THE FRUIT ROTS OF THE CUSTARD APPLE.

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SUMMARY.

Phomopsis anonacearum Bondartzeva-Monteverde was isolated from fruit affected with black canker. Though pathogenicity tests were inconclusive, it is considered that the fungus is responsible for the disease. A marginal leaf scorch is attributed to the same organism.

The phycomycete Phytophthora palmivora Butler is responsible for purple blotch.

Botryodiplodia theobromae Pat. was shown by pathogenicity tests to be the cause of Diplodia rot.

INTRODUCTION.

The custard apple (*Annona squamosa* L.) is relatively free from serious diseases in southern Queensland. However, particularly under conditions of high rainfall, the fruit sometimes develop purplish black discoloured areas which either cause the fruit to fall off the tree or render them unfit for marketing. Lack of knowledge regarding the etiology of this trouble led to investigations being carried out over the past three seasons with a view to determining the agent or agents responsible.

During the course of these investigations three organisms have been found associated with somewhat different symptoms on custard apple fruit. These are *Phomopsis anonacearum* Bondartzeva-Monteverde, *Phytophthora palmivora* Butler, and *Botryodiplodia theobromae* Pat. Each of these diseases is now described.

BLACK CANKER.

This disease was recorded as early as 1926 and it has appeared spasmodically in each succeeding season. In the 1948–49 season, losses at an economic level were reported by many growers in the Sunnybank and Redland Bay areas near Brisbane. It has since been observed on fruit grown at Charters Towers in North Queensland.

Symptoms.

The condition is first recognised by the occurrence of purple lesions on the fruit, most commonly at or near the apical end. These vary greatly in size from small circular spots $\frac{1}{2}$-in. in diameter up to blotches covering half of the affected

fruit. The lesions become extremely hard and with age deep cracks develop in them (Fig. 1). Close examination reveals the presence of pycnidia which are slightly raised from the surface. Under moist conditions it is common to see white spore tendrils being extruded from the pycnidia (Fig. 2).

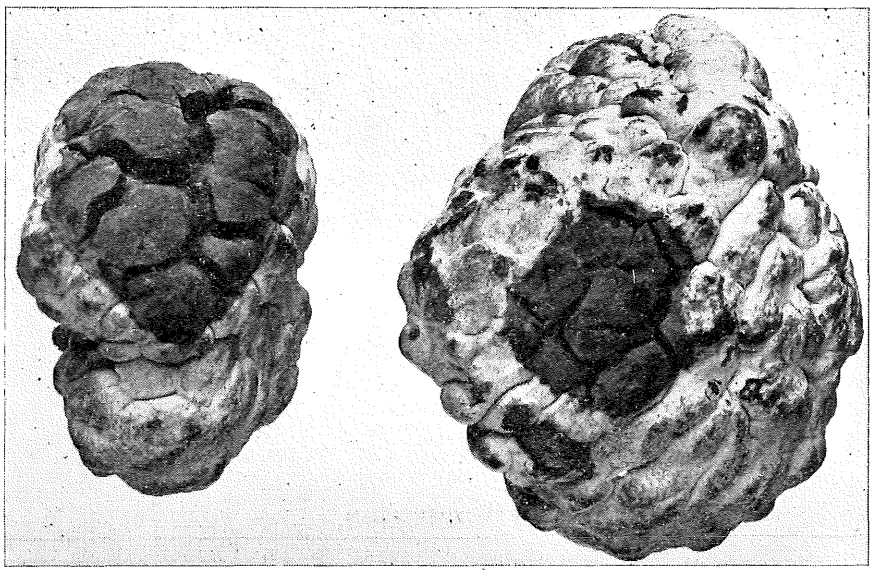

Fig. 1.
Typical Lesions of Black Canker.

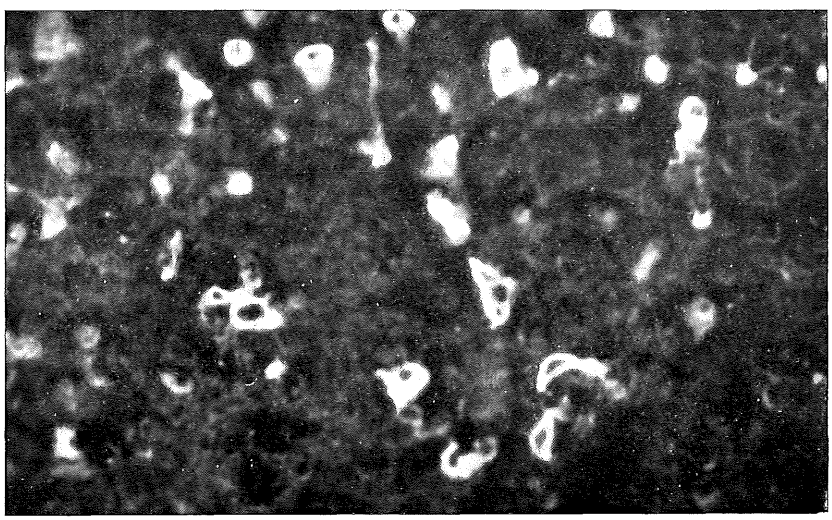

Fig. 2.
Microphotograph of Spore Tendrils of *Phomopsis anonacearum* on a Black Canker Lesion.

Internally the lesions are very characteristic, being brown in colour and usually no more than $\frac{1}{4}$-in. deep. The surrounding tissue is not affected and in mature fruit the remainder of the flesh is quite sound. However, the external discolouration renders affected fruit unfit for marketing.

