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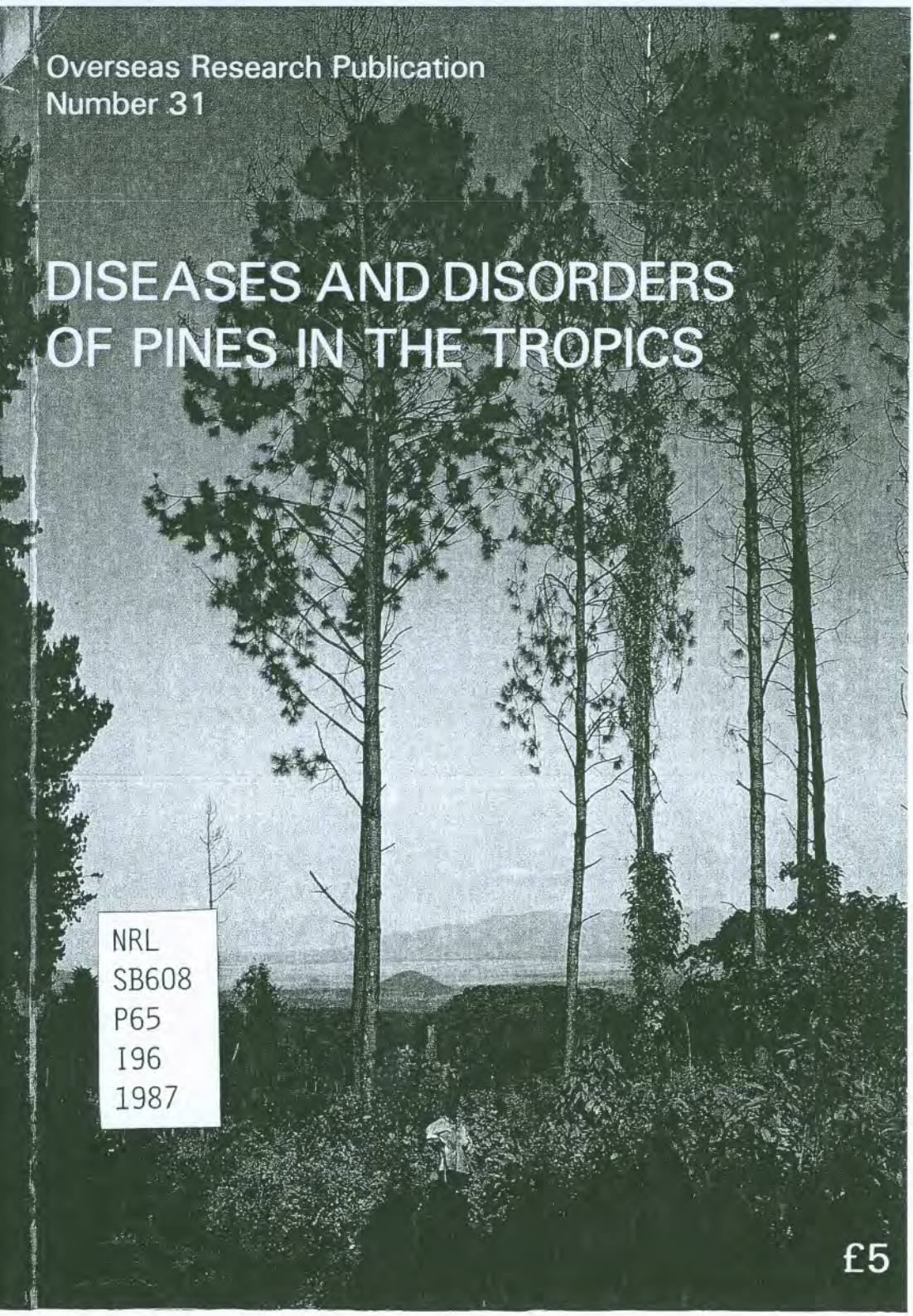
DISEASES AND DISORDERS OF PINES IN THE TROPICS



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Symptoms: 1. Sunken, red-brown lesions form at any point along the needles. These rapidly develop into necrotic bands which cause the distal parts to die.
2. Plants typically become infected towards the extremities of either the leading or lateral branches, usually in a sudden sporadic way.
3. The disease usually affects nursery plants and young trees in plantations causing a bright red-brown foliage blight and subsequent needle cast. (Photo 8)
4. The fungus spreads rapidly down the proximal part of affected needles and into the tissues of green shoots, especially on young plants. This may be fatal to young plants, but usually is limited to the young shoots of older plants.
5. In damp weather white brushes of conidia may be seen on affected tissues.

