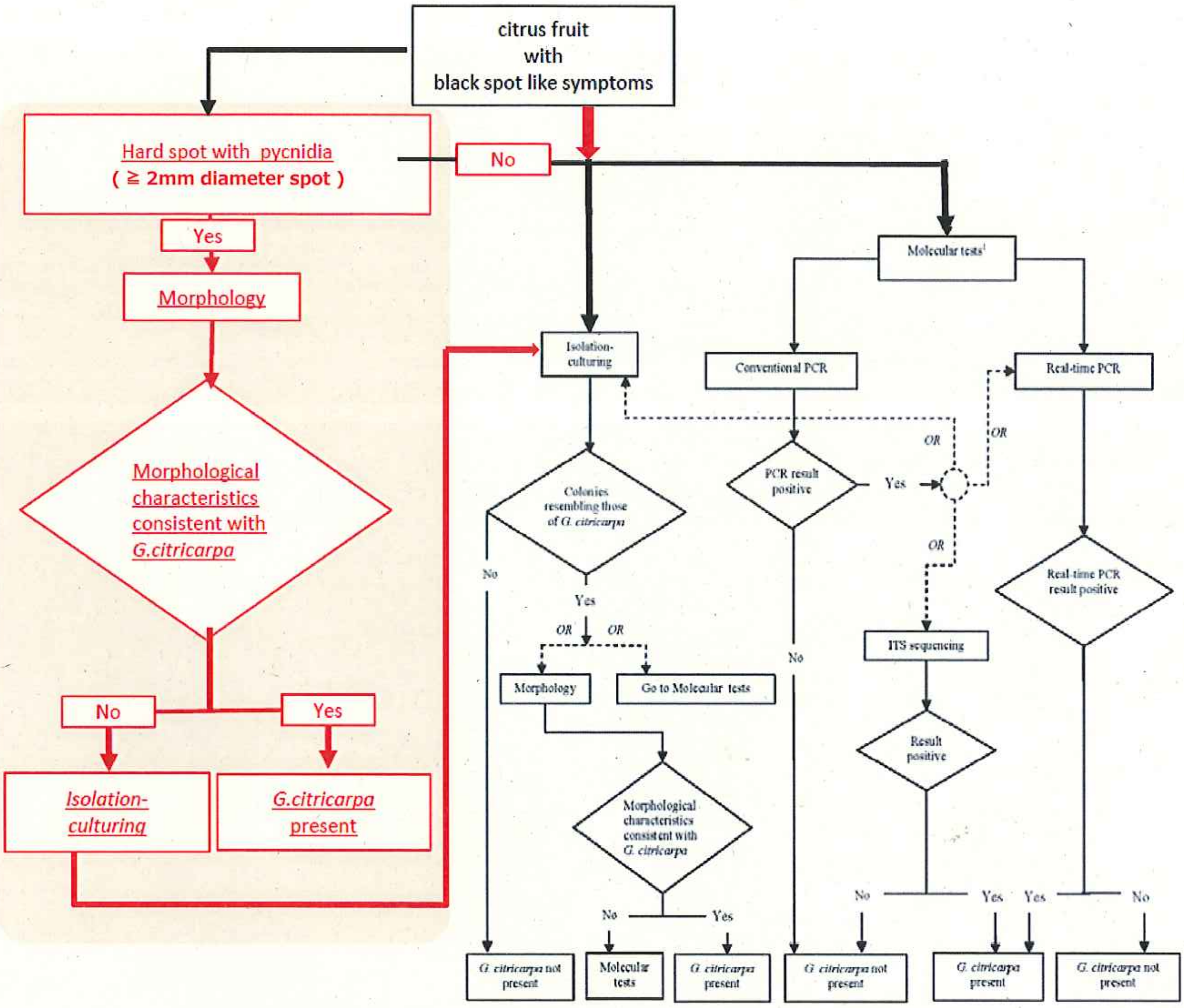
Draft Annex to ISPM 27:2006: Phyllosticta citricarpa (McAlpine) Aa on fruit (2004-023)

Comm. no.	Para. no.	Comment type	Comment	Explanation
1	*17*	Substantive	Name: Phyllosticta citricarpa (McAlpine) Aa Synonyms: Guignardia citricarpa Kiely Phyllostictina citricarpa (McAlpine) Petr. Phoma citricarpa McAlpine Phoma citricarpa ~~Phoma citricarpa var. mikan Hara~~ = Leptodothiorella sp. Taxonomic position: Eukaryota, Fungi, Ascomycota, Pezizomycotina, Dothideomycetes, Botryosphaeriales, Botryosphaeriaceae Common names: Citrus black spot (for common names in other languages, see CABI (2011)) Reference: MycoBank 320327	In paragraph 17, it states that "Phoma citricarpa var. mikan Hara" is a synonym of "Phyllosticta citricarpa". There are literatures which states that "Phoma citricarpa" is a synonym of "Phyllosticta citricarpa" (Sutton et al(1966)*[1], EPPO Data Sheets on Quarantine Pests(2013)*[2], EPPO database PQR(2013)*[3]). However, the name of "Phoma citricarpa var. mikan Hara" has been changed into "Phoma erratica var. mikan Hara" because it is not a species of "Phoma citricarpa" but of "Phoma erratica" (Hara(1960*[4],1961*[5])、Kitajima(1989)*[6]). Therefore, "Phoma citricarpa var. mikan Hara" should be replaced with "Phoma citricarpa". *1~6: Please refer the attached PDF file.

Comm. no.	Para. no.	Comment type	Comment	Explanation
2	38	Substantive	This protocol describes the detection and identification of P. citricarpa on symptomatic citrus fruit. Citrus fruit should be inspected for any symptoms typical of citrus black spot (see section 3). If suspected symptoms are present in the form of spots or lesions, they are examined with a magnifying lens or a dissecting microscope for the presence of pycnidia. However, as the pycnidia and conidia of P. citricarpa are very similar to those of P. citriasiana, the recently described pathogen on C. maxima (Wulandari et al., 2009), the identity of P. citricarpa has to be confirmed by applying the diagnostic methods described below (Figure 4). The flow chart drawn on the left part in Figure 4 shows a diagnostics option which can be conducted in a relatively short time. If pycnidia are present in hard spot lesions described in Section 3.1 (≧2 mm in diameter in size), morphology of the pycnidia and conidia should be examined with a dissecting microscope and a light microscope for observation. If their morphological characteristics are consistent with the ones described in Section 4.1.3, it is concluded that P. citricarpa is present. If the morphological characteristics are inconsistent with the ones described in Section 4.1.3, Method A is applied.Diagnostic Method A (isolation and culturing) is used for the identification of P. citricarpa on citrus fruit, but can also be used on leaves, twigs and pedicels, whereas Method B (molecular assay) applies to citrus fruit only.	In paragraph 15, it states that 'It should be noted that in symptomless citrus fruit or fruit with very small spots (<2 mm in diameter) without pycnidia, the non-pathogenic endophyte Phyllosticta capitalensis Henn. (formerly incorrectly referred to as Guignardia mangiferae A.J. Roy) (Glienke et al., 2011), recorded in many plant families, may be present.'. And in paragraph 22, it states that 'Citrus black spot can be easily identified by hard spot lesions with pycnidia.'. So if there is a symtom which has typical hard spot ≥2mm in diameter and pycnidia, there is a possibility that the fruit is infested by Guignardia citricarpa. Therefore, we propose to add a new diagnostic method as the first step of the flow of Fig.4. It can be a quick diagnostic method and it is practical and beneficial for countries which does not have any special measures for fresh fruits other than visual inspection.

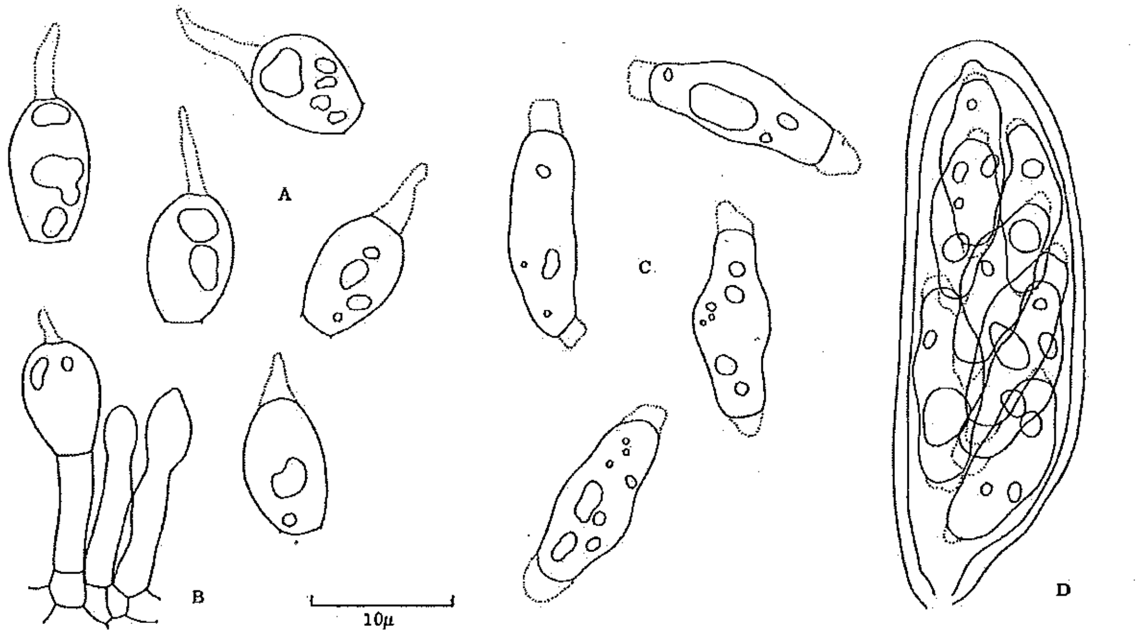
Comm. no.	Para. no.	Comment type	Comment	Explanation
3	*134*	Substantive	Japan would like to resubmit the following comment submitted in the member consultation period in 2012. Japan thinks that a flow which is not through isolation and culturing and does not depend on molecular test would be available (The revised proposed flow is shown in the attached sheet). (The comment submitted in 2012) A new diagnostic method should be added as the first step of the flow of Fig.4. on the basis of the typical symptom (hard spot) on fruit and the presence of pycnidia.	For the explanation, please see comment on paragraph 38.

proposed amendment of Fig.4



C.M.I. Descriptions of Pathogenic Fungi and Bacteria No. 85

GUIGNARDIA CITRICARPA



A, Conidia; B, blastic conidiophores; C, ascospores; D, ascus.

Guignardia citricarpa Kiely in *Proc. Linn. Soc. N.S.W.*, **73**:295, 1949.
Conidial state: *Phyllostictina citricarpa* (McAlp.) Petrak, 1953.
≡*Phoma citricarpa* McAlp., 1899.

Ascocarps amphigenous on dead leaves, not formed in fruit or leaf lesions, solitary or aggregated, globose, immersed, dark brown to black, 95–125μ diam.; wall up to 5 cells thick, sclerotioid on the outside, pseudoparenchymatic and thin-walled within, ostiole nonpapillate, circular, 10–17·5μ diam. *Asci* clavate-cylindrical, shortly stipitate, 8-spored, 40–65 × 12–15μ; ascus wall thick, bitunicate. *Ascospores* aseptate, hyaline multi-guttulate, cylindrical but swollen in the middle, ends obtuse, each with a colourless appendage, 12·5–16 × 4·5–6·5μ. Pseudoparaphyses absent.