Fruit at all stages of maturity and of all sizes have been found affected from as early as February through to the conclusion of the main harvesting season in June.

Isolations and Pathogenicity Tests.

A fungus was consistently isolated from the edge of the lesions and from pycnidia and spore tendrils taken from diseased material.

Over a period of three seasons numerous attempts have been made to infect fruit with this fungus.

A series of tests was conducted on immature fruit in the laboratory and in the field with cultures isolated from diseased specimens, employing the following technique :

The surface of the fruit was wiped over with alcohol and allowed to dry. Small areas were then marked off and from the centre of these a small cube about $\frac{1}{8}$-in. square was cut to a depth of $\frac{1}{4}$-in. and removed. Small pieces of inoculum from the cultures on potato-dextrose agar were then placed in the small cavity so created and the cube replaced. This was done in the field on fruit still on the trees, and in the laboratory on fruit held in a moist chamber.

A total of 36 such inoculations has been done into fruit at various stages of maturity, and on only two occasions has any degree of success been achieved.

One fruit was successfully infected in April, 1951. The tissue for about half an inch around the point of inoculation was discoloured purple and became hard. Close examination revealed pycnidia. This fruit was removed and placed in a moist chamber for 48 hours, during which time the lesion expanded somewhat and extended rather deeper into the tissue than naturally occurring lesions. The pycnidia were found to be producing typical pycnospores (Table 1).

Table 1.

SPORE MEASUREMENTS (in microns)—*Phomopsis* spp.

Source.	Pycnidia Diameter.	A Spores.	B Spores.
Black canker lesions (5)	96 to 150 x 60 to 105. Average 132 x 78 (50)	6·25 to 8·1 x 1·9 to 3. Average 6·6 x 2·4 (250)	
Black canker (artificial infection) (2)	96 to 150 x 60 to 120. Average 135 x 90 (10)	5 to 7·5 x 2·5 to 3·0. Average 6 x 2·75 (100)	16·5 to 24 x 1. Average 20·1 x 1 (50)
Marginal leaf scorch (2)	105 to 150 x 75 to 96. Average 117 x 81 (20)	5 to 7·5 x 1·9 to 3. Average 6·3 x 2·0 (100)	
Inoculated twigs (1)..	350 to 800. Average 585 (20)	5·25 to 7·5 x 2·25 to 3. Average 6·5 x 2·75 (25)	16·5 to 25·5 x 1. Average 19·5 x 1 (25)
Phomopsis anonae, on bark of *A. cherimoliae* (De Urries, 1951)	300 to 1,000	6·5 to 9·5 x 1·5 to 2·5	20 to 30 x 1 to 1·5. C spores. Average 13
Phomopsis anonacearum, on leaves of *A. cherimoliae* (Bondartzeva-Monteverde, 1936)	120 to 140	5 to 8 x 2 to 2·5 ..	

(Figures in brackets indicate the number of samples examined.)

A similar infection was obtained in one fruit during April, 1952, but with the rather more typical symptom of a hard shallow lesion.

A second technique employed involved placing portions of the cultures over small pin-hole injuries made with a needle and enclosing the fruit in a plastic bag to prevent rapid drying out of the culture. Negative results were obtained with this method.

During both seasons when these inoculations were conducted, natural infection was extremely low.

Following the failure to reproduce typical symptoms easily with culture inoculum, attempts were made to inoculate fruit with spore material. The techniques and the results were as follows :

1. Spore tendrils were picked off affected lesions and used as inoculum in much the same way as the cultures had been used previously. In addition, fruit in the field so inoculated were enclosed in moistened plastic bags to maintain humidity.

Negative results were obtained.

2. Spore suspensions were prepared in sterile water from fresh spore tendril material and used as inoculum in the field. The fruit were surface-sterilized with alcohol, sprayed with sterile water, then with spore suspension. and finally with sterile water again. A fine clinical atomiser was used for spraying. (Some of

the fruit were slightly injured with a needle before application of the spore suspension, because it was considered possible that infection occurred naturally through injuries.) After spraying, the fruit were enclosed in plastic bags which had been moistened internally to maintain humidity. Twenty-five fruit at all stages of maturity were treated in this way. A check was made on the suspension used in each case and spore germination was found to be very good after 24 hours.

Typical symptoms were not reproduced in any of the fruit so treated. However, five of the uninjured fruit developed an unusual " pin-head " spotted appearance which failed to develop further in the field. As these fruit approached maturity they were removed and placed in moist chambers in the laboratory. Under these conditions the fruit rapidly became discoloured (Fig. 3) and commenced to produce pycnidia from which spore tendrils were extruded. The spores were identical with those produced by the pycnidia on diseased fruit (Table 1). Control fruit, although finally discoloured purple, took much longer to reach this condition and failed to produce pycnidia.