Hosts: *Pinus caribaea, P.kesiya, P.oocarpa,* and various broadleaved plants, ferns and palms.

Distribution: Malaysia, Brazil, Surinam on *Pinus* spp, but pantropical on other hosts.

Epidemiology: The disease occurs during periods of persistent rainfall, or wet conditions after overhead irrigation in nurseries. Numerous conidia are produced externally on infected tissues in damp conditions. These then spread to healthy needles by splash-dispersal during heavy rain, and rapidly infect the tissues. First symptoms appear within 1 or 2 weeks, and the foliage and shoot blight symptoms develop thereafter. Sporulation of the fungus can then take place on affected tissues whenever environmental conditions are favourable. The occurrence of microsclerotia under natural conditions has not been observed, however, they may assist the fungus to survive during adverse conditions.

Impact: The disease occurs as a sporadic slight to severe blight, and subsequent premature cast, of the outer foliage of late-stage nursery plants and young trees in plantations. Most plants suffer little damage even though up to 75% may be infected to some extent. Occasionally the disease may cause a severe foliage and shoot blight resulting in up to 80% mortality of young plants, or a considerable growth check to older plants.

Controls: None have been investigated.

The pathogen: *Cylindrocladium pteridis* Wolf. [syn. *C.macrosporum* Sherb.] (Fig. 15)

Conidiophores 150–300 μm long, numerous, fasciculate, phialidic, borne laterally on a main stipe. Conidia hyaline, mostly 1-septate, cylindric, straight, 70–105 × 5.5–70 μm, formed in slime drops. Smaller, curved conidia, 25–45 × 3.5–4.5 μm, are sometimes present also. Both forms are pathogenic and both give rise to the large-spored form in culture. The stipes

are long, inconspicuously septate, and terminate in a narrowly-clavate vesicle.

The fungus can be readily isolated on PDA from conidia, or surface-sterilized needles forming irregular, flat, dense colonies which become light brown in colour with red-brown sclerotia and thickwalled chlamydospores. Small conidia form only on weak media such as water agar. The cultures grow well at 26°C but tend to lose their ability to sporulate after prolonged storage or repeated transfers.

References: 27, 35, 39, 49, 70, 79, 80.

2.4.6 BROWN-NEEDLE DISEASE

This disease, which is also known as 'Cercospora needle-blight', was first recorded in Japan in 1913 and subsequently in neighbouring countries. Since 1960 it has been reported from many other countries in Asia and Africa, and very recently from indigenous forests in Central America. It is probably indigenous to pine forests in E. Asia and Central America.

Symptoms: 1. Causes a grey-brown necrosis of needles, and subsequent needle cast, on plants >2 months old in nurseries and on trees up to 5 years of age in plantations and forests. Occasionally older trees of certain susceptible species may remain infected for much longer. (Photo 9, rear cover)
2. Plants typically become infected at the centre of the lower crown, and the disease subsequently spreads gradually upwards and outwards towards the branch tips.
3. Foliage of all ages is susceptible, including young primary needles.
4. Lesions first appear as pale-green spots or bands which rapidly turn yellow and then greyish-brown as they become necrotic. These bands are 5–15 mm broad, and often form on the distal parts of young needles and at the base of older needles.
5. Black fungus stromata develop in the needle cortex of the bands which erupt through stomata and epidermal splits imparting a blackish colouration to the bands.
6. In damp weather small, grey tufts of conidia may be just visible on the erumpent stromata. Spermatia may also be extruded in tiny, clear droplets from spermagonia.
7. The distal portions of affected needles die rapidly and become colonized by various saprophytic fungi, whereas the proximal portions remain alive for some time.

Hosts: Many tropical and temperature *Pinus* spp, and 5 other temperate conifers.

Distribution: Mainly tropical.

