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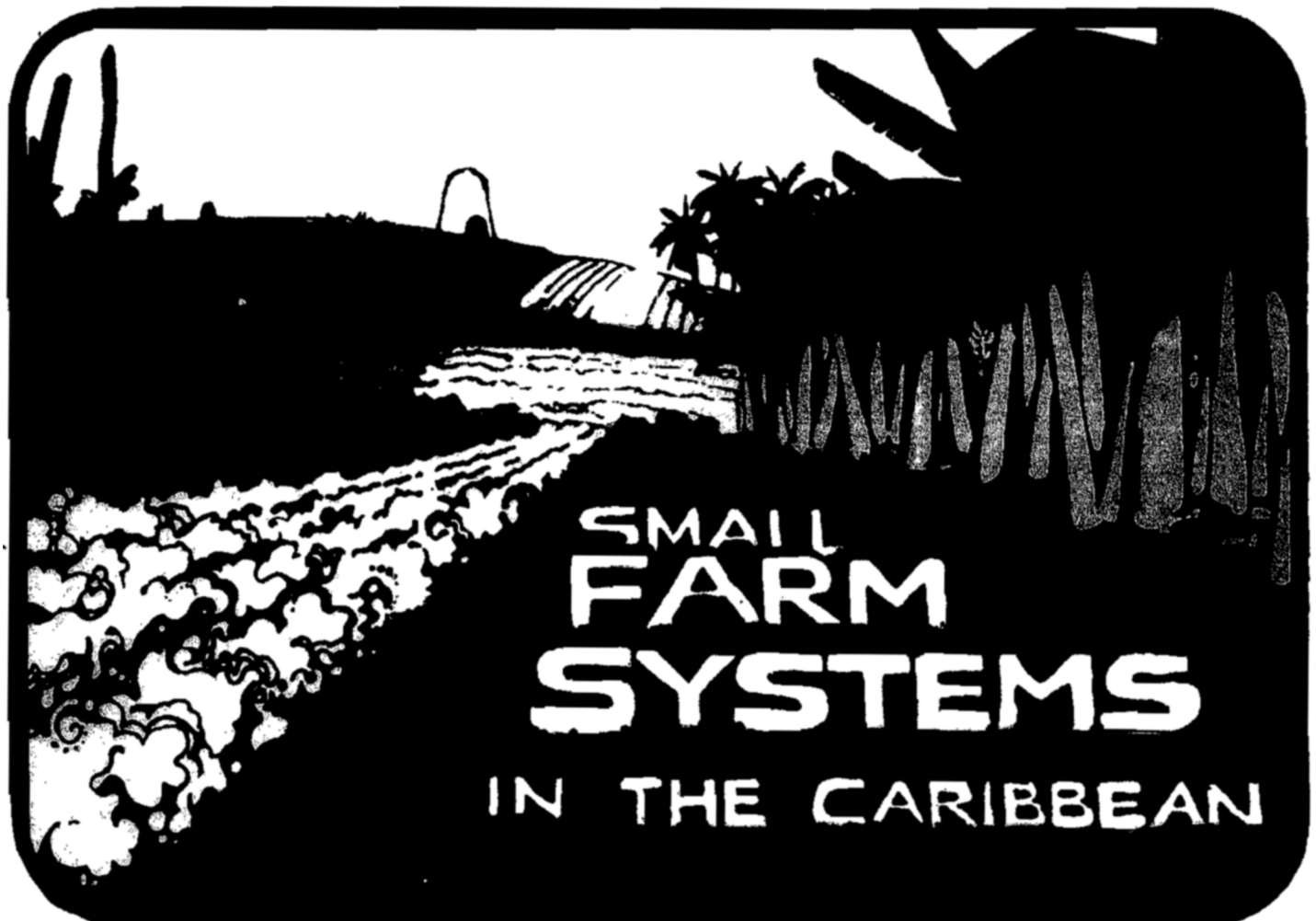
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# Lethal Diseases of Coconut Palm in the Caribbean Region