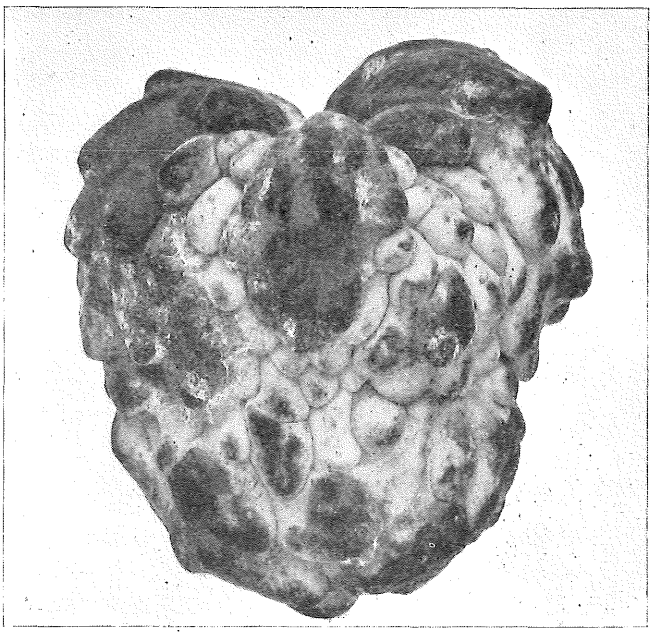

Fig. 3.

Discolouration Developing on Fruit Sprayed with a Suspension of *Phomopsis anonacearum* Spores.

3. Spore suspensions prepared as for (2) were applied to fruit held in moist chambers in the laboratory.

Similar results were obtained, the inoculated fruit turning purple very quickly and producing pycnidia and typical spores. One such fruit produced pycnidia bearing both A spores and B spores (See later).

Marginal Leaf Spotting and its Relationship to Black Canker of the Fruit.

An interesting recording of a marginal leaf scorch was made on custard apple leaves in 1952. A large number of leaves on many trees were exhibiting dead areas, particularly at the tips of the leaves (Fig. 4). Close examination of these demonstrated the presence of pycnidia, which proved to contain A spores similar in shape and size to those previously recorded on black canker lesions. Again under moist conditions the spores were extruded from the pycnidia in white tendrils. Further investigations demonstrated that this leaf condition was widespread, particularly as the season advanced.

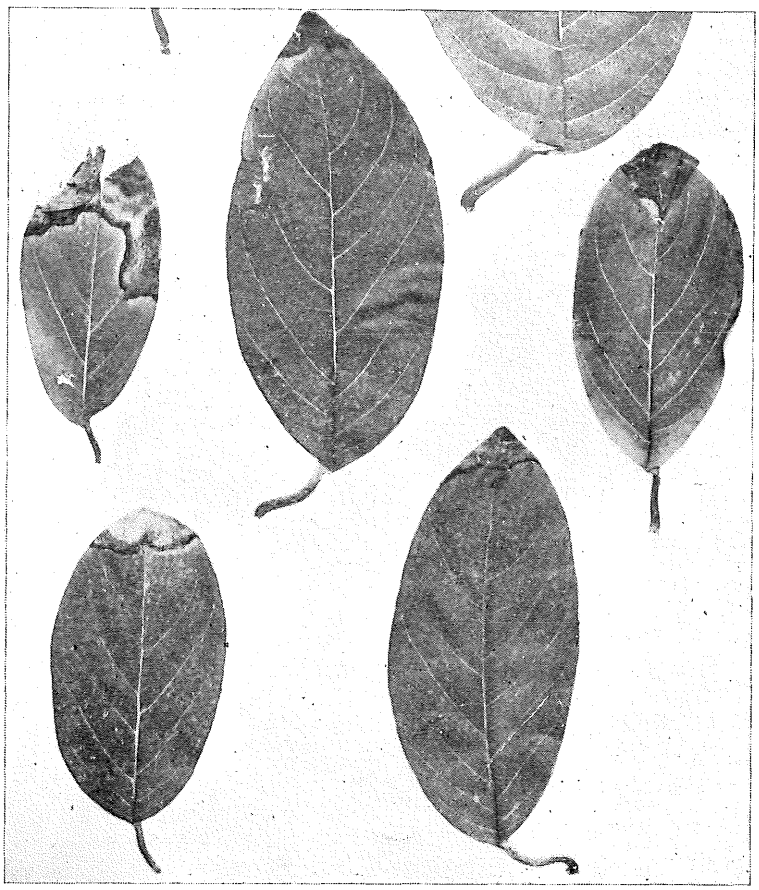

Fig. 4.

Marginal Leaf Scorch with Which *Phomopsis anonacearum* is Associated.

A thorough examination of such material and of dead leaf tissue from beneath the tree failed to reveal any fructification which might prove to be the perfect stage of the fungus.

Healthy and affected leaves were then submitted to various laboratory treatments similar to those used by Kiely (1948) to induce the production of *Guignardia citricarpa* on citrus leaves. Abundant pycnidia were produced by this means on all diseased and some apparently healthy leaves, but no perfect stage was encountered in any of the treatments.

Stem material was examined for possible fructifications of the fungus but none was found.

Pathogenicity tests were then conducted with the diseased leaf material. A spore suspension was made from spore tendrils and fruit inoculated by the spray technique already described. No infection was obtained.