Asia— Bangladesh, China, Hong Kong, India, Japan, Korea, Malaysia, Nepal, Papua New Guinea, Philippines, Sri Lanka, Taiwan, Thailand, Vietnam, (Indonesia?)

Africa— Kenya, Malagasy, Malawi, South Africa, Swaziland, Tanzania, Zambia, Zimbabwe.

Americas— Brazil, Costa Rica, Honduras, Jamaica, Nicaragua.

Epidemiology: Spread of the disease occurs during periods of persistent rainfall, or in wet conditions caused by overhead irrigation. The fungus can, however, remain viable for many months in dry infected foliage, subsequently producing large numbers of conidia when wetted. The transfer of infected needle pieces in uncleaned seed, or with mycorrhizal soil inocula, and maybe on infected plants in earlier times, probably enabled the disease to spread to various tropical countries.

Conidia are liberated and dispersed aerially by rain splash within and between neighbouring plants when they are closely-spaced in nursery beds. Dispersal of conidia is apparently less efficient between trees in plantations, and probably occurs only rarely over longer distances. However, this latter observation may result partly from the decreased susceptibility of the trees to infection at this stage. Conidia may remain viable for ~1 month, but under moist conditions will germinate on the surfaces of needles within 24–40 hours, and penetrate via stomata within a further 2 or 3 days. A period of approximately 3–7 days can therefore suffice for the production of spores, their dispersal, and needle infection to occur. First symptoms may appear within 2 weeks on highly-susceptible species, but usually takes at least 4–6 weeks. The production of fungal stromata and the formation of conidia then occurs soon afterwards. However, in response to unknown stimuli, one of the two other spore forms can sometimes be formed in addition to, or instead of the conidia. The spermatia probably effect fertilization and the subsequent development of the teleomorph, the function of which is presently unclear.

Impact: The disease causes a slight to severe blight, and subsequent premature needle-cast, of the lower foliage of nursery plants >2 months of age in many tropical and subtropical countries. This causes the slow growth of seedlings, a high cull rate, and in some cases mortality up to 85%.

Resistant *Pinus* spp. may have a small proportion of their foliage affected, but suffer little growth reduction and no mortality.

Disease severity is associated both with the innate susceptibility of the host and with the environmental factors which affect host and the pathogen. Thus normally-resistant species can be significantly affected in conditions highly-favourable to the fungus or highly unfavourable to the host; and susceptible species may be only slightly affected in conditions unfavourable to the fungus. The fact that species such as *P. patula* are moderately susceptible during their first year in Asian countries, but not in Africa, suggests that differences in pathogenicity between isolates may also occur.

Most species develop effective resistance by 2–3 years of age, however, trees which are severely infected initially may remain stunted and severely blighted for many years. Such trees often succumb to competition from healthier trees or weed growth. In a few cases, such as *P. radiata* and *P.*

canariensis, infection may occur on much older trees, especially on highly-susceptible individuals.

A.Highly susceptible spp. with appreciable mortality		B.Susceptible but with little mortality		C.Slightly susceptible	
P. attenuata	0–2 y	*P. canariensis*	0–15 y	*P. elliottii*	0–1 y
P. caribaea	0–4 y	*P. massoniana*	0–4 y	*P. greggii*	0–1 y
P. kesiya	0–4 y	*P. merkusii*	0–2 y	*P. maximinoi*	0–1 y
P. muricata	0–5 y			*P. palustris*	0–2 y
P. oocarpa	0–5 y			*P. patula*	0–1 y
P. pseudostrobus	0–2 y			*P. strobus*	0–2 y
P. radiata	0–10 y			*P. taeda*	0–1 y
P. roxburghii	0–5 y			*P. tecunumanii*	0–1 y
				P. wallichiana	0–1 y

Controls: 1. Employ general nursery hygiene measures to minimize the risk of infection. Such measures should include the removal of all pines in and around the nursery; the cleaning-out of the nursery between annual production cycles; the physical separation of young seedlings from older plants where the nursery cycle is >12 months; banning transfers of plants between nurseries; and by taking great care with mycorrhizal-soil introductions.

2. Apply foliar sprays of fungicides at 2–4 week intervals during conditions favourable for the spread of the fungus. The level of control achieved has been very variable in the countries where it has been attempted. Recommended fungicides are Benomyl, Daconil, and Thiophanate applied with effective wetting agents. Copper fungicides have been reported to be effective in Japanese nurseries, but not elsewhere.