Pycnidia formed in fruit and leaf lesions, also amphigenous on dead leaves, solitary, sometimes aggregated, globose, immersed, mid-to-dark brown, 115–190μ diam., wall up to 4 cells thick, sclerotioid on the outside, pseudoparenchymatous within, ostiole darker slightly papillate, circular, 12–14.5μ diam. *Conidia* obovate to elliptical, hyaline aseptate, multi-guttulate, apex slightly flattened with a colourless subulate appendage, base truncate, 8–10·5 × 5·5–7μ, formed as blastospores from hyaline, unicellular, cylindrical conidiophores up to 9μ long.

On *Citrus* spp. Also recorded in a non-pathogenic form on many other hosts in the following families: Anacardiaceae, Aquifoliaceae, Bignoniaceae, Burseraceae, Cunoniaceae, Dioscoreaceae, Gramineae, Lauraceae, Leguminosae, Liliaceae, Lythraceae, Magnoliaceae, Myrtaceae, Orchidaceae, Passifloraceae, Proteaceae, Rosaceae, Rutaceae, Solanaceae, Sterculiaceae, Theaceae (RAM **29**:208; **43**, 1922a) and Herb. IMI.

DISEASE: Black spot of citrus. Kiely (1949) described 3 types of fruit lesion: *Hard spot and shot-hole spot* numerous at first, circular, brown with slight depressions, later more depressed in the centre which turns grey-white, margin black and surrounded by a ring of green rind tissue; *Freckle spot* develops after hard spot phase with abundant lesions, small, deep organge to brick red, finally brown, lacking a green ring; *Virulent spot*, irregular, confluent, rapidly spreading, black in the centre where pycnidia are produced, brown nearer the edge, finally brick red at the periphery forming the margin of the sunken lesion. McOnie found field temperatures affected symptom expression (RAM **44**:1556b). Also occurs on leaves, twigs and flowers of citrus and other hosts, often as latent infections.

GEOGRAPHICAL DISTRIBUTION: Widely distributed on a large number of hosts. Countries where the fungus has been reported as a pathogen of citrus fruit in the field are designated below with an asterisk:

Africa (?Egypt, Kenya, *Mozambique, Nigeria, *Rhodesia, *South Africa, Uganda); Asia (Ceylon, *China, *Formosa (Taiwan), Hong Kong, ?India, *Indonesia, Iran, Israel, *Japan, Korea, ?Malaya, Okinawa, ?Pakistan, ?Philippines, ?Singapore, ?Thailand, ?Viet-Nam); Australasia & Oceania; (*Australia, ?Fiji Islands, ?Hawaii, New Hebrides); Europe (Sicily, Spain, U.S.S.R. (Georgia)); North America (United States (Florida)); Central America and the Caribbean (Honduras, Jamaica, Trinidad); South America (*Argentine, *Brazil, *Peru, Venezuela). (CMI Map 53, ed. 3, 1961; RAM **29**:208; **44**, 701, Herb. IMI).

PHYSIOLOGIC SPECIALIZATION: McOnie (RAM **43**, 1922a) has described a form isolated from latent infections in citrus and 14 other cultivated and indigenous hosts in South Africa, which is non-pathogenic to citrus. This is distinguished in culture from the pathogenic strain by its darker colour, more luxurious and much faster growth, and by its ready production of perithecia. The pathogenic form may also be isolated from symptomless rind of fruit but predominates in lesions and is distinguished from the saprophytic form by the production of pycnidia in culture. Both types were found in the symptomless rind of oranges, lemons and grapefruit in orchards affected with black spot in Nelspruit, South Africa.

TRANSMISSION: By air-borne ascospores from perithecia produced on citrus leaf litter (RAM **43**, 1922b). Conidia produced from pycnidia require water droplets for emergence and dispersal. They play a minor role by contributing to the infection of low hanging fruit.

Mycelium in latent infections of citrus leaves remains viable up to 18 days and may be detected when the leaves are incubated at 30°C. (Kiely, 1949). Nursery trees may also carry latent infection into other citrus growing areas (Kiely, 1949, Wager, 1953).

Wounds on fruit made by insects may also provide infection courts (RAM **16**:247, **22**:19).

NOTES: Black spot was first described from New South Wales in 1895 from areas round Sydney where losses caused to late Valencia oranges from blemished fruit were serious both from infections in the field and from latent infections which developed on fruit in transit.

A succession of epiphytotics caused glut conditions in the local market with serious economic repercussions which led to a Royal Commission of Inquiry into the fruit industry of New South Wales in 1939.

The disease was first reported from South Africa in 1929 only in the cool mist belt of Natal but later in 1945 assumed more serious proportions when it spread to the hot dry sub-tropical East & North Transvaal, and rendered more than 90% of fruit from unprotected trees in some areas unfit for export.

Black spot was subsequently discovered in Rhodesia in 1961 in lemon and late Valencia orchards but has remained localized (Whiteside, 1965). Damage is most severe when mean max. temps. are between 24–25°C. at the time fruit is maturing or when the temp. at peak maturity coincides with 30°C.

Good control has been achieved from the use of sprays containing weak Bordeaux and white oil, cuprous oxide and zineb (RAM **30**:566; **43**, 1922g). Routine fumigation of trees with HCN for control of scale insects has been found to reduce the incidence of the pathogen as well (*Phytopathology*, **55**:486, 1965).

LITERATURE: Kiely, *Proc. Linn. Soc. N.S.W.*, **73**:249–292, 1949 [58 ref.], Wager, *Sci. Bull. Dep. Agric. For. Un. S. Africa*, 303, pp. 52, 1953, Schüepp, *Phytopath. Z.*, **40**:258–271, 1961 [21 ref.], McOnie, *Phytopathology*, **54**:40–43; 64–67, 1964; Whiteside, *Rhod. Agric. J.*, **62**:87–91, 1965 (disease & bibliography); Kiely, *Sci. Bull. Dep. Agric. N.S.W.*, 71, pp. 88, 1950 [26 ref.]; McOnie, *Phytopathology*, **54**:1448–1453: 1488–1489, 1964 (epiphytology & control); Hudson, *Trans. Br. mycol. Soc.*, **45**: 395–423, 1962 (taxonomy & ecology on sugarcane).

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Data Sheets on Quarantine Pests

Guignardia citricarpa

IDENTITY

Name: *Guignardia citricarpa* Kiely
Anamorph: *Phyllosticta citricarpa* (McAlpine) Van der Aa (macroconidial state)
Synonyms: *Phoma citricarpa* McAlpine
Phyllostictina citricarpa (McAlpine) Petrak
Synanamorph: *Leptodothiorella* sp. (microconidial state)
Taxonomic position: Fungi: Ascomycetes: Dothideales
Common names: Black spot, hard spot, shot-hole, freckle spot, virulent spot, speckled blotch of citrus (English)
Maladie des taches noires (French)
Schwarzfleckenkrankheit (German)
In recent publications citrus black spot has been referred to by the acronym CBS (Kotzé, 1981; Herbert & Grech, 1985).
Notes on taxonomy and nomenclature: On the basis of gross morphology, the name *G. citricarpa* has been applied to several *Guignardia* samples and isolates derived from citrus and non-citrus hosts, irrespective of whether or not they can cause black spot disease of citrus (Kiely, 1949a; McOnie, 1964a; Van der Aa, 1973; McMillan, 1986;). McOnie (1964a; 1964c) reported that two *Guignardia* species, the black-spot-causing *G. citricarpa* and a non-pathogenic *Guignardia* sp., occur on citrus. Furthermore, on some of the non-citrus hosts, several different *Guignardia* species have been described (Petch, 1923; Roy, 1968; Pande, 1969; Van der Aa, 1973; Punithalingam, 1974; Ullasa & Rawal, 1984). This has resulted in confusion over taxonomy, identity and host range of *G. citricarpa*. It is therefore imperative that, until a thorough reassessment and characterization of the *Guignardia* isolates causing black spot of citrus and those assumed to be found on alternate hosts are carried out, the name *G. citricarpa* is exclusively applied to the fungus causing black spot of citrus.
Bayer computer code: GUIGCI
EPPO A1 list: No. 194
EU Annex designation: II/A1 (strains pathogenic to citrus)

HOSTS

The principal hosts are *Citrus* species: *C. limonia*, *C. nobilis*, *C. poonensis*, *C. tankan*, grapefruits (*C. paradisi*), lemons (*C. limon*), limes (*C. aurantifolia*), mandarins (*C. reticulata*), oranges (*C. sinensis*). Sour oranges (*C. aurantium*) are not susceptible.

Non-citrus hosts reported to harbour *G. citricarpa* include almonds (*Prunus dulcis)*, avocados (*Persea americana*), *Eucalyptus* spp., guavas (*Psidium guajava, P. montanum*), mangoes (*Mangifera indica*), passionfruits (*Passiflora edulis*), *Rubus* spp. and a variety of ornamentals such as *Caesalpinia pulcherrima*, *Callistemon citrinus*, *Camellia japonica*, *Dendrobium speciosum*, holly (*Ilex aquifolium*), *Magnolia* sp., *Smilax* sp. (Kiely, 1948; Kiely, 1949b; McOnie, 1964a). Other recorded hosts are cardamoms (*Elettaria* *cardamomum*) (Allen, 1971), *Cola nitida*, *Dioscorea pentaphylla* (Roy, 1965), *Eucalyptus deglupta* (FAO, 1960) and sugarcane (*Saccharum officinarum*) (Hudson, 1962).

The non-citrus host list is controversial and doubtful for two main reasons: 1) adequate cross inoculation details are lacking and 2) on *Camellia*, *Dioscorea*, *Ilex*, *Persea*, *Psidium*, *Mangifera* and *Smilax*, species have been described under the names *Guignardia camelliae* (Cooke) Butler, *G. dioscoreae* A.K. Pande, *G. philoprina* (Berk. & M.A. Curtis) Van der Aa, *G. perseae* Punithalingam, *G. psidii* B.A. Ullasa & R.D. Rawal, *G. mangiferae* A.J. Roy and *G. smilacis* A.J. Roy, respectively.

GEOGRAPHICAL DISTRIBUTION

The geographical distribution is given for true *G. citricarpa* and then for doubtful or non-pathogenic records, which are probably other species (see Notes on taxonomy and nomenclature). Citrus black spot, originating in south-east Asia, spread to Australia, South Africa and China many years ago.

- ***Guignardia citricarpa***

  EPPO region: Absent.

  Asia: Bhutan, China (Fujian, Guangdong, Sichuan, Yunnan, Zhejiang; Fawcett, 1936), Hong Kong, Indonesia (Java), Philippines, Taiwan.

  Africa: Kenya, Mozambique, South Africa (Wager, 1952; Herbert & Grech, 1985), Zambia, Zimbabwe.

  Oceania: Australia (New South Wales, Queensland, Victoria; McAlpine, 1899), New Zealand, Vanuatu.

  EU: Absent.

  Distribution map: See CMI (1990, No. 53).

- **Doubtful *G. citricarpa* or *Guignardia* spp. non-pathogenic to citrus**

  EPPO region: Egypt, Israel, Italy (Sicily), Lebanon, Spain (McOnie, 1964c).

  Asia: Georgia, India (Assam on *Dioscorea pentaphylla*), Iran, Israel, Japan (including Ryukyu Archipelago), Korea Democratic People's Republic, Korea Republic (intercepted in USA), Lebanon, Malaysia (peninsular, Sabah, Sarawak; on *Eucalyptus deglupta*), Myanmar, Pakistan (intercepted in USA), Singapore (intercepted in USA), Sri Lanka (on tea), Thailand (intercepted in USA), Viet Nam (intercepted in USA).