In a further attempt, infected leaves which had been surface-sterilized were tied so as to be in close contact with healthy surface-sterilized fruit. The whole fruit was then wrapped in moist cotton-wool and enclosed in a plastic cover to maintain humidity. A similar technique had been employed by Kiely to

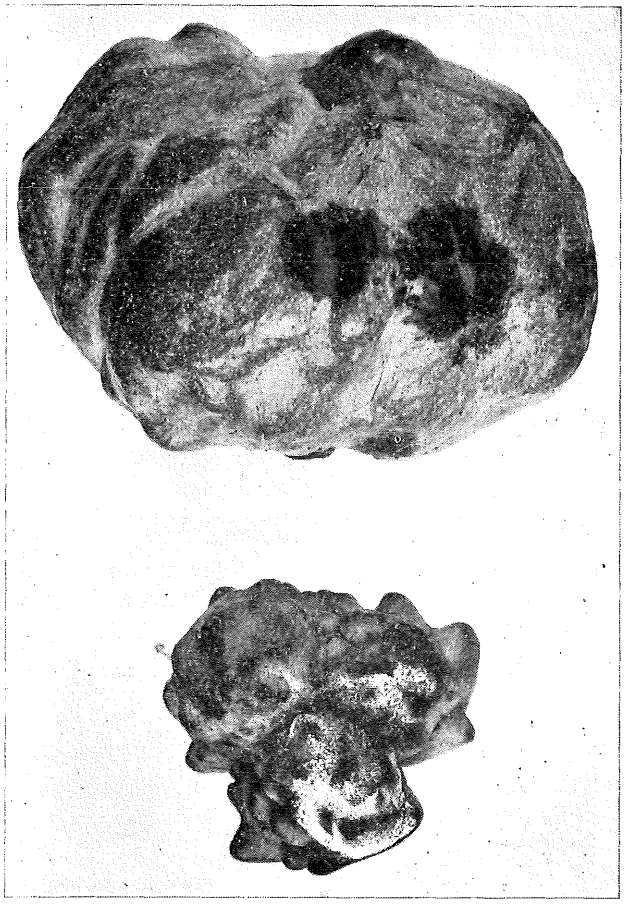

Fig. 5.
Lesions Developing on Custard Apple Fruit Inoculated with Diseased Leaf Material.

test the pathogenicity of *G. citricarpa*. After seven days definite symptoms were recorded on three of the eight fruit so inoculated. Definite hard purple lesions producing pycnidia appeared (Fig. 5) and the fungus was isolated from them.

Attempts were made to infect healthy leaves on the trees with the fungus obtained from black canker lesions and marginal leaf spot. Spore suspensions were prepared and fresh young leaves sprayed and enclosed with plastic bags as was done in the fruit inoculations. Negative results were obtained.

One series of leaves showing marginal scorch was retained in a dried condition in the laboratory for 12 months. At the end of this period these leaves were moistened and incubated at 27·5°C. The pycnidia present produced spores abundantly.

Although the results of the artificial infection experiments were disappointing, the universal association of this fungus producing pycnidia with the disease in the field, coupled with the knowledge that species of this type are often difficult to deal with under artificial conditions, leaves little doubt that this organism is responsible for black canker.

There is also little doubt that the organism associated with the marginal leaf scorch is identical with the black canker fungus.

Description and Identification of the Fungus.

The organism on potato-dextrose agar produces relatively slow-growing white colonies with a floury surface. Concentric rings are built up in these colonies and with age the substrate becomes a dark brown. After approximately 90 days pycnidia develop on the colonies, but no pycnospores have been found in them.

The fungus has a temperature range from a minimum of 7°C. to a maximum of 35°C., with the optimum level of growth occurring at 28·5°C.

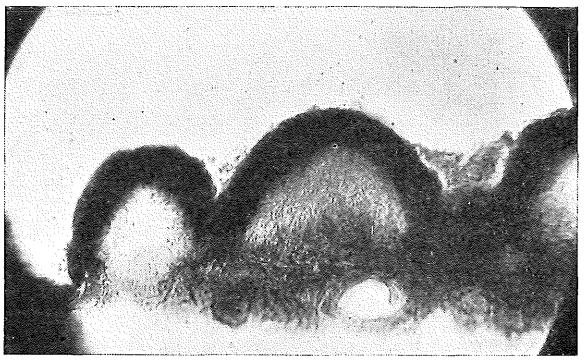

Fig. 6.

Microphotograph of Pycnidia of *Phomopsis anonacearum* on Diseased Fruit.

On black canker lesions the fungus produces pycnidia which are erumpent (Fig. 6), usually solitary and commonly ostiolate. The walls are carbonaceous black by transmitted light. These pycnidia produce spores which are rather variable in shape but are mostly fusiform, elliptical and commonly binucleate. Sporophores are simple, rod shaped about 10 μ in length and slightly narrower than the spores.

Specimens were submitted to the Commonwealth Mycological Institute, Kew, which reported that pycnidia in culture were producing both the A spores described above and B spores. The latter were described as curved to hamate, measuring 20–30 μ long and less than 1 μ broad. Such spores have never been encountered on naturally infected fruit in Queensland but have recently been found on artificially inoculated fruit. Measurements of pycnidia and both types of spores appear in Table 1.

On marginal leaf scorch lesions the pycnidia are normally immersed (Fig. 7), have a black carbonaceous wall and are ostiolate. Measurements of pycnidia and A spores appear in Table 1. No B spores have been found in these pycnidia.

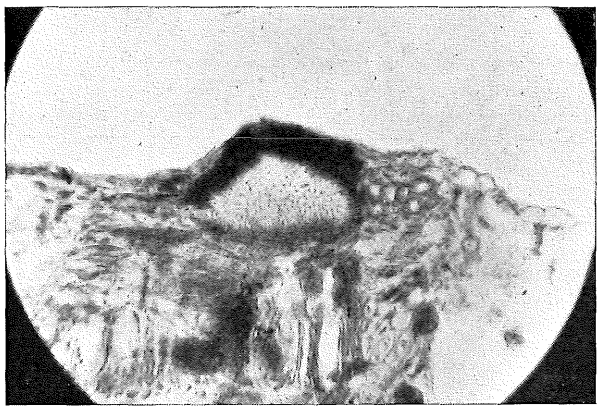

Fig. 7.