3. Replace highly susceptible species with a more resistant, but equally-productive species, ie. *P. elliottii* in place of *P. massoniana*.

The pathogen: *Mycosphaerella gibsonii* H. Evans (Fig. 18)

Some early records of the teleomorph were incorrectly determined as *Mycosphaerella pinicola* (Fautr.) Naoum. The record of *M. pini-patulae* Sechet from Malagasy may also refer to this fungus. Dark-brown or black, small or large stromata are formed in the grey-black necrotic bands from broad, branched, septate, dark brown mycelium growing between the cells of the needle cortex. This mycelium is usually quite sparse except adjacent to stromata. The stromata bear ascomata, conidiomata or spermagonia, either alone or in combination, or in succession. They usually become erumpent by rupturing the epidermis along 1 or 2 lines of stomata, sometimes forming a raised epidermal dome. The ascomata are very variable, from discrete, subepidermal, uniloculate, globose structures predominant in Asian collections, to erumpent, linear, multiloculate structures predominant in African and American collections. They are 50–800 μm long, 50–150 μm wide and 50–150 μm deep and are composed of dark-brown thickwalled pseudoparenchymatous cells enclosing 1 or more globose or flask-shaped, ostiolate, periphysate locules, 50–75 × 55–75 μm in size with white contents. The asci are bitunicate, clavate/cylindric, 35–38 × 5.5–7.0 μm in size, with a thickened, bluntly-rounded apex, and

contain 8 spores arranged in 2 oblique rows. Interthecial tissues are sometimes present. The ascospores are hyaline, two-celled, ellipsoid or cuneate, 8.5–11.0 × 2.2–2.8 μm in size and usually 4–guttulate.

The conidiomata [*Cercoseptoria pini-densiflorae* (Hori & Nambu) Deighton] are silvery-grey to dark green or black, and either form small, discrete, fasciculate structures protruding through stomata, or large sporodochia on the surface of extensive deep-seated stromata. The conidiogenous cells are subhyaline to green, or pinkish-brown, clavate to cylindric, 20–30 × 2.5–3.5 μm, septate, unbranched, and produce conidia polyblastically and sympodially in dry, grey-green tufts. The conidia are hyaline becoming grey-green or pale brown, smooth, thin-walled, cylindric/long-obclavate with a rounded or pointed apex and a truncate base, straight or slightly curved, 20–80 × 2.0–4.5 μm in size and 1–10 septate.

Spermagonia are formed in discrete, unilocular stromata, or as locules in the upper parts of large stromata [*Asteromella* sp.]. They consist of a thin dark-brown wall enclosing white contents. The spermatia form on conidiogenous cells lining the inner wall of the locules and are hyaline, rod-shaped and 2–3 × 1 μm in size. They often become exuded in tiny hyaline droplets.

The fungus can be readily isolated from conidia, and less easily from excised stromata and surface-sterilized needles. It forms grey to grey-green or black, compact colonies which often become pulvinate and stromatic. They are mostly non-sporulating, although Asian isolates quite often produce brown, thinwalled spermagonia containing spermatia in a pale-grey slime when grown under black light. These isolates also produce conidia very occasionally in small fertile patches on stromatic colonies when exposed to black light. Growth on various media is slow (~1.0 cm/week) with the optimum at ~25°C. The African isolates grow more slowly, are more inhibited by black light, and are generally less-spreading, than Asian isolates. Deighton (TBMS, 88;390) has recently transferred the anamorph to *Pseudocercospora*.