  Africa: Egypt (intercepted in USA), Nigeria (on *Cola nitida*), South Africa (Cape Province), Swaziland, Tanzania (on cardamoms; Allen, 1971), Uganda.

  North America: USA (Florida on mangoes, McMillan, 1986; Farr *et al.*, 1989; Hawaii, intercepted in mainland USA). The report from Florida failed to show that black spot of citrus could be produced with the mango isolate and made no comparison with *G. mangiferae* naturally found on mangoes.

  Central America and Caribbean: Belize, Cuba (various hosts but not citrus), Honduras, Jamaica, Trinidad.

  South America: Argentina, Brazil (São Paulo), Peru, Venezuela (on *Tabebuia pentaphylla*).

  Oceania: Cook Islands, Fiji (Dingley *et al.*, 1981), Niue, Papua New Guinea (on tea), Samoa, Tonga.

  EU: Present.

  Distribution map: See CMI (1990, No. 53).

BIOLOGY

The asexual states of the citrus black spot fungus are *Phyllosticta* (macroconidial) and *Leptodothiorella* (microconidial). The latter is sometimes referred to in the literature as the 'spermagonial' state and the dumb-bell shaped microconidia as spermatial cells (Kiely, 1949a; Van der Aa, 1973) but to date no evidence has been found to substantiate the claim that it has this function. The *Phyllosticta* state occurs on fruit lesions, leaf lesions, dead twigs, fruit stalks and in abundance on leaves on the orchard floor (Kiely, 1949a; Kotzé 1981). The *Leptodothiorella* state usually appears on fallen leaves before ascocarps develop; the rôle of the microconidia is unclear. Ascocarps occur throughout the year on leaf litter lying on the orchard floor.

Cultures of *G. citricarpa* grow well on agar media; the optimal temperature for growth has been reported to be 24-27°C (Wager, 1952) and optimum growth in liquid basal synthetic medium has been reported to be at 27°C (Kotzé, 1981). Germination of macroconidia has been reported to be stimulated by citric acid solutions at concentrations of 0.1-0.5%. Maximum germination, nearly 80%, has been obtained using 0.3% citric acid solution and incubating conidia for 4 days at 25°C in a damp chamber (Kiely, 1949a). Germination of macroconidia in tap water has been reported in South Africa (Wager, 1952). Longevity of macroconidia differs from country to country. In Australia, freshly exuded mature macroconidia have been reported to lose their ability to germinate 1 month after they were produced (Kiely, 1949a) but in South Africa macroconidia have been reported to retain their germinative capacity up to 5 months (Wager, 1952). Macroconidia on germination enter both unwounded and wounded fruits, and through abrasions caused by hail or insect damage (Kiely, 1949a; Lee, 1969). In field trials carried out in Australia, young fruits inoculated with conidial suspensions after petal fall in October produced black spot disease after nearly 1 year (Kiely, 1949a). In South Africa, young citrus fruits inoculated with high concentrations of macroconidia near mid-November showed speckled blotch lesions by the end of January the following year (McOnie, 1964e). The role of macroconidia in spreading the black spot disease is considered to be of minor importance when compared with airborne ascospores which are regarded as the primary source of inoculum (Kiely, 1949a; McOnie, 1964b; Kotzé, 1981; Zheng, 1983).

The disease spreads in orchards by infection coming from macroconidia and ascospores. It takes several years from the time the first symptoms are noticed until the disease reaches epidemic proportions in South Africa (Kotzé, 1981). Macroconidia are water-borne and require droplets of water for their emergence and dispersal (Wager, 1952) and pycnidia have no special release mechanism for expelling conidia into the atmosphere (Kotzé, 1981). Macroconidia are washed down or rain-splashed from dead twigs and old fruit stalks to infect susceptible fruits in Zimbabwe (Whiteside, 1967). Ascospores are forcibly ejected vertically up to 1 cm and carried by wind and water. Dew, rain and high temperature promote the release of ascospores from ascocarps developed on leaf litter from the floor of orchards during May to October in Taiwan (Huang & Chang, 1972), from November to June in South Africa (McOnie, 1964d), and throughout the year in Australia (Kiely, 1949a). Release of ascospores commences within the first hour after the leaf litter has become wet (Kiely, 1949a; Kotzé, 1981). Rainfall as little as 3 mm can bring about the discharge of ascospores from mature ascocarps (McOnie, 1964d). Significant fruit infection has been correlated with an abundance of ascospore inoculum in the atmosphere (McOnie, 1964b).

In Australia, ascospores take more than 24 h to germinate at 25°C and 4 days to reach 98% germination (Kiely, 1949a), whereas in South Africa peak germination approaching 100% has been observed in 24 h (McOnie, 1967). Ascospores on germination produce appressoria with infection pegs that penetrate the cuticle. The infection pegs produce at their tips, between the cuticle and the upper epidermal cells, knots of fungal tissue which are considered to establish latent infection (McOnie, 1967; Kotzé, 1981). Flowers and fruits are susceptible to infection from anthesis until approximately 16 weeks later (Kellerman & Kotzé, 1979). Infection is usually followed by a long period of latency which may last 12-36 months in Australia and about 3-12 months after anthesis for fruit infection in South Africa (McOnie, 1967; Kellerman & Kotzé, 1979). Disease symptoms first develop on fruits which are at or near maturity depending on several factors: *Citrus* species or variety, prevailing weather conditions and duration of latent period (McOnie, 1967). In Australia primary infections of young leaves are initiated by wind-borne ascospores during September and October and young fruits from October to February. Latent infections on green leaves provide ascospore inoculum, whenever such leaves fall, over a period of 1 to approximately 3 years. The presence of *G. citricarpa* mycelium in healthy green citrus leaves in commercial nurseries has been demonstrated and mycelium in latent infections has been reported to survive 18 days in wilted air-dried citrus leaves and then to produce fructifications when such leaves were moistened and incubated at 30°C (Kiely, 1949a).

The existence in Australia of a primary and secondary infection cycle and their relationship have been demonstrated by Kiely (1949a). Primary latent infection of young fruits gives rise to pycnidia with macroconidia after 12-15 months, and at maturity they develop black spot lesions, which in turn initiate a secondary infection cycle. In South Africa, the seasonal cycle of the pathogen, the climatic conditions and the cycle of citrus fruit and leaves are regarded as the three primary components affecting a black spot epidemic (Kotzé, 1981). The leaf litter on the floor of the orchard acts as the reservoir for ascocarps which develop within 50-180 days but maturation depends on intermittent wetting and drying of leaves and prevailing temperature (Lee & Huang, 1973; Kotzé, 1981). Heavy dew alone has been reported to be sufficient for maturation and release of ascospores in New South Wales (Kiely, 1950), but in South Africa irrigation and dew have been reported to have little or no noticeable effect on ascocarp development or ascospore release (McOnie, 1964d). Cool, dry weather has been reported to prolong ascocarp maturation up to 6 months under South African conditions (Kotzé, 1981). Rainfall pattern has been reported to influence the release of the primary inoculum (ascospores) into the atmosphere; 3 mm of rain is considered sufficient for the release of large numbers of ascospores but continuous heavy showers are reported to affect ascospore discharge adversely and reduce ascospore load in the air (McOnie, 1964d; Kotzé, 1981).

In Australia, Kiely (1950) has reported the existence of a positive correlation between disease development and rainfall during the susceptible period and a negative one during the period after petal fall when infection occurred. Mean maximum temperature for disease development is between 24 and 25°C. Disease development in fruits of orange cv. Valencia in coastal New South Wales is favoured by high temperature and low soil moisture (Kiely, 1969). In South Africa symptom expression is favoured by high temperature (McOnie, 1964e) and late-hanging fruit in orange cv. Valencia (Kellerman & Kotzé, 1979). Once re-greening of the rind starts black spot development ceases. Other fungi which are sometimes associated with speckled blotch of citrus are *Alternaria* sp. and *Glomerella cingulata* (Kiely, 1960).

DETECTION AND IDENTIFICATION

Symptoms

Black spot of citrus was first officially noticed in Australia in 1895 on fruits in the citrus-growing areas around Sydney (Kiely, 1949a). Spot development on oranges cv. Valencia goes through several stages and Australian growers refer to these phases of fruit lesions as hard spot and shot hole spot; freckle spot; and spreading or virulent spot (Kiely, 1949a). In Australia, hard spot and shot-hole spot usually develop on oranges cv. Valencia in mid-August (late winter), with 50 or more lesions per fruit. Lesions are at first circular and brown with slight depressions, which gradually sink in the centre developing into crater-like depressions, grey-white in the centre with black margins encircled by green rind tissue.

The smaller, orange to brick-red freckle spots usually appear on the half of the fruit exposed to the sun, with several hundred spots per fruit. When conditions are favourable for spotting, hard spot development is replaced by freckle spot which drastically reduces the keeping quality of fruits. Virulent spots are common, developing 2-3 weeks after freckle spot development with the onset of warmer conditions. They spread rapidly becoming confluent, involving approximately two thirds of the fruit surface in 4-5 days and assuming irregular shapes. Freckle spots may develop into virulent lesions and virulent spots may engulf freckle and hard spot lesions. Virulent spots extend deeper into the rind. An epidemic of virulent spots may occur when orange cv. Valencia is at the peak of maturity (Kiely, 1949a). Another development phase of black spot, speckled blotch, has been reported on citrus fruits in Australia (Kiely, 1960) and South Africa (McOnie, 1964e).

In inoculation tests carried out in Taiwan, only freckle spots and virulent spots were produced by isolates from fruit with hard spot or black speckle lesions; freckle spots developed into virulent spots on fruits in continuous storage (Lee, 1969).

Lesions on leaves of orange cv. Valencia are rare in the Gosford area of New South Wales but common in Queensland (Kiely, 1949a). Lesions usually occur on lemons as sunken spots, 1.5-3 mm in diameter. Black spot leaf lesions are very common in Transvaal and Natal (Wager, 1945; Kiely, 1949a).

Morphology

Phyllosticta state: macroconidial state pycnidial, immersed, dark-brown to black, globose 115-190 µm. Macroconidia hyaline, variable in shape, obovoid to broadly ellipsoid or pyriform, aseptate, (6-)8-10.5(-13) x (5-)5.5-7(-9) µm, surrounded by a colourless gelatinous coat and with a subulate, apical appendage 5-15 µm long, caducous. *Leptodothiorella* state: microconidial state pycnidial, resembling the pycnidia of the *Phyllosticta* state in general morphology, usually developing prior to ascocarp formation. Microconidia hyaline, dumbbell-shaped, 5-8 x 0.5-1 µm. Similar pycnidia develop in agar culture. Ascocarps solitary or in groups; solitary ascocarps globose, 125-135 µm, papillate, ostiolate; aggregated ascocarps 220-360 µm. Asci clavate-cylindrical, bitunicate, 45-85 x 12-15 µm, 8-spored, uniseriate. Ascospores hyaline, aseptate, broader in the middle, cylindrical, 8-17.5 x 3.3-8 µm, ends obtuse with colourless terminal mucoid appendage. Paraphyses and periphyses absent.

Detailed descriptions are given by McAlpine (1899), Kiely (1949a), Sutton & Waterston (1966) and Van der Aa (1973).