Microphotograph of Pycnidia of *Phomopsis anonacearum* on Leaf Lesion.

The fungus has been identified as *Phomopsis anonacearum* Bondartzeva-Monteverde by M. B. Ellis and E. W. Mason of the Commonwealth Mycological Institute. This species was described from hothouses in Leningrad as causing a leaf disease similar to that described here as marginal leaf scorch (Bondartzeva-Monteverde, Gutner and Novosselova 1936), but no previous record of it causing a fruit disease can be found. In the original description no mention is made of B spores and evidence in Queensland is that their occurrence under natural conditions, if ever, is rare.

Phomopsis anonae De Urries has been described on the bark of *Annona cherimoliae* in Valencia (De Urries, 1951). To compare *P. anonacearum* with the description given by De Urries, custard apple twigs were placed in glass tubes

so that their bottoms were in sand. After autoclaving, sterile water was added to the sand, and the stems inoculated with cultures of *P. anonacearum* isolated from black canker lesions. After 26 days a number of twigs were covered with a white weft of mycelium, and large stromatic structures which proved to be pycnidia were evident on the bark.

These pycnidia were usually erumpent and extremely variable in shape and size from compressed globular to flask-shaped. Often there was a distinct neck, in some cases more than one, opening with a round ostiole. Often, white spore tendrils were seen extruding from these pycnidia. The walls of the fructifications were an olivaceous brown and much thickened, particularly towards the top (Fig. 8). The bottom wall was often elevated in sections, giving a divided appearance to the pycnidial cavity. Spores of two types, A and B, similar to those previously described were produced.

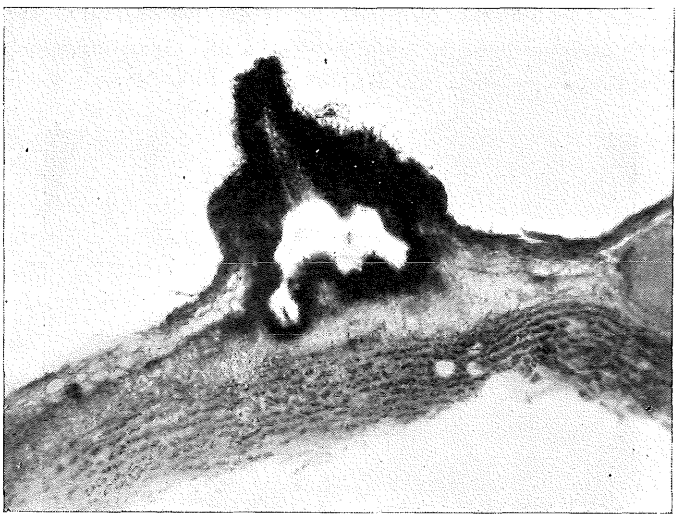

Fig. 8.

Microphotograph of Pycnidia of *Phomopsis anonacearum* on Inoculated Stems.

These fructifications differ somewhat from the normal pycnidia found on black canker lesions and appear identical with those described by De Urries for *P. anonae*. De Urries describes a third spore type which was not found here and his measurements for A spores are slightly larger (Table 1). However, it does seem very probable that *Phomopsis anonae* De Urries is a synonym of *Phomopsis anonacearum* Bondartzeva-Monteverde.

A species of *Phoma* has been recorded causing a leaf spot on custard apple in New South Wales (Noble, Hynes, McCleery and Birmingham, 1934).

A fungus identical with *Phomopsis anonacearum* has recently been isolated from diseased fruit of bullock's heart (*Annona reticulata* L.) growing in North Queensland.

Field Infection.

The evidence indicates that the occurrence of *P. anonacearum* on leaf tissue provides a very effective means of overwintering of the fungus. The difficulty of obtaining infection artificially with pycnospore suspensions throws doubt on the importance of this stage in primary infection. However, field evidence shows that the disease is most severe under conditions of high rainfall when the humidity is high and when pycnidia would be expected to be liberating many spores. The importance of a possible perfect stage in infection has not been overlooked but no evidence for the occurrence of such a stage has been obtained.

There is a possibility that mummified fruit lying under the trees may be a source of infection, but although many of these have been examined, none of the *P. anonacearum* or related fructifications have been encountered. Those examined have invariably been overgrown with *Botryodiplodia theobromae* and saprophytic organisms.

PURPLE BLOTCH.

This disease was first observed at Sunnybank in February 1950, when a grower reported considerable fruit fall. Since then affected fruit have been found on many farms. Because of its ability to attack very young fruit, the disease causes losses of which the grower is often quite unaware. Severe outbreaks have been very restricted but it remains a potential danger during periods of high rainfall.

Symptoms.

The presence of the disease in a plantation is first indicated by excessive fall of small immature fruit. Close examination of the trees reveals that many of the fruit show purple lesions which commence as small spots but rapidly expand until most of the fruit surface may be discoloured. The affected portion of the fruit does not become hard and the lesion has a somewhat indistinct margin (Fig. 9).

Infected fruit falls at a touch and a brown discolouration is seen extending from the fruit into the fruit stalk. During a severe outbreak many discoloured fruit can be seen on the ground. These quickly become " mummified " and are difficult to distinguish from fruit that fell during the previous season.

Fruit of any size may be infected, with specimens as small as 1-in. in diameter being commonly found. The disease develops rapidly, careful tagging at Sunnybank showing that falling occurs within four days of the first appearance of purple discolouration on small fruit. Where clean cultivation is not practised it is easy to visualize severe losses occurring before the grower realises the presence of the disease.