Randolph E. McCoy

University of Florida

Research and Education Center

3205 S.W. College Avenue

Fort Lauderdale, FL 33314 USA

Lethal diseases of coconut palm in the Caribbean region include lethal yellowing (LY), hartrot (HR), redring (RR), budrot, and buttrot. Of these, LY is by far the most important. Lethal yellowing occurs in and to the north of Jamaica, in Florida and Texas, and from the Bahamas to Quintana Roo, Mexico. The common coconut cultivar of the Caribbean region, the 'Jamaica Tall' ('Atlantic Tall') is highly susceptible to LY. LY is associated with a mycoplasma-like organism which obligately infects the phloem of diseased palms, and is carried from palm to palm by the leafhopper *Hyndus crudus*.

HR produces symptoms very similar to LY, but is associated with flagellated protozoa of the genus *Phytomonas*, which also are obligate phloem-inhabitants. HR occurs in South America, the southern islands of the Caribbean, and in Central America. The vector of HR is not known with certainty. RR occurs over the same range as HR and occurs with LY in the Yucatan peninsula. RR is caused by the nematode *Radaphnelincbus cocophilus* and its vector is the palm weevil. Budrot and buttrot, both caused by fungal invasions, annually cause minor losses in coconut palms throughout the region.

Three major systemic lethal diseases of coconut palm are present in and around the Caribbean Basin. These are redring (RR), lethal yellowing (LY), and hartrot (HR) or Cedros wilt. In addition, a number of lesser important diseases of a systemic or lethal nature may be found, thus leading to some confusion in symptomatology and diagnosis. Two major diseases, LY and HR, are of very similar symptomatology and workers have had to rely on electron, or phase contrast light microscopy for diagnosis. The third major disease, RR, is readily distinguished in the field. Minor losses of coconut palms in all or parts of the region are attributed to budrot, buttrot, bronze leaf wilt, and lightning strike.

Early literature describing maladies of coconut palm in the Caribbean region often confused these various syndromes, especially when described from different localities. In consequence, some of the information published prior to the 1960's on these diseases is unreliable. The objectives of the current investigation are to survey the Caribbean region and determine the localization, particularly, of LY and HR diseases. In addition, alternative methods of diagnosis are being studied. During the course of this work, observations have also been made on other problems of coconut palm. This paper summarizes information on the symptomatology and localization of systemic and lethal diseases of coconut palm in the Caribbean region.

## Symptomatology and Diagnosis

### Lethal Yellowing

The common cultivar of the Caribbean region, 'Jamaica Tall', is particularly susceptible to LY disease. Symptoms usually begin with the abortion of all developing fruit. Fallen immature nuts usually have a dark water-soaked discoloration at the stem end. Following, or occasionally preceding nutfall, a necrosis of developing inflorescences occurs. Necrotic inflorescences are dark brown in color and the male flowers remain attached. Fruit do not develop on these inflorescences. Occasionally, a single yellow leaf may occur in mid-crown at the time of nutfall and inflorescence necrosis. However, systemic foliar yellowing usually does not begin until four to eight weeks after initial symptoms. This systemic yellowing begins in the oldest or lower leaves and extends upwards through the crown over approximately an eight

week period. Necrotic leaves abscise cleanly from the trunk. Collapse of the spear leaf usually occurs at about midway through the foliar yellowing cycle. The necrosis affecting the spear leaf then extends downwards into the meristem, which succumbs to a putrid, foul smelling decay. The entire LY syndrome develops over a three to five month period and ends with a dead telephone pole-like trunk.

Electron micrography of bud, inflorescence, root, and flag leaf material from LY diseased coconut palms has consistently revealed the presence of mycoplasma-like organisms (MLO) within sieve tubes (Plavsic-Banjac et al., 1972; Thomas, 1979). The MLO are extremely small, cell wall-less bacteria of variable morphology (McCoy, 1984). LY has been demonstrated to be transmitted by the planthopper *Myndus crudus* in Florida (Howard and Thomas, 1980).

