WORKING PAPER NO. XXIX

COCONUT WITHERING DISEASE OF CEYLON AND THE INDIAN ROOT (WILT) : A COMPARISON OF SYMPTOMS

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What appears to be a serious disease of the coconut manifesting itself sporadically in a number of pockets in Ceylon, mostly in the Southern Province, is of recent origin and first reported about 1955. The most obvious symptom of this disease starts with the drying of the fronds and results in rapid withering away of the crown in most cases. Therefore, the name 'Coconut Withering Disease of Ceylon' or briefly 'Coconut Withering' is suggested for this malady. Many of the symptoms of this disease are similar to the Root (Wilt) of South India, which first appeared simultaneously in three centres in Kerala about 45 km. apart nearly eighty years ago and became significant after a severe flood in 1882 when the coconut tract was considerably water-logged. As reported by some coconut growers, sudden withering of fronds in some palms in Ceylon was first noticed after the unusually heavy rains about ten years ago.

Since many of the symptoms of the Root (Wilt) have been reported from time to time (Butler, 1908; Varghese, 1934; Menon and Nair, 1949, 1951; Nagaraj and Menon, 1955, 1956; Menon and Pandalai, 1958; Shanta et al, 1960; Menon, 1961 etc.), I give below relatively more information on the Coconut Withering. External symptoms of the disease are more obviously noticed on the crown and in a lesser degree on the roots. Striking symptoms on the stem are not visible.

1. SYMPTOMS ON THE CROWN

Withering of fronds: As stated, the most conspicuous symptom of the Coconut Withering disease is the withering in stages of the leaflets of some older fronds (Fig. 1). Though this symptom generally starts manifesting with very old leaves, middle aged leaves showing first symptoms are not very uncommon. In a leaf, the distal leaflets are affected most, and the withering intensity gets reduced towards the base of the leaf. In a leaflet also a similar gradation in intensity may be noticed, the tip being affected most. The outer margins of the lamina start withering, which ultimately reaches the midrib.

Where the withering is very acute, some of the brittle lamina break away in bits by wind, leaving in course of time an almost bare midrib. This condition was noticed in the Rathmahara Estate where in 1962 though only about one per cent of the palms showed visible symptoms, trees with up to 30 leaves showing these symptoms in degrees were noticed. Though only palms between ages 35 and 50 were reported to show the symptoms, I noticed early withering on the fronds of non-bearing seedlings as young as 4-5 years at Kittanduwa and Woodland Estates. So far it has been considered that the King Coconut (Thambili) as well as the dwarf forms are resistant to the disease. But unfortunately even this hope has to be given up. The orange, green and ivory forms of the dwarf are equally susceptible to the Indian Root (Wilt) (Fig. 1a).

Necrotic streaks: The physiology leading to the withering of leaves is not known. On close examination of the affected leaves, necrotic streaks as seen in Fig. 2 were noticed on some of them. They appear first on young leaves, four to six months after complete emergence. The streaks appear as thin, translucent, whitish or yellowish lines varying from 2 mm to 20 mm in length. Gradually they turn deep yellow, brown, dark-brown or grey. With time, their length increases and some adjoining ones may coalesce into broader streaks. When many such lines join together, a withered patch may appear. Similar necrotic streaks are very common with the Root (Wilt). This necrosis has been presumed to develop from the blockage of the phloem tissue.

Mottling of leaves: Fig. 3 depicts acute mottling on portions of the leaflets. Though yellow mottling has been regarded as the most dependable or obvious symptom of the Cadang-Cadang disease of the Philippines, this is not a universal symptom of the Root (Wilt). In Ceylon, where yellowing is present, usually a uniform discolouration of the lamina, increasing in intensity towards the distal end of a leaf, and in a leaflet towards its free end is perceivable. This condition has been mostly associated with palms which showed favourable response to magnesium (Nethsinghe, 1959, 1961a, 1961b; Salgado and Nethsinghe 1960). But there are others which showed withering as well as yellow mottling. The mottles which appear as minute spots like the effects of pin-pricks, steadily enlarge and become deeply yellowish. Several spots coalesce forming bigger patches, each usually showing uneven colour-densities. These patches turn brown and begin to dry up prematurely. The mottles never appear as streaks and have to be regarded as different from the necrotic streaks.