Affected fruit are usually completely discoloured brown internally even prior to fall (Fig. 10). This is in direct contrast to the shallow lesions characteristic of black canker.

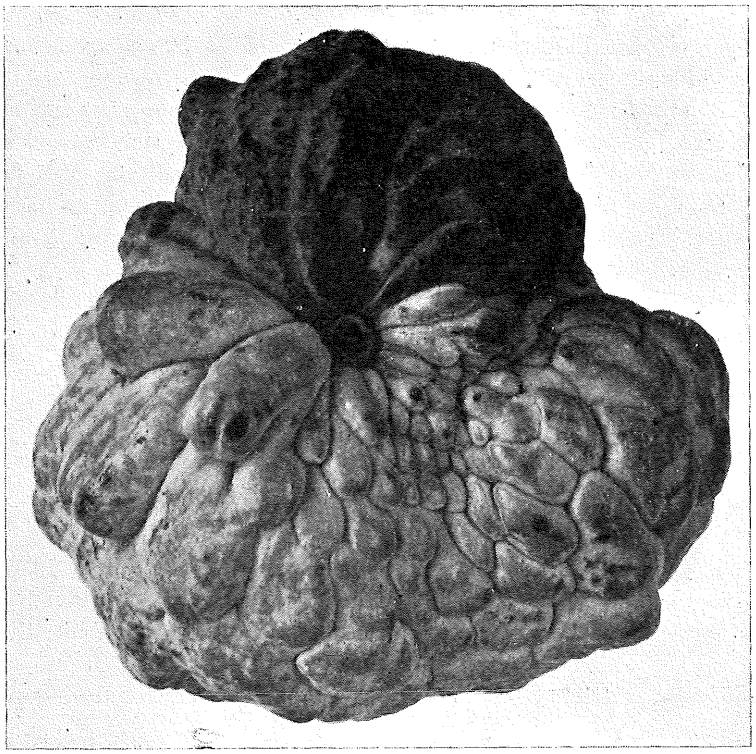

Fig. 9.
Purple Blotch—Field Symptom.

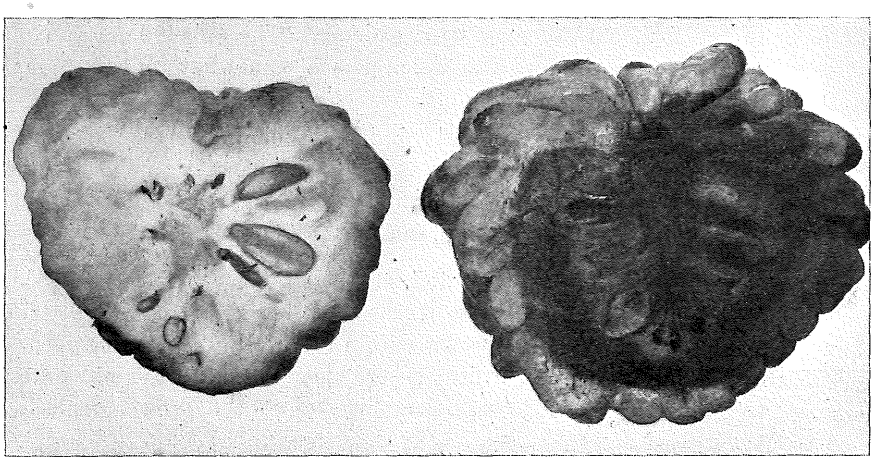

Fig. 10.
Internal Discolouration Produced on the Right by *Phytophthora palmivora* and on the Left by *Phomopsis anonacearum* (lesion on lower left hand side).

The disease has been recorded in the field during February and March and it has been possible to obtain positive artificial infection as late as May.

Isolations and Pathogenicity Tests.

A white phycomycete has been consistently isolated from the brown discoloured tissue of diseased fruit.

The technique envolving the removal of cubes, as described earlier, was used for testing the pathogenicity of these isolates.

Fruit ranging in size from as small as 1-in. in diameter were inoculated in the field and positive infection was obtained from February until May. The small fruit became discoloured purple and fell 4–5 days after inoculation. Larger fruit took 10 days to fall in February and up to 20 days later in the season. Typical external and internal symptoms were reproduced (Fig. 11).

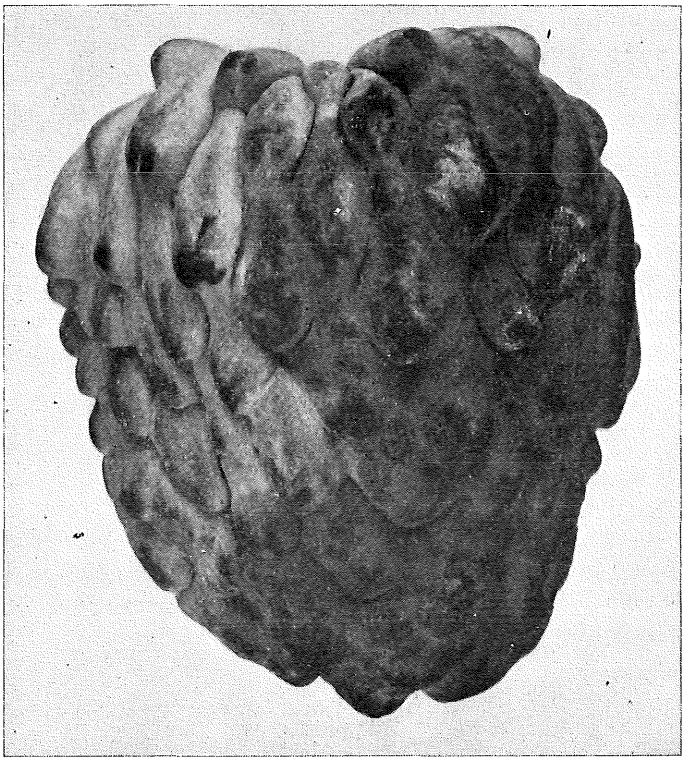

Fig. 11.
Symptoms Following Inoculation with *Phytophthora palmivora.*

In the laboratory, inoculated fruit rapidly developed large lesions and became discoloured internally.