Detection and inspection methods

Citrus trees introduced to new sites can be tested for latent infection by sampling green leaves as suggested by Kiely (1949a).

MEANS OF MOVEMENT AND DISPERSAL

G. citricarpa is dispersed naturally only over short distances. It has been introduced to new sites in South Africa by distributing nursery trees with latent infection from Pietermaritzburg where citrus black spot was first reported in 1929 (Wager, 1952). It has been claimed that the disease was spread in Zimbabwe on bud wood or nursery trees before restriction was placed on material from South Africa (Whiteside, 1965). Grafting infected twigs on healthy trees is considered to be a means of spreading *G. citricarpa* to new trees (Schüepp, 1961). The fungus has been intercepted in the USA on fruits from several countries (see Geographical Distribution). However, only pycnidiospores form on fruit and these are not airborne, so the risk of spread on fruit is relatively low (Whiteside *et al.*, 1988).

PEST SIGNIFICANCE

Economic impact

Black spot of citrus is a serious disease of citrus cultivars in Australia (Kiely, 1949b; 1969), Guangdong province in China (Fawcett, 1936) and South Africa (McOnie, 1964b). In the Windsor and Hawkesbury River areas of Australia in 1931, all orchards of orange cvs Washington Navel, Joppa and White Siletta were severely affected and losses of 80% were common in individual orchards (Kiely, 1960). Before the adoption of control measures, heavy losses in orange cv. Valencia had been reported in the coastal orchards in New South Wales (Kiely, 1949a; 1949b). In South Africa 90% of fruits from unprotected trees were claimed to be unfit for export (McOnie, 1964b) and losses of more than 80% of unprotected fruits were reported to be common (McOnie, 1964d). In Zimbabwe black spot was known from 1965 but reached epidemic proportions in 1978 (Kotzé, 1981). In South Africa, summer rains on lemon orchards is the most important factor in establishement of an epidemic and so far black spot has not been known to disappear or decline once it has reached the epidemic stage (Kotzé, 1981). It is mainly a fruit disease and the unsightly lesions do not cause post-harvest decay but render the fruits unmarketable. During the period between 1929 and 1939, when epidemics were at their worst in Australia, the wholesale market for oranges in Sydney was depressed due to growers creating a glut for fear of their fruits developing disease.

G. citricarpa is considered to be the most important pathogen of citrus in China, Australia and South Africa, where the citrus industry is of major importance (McOnie, 1967). Recent statistics on crop losses are unavailable.

Control

Since all commercially grown *Citrus* species except *C. aurantium* (sour oranges) are susceptible (McOnie, 1964d; Kotzé, 1981), a range of fungicides has been tested and recommended for protection and control. The use of preventive sprays such as Bordeaux + white oil, Bordeaux and zineb or mezineb (Kiely, 1949a; 1950; 1963; 1969; Wager, 1952), mancozeb (Kellerman & Kotzé, 1979), benomyl + mineral oil (McOnie *et al.*, 1969; Kellerman & Kotzé, 1973; 1979; Kiely, 1976; Tsia *et al.*, 1977; Bertus, 1981; Kotzé, 1981) have been reported to give adequate control. Since 1971, black spot of citrus has been controlled in South Africa by a single application of benomyl but recently in orchards of orange cv. Valencia in Eastern Transvaal, benomyl became ineffective due to tolerance by some *G. citricarpa* strains (Herbert & Grech, 1985). The benomyl-tolerant strains were also found to be tolerant of other benzimidazoles but sensitive to mancozeb. The benomyl-tolerant isolates have been reduced from over 90% to 30% by the use of mancozeb. Another control measure is orchard sanitation, including the removal of mature fruits before the new crop set, to prevent pycnidial inoculum getting washed down. Stripping nursery trees of leaves before being sold has also been recommended (Wager, 1952).

Phytosanitary risk

G. citricarpa has recently been added to the A1 quarantine list of EPPO; it is an A1 pest for CPPC and an A2 pest for APPPC and IAPSC. True *G. citricarpa* is absent from the EPPO region. Though of tropical origin, the fungus has established itself and causes serious damage in subtropical climates, e.g. China, New South Wales (Australia) and South Africa. It could be expected to establish and cause significant losses if introduced into the Mediterranean citrus-growing areas.

PHYTOSANITARY MEASURES

Importation of planting material of citrus from countries where true *G. citricarpa* occurs should be prohibited (as it is on account of several other non-European citrus pests). The fungus can readily be carried on imported citrus fruits, but the risk of spread from these is relatively low. Fruits from infested countries should come from orchards found free from, or treated against, the pest.

BIBLIOGRAPHY

Allen, D.J. (1971) Some newly recorded diseases of minor horticultural crops in Tanzania. *East African Agricultural and Forestry Journal* **37**, 22-25.

CMI (1990) *Distribution Maps of Plant Diseases* No. 53 (edition 6). CAB International, Wallingford, UK.

Bertus, A.L. (1981) Fungicidal control of black spot and melanose on coastal Valencia oranges in New South Wales. *Australasian Plant Pathology* **10**, 53-55.

Dingley, J.M.; Fullerton, R.A.; McKenzie, E.H.C. (1981) *Survey of agricultural pests and diseases. Technical report. Volume 2. Records of fungi, bacteria, algae and angiosperms pathogenic on plants in Cook Islands, Fiji, Kiribati, Niue, Tonga, Tuvalu and Western Samoa*, 482 pp. FAO, Rome, Italy.

FAO (1960) *Quarterly Report July to September 1960. FAO Plant Protection Committee for the South East Asia and Pacific Region*, pp. 1-2. FAO, Bangkok, Thailand.

Farr, D.F.; Bills, G.F.; Chamuris, G.P.; Rossman, A.Y. (1989) *Fungi on plants and plant products in the United States*. APS Press, St Paul, Minnesota, USA.

Fawcett, H.S. (1936) *Citrus diseases and their control*, 656 pp. McGraw-Hill Publishing Company, London, UK.

Herbert, J.A.; Grech, N.M. (1985) A strain of *Guignardia citricarpa*, the citrus black spot pathogen, resistant to benomyl in South Africa. *Plant Disease* **69**, 1007.

Huang, C.S.; Chang, S.L. (1972) *Taiwan Agricultural Research* **21**, 256-263.

Hudson, H.J. (1962) Succession of micro-fungi on ageing leaves of *Saccharum officinarum*. *Transactions of the British Mycological Society* **45**, 395-423.

Kellerman, C.R.; Kotzé, J.M. (1973) A single application of benomyl controls citrus black spot. *Citrus and Sub-tropical Fruit Journal* No. 476, pp. 19, 20, 22.

Kellerman, C.R.; Kotz, J.M. (1979) The black spot disease of citrus and its control in South Africa. *Proceedings of the International Society of Citriculture* **3**, 992-996.

Kiely, T. (1948) *Guignardia citricarpa* n.sp. and its relationship to the black spot disease of citrus in coastal orchards of New South Wales. *Journal of the Australian Institute of Agricultural Science* **14**, 81-83.

Kiely, T.B. (1949a) Preliminary studies on *Guignardia citricarpa* n.sp.: the ascigenous stage of *Phoma citricarpa* McAlp. and its relation to black spot of citrus. *Proceedings of the Linnean Society of New South Wales* **73**, 249-292.

Kiely, T.B. (1949b) Black spot of citrus in New South Wales coastal orchards. *Agricultural Gazette of New South Wales* **60**, 17-20.

Kiely, T.B. (1950) Control and epiphytology of black spot of citrus on the central coast of New South Wales. *Science Bulletin New South Wales Department of Agriculture* No. 71, 1-88.

Kiely, T.B. (1960) Speckled blotch of citrus. *Agricultural Gazette of New South Wales* **71**, 474-476.

Kiely, T.B. (1963) Black spot of Valencia oranges. Experiments in control on the central coast of N.S.W. *Agricultural Gazette of New South Wales* **74**, 652-659.

Kiely, T.B. (1969) Black spot of citrus. *Agricultural Gazette of New South Wales* **80**, 658-662.

Kiely, T. (1976) Control measures for black spot of Valencias. *Rural Newsletter* **59**, 35-36.

Kotzé, J.M. (1981) Epidemiology and control of citrus black spot in South Africa. *Plant Disease Reporter* **65**, 945-950.

Lee, Y.S. (1969) Pathogenicity of different isolates of *Guignardia citricarpa* Kiely from various sources to Ponkan fruits. *Journal of Taiwan Agricultural Research* **18**, 45-50.

Lee, Y.S.; Huang, C.S. (1973) [Effect of climatic factors on the development and discharge of ascospores of the citrus black spot fungus]. *Journal of Taiwan Agricultural Research* **22**, 135-144.

McAlpine, D. (1899) *The fungus diseases of citrus trees in Australia, and their treatment.* Government Printer, Melbourne, Australia.

McMillan, R.T. (1986) *Guignardia citricarpa* a cause of black spot on mango in Florida. *Journal of Phytopathology* **117**, 260-264.

McOnie, K.C. (1964a) The latent occurrence in citrus and other hosts of a *Guignardia* easily confused with *G. citricarpa*, the citrus black spot pathogen. *Phytopathology* **54**, 40-43.

McOnie, K.C. (1964b) Source inoculum of *Guignardia citricarpa*, the citrus black spot pathogen. *Phytopathology* **54**, 64-67.

McOnie, K.C. (1964c) Apparent absence of *Guignardia citricarpa* Kiely from localities where citrus black spot is absent. *South African Journal of Agricultural Science* **7**, 347-354.

McOnie, K.C. (1964d) Orchard development and discharge of ascospores of *Guignardia citricarpa* and the onset of infection in relation to the control of citrus black spot. *Phytopathology* **54**, 1448-1453.

McOnie, K.C. (1964e) Speckled blotch of citrus induced by the citrus black spot pathogen, *Guignardia citricarpa*. *Phytopathology* **54**, 1488-1489.

McOnie, K.C. (1967) Germination and infection of citrus by ascospores of *Guignardia citricarpa*. *Phytopathology* **57**, 743-746.

McOnie, K.C.; Kellerman, C.; Kruger, D.J. (1969) Benlate a highly promising new fungicide for the control of black spot. *South African Citrus Journal* **423**, 7-9.

Pande, A.K. (1969) The genus *Guignardia* from Maharashtra. *Sydowia* **22**, 366-368.

Petch, T. (1923) *The diseases of the tea bush.* Macmillan & Co, London, UK.

Punithalingam, E. (1974) Studies on Sphaeropsidales in culture. II. *Mycological Papers* No. 136, 1-63.

Roy, A.J. (1968) Some fungi from Almora. *Indian Phytopathology* **20**, 340-348.

Roy, A.K. (1965) Additions to the fungus flora of Assam - I. *Indian Phytopathology* **18**, 327-334.

Schüepp, H. (1961) [Studies on *Guignardia citricarpa* Kiely, the causal organism of black spot of *Citrus*]. *Phytopathologische Zeitschrift* **40**, 258-271.

Sutton, B.C.; Waterston, J.M. (1966) *Guignardia citricarpa. CMI Descriptions of Pathogenic Fungi and Bacteria* No. 85. CAB International, Wallingford, UK.

Tsia, Y.-P.; Shiao; Liau, T.H.; Sun, M.H. (1977) [Field trials of citrus black spot control in Taiwan]. *Plant Protection Bulletin, Taiwan* **19**, 140-145.

Ullasa, B.A.; Rawal, R.D. (1984) *Guignardia* fruit rot of guava - a new disease from Bangalore. *Current Science* **53**, 435-436.