Flaccidity and 'ribbing' of leaflets: I did not come across in Ceylon even a single case of acute wilting of the crown as noticed in palms showing wilt diseases. However, some flaccidity and a consequent ribbing of the leaflets was noticed on most withering palms. The motor mechanism which regulates the spreading and folding of the lamina of leaflets is very much weakened, and the leaflets remain fully

spread out when the disease sets in. Such leaflets gradually lose their moisture content and their tissues become stiffer tending to curve down-wards. The 'ribbed' leaflets start drying from tip downwards and their laminae often break off in flakes. Such leaves wither prematurely and drop off. Usually this symptom starts with the older leaves and the pace of their shedding in such trees exceeds production, with a consequent reduction in the total number of leaves on the crown. Along the coast-line of the disease-belt of Ceylon, many trees showed symptoms of drying of fronds and ribbing of leaflets. Whether it is due to sea-spray and/or disease could not be made clear.

Foliar yellowing: There is no doubt that yellowing is also associated with Coconut Withering although it has not been considered so. I have little doubt that more obvious withering symptoms will appear in course of time on most palms which now show only yellowing, if the disease remains uncontrolled for a few more years. With the increase in the severity of the disease, more complicated symptoms are bound to appear as has been the case with the Root (Wilt). Many of the trees showing foliar yellowing and which respond favourably to magnesium have to be regarded as palms displaying one form of the unknown disease. Palms showing only yellowing of the foliage in South India were first believed to suffer from a physiological disease having little to do with the Root (Wilt). But the condition of their roots, nature of the root exudation and transmissibility of the disease suggested their identity with the other forms of the Root (Wilt). The similarity of the effects of magnesium, which has been found to be highly beneficial with Root (Wilt) may further indicate that foliar yellowing is only a stage or form of the Coconut Withering. Nevertheless, this hypothesis requires confirmation, for my limited study of the disease in Ceylon is inadequate to ascertain its truth.

Snapping of petioles and breaking of leaf-tips: With the general weakening of the crown, the leaves lose their resistance to wind and their petioles snap. Thus, in a number of palms drooping of a few leaves was noticed. Often the tips of leaves were broken and they were seen hanging by their attachment with the rachis. These broken tips turn yellow and wither; but still cling to the rest of the leaf and get tossed by the wind. The above two symptoms are more pronounced in the case of the Root (Wilt). Leaf samples from diseased palms of Ceylon were cultured and the fungi Botryodiplodia theobromae and Penicillium sp. were isolated from them.

Nut and the inflorescence: When a sizeable reduction in the green leaf area sets in, decline in nut-production is the inevitable result. The diseased palms produce lesser and smaller fruits, and presumably copra of poor quality and quantity. Shedding of young nuts and/or buttons is not reported although it is quite common with the Root (Wilt), specially at the early stage when a heavy bearer develops the

symptoms (Menon and Nair, 1951). At Farnham Estate, Puwakpitiya, I examined some trees of both Thembili and tall varieties which showed shedding of immature nuts as a result of soft-rotting that developed usually from the stalk-end of the nut. A species of Phytophthora as well as Rhizoctonia sp. were isolated from the mesocarp of these fruits. Puwakpitiya is predominantly a rubber growing tract and I was told that Phytophthora palmivora causing bark-rot in Hevea braziliensis is prevalent there. One peculiarity not so far noticed in India is that the affected nuts before developing the soft-rot turn brick-red externally irrespective of their natural colour and appear as though the nuts were painted.