Identity and Description of the Fungus.

A culture of the phycomycete forwarded to the Commonwealth Mycological Institute, Kew, was identified by Miss G. M. Waterhouse as *Phytophthora palmivora* Butler and classified in the "Cacao" group. The fungus has a temperature range from a minimum of 10°C. to a maximum of 35°C., with an optimum at approximately 31°C. on malt extract agar. No sexual bodies are produced on solid oatmeal agar media, but there is a ready formation of clamydospores and ovoid to elliptical papillate sporangia. Only chlamydospores and sporangia are formed when sterile mycelium is transferred from pea broth to distilled water. On potato-dextrose agar the colonies are relatively slow growing, flat, with a slight development of white aerial mycelium.

P. palmivora (syn. *P. parasitica* Dastur) has been previously recorded in Queensland on citrus and recently on rhubarb and rosella by G. D. Bowen (Queensland Department of Agriculture and Stock, unpublished records, 1952).

Phytophthora sp. has been recorded in New South Wales in association with a leaf spot and scald, twig dieback and brown rot in custard apple (New South Wales Department of Agriculture, 1951).

Field Infection.

The disease is restricted to the fruit on the lower branches of the tree and has been recorded only after heavy falls of rain. This evidence would suggest that the fungus is a soil inhabitant and gains access to the lower fruit during periods of rainy weather through rain splash. The only severe outbreak of the disease has occurred on a property where poultry running in the orchard maintain a bare surface on the soil. Under such conditions the splashing of infective material on to fruit would be greatly assisted.

DIPLODIA ROT.

This disease is frequently encountered in custard apple plantations but is not the cause of much economic loss. It has been recorded as far north as Charters Towers and is prevalent in the main areas surrounding Brisbane, particularly in rather neglected plantations.

Symptoms.

The most usual condition produced by this disease is a mummification of fruit which remain attached to the tree. The disease usually commences as a small lesion which rapidly expands and becomes hard and cracked, resembling somewhat the external symptoms produced by black canker. Such lesions usually cover at least half of the fruit and numerous large pycnidia are often visible on their surface (Fig. 12).

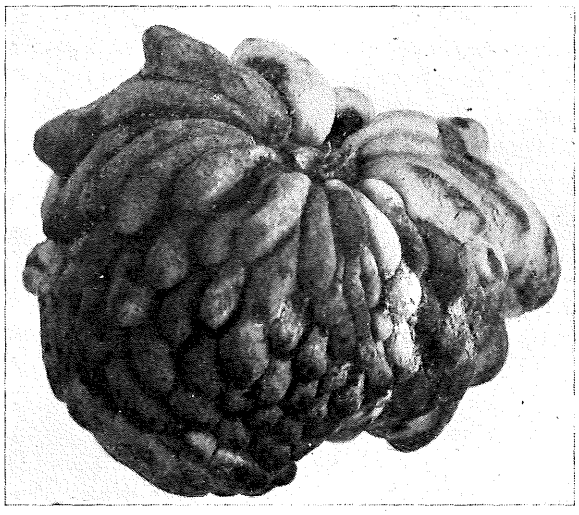

Fig. 12.

Fruit Rot Caused by *Botrydiplodia theobromae.*

The lesions extend deep into the internal tissue of the fruit, often completely discolouring it and producing a brown corky condition similar to that associated with purple blotch (Fig. 13).

Fig. 13.

Internal Discolouration Produced by *Botryodiplodia theobromae.*

Isolations and Pathogenicity Tests.

A fungus was first isolated from the discoloured tissue of affected fruit by G. D. Bowen in 1950 (Queensland Department of Agriculture and Stock, unpublished records, 1950). Single spore isolates and pycnidial isolates have since yielded the same organism.

The technique of placing culture inoculum in small injuries, as described earlier, was used to test the pathogenicity of several isolates. Fruit in the field and in the laboratory were successfully inoculated by this method. In the laboratory, lesions were large, spreading rapidly over the fruit and quickly discolouring all the tissue. Numerous pycnidia exuding tendrils were produced. The fungus was re-isolated. In the field, the inoculations in March and April were successful, while later inoculations under colder weather conditions were a failure. The infected fruit first produced a small purple lesion, which, after a slow initial period of 14 days, rapidly spread over the whole of the fruit. Unlike purple blotch, the fruit remained attached to the tree. Pycnidia were also produced on these fruit. The fungus was re-isolated.

Description and Identification of the Fungus.

On potato-dextrose agar the fungus produces quick-growing colonies with at first rather sparse, white to grey aerial mycelium, which becomes woolly and black with age. The substrate quickly changes from light green to a deep greenish black colour.

The fungus has a temperature range from a minimum of 9·5°C. to a maximum of 40°C. Optimum development is obtained at a temperature of approximately 29°C.