Van der Aa, H.A. (1973) Studies in *Phyllosticta* I. *Studies in Mycology* No. 5, 1-110.

Wager, V.A. (1945) Black spot of oranges. *Farming in South Africa*, September 1945, 6 pp.

Wager, V.A. (1952) The black spot disease of citrus in South Africa. *Science Bulletin, Department of Agriculture, Union of South Africa* No. 303, 1-52.

Whiteside, J.O. (1965) Black spot disease in Rhodesia. *Rhodesian Agricultural Journal* **62**, 87-91.

Whiteside, J.O. (1967) Sources of inoculum of the black spot fungus, *Guignardia citricarpa* in infected Rhodesian citrus orchards. *Rhodesia, Zambia, Malawi Journal of Agricultural Research* **5**, 171-177.

Whiteside, J.O.; Garnsey, S.M.; Timmer, L.W. (1988) *Compendium of citrus diseases.* APS Press, St Paul, Minnesota, USA.

Zheng, X.M. (1983) [Studies on the black spot of citrus (*Guignardia citricarpa* Kiely)]. *Journal of the South China Agricultural College* **4**, 53-60.

Guignardia citricarpa

EPPO Code : GUIGCI

Preferred name : Guignardia citricarpa

Author(s) : Kiely

Taxonomy

--Fungi (1FUNGK)
---Ascomycota (1ASCOP)
----Pezizomycotina (1PEZIQ)
-----Dothideomycetes (1DOTHC)
------Botryosphaeriales (1BOTSO)
-------Botryosphaeriaceae (1BOTSF)
--------Guignardia (1GUIGG)
---------Guignardia citricarpa (GUIGCI)

Other scientific names

Phoma citricarpa McAlpine
Phyllosticta citricarpa (McAlpine) van der Aa
Phyllostictina citricarpa (McAlpine) Petrák

Common names

Fruchtfleckigkeit: Zitrus [DE]
Schwarzfleckigkeit: Zitrus [DE]
black spot of citrus [EN]
cBS [EN]
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hard spot of citrus [EN]
shot-hole of citrus [EN]
speckled blotch of citrus [EN]
virulent spot of citrus [EN]
mancha negra de las frutas de citricos [ES]
manchas negras de los agrios [ES]
maladie des taches noires des agrumes [FR]
taches noires des fruits des agrumes [FR]

Africa

Algeria	Absent, confirmed by survey
Angola	Absent, confirmed by survey
Benin	Absent, unreliable record
Botswana	Absent, confirmed by survey
Burkina Faso	Absent, confirmed by survey
Cameroon	Absent, confirmed by survey
Central African Republic	Absent, confirmed by survey
Congo	Absent, confirmed by survey
Congo, Democratic republic of	Absent, confirmed by survey
Cote d'Ivoire	Absent, confirmed by survey
Egypt	Absent, confirmed by survey
Ethiopia	Absent, confirmed by survey
Gabon	Absent, confirmed by survey
Ghana	Present, restricted distribution
Guinea	Absent, unreliable record
Guinea-Bissau	Absent, confirmed by survey
Kenya	Present, no details
Liberia	Absent, confirmed by survey
Libya	Absent, confirmed by survey
Madagascar	Absent, confirmed by survey
Malawi	Absent, confirmed by survey
Mauritius	Absent, confirmed by survey
Morocco	Absent, confirmed by survey
Mozambique	Present, no details
Nigeria	Absent, confirmed by survey
Senegal	Absent, confirmed by survey
Seychelles	Absent, confirmed by survey
Sierra Leone	Absent, confirmed by survey
Somalia	Absent, confirmed by survey
South Africa	Present, restricted distribution
Sudan	Absent, confirmed by survey
Swaziland	Absent, unreliable record
Tanzania	Absent, confirmed by survey
Togo	Absent, confirmed by survey
Tunisia	Absent, confirmed by survey
Uganda	Present, few occurrences
Zambia	Present, no details
Zimbabwe	Present, no details

America

Antigua and Barbuda	Absent, confirmed by survey

Argentina		Present, restricted distribution
Bahamas		Absent, confirmed by survey
Belize		Absent, confirmed by survey
Bolivia		Absent, confirmed by survey
Brazil		Present, restricted distribution
Brazil	Rio Grande do Sul	Present, no details
Brazil	Rio de Janeiro	Present, no details
Brazil	Sao Paulo	Present, no details
Cayman Islands		Absent, confirmed by survey
Chile		Absent, confirmed by survey
Colombia		Absent, confirmed by survey
Costa Rica		Absent, confirmed by survey
Cuba		Present, no details
Dominica		Absent, confirmed by survey
Dominican Republic		Absent, confirmed by survey
El Salvador		Absent, confirmed by survey
Grenada		Absent, confirmed by survey
Guatemala		Absent, confirmed by survey
Guyana		Absent, confirmed by survey
Haiti		Absent, confirmed by survey
Honduras		Absent, confirmed by survey
Jamaica		Absent, confirmed by survey
Mexico		Absent, confirmed by survey
Montserrat		Absent, confirmed by survey
Nicaragua		Absent, confirmed by survey
Panama		Absent, confirmed by survey
Paraguay		Absent, confirmed by survey
Peru		Absent, confirmed by survey
Puerto Rico		Absent, confirmed by survey
Saint Lucia		Absent, confirmed by survey
St Vincent and the Grenadines		Absent, confirmed by survey
Suriname		Absent, confirmed by survey
Trinidad and Tobago		Absent, confirmed by survey
United States of America		Present, few occurrences
United States of America	Florida	Present, few occurrences
United States of America	Hawaii	Absent, confirmed by survey
Uruguay		Absent, confirmed by survey
Venezuela		Absent, confirmed by survey

Asia

Afghanistan		Absent, confirmed by survey
Bahrain		Absent, confirmed by survey
Bangladesh		Absent, confirmed by survey
Bhutan		Present, no details
Brunei Darussalam		Absent, confirmed by survey

Cambodia		Absent, confirmed by survey
China		Present, restricted distribution
China	Fujian	Present, no details
China	Guangdong	Present, no details
China	Sichuan	Present, no details
China	Xianggang (Hong Kong)	Present, no details
China	Yunnan	Present, no details
China	Zhejiang	Present, no details
India		Absent, confirmed by survey
India	Assam	Absent, confirmed by survey
Indonesia		Present, no details
Indonesia	Java	Present, no details
Iran		Absent, confirmed by survey
Iraq		Absent, confirmed by survey
Israel		Absent, confirmed by survey
Japan		Absent, confirmed by survey
Japan	Honshu	Absent, confirmed by survey
Japan	Ryukyu Archipelago	Absent, confirmed by survey
Jordan		Absent, confirmed by survey
Korea, Republic		Absent, confirmed by survey
Kuwait		Absent, confirmed by survey
Lebanon		Absent, confirmed by survey
Malaysia		Absent, confirmed by survey
Malaysia	Sabah	Absent, confirmed by survey
Malaysia	Sarawak	Absent, confirmed by survey
Malaysia	West	Absent, confirmed by survey
Myanmar		Absent, confirmed by survey
Oman		Absent, confirmed by survey
Pakistan		Absent, confirmed by survey
Philippines		Present, no details
Qatar		Absent, confirmed by survey
Saudi Arabia		Absent, confirmed by survey
Sri Lanka		Absent, confirmed by survey
Taiwan		Present, no details
Thailand		Absent, confirmed by survey
Uzbekistan		Absent, confirmed by survey
Viet Nam		Absent, confirmed by survey
Yemen		Absent, confirmed by survey

Europe

Albania		Absent, confirmed by survey
Azerbaijan		Absent, confirmed by survey
Bosnia and Herzegovina		Absent, confirmed by survey
Croatia		Absent, confirmed by survey
Cyprus		Absent, confirmed by survey

France		Absent, confirmed by survey
Georgia		Absent, confirmed by survey
Greece		Absent, confirmed by survey
Italy		Absent, confirmed by survey
Italy	Sicilia	Absent, confirmed by survey
Malta		Absent, confirmed by survey
Montenegro		Absent, confirmed by survey
Netherlands		Absent, intercepted only
Portugal		Absent, confirmed by survey
Spain		Absent, confirmed by survey
Turkey		Absent, confirmed by survey

Oceania

American Samoa		Absent, confirmed by survey
Australia		Present, restricted distribution
Australia	New South Wales	Present, no details
Australia	Queensland	Present, no details
Australia	Victoria	Present, no details
Cook Islands		Absent, confirmed by survey
Fiji		Absent, confirmed by survey
French Polynesia		Absent, confirmed by survey
Guam		Absent, confirmed by survey
New Zealand		Present, no details
Niue		Absent, confirmed by survey
Papua New Guinea		Absent, unreliable record
Samoa		Absent, confirmed by survey
Tonga		Absent, confirmed by survey
Vanuatu		Present, no details
Wallis and Futuna Islands		Absent, confirmed by survey

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-------Botryosphaeriaceae (1BOTSF)
--------Guignardia (1GUIGG)
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maladie des taches noires des agrumes [FR]
taches noires des fruits des agrumes [FR]

Provisional translation

Hara, K.（1960）. Ann. Phytopathol. Soc. Japan 25(5): 225.（in Japanese）

（4）Kanesuke Hara **Phoma rot（Kokuhan-byo）of Citrus**

In 1920, a disease which had black lesions with a diameter of about two centimeters on the fruits of *Citrus natsudaidai* widely occurred in Shizuoka prefecture, Japan. As a result of examination, the disease was found to be different from Citrus black spot in Taiwan, which was caused by *Phoma citrocarpa* McAlpine. Therefore, the author named the causal fungus *Phoma citrocarpa* McAlpine var. *mikan* Hara（Hara, K.（1921）. Trans. Shizuoka Agr. Farm.' Assoc. 283（Spec. Suppl.）: 33-36.(in Japanese)）. As Japan was very cautious about the invasion of the Citrus black spot from Taiwan to Japan at that time, Dr. Haruyoshi Takeuchi at Kyushu University made a comparative study of both fungi and found that the causal fungus of Phoma rot which was found in Shizuoka is different from that of Citrus black spot in Taiwan. After that, Phoma rot had occurred on fruits such as Satsuma mandarin（Mikan, in Japanese）and Navel oranges in Japan. On the other hand, the author identified a disease caused by *Phyllosticta citricola* which was named Phyllosticta leaf spot（Oomaruhoshi-byo, in Japanese）Hori by Dr. Hori as *Phyllosticta erratica* Ell. et Ev., which widely distributes in U. S. . In addition, the author changed the name of causal fungus of Phoma rot to *Phoma erratica*（Ell. et Ev.）Hara var. *mikan* Hara because he recognized this fungus as a variety of *Phyllosticta erratica* Ell. et Ev.（snip）

該虫の多数生育している蜜柑樹枝を採集し，それに紫赤彊病菌の胞子懸濁液を撒布し底部に水を入れた円筒形標本瓶に入れ，それを実験室（午前10時，15～20°C）に放置し，イセリヤカイガラムシの発病状態を調査した結果，接種後10～20日目に全虫体表に菌叢が新生され斃死した。また野外の3年生蜜柑樹にイセリヤカイガラムシが多発していたので，同年の5月26日に培養家蚕蛹を入れた小金網箱（1箱当り10～15個入り）を樹間（1樹当り3～4個）に懸垂した結果，処置後2～3カ月目に全虫の斃死をみた。なお同一試験を1960年4月17日と5月24日の2回にわたつて行なつたが同一結果を得た。（高知大農）

