 20, 272-279.

STAGER, R., 1922. Centralbl. Bakt. II. Ab. Bd., 56, 329-339.

STAGER, R., 1923. Mitt. Naturf. Ges. Bern., 1922, 11-20.

THIRUMALACHER, M. T., 1945. Nature, clv, 3935, 395-396.

THOMAS, K. M., RAMAKRISHMAN, T. S. AND SRINIVASAN, K. V., 1945. Proc. Indian Acad. Sci. Sect. B, xxi, 93-100.

WILSON, A. S., 1875. Gard. Chron. N.S., iv, 774-775, 807-808.