Diagnosis of lethal yellowing has thus far been restricted to symptomatology with confirmation by electron microscopy. A new approach using the DNA-specific fluorochrome DAPI (Seemueller, 1976) is being investigated and shows considerable promise as a rapid alternative to electron microscopy.

### Hartrot

Symptomatically, HR is very similar to LY in coconut palm. Both diseases are characterized by nutfall, inflorescence necrosis, foliar death, and a putrid rot of the growing point. However, HR characteristically has a more rapid decline. Affected palms usually die within two months of the onset of symptoms. Also HR tends to produce a rapid browning of affected leaves rather than the spectacular yellowing of LY. In addition, HR affected leaves tend to break along the midrib. Extensive root necrosis is characteristic of both diseases.

Diagnosis of HR is best made by light or electron microscopy of root, inflorescence, or meristem tissues. Plant juice squeezed from infected tissues and observed immediately by phase contrast illumination at 400X in a light microscope will reveal the presence of numerous *Phytomonas stabeli*, flagellated protozoa of the family Trypanosomatidae. Electron microscopy has revealed that *P. stabeli*, like the LY MLO, is also limited to sieve tubes of the phloem (Parthasarathy et al., 1976; Waters, 1978;

McCoy and Martinez-Lopez, 1982). Some investigators suspect the vector of harrot to be a plant bug of the Pentatomid family (Griffith, 1981). However, this author suggests that a leafhopper may be involved because the limitation of the flagellates to sieve tubes suggests the vector to be a phloem feeding insect. In support of this hypothesis it was shown that another flagellate, *P. davidi*, could multiply to high titers within a leafhopper known to be a vector of several MLO diseases (McCoy and Markham, 1983).

### Red Ring

Red ring disease is another systemic, fatal malady of coconut palm in the Caribbean region. Foliar symptoms are somewhat non-specific, but a discoloration and drooping of the leaves usually occurs in association with rotting of the bud and roots. Fruit on RR diseased palms is often retained, and the time from initial symptoms till death of the palm averages four months. However, the definitive visual symptom of RR is the presence of a brick-red ring of discolored tissue some 5 to 10 cm beneath the outer layer of the stem and extending more or less the length of the stem. The discoloration may extend into the older leaf petioles as well.

Red ring disease is caused by the nematode *Rhadinaphelincus cocophilus* (Dean, 1979). This long slender nematode invades ground tissues of the stem, and may be observed when infected tissue samples are placed in a petri dish with water for several hours to overnight. The nematodes may be lifted from the water with the aid of a dissecting microscope and a sharpened bamboo sliver, and placed on a microscope slide for observation at higher magnification. C.G. Dean (1979) gives an excellent description of the nematodes. The RR nematode is transmitted from palm to palm by the black palm weevil *Rhynchophorus palmarum*. Adult weevils emerging from infected palms are infested with the nematode, and serve to carry the pathogen to nearby healthy palms.

Diagnosis of RR is based, in part, on the field symptom of the red ring which can be observed by cutting a notch into the base of the palm with a machete or axe. However, a definitive diagnosis is dependent on the recovery and identification of the nematode *R. cocophilus*.

### Budrot

Budrot, caused by the fungus *Phytophthora palmivora* appears to be of minor importance, causing small losses of palms throughout the region. Budrot is characterized by the collapse of the youngest leaves in the crown, followed by a putrid rot of the growing point. Developing fruit are retained and the older leaves may remain green for up to a year after loss of the whorl of younger leaves.

Diagnosis of budrot is primarily by symptomatology. Isolations of *Phytophthora* may be made from bud tissues distant from the secondary rot that invariably occurs in the meristematic region. The occurrence of palm weevils in the bud may produce symptoms that mimic budrot, as may a nearby lightning strike.

### Buttrot

Buttrot is another lethal disease of coconut palm that is considered to be of overall minor importance. Buttrot is caused by invasion of the base of older palms by the fungus *Ganoderma*. Dark colored, fungal brackets may be seen at the base of 20- to 40-year old infected palms. Infected palms decline and die slowly with a slow tapering off of growth. The fungal brackets are considered diagnostic. Infection by *Ganoderma* usually occurs through soil.