(2) 国枝鉱造 **ストレプトマイシン耐性菌の耐性化に関する考察（第7報）** *Erwinia carotovora* の SM 耐性株に菌体内 ATP 減量の現象が普遍的に認められた事実は，この現象が本細菌に対する SM の作用機作の第一義的あるいはそれに直接共軛するものではないかと予想される。この点を明らかにする目的で原株（SM 感性株）の Resting cell（休止菌）に SM を接触処理して菌体内 ATP 量に生ずる変動の有無を検討した。30°C 20時間平板培養した若い菌体を集菌し再溜水燐酸 buffer で数回洗滌後燐酸 buffer に懸濁して24時間30°C に静置して残存エネルギーを消耗させたものを供試 Resting cell 菌体とした。この菌体を SM 濃度 1 mg/ml 水溶液に懸濁し 0±1°C の氷室に70時間静置して SM 接触処理とした。対照として再溜水に懸濁したものを用いた。分離系統を異にする2菌系の原株とも処理後の菌体内 ATP 定量により対照に比し顕著な ATP 減量現象が認められた。（兵庫農大加古川農場）

(3) 石井 博・川尻啓介 **ムギ類あかかび病の流行機構に関する研究（第10報）潮風の本病に及ぼす影響** 本邦の西南太平洋側のあかかび病の流行因子である ESE～SW の風向の頻度は，1～6月では月が進むにつれて大となり，霧，潮風をもたらす。今回は特にその潮風があかかび病の流行に関与するところを実験したので報告する。0.05, 0.1, 0.5 および 1.0% の食塩水（市販）を作り，徳島農試実験圃場（海岸より8 km）のハダカムギ（糊熟期）とコムギ（乳熟期）の各品種の穂にそれぞれに散布し，10日後に調査した。前者白麦8号の罹病粒率はそれぞれ 4.7, 18.4, 23.0, 25.7% で無散布は 2.1% であり，後者農林65号の罹病小穂率はそれぞれ 1.5, 7.6, 9.8, 10.7% で無散布は 0.4% であつた。本実験の範囲では食塩の濃度が高い程，罹病が大となつた。次いで海岸からムギ類の栽植地の距離別にムギ穂を採集し，蒸溜水で洗滌，NaCl を Mohr 法で分析した。海岸から 22.5 km の採集地まで NaCl の検出をみ，海岸に近い程，検出量多く 0.2～1.5 km のハダカムギでは 1.0% 食塩水散布した場合と近似量であつた。海洋性気候地帯では海岸に近い程発生が多いが，この一因は潮風によるものである。（徳島農試）

(4) 原 摂祐 **ミカン類のこくはん病** 大正9年に静岡県のナツミカンの果実に黒い100円銀貨位の紋を生ずる病害が甚だしく発生した。それで本病を研究したが台湾のくろほし病とは異なるものと認め *Phoma citrocarpa* McAlpine の変種として *P. citrocarpa* var. *mikan* Hara（静岡県農会報283号，大正10年5月）と命名した。当時わが国では台湾のくろほし病を非常に恐れていたので九州大学武内晴好氏が彼我両菌を比較研究の結果わが国産は台湾のくろほし病と異なるものと決定されて今日に及んでいる。その後ウンシユウ・ネーブル等にも発生するようになつた。堀博士がおおまるほし病の和名と *Phyllosticta citricola* Hori と命名されたものがある。この菌を私は米国に広く分布する *Phyllosticta erratica* Ell. et Ev 菌と同定した。わが国のこくはん病菌もこの菌の系統であると考え，*Phoma erratica* (Ell. et Ev) Hara var. *mikan* Hara と改名する。附記 ミカンのくろだま菌病 *Phellomyces citri* Hara を *Sclerotium citricola* Hara と改めた方がよいと考える。

(5) 中沢雅典・長尾周幸 **殺菌剤の治療効果に関する研究（IX） 有機水銀剤接触菌糸の発育停止とその後の生死** 有機水銀剤の治療効果は，寄主組織内への浸透力および菌体接触直接殺菌力などの性能が大きく関与していることは，すでに指摘報告した通りである。薬剤散布防除における実際場面では，後者にはさらに殺菌剤の各種性質が関係を有する。例えば殺菌剤の残効性も本問題と無関係ではあり得ない。すなわち，残効の存在する限り，常に寄主体上では菌体の侵害活動を抑え得るわけである。筆者等は寄主体上で菌体が殺菌剤に遭遇した場合の想定を in vitro もしくは semi in vitro に求め，菌体がいかなる発育様相を示すか，また接触後の菌体を非接触にもどした場合の活力について観察して来た。ここでは1959年度，*Gibberella* および *Glomerella* 菌と MMC を用いて行なつた実験結果に就いて報告する。（愛知農試玉野分場）

(6) 大島俊市 ***Trichoderma lignorum* 分生胞子の発芽と環境条件** 温度 20～35°C, pH 2.0～6.0 の範囲でよく発芽する。強酸性環境で発芽しうること

Provisional translation

Hara, K.（1961）. Plant Prot. 15(6):265-266.（in Japanese）

Overviews of Citrus Diseases

Kanesuke Hara

（snip）

Ⅱ　Phoma rot（Kokuhan-byo）of Citrus

The symptoms of Phoma rot of Citrus fruits in Japan is different from Citrus black spot which was found in Australia and widely distributes from Taiwan to southern China（Southeast Asia）. Therefore, the author newly named the causal fungus *Phoma citricarpa* McAlpine var. *mikan* Hara. After that, a comparative study of the both casual fungus was made by Dr. Haruyoshi Takeuchi and the results of the study also showed that the fungus are different from each other. As it was found that the Australian strain does not exist in Japan, the causal fungus of Phoma rot is not a variety of *Phoma citricarpa* McAlpine. Hence, the author changed the name of the fungi to *Phoma erratica*（Ell. et Ev.）Hara var. *mikan* Hara. A detail information is provided in Hara, K.（1960）. Ann. Phytopathol. Soc. Japan 25(5): 225.（in Japanese）.（snip）

柑 橘 病 害 管 見

原 摂 祐

I カッショクマルホシ病

昭和34年9月の日付で静岡県柑橘販売農業協同組合連合会は静岡県柑橘史を出した。B判1125ページに達する豪華版である。数年間専門の編集委員を置き専心編集に従事させてでき上りの原稿を柑橘専門家の田中諭一郎博士が校閲され，また高橋郁郎氏，野呂癸巳次郎氏，田中長三郎博士，熊谷八十三先生，野口徳三博士の記事もあり，私も筆を入れた点もある。同書777ページにカッショクコマルホシ（褐色小円星）病菌を収めている。しかも同病菌を新種と改めているからこの記事を公表しておきたい。

ラクヨウ病と称せられたものは種々な病害を混合しているので，西田藤次博士は *Gloeosporium foliicolum* NISHIDA を病原菌とされ，堀正太郎博士はラクヨウ病と称せられるものを検鏡してカッショクコマルホシ病 *Phyllosticta curvispora* HORI，カッショクオオマルホシ病 *Phyllosticta citricola* HORI，シロマルホシ病 *Phyllosticta Beltranni* PENZ.，タンソ病 *Colletotrichum gloeosporioides* PENZ.，*Gloeosporium citricolum* MASS. の5種とされ，従来オウハン病として病原菌を *Bacillus flavomaculans* HORI et BOKURA とされた病害も落葉病の1種と認められていた。

堀正太郎博士の記事は大正2年7月園芸の友（9巻7号）に発表された由，大正5年11月植物病害講話第2編に再録されてある。西田藤次博士は大正3年11月"新編柑橘病害と防除法"なる著書を出された。その106ページに褐色大円星病と107ページに褐色小円星病の図を出しておられるが，精密な図とは思われない。堀正太郎博士の図もきわめて不完全であり記載も悪い。よって私はこれらに大改正を加えて昭和13年12月農業及園芸第13巻12月号に本邦柑橘類落葉病の害菌学的研究と題して図説を発表した。本研究は昭和25年1月富樫浩吾博士の果樹病学に引用してある。のみならず，同書は他の病害の記載も正確で参考となる良書である。

西田博士の著書106ページ第17図の褐色大円星病（*Phyllosticta citricola* HORI）の図，第18図の褐色小円星病（*Phyllosticta curvispora* HORI）の図はいずれも粗雑でいずれの種を図説されたのか不明である。*Phyllosticta citricola* HORI は私が *Phyllosticta erratica* ELLIS et EVERHART と同定した種類で担子梗がある。*P. curvispora* HORI とされた菌は堀博士の菌の図のように胞子は彎曲していないのと，胞子の両端に油球がない。この菌は私が記載したカッショクコマルホシ病菌 *Mycosphaerella horii* HARA の分生子殻を図示されたものである。

当時カッショクコマルホシ病とされたものは東海近畿農業試験場園芸部において，田中彰一博士と山田畯一氏との研究によれば前年堀正太郎博士と卜蔵梅之丞氏が発表された黄斑病（*Bacillus flavo-maculans* HORI et BOKURA）であることが証明された。しかして細菌が寄生して黄斑病を起こすものでなく，初めから *Mycosphaerella horii* HARA 菌が寄生するもので最初病斑上に子殻を生ずる。この子殻の表面に *Cercospora* の分生胞子を生ずるものである。西田博士の褐色小円星病の図の子殻の上面の毛状体はこの *Cercospora* の担子梗を書かれたものであろう。前記田中・山田両氏の研究においてもこの三段の菌の形態がはっきり証明して記述されている。しかも私の研究のように生菌を顕微鏡下で見た記事でなく各種の状態の病徴部から菌糸を分離してその発育状況を連続的に記してあり，もはや疑を入れる余地はない研究である。

私が農業及園芸に *Phyllosticta curvispora* HORI としたものは前にも記したように胞子は彎曲しないものであるが，両端に油球があるから一時同菌と同定していたのである。しかし私の菌には両端に油球はあるが彎曲しないから別に新たに命名する必要が生じた。私は静岡県に在職中ご懇意を受けた静岡県の柑橘指導界の重鎮中山金作氏に献名することとし前記のように静岡県柑橘史に掲げた。

病徴：病斑は円形，楕円形または不正円形である。初めは暗褐色であるが，のち中央部は退色し灰色となり，健全部との境いは赤褐色または暗褐色である。大きさ1～5mmある。表面の灰色の部分には黒色小粒点を散布または密布する。裏面にも同様生ずるが数は少ない。

病原菌：子殻は両面性とくに表面性である。球形または扁球形で大きさ50～80μある。寄主の表皮下に埋れている。殻壁は菌柔組織より成り，暗褐色を呈する。口孔部は乳頭状で，表皮の面に開く，口孔は円く15～20μの直径がある。胞子は円筒形あるいは紡錘形に近いが両

端は円いかまたは少しく細まるものがある。かつ両端に油球が1個ずつある。大きさ 6～8×2.0～2.5μ あり無色である。

産地：大正8年4月静岡市城内でナツミカンの葉上に発見以後静岡県各地でウンシュウミカン，ダイダイ，ナツミカンなどに生ずる。いま次に記相文を示しておく。

Phyllosticta nakayamai Hara n. sp.

Maculis rotundatis vel Ellipticis interdum irregularibus, primo badiis dein cinereis, margine badiis, 1～5mm diam. Pycnidiis amphigenis, hypodermicis, globosis vel sphaeroideis, 50～80 μ diam. Matricibus pycnidiorum parenchymaticis, badiis.