References: 1, 20, 27, 38, 47, 71, 72

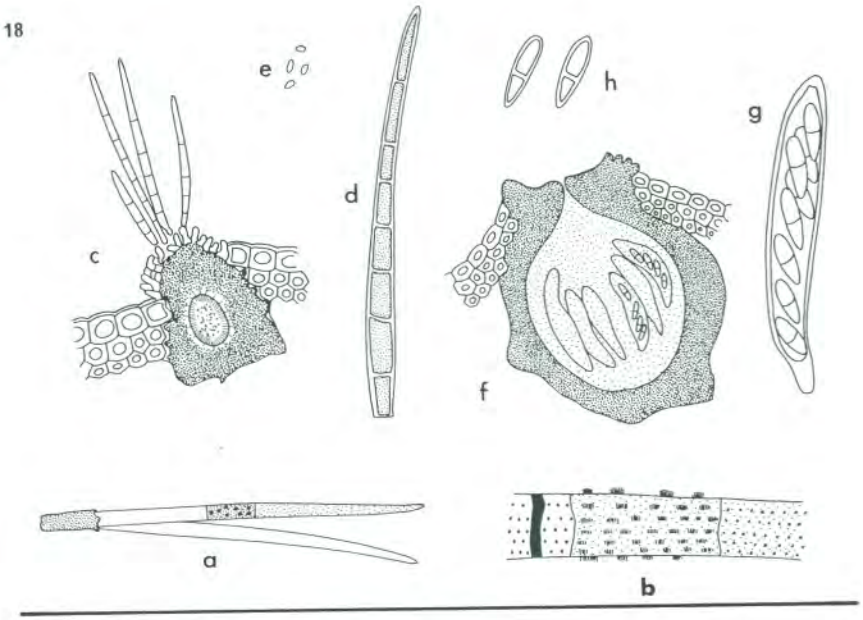
2.4.7 BROWN-SPOT NEEDLE-BLIGHT

This is an important pine foliage disease in the U.S.A., where it has been known since the 19th century, either as the above or as *'Lecanosticta* needle blight'. It has since been found in a few countries outside the U.S.A., however, most records have been shown to be misidentifications of *'Dothistroma* needle blight'.

Symptoms: 1. Causes a brown necrosis of needles, and subsequent needle cast, on plants >4 months old in nurseries, and on young trees in plantations. Occasionally some older trees of particular species may also be severely attacked.

2. Plants typically become infected at the centre of the lower crown, and the disease subsequently spreads gradually upwards and outwards to the branch tips.

3. Foliage of all ages is susceptible on many species, including young primary needles.



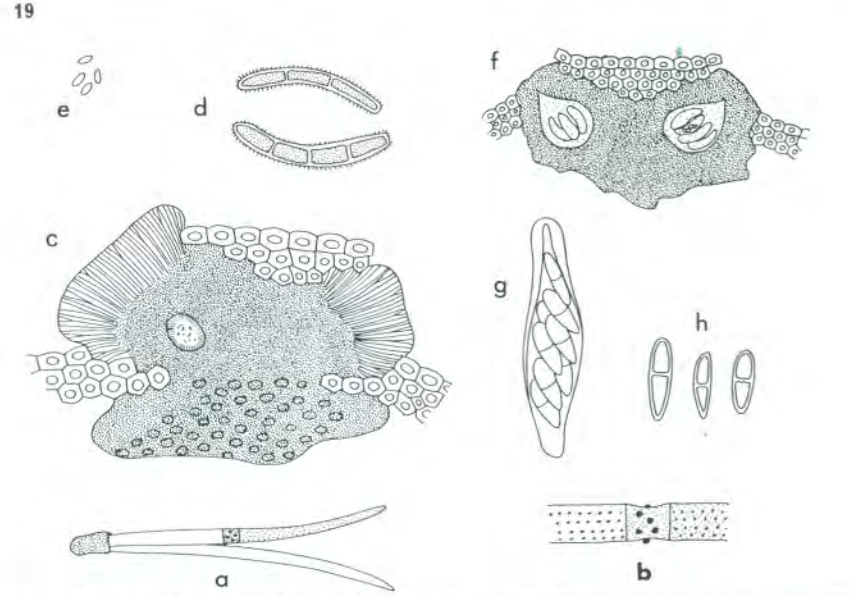


Fig. 18 MYCOSPHAERELLA GIBSONII—a. lesion; b. lesion with fasciculate conidiophores and conidia; c. V.S. stroma with a conidioma and a spermagonium; d. conidium; e. spermatia; f. V.S. ascoma; g. ascus; h. ascospores. **Fig. 19** MYCOSPHAERELLA DEARNESSII—a. lesion; b. lesion with black erumpent stromata; c. V.S. stroma with conidiomata and a spermagonium; d. conidia; e. spermatia; f. V.S. stroma with ascomata; g. ascus; h. ascospores.