### Stem Bleeding

Stem bleeding disease has been reported from most areas of the Caribbean Basin. This disease is caused by the fungus *Ceratocystis (Thielaviopsis) paradoxa*. As its name implies, stem bleeding is characterized by a soft rotting of the internal tissues of the stem and the copious oozing of sap outside of the stem. Diagnosis should be confirmed by isolation of the causal fungus, as lightning strike and trunk borers will also cause bleeding of the stem.

### Lightning Strike

Coconut palms are apparently good conductors of electricity, as annually up to 1% loss may be expected from lightning strikes. Symptoms of lightning strike are an almost immediate collapse of foliage with discoloration to a watersoaked green, followed by dessication. Fruit is generally retained and the stem will become discolored from the copious bleeding of rust brown sap. Occasionally a grazing strike or the strike of a nearby tree will cause the death of the younger whorl of leaves with an ensuing budrot that will mimic the budrot disease caused by *Phytophthora*.

A related, though not fatal, problem is power line burn which occurs on palms grown adjacent to a power line. Fronds blown into contact with wires by the wind will be burned by electricity arcing to the leaves. Leaves adjacent to power lines are usually brown and dessicated at the tips, and extensively yellowed at the base.

### Bronze Leaf Wilt

Bronze leaf wilt is a problem on hardpan soils in certain regions. It is apparently a physiological problem related to lack of moisture in the dry season, followed by waterlogging during the rainy season (Griffith, 1981). The literature concerning this syndrome is particularly confusing since the name has been used interchangeably with Cedros wilt (harrot) prior to the discovery of flagellates in palms affected by the latter disease. Bronze leaf wilt is not necessarily a fatal problem and affected palms usually recover fully (Griffith, 1981).

### Geographic Distribution

The distribution of these lethal diseases of coconut palm, within and surrounding the Caribbean Basin, is not uniform (Fig. 1). Lethal yellowing occurs in and to the north of Jamaica, through Cuba, and into Florida. LY extends from Grand Bahama on the east, to the Rio Grande Valley of Texas (where it affects date palms), with a further outbreak on the eastern coast of the Yucatan Peninsula (McCoy [ed.], 1983; McCoy et al., 1980). Currently LY is spreading rapidly in the state of Quintana Roo, Mexico. LY has been reported from the island of Hispaniola but has not been observed there in recent times (Howard et al., 1981). LY is also noticeably absent from many of the Bahama Islands, Puerto Rico, and the Lesser Antilles. LY has not been reported from Central or South America.

Harrot disease has been reported in most of northern South America, and from Central America (Doller et al., 1977; Griffith, 1981; McCoy and Martinez-Lopez, 1982; Parthasarathy et al., 1976; Waters, 1978). HR is not known to overlap areas where LY has occurred. Red ring is found in most areas where HR occurs and as far north as Quintana Roo, Mexico where it may be found in the same locality as LY (McCoy et al., 1980). The bronze leaf wilt disease has been reported from Trinidad and Venezuela (Griffith, 1981). The diseases budrot, buttrot, and stem bleeding have been reported from most areas where coconut is grown, albeit usually in low numbers of palms affected. As mentioned, a number of these syndromes may be confused with the symptoms of lightning strike and it is possible that many of the reports of these diseases may actually have been due to lightning.

FIG. 1. Map of the greater Caribbean region showing areas of occurrence of the three major coconut palm diseases, lethal yellowing (LY), harricot (HR), and red ring (RR).



## Discussion

The major diseases of coconut palm, LY, HR, and RR occur in specific geographical ranges. Because of confusion in symptomatology of these and several other problems, there is some confusion in the literature as to which diseases occur where. The objectives of the current research project are to define where these

diseases, particularly LY and HR, occur, and to investigate new and simpler diagnostic methods. The major benefit of the research is the development of information valuable to plant quarantine programs designed to protect coconut production within the Caribbean Basin.

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