Ostiolis papilliformibus, oribus rotundatis, 15～20μ diam. Sporidiis cylindricis vel fusiformibus, utrimque rotundatis et unioleosis, 6～8×2.0～2.5 μ, hyalinis.

Hab. in foliis vivis *Citrus aurantium* Shizuoka Prov. Suruga. 4. 1919, leg. K. Hara.

図は果樹病学55図4～6に示されてあるから略する。堀正太郎博士の *Phyllosticta curvispora* Hori は Phoma または Phyllosticta のB型の胞子かも知れない。

II　コクハン（黒斑）病

オーストラリアで発見され台湾から南支南洋に広く分布する黒星病 *Phoma citricarpa* McAlp. は本邦においてミカン類の果実に発生する黒斑病とは病徴において異なるところがあり病原菌にも差異があったからコクハン病と新しく命名し病原菌を *Phoma citricarpa* McAlp. var *mikan* Hara と命名した。その後九州大学において武田晴好氏が両菌を比較研究された結果もコクハン病菌と黒星病菌とは異なるものであろうことが判明した。ところが豪州系の菌類は日本には存在しないことを知り得たのでわが国産のコクハン病菌は *Phoma citricarpa* McAlp の変種ではない。故に *Phoma erratica* (Ell. et Everh.) var *mikan* Haraと改めることにした。なお本病の来歴につき詳細が記してある（日本植物病理学会関西部会講演集）。私は最初本病は台湾に発生する黒星病と同一なるものと認め同名を以て静岡県農会報283号（35ページ）大正10年5月に発表したことがある。

III　クロダマ病

ミカン類を貯蔵中に発生し果実は墨黒色となりただ硬化するのみである。*Phellomyces citri* Hara と命名し実験作物病理学578ページに発表した。その後静岡県では貯蔵庫において発生するもののようで最近の病害書にも記録がある。本病菌は果実が黒変し菌糸を見るのみで結実体が現われない故に仮に前記の名を命じたが，本病菌も日本植物病理学会関西部会講演集に *Sclerotium citricolum* Hara と改名する旨を記した。それは *Phellomyces* よりは理解しやすいからである。しかし *Sclerotium citri* Catt. なる名は前にあるから重複をさけるためである。

有機燐製剤の危害防止に関する標語募集!!

農林省，厚生省共催の「有機燐製剤危害防止運動」はさる5月15日から1カ月間開催されていますが，その実施要綱にもとづき，危害防止の徹底をはかることなど，この運動を一層効果あらしめるため，農林省振興局，厚生省薬務局の主催で下記要領で危害防止に関する標語を一般から募集しています。これは有機燐製剤の適正な使用および管理についての注意を喚起するためのもので，入選標語は今後の運動に活用されます。ふるってご応募下さい。

記

募集期間：昭和36年6月14日まで（同日の消印あるものは有効）

応募方法：葉書1枚に応募標語1句を書き，住所氏名および職業を明記のうえ，農林省振興局植物防疫課（東京都千代田区霞ケ関2の1）あて郵送のこと。応募資格，応募数は制限しない。

審査方法：農林省振興局長，厚生省薬務局長，農林省振興局植物防疫課長，厚生省薬務局薬事課長をもって組織する審査会において審査する。

入選発表および表彰方法：入選は8月1日までに決定し入選者には農林省振興局長，厚生省薬務局長連名の賞状と，副賞として次のとおり賞金を送るとともに入選作などを関係各機関に通知する。

1等　1名　1万円，2等　2名　各5千円
3等　5名　各1千円

文　献

1) 卜蔵梅之丞 (1917)：四国地方病害視察―カンキツ黒腐病．病虫雑 4：143.
2) 原　摂祐 (1919)：柑橘の黒腐病．日園雑 31(4)：17.
3) 池屋重吉 (1941)：柑橘黒腐病菌の柱頭接種　1．病虫雑 28：40～45.
4) 池屋重吉 (1941)：柑橘黒腐病菌の柱頭接種　2．病虫雑 28：118～122.
5) 倉本　孟 (1973)：カンキツ黒腐病　1．温州ミカンにおける病原菌の柱頭侵入の可能性．日植病報 40：150.
6) 倉本　孟 (1978)：カンキツ黒腐病―とくに病原菌の病原性ならびに生態．果樹試報 B5：59～89.
7) Kohmoto, K., Scheffer, R.P. and Whiteside, J.O. (1979)：Host-selective toxins from *Alternaria citri*. Phytopath. 69：667～671.
8) 西田藤次 (1914)：柑橘病害と予防法（嵩山堂）：90.
9) 小野公夫 (1978)：カンキツ黒腐病　8．チオファネートメチル剤と菌の発育，発病．日植病報 44：372.
10) 鶴田章逸 (1917)：柑橘の黒腐病．病虫雑 4：341～348.

1.23 黒　斑　病 (Phoma rot)

異　名：黒星病

病原菌：*Phoma erratica* (Ellis et Everhart) Hara var. *mikan* Hara (*Phoma citricarpa* Mc Alpine var. *mikan* Hara)
[Deuteromycotina-Sphaeropsidales]

Phoma 菌によるカンキツ果実の腐敗は McAlpine (1899) によってオーストラリアで発見され，病原菌は *Phoma citricarpa* とされ，その後 Lee (1920) によって詳細な報告が行なわれている。この病害に関しては西田 (1914)，原 (1916) は黒星病という病名で紹介し，また Lee，曾我 (1920) によってこの邦訳がなされ，黒点病とされている。

その後わが国では南方諸国からの輸入果実または台湾における発病についての報告がある。すなわち澤田 (1935) は台湾における発病状況を報じ，小平，佐藤 (1938) は台湾産の果実中の菌の存在状況から感染時期を推察し，徳永 (1940) は病原菌の柑橘果実への侵入時期を明らかにした。末田 (1941) は潜伏感染を詳細に報じ，果実だけでなく葉，枝にも潜伏するとし，徳永，横浜 (1955) も潜伏感染の機構について報告した。

これより先，原 (1921) は静岡県下でウンシュウミカンの葉，ナツダイダイの果実から *Phoma* 菌を分離してわが国における黒星病の存在を認め，堀 (1913) の報告した褐色大円星病の病原菌である *Phoma citricola* は原の分離した *Phoma citricarpa* と同一のものであるとした。さらに果実上の病徴が海外における black spot とは異なるために黒斑病に改め，病原菌を *Phoma citricarpa* McAlp. var. *mikan* Hara とした (1925)。さらに武内 (1931) は病原菌について詳細な検討を加え，発病部位，病原菌の形態，各種培地上の生育および生育温度などの特徴から，原(1925)の説の正しいことを確認した。原 (1960, 1961) はその後，*Phoma citricarpa* はオーストラリアの菌であって日本には存在しないものであり，日本の菌はこれの変種ではなく別種であると考えられるので *Phoma erratica* (Ell. et Ev.) Hara var. *mikan* Hara とするのが至当であるとした。

なお，海外の黒星病菌は Kiely, T.B. (1949) によって落葉中に完全時代が発見されたことによって *Guignardia citricarpa* Kiely となっており，諸外国ではこの菌名が用いられている。

貯蔵の中期から末期にかけて発病する。発病はほかの腐敗病に較べて少ないが収穫前に霜の害を受

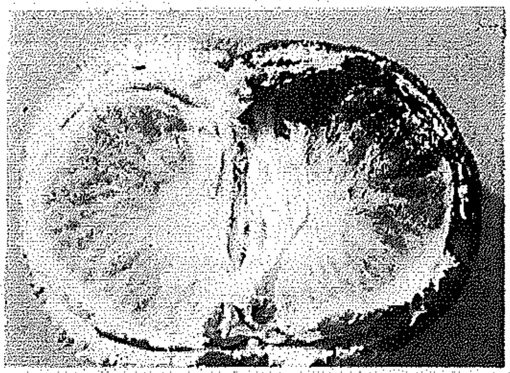

図 1.49　発病果
内部に黒色の柄子殻が形成される.

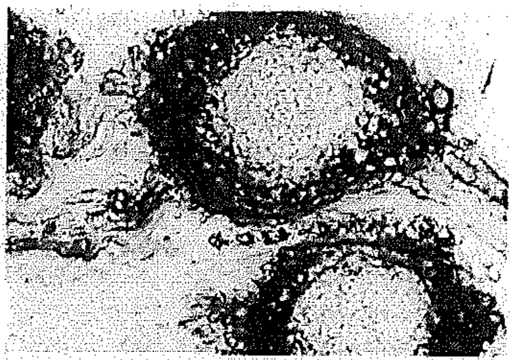

図 1.50　柄子殻

けたり，あるいは貯蔵庫が乾燥し過ぎた場合に発病が多い。病原菌は果実の生育期間中に果皮組織内に潜伏感染しており，貯蔵後果実の生理的変化によって発病する。果皮は水分を失ったように萎凋して淡褐色に変わり，次第に黒変して乾腐状になり，果皮の表面や裏面またはじょうのうの内外に黒色の小粒点を生ずる。これは柄子殻で黒色，球形，80～130×100～150μm。柄胞子に2型あり，一つは無色，単胞，楕円形～球形，8～12×6μm，ほかの一つはほぼ同形でこれより小さい。

葉にも発病する。褐色大円星病（堀，1913）の病名の示すとおり，初めは油浸状の輪郭のはっきりしない病斑であるが後に円形，汚褐色～灰褐色となり，病斑の表面に柄子殻を生ずる。秋期に発病し，翌春に落葉する。

病原菌の生育温度は11～33Cで，*Phoma citricarpa* の 15～38C に比較して低温域で発育する。

文　献

1) Calavan, E.C. (1960) : Black spot of Citrus. Cal. Citrogr. 4(18) : 20～24.
2) 原　摂祐 (1916) : 果樹病害論 (日本柑橘会) : 259～261.
3) 原　摂祐 (1921) : 静岡県病害管見 (50). 蜜柑の黒星病. 静岡県農会報 283 : 35. なし
4) 原　摂祐 (1925) : 実用作物病理学 (養賢堂) : 324.
5) 原　摂祐 (1960) : ミカン類のこくはん病. 日植病報 25 : 225.
6) 原　摂祐 (1961) : 柑橘病害管見―黒斑病. 植物防疫 15 : 266.
7) 堀　正太郎 (1913) : 柑橘落葉性病害予防の好期. 果樹 123 : 21.
8) Kiely, T.B. (1949) : Preliminary studies on *Guignardia citricarpa* n. sp.: the ascigenous stage of *Phoma citricarpa* McAlp. and its relation to black spot of Citrus. Proc. Linnean Soc., N.S.W. Sci. Bull., Dept. Agric. N.S.W., 71 : 88pp (Calavan, E.C., 1960 による).
9) 小平武夫, 佐藤　保 (1938) : 柑橘黒星病の感染期. 病虫雑 25 : 766～770. なし
10) Lee, H.A. (1920) : Black spot of Citrus fruits caused by *Phoma citricarpa* McAlp.. Phill. Jour. Sci. 17(6) : 635～641.
11) Lee, H.A., 曾我慶英 (1920) : 柑果の黒点病. 日園雑 32(11) : 7～14.
12) 西田藤次 (1914) : 柑橘病害と予防法 (嵩山堂) : 69～71.
13) 澤田兼吉 (1935) : 蜜柑黒星病の発生蔓延 (1). 台湾農事報 31(7) : 632～643.
14) 澤田兼吉 (1935) : 蜜柑黒星病の発生蔓延 (2). 台湾農事報 31(8) : 712～730.
15) 末田平七 (1941) : 柑橘黒星病の寄生に関する実験的研究. 台湾博物学会報 31(217-218) : 416～432.
16) 曾我慶英 (1920) : 柑橘果実の黒星病 (1). 病虫雑 7 : 519～526.
17) 曾我慶英 (1920) : 柑橘果実の黒星病 (2). 病虫雑 7 : 567～571.
18) 武内晴好 (1931) : 本邦柑果の黒星病の病原菌 1. 病虫雑 18 : 40～43.
19) 武内晴好 (1931) : 本邦柑果の黒星病の病原菌 2. 病虫雑 18 : 112～116.
20) 武内晴好 (1931) : 本邦柑果の黒星病の病原菌 3. 病虫雑 18 : 202～206.
21) 武内晴好 (1931) : 蜜柑黒星病菌の系統. 病虫雑 18 : 319～328.