On potato-dextrose agar the fungus fails to produce any fruiting bodies when grown in darkness. Under laboratory light at room temperatures, stromatic structures are produced after three weeks. These structures are up to 3 mm. in height and have numerous pycnidia embedded in them.

The pycnidia occurring on infected fruit on the tree are usually seperate, globose in shape and occur superficially on the surface. They produce elliptical spores which are at first hyaline and non-septate but become dark brown and one-septate with age. Distinct longitudinal striations are visible on the exospore.

On some mummified fruit found on the ground the stromatic structures described above as occurring on culture media have been observed. It has been possible to produce these on infected fruit by placing them in a moist chamber in the laboratory. Spores similar to those occurring in the individual pycnidia are produced from these stromatic structures (Fig. 14). Table 2 records the relative sizes of the spores and pycnidia obtained.

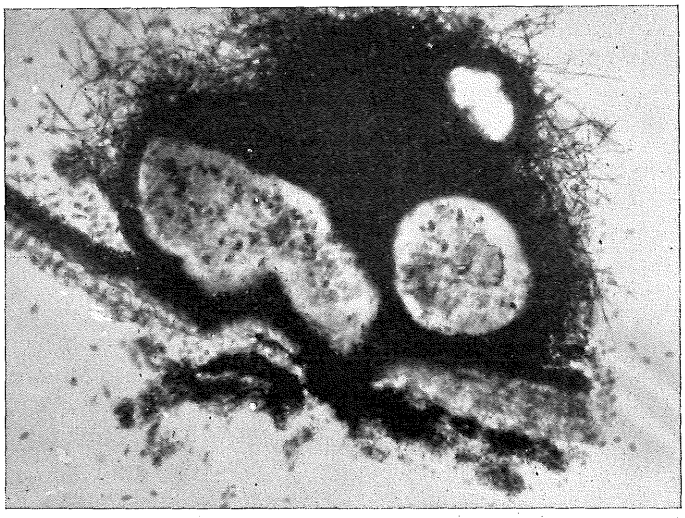

Fig. 14.
Microphotograph of a Section Through a Stroma of *Botryodiplodia theobromae*.

Table 2.

SPORE MEASUREMENTS (in microns)—*Botryodiplodia theobromae*.

Source.	Pycnidia Diameter.	Hyaline Non Septate Spores.	One Septate Dark Spores.
Diseased fruit (single pycnidia) (5)	220 to 450. Average 240 (40)	21 to 30 x 12 to 16·5. Average 25 x 14·5 (125)	21 to 30 x 12 to 16·5. Average 25 x 14·5 (125)
Diseased fruit (Stroma) (2)		Average 25 x 14·5 (25)	Average 25 x 14·5 (25)
Culture (Stroma) (2)		19·5 to 27 x 12 to 15. Average 24·4 x 12·2 (50)	21 to 28·5 x 12 to 15. Average 24·9 x 13·5 (50)
Stem dieback (2) ..	225 to 450. Average 275 (10)	Average 24 x 12·5 (50)	Average 24 x 12 (50

(Figures in brackets indicate the number of samples examined.)

The spore measurements and presence of stromatic structures place the fungus as *Botryodiplodia theobromae* Pat. This has been recorded previously under the synonym *Lasiodiplodia theobromae* on fruit of *Annona squamosa* in the Philippine Islands (Philippine Islands Bureau of Agriculture, 1926) and as a wound parasite and saprophyte on many tropical crops.

Field Infection.

The fruiting bodies of this fungus, both in the single pycnidial form and in the large stromatic structures, have been found frequently associated with dieback in custard apple trees (Table 2). It has not been determined whether this organism is acting as a parasite or merely as a secondary invader of the dying stem tissue.

The widespread occurrence of the organism on dead wood and in mummified fruit assures an abundant supply of infective material. The disease on the fruit is never in serious proportions and it appears likely that the organism is acting here merely as a wound parasite.

Diplodia natalensis has been recorded causing stem blight of *A. squamosa* in Texas (Freeman Weiss, 1950). As both the simple pycnidia characteristic of *D. natalensis* and the stromatic structure characteristic of *B. theobromae* have been found on local diseased stem material, it is probable that the disease reported in Texas is a similar condition.

In Queensland, *Botryodiplodia theobromae* has recently been recorded on the fruit of bullock's heart (*Annona reticulata*) in the Barron River area. It has previously been recorded on *Araucaria cunninghamii* (Young, 1936), while *D. natalensis* has been obtained from *Pinus* sp. (Young, 1936) and is common on citrus fruit, causing a stem end rot.

Lemons inoculated with the fungus isolated from custard apples produced stem end lesions similar to those caused by *D. natalensis*.

GENERAL REMARKS AND CONTROL.

The total area planted to custard apples in Queensland approximates 400 acres, made up in the main of small areas from 1 acre to 10 acres in size. The main producing localities are in the Brisbane district, where this fruit is commonly grown in association with such crops as vegetables and papaws.

In the past none of these diseases on custard apples has been severe enough to warrant expensive control measures being undertaken. Black canker does at times cause losses at an economic level. Purple blotch, although capable of producing severe losses, has been restricted to a small number of farms. However, there are difficulties encountered in spraying custard apple trees on account of their large size and the fact that the fruit are hidden in the rather profuse foliage. For the present, attention to cultural methods, particularly orchard hygiene involving removal of dead wood and mummified fruit, should assist in minimising the incidence of these diseases.

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