24) 徳永芳雄 (1940)：柑橘黒星病菌の柑果侵入時期. 台湾農事報 36(5)：491～497.
23) Tokunaga, Y., Yokohama, M. (1955)：Latent infections associated with some fruit diseases. 栃内・福士記念論文集：249～254.

1.24 フザリウム腐敗病 (Fusarium rot)

病原菌：*Fusarium* sp.

[Deuteromycotina-Moniliales-Tuberculariaceae]

田中ら (1954) の命名によるもので，貯蔵の初期から発生するが発病率は大きくない。また腐敗の速度も伝染の程度も軽微である。初めは暗褐色水浸状の病斑であるが病斑が拡大すると周辺部にしわを生ずる。病斑の中心部から白色，綿毛状の厚い菌叢を生じ，これはしばしば淡紅色を呈する。菌叢内には *Fusarium* 型の胞子が形成される。伝染経路は不明である。

文　献

1) 北島　博，梶原敏宏 (1962)：作物病害図説 (養賢堂)：117 図版.
2) 田中彰一，北島　博，山田畯一，岸　国平，宮川経邦 (1954)：貯蔵蜜柑の腐敗防止 1. 貯蔵蜜柑の腐敗 1. 東近農試研報園芸 2：75.

1.25 黒　玉　病 (Phellomyces rot)

病原菌：*Sclerotium citricolum* Hara

[Deuteromycotina-MyceliaSterilia]

原 (1930) の発表した病害で病原菌を *Phellomyces citri* Hara としたが，その後，病原菌を *Sclerotium citricola* Hara と改め (1960)，さらに *S. citricolum* とした (1961)。

貯蔵の中期から末期にかけて発病するが，発病は少ない。果実の一部が黒変し，変色部が拡大すると果実は軟らかくなって果皮は革質化する。後に水分を失って乾燥し，内部に径3～5mm の黒色の菌核を生ずる。

文　献

1) 原　摂祐 (1930)：実験作物病理学 (養賢堂)：578.
2) 原　摂祐 (1960)：ミカン類のこくはん病. 日植病報 25：225.
3) 原　摂祐 (1961)：柑橘病害管見. 植物防疫 15：266.

1.26 白 か び 病 (sour rot)

病原菌：*Geotrichum candidum* Link ex Persoon (*Oosporoidea citri-aurantii* (Ferraris) Saccardo)

[Deuteromycotina-Moniliales-Moniliaceae]

この病原菌は Ferraris (1900) の発見によるもので最初は *Oidium citri-aurantii* と呼ばれたが Saccardo, Sydow (1902) によって *Oospora citri-aurantii* とされ，さらに Sumstine (1913) によって *Oosporoidea citri-aurantii* とされた。その後 Butler ら (1965) は詳細な比較研究の結果 *Geotrichum candidum* Link ex Persoon とし，さきに Ciferri (1955) によって提唱された変種名 (*G. candidium* var. *citri-aurantii*) は混乱を招くために採らないとした。

果樹病害各論

農学博士　北　島　　博

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1.23 Kokuhan-byo（Phoma rot of Citrus）

Synonym of disease name in Japanese: Kurohoshi-byo

Scientific name of the pathogen: *Phoma erratica*（Ell. et Ev.）Hara var. *mikan* Hara（*Phoma citricarpa* McAlpine var. *mikan* Hara）
［Deuteromycotina-Sphaeropsidales］

Citrus fruit rot caused by *Phoma* was found in Australia by McAlpine（1899）and named *Phoma citricarpa*, following the detailed report by Lee（1920）. In Japan, the disease was reffered by Nishida（1914）and Hara（1916）as "Kurohoshi-byo（Citrus black spot）". After that, a detail English description of this disease was translated into Japanese by Lee and Soga（1920）and the name of the disease was translated as "Kokuten-byo".

Thereafter, it was reported that a black spot was found on the citrus fruits imported from southern countries and in Taiwan; Sawada（1935）reported the situation of the occurance of the disease in Taiwan, Kodaira and Sato（1938）inferred the period of infection of the fungus from its states in the diseased fruits imported from Taiwan, and Tokunaga（1940）clarified the period in which the fungus infects citrus fruits. Sueda（1941）reported the details of the latent infection of the fungus not only in fruits but also in leaves and branches. Tokunaga and Yokohama（1955）also reported the mechanisms of the latent infection.

Before that, Hara（1921）recognized the existence of "Kurohoshi-byo", caused by *Phoma,* on the leaves of Satsuma mandarins and fruits of *Citrus natsudaidai* in Japan. He described that *Phoma citricola*, causal agent of "Kasshoku-dai-maruhoshi-byo"（Phyllosticta leaf spot）was identical of *Phoma citricarpa* isolated by himself. Later, Hara（1925）changed the name of the disease to "Kokuhan-byo"（Phoma rot of Citrus）and the name of the causal fungus to *Phoma citricarpa* McAlpine var. *mikan* Hara because the symptom of *Phoma* disease on citrus fruits in Japan was different from that of foreign black spot disease. Furthermore, Takeuchi（1931）examined the diseased plant part, morphology, characteristics of growth on various culture media and growth temperature of the causal fungus in detail and validated the descriptions made by Hara（1925）. After that, Hara（1960, 1961）described that the name of *Phoma citricarpa* should be corrected as *Phoma erratica*（Ell. et Ev.）Hara var. *mikan* Hara because *Phoma ctricarpa* is the Australian strain and has never been in Japan, and therefore the causal agent of "Kokuhan-byo"（Phoma rot of Citrus）is not a variety of *Phoma citricarpa* but an another *Phoma* species.

As well, the name of foreign citrus black spot fungus was changed to *Guignardia citricarpa* Kiely for the reason of detection of the perfect state of the fungus on fallen host leaves.

"Kokuhan−byo" occurs on fruits during the middle to later stage of the storage of host fruits. Usually, the occurrence of this disease is lower than other diseases. However, if the fruit suffers from frost damage before harvest or is kept under overdrying condition during storage, the occurence of the disease increases. At first, the causal fungus is immersed in the infected pericarp tissue during the fruit growth and then the disease occurs on account of physiological change during the time of storage. The infected fruit surface shrivels as if it loses its water content, turns yellowish brown, and eventually turns black and dry rotten. Black pastules（pycnidia） are formed on such as the diseased fruit upper surface. Pycnidia are black, globose, 80−130 × 100−150 μm. Conidia have two different types, one is hyaline, unicellular, elliptic to globose, 8−12 × 6 μm, and the other is smaller than the former.

The disease also occurs on leaves. At first, water−soaked, obscure outlined lesion are formed, but later, the lesion becomes circular, dirty to grayish brown and pycnidia are formed on the lesion. The disease occurs in autumn and defoliates in spring.

The fungus grows at 11−33 deg C. The range of the temperature is lower than that of *Phoma citricarpa* which grows at 15−38 deg C.

LITERATURE

1） Calavan, E. C.（1960） : Black spot of Citrus. Cal. Citrogr. 4（18）:20−24.
2） Hara, K. （1916） : Diseases of fruit trees （Kaju-byogai-ron）. Nihon-Kankitsu-Kai, Shizuoka:259−261.
3） Hara, K. （1921） : Overviews of Plant Diseases in Shizuoka−pref. Trans. Shizuoka Agr. Farm.' Assoc. 283:35.（in Japanese）
4） Hara, K. （1925） : Manual of crop diseases （Jitsuyo−sakumotsu−byorigaku）. Yokendo, Tokyo: 324.（in Japanese）
5） Hara, K.（1960） : Phoma rot（Kokuhan-byo） of Citrus. Ann. Phytopathol. Soc. Japan 25（5）: 225.（in Japanese）
6） Hara, K.（1961） : Overviews of Citrus Diseases − Phoma rot（Kokuhan-byo） of Citrus. Plant Prot. 15（6）:265−266.（in Japanese）
7） Hori, S.（1913） : Proper time of preventing deciduous diseases of Citrus. Fruit Tree（Kaju） 123: 20-21.（in Japanese）
8） Kiely, T. B.（1949） : Preliminary studies on *Guignardia citricarpa* n. sp.: the ascigerous stage of *Phoma citricarpa* McAlp. and its relation to black spot of Citrus. Proc. Linnnean Soc., N. S. W. Sci. Bull., Dept. Agric. N. S. W., 71 : 88pp（in Calavan, E. C., 1960）.
9） Kodaira, T. & Sato, T.（1938） : Infection period of Citrus black spot fungus. J. Plant Prot. 25（10）:766−770.（in Japanese）
10） Lee, H. A.（1920） : Black spot of Citrus fruits caused by *Phoma citricarpa* McAlp.. Phill. Jour. Sci. 17（6） : 635−641.
11） Lee, H. A. and Soga, Y.（1920） : Kokuten-byo of Citrus fruits. Nichi−en−zatsu 32（11）:7−14.（in Japanese）

12）Nishida, T.（1914）：Citrus diseases and their control. Suuzando : 69−71.（in Japanese）
13）Sawada, K.（1935）：Occurence and spread of Citrus black spot（1）. The Formosan agricultural review 31(7):632−643.（in Japanese）
14）Sawada, K.（1935）：Occurence and spread of Citrus black spot（2）. The Formosan agricultural review 31(7):712−730.（in Japanese）
15）Sueda, H.（1941）：Experimental Research for parasitism of Citrus black spot fungus. Trans. Taiwan Nat. Hist. Soc.（in Japanese）
16）Soga, Y.（1920）：Black spot of Citrus fruit（1）. J. Plant Prot. 7:519−526.（in Japanese）
17）Soga, Y.（1920）：Black spot of Citrus fruit（2）. J. Plant Prot. 7:567−571.（in Japanese）
18）Takeuchi, H.（1931）：Causal fungus of "Kurohoshi-byo" in Japan 1. J. Plant Prot. 18:40−43.（in Japanese）
19）Takeuchi, H.（1931）：Causal fungus of "Kurohoshi-byo" in Japan 2. J. Plant Prot. 18:112−116.（in Japanese）
20）Takeuchi, H.（1931）：Causal fungus of "Kurohoshi-byo" in Japan 3. J. Plant Prot. 18:202−206.（in Japanese）
21）Takeuchi, H.（1931）：Strains about the causal fungus of "Kurohoshi-byo" of Unshu mandarin. J. Plant Prot. 18:319−328.（in Japanese）
24）Tokunaga, Y.（1940）：Infection period of Citrus black spot fungus to the fruit. The Formosan agricultural review 36(5):491−497.（in Japanese）
23）Tokunaga, Y., Yokohama, M.（1955）：Latent infections associated with some fruit diseases. in Tochinai−Hukushi−Kinen−Ronbun−Shu : 249−254.