The nuts of affected trees (Coconut Withering) are shrunk considerably and are disproportionately long, but not longer than a normal nut. While such a conspicuous phenomenon is not noticed with Root (Wilt), the overall size and quality of the nuts get affected. Nuts of Cadang-Cadang affected palms usually maintain the globose shape, but their size, resulting partially from a reduction in the thickness of the husk, is reduced (De Leon, 1951; 1952).

I was not successful in finding conspicuous symptoms on flower bunches or tender flowers of which we have several for the Root (Wilt) (Fig. 4). The withering palms bear a flower bunch in almost every leaf axil, though reduced in size, and develop one or two oblong or shrivelled nuts each. The presence of inflorescences even in acute stages may be due to the fact that the condition of the tree is run down very quickly from the onset of disease and that the already formed inflorescences still remain visible on the crown, although poorly developed. This is not the case with the acute stage of Root (Wilt) and Cadang-Cadang, where the trees are completely barren of spadices.

Foliar spiral and disease incidence: It was found that there is no correlation between the foliar spiral and the incidence of Root (Wilt) disease since both right- and left-handers were equally affected (Davis, 1963). Radha and Pandalai (1964) also give further figures in support of this.

Similarly, there seems to exist no correlation between the leaf spiral and the incidence of Coconut Withering. Of the 72 diseased palms at various stages of decline examined at Kirimetiya Estate, Woodlands Farm and Sirikanduwa Estate, 35 possessed left-handed foliar spirals.

2. SYMPTOMS OF THE STEM

Striking disease symptoms are not visible on the stem. Since the disease is of recent origin, there are only very few trees with fairly long portions of stems grown after the incidence of the disease. The stem is generally weak and in some cases acute tapering also developed, and the diminutive crown is blown off from the tip of the tapering stem in course of time.

3. SYMPTOMS ON THE ROOT SYSTEM

Deterioration in the condition of the root system is another major symptom of Coconut Withering. In Root (Wilt), many instances of root-damage proved to be a presage of foliar symptoms. Apparently healthy palms in the Root (Wilt) belt which showed root exudation of a particular nature could be predicted to develop further symptoms in the course of a year or so. Some of the more obvious symptoms observed on the root system are mentioned below :

Rotting of root tips : The coconut has a few thousands of almost uniform main roots emanating from the lowest part of the stem, the bole. The growing tips of these roots having thin-walled but prominent epidermal layers were affected in most cases of a withering palm. There appears to exist a correlation between the condition of the crown and the extent of root-damage. The palm in its endeavour to maintain a greater absorptive surface, produces branch-roots from just behind the damaged (rotting) tips. After a short while, the growing tips of these branch-roots stop growing and rot in turn. This process may be repeated several times.

Cessation of root growth : Some trees, in addition to having few or many roots with damaged growing points, may have many others with hardened tips. The growing region of a healthy root has thin-walled epidermal cells with poorly developed hypodermal layer. But as the root grows older, its epidermis withers and the hypodermis develops into a hard protective layer which is impervious to water. This hard epidermal layer is seen to have developed up to the very tip in many affected roots. Such roots do not grow, although their tips are free from rotting, but are very hard and turn dirty brown or grey (Fig. 5). The damaged condition of the roots is also noticed on the rootlets of all orders. According to Calica and Bigornia (1960), the higher order roots abound in healthy palms but the Cadang-Cadang affected ones are conspicuously lacking in tertiaries and quarternaries. The Botanist, Coconut Research Institute of Ceylon, observed root-rotting in some apparently healthy palms also, which probably indicates that Coconut Withering is preceded by a progressive decay of the root system and that the disease is getting a firm hold throughout the estate. However, this condition has to be differentiated from the normal root decay in healthy palms due to aging. Diseased palms in the acute stage and perfectly healthy looking ones live in close proximity to each other without any apparent bad effect on the healthy ones. No striking anatomical variation between the healthy and diseased roots could be noticed. However, in the aerial roots of diseased palms a large thin-walled cell surrounded by 2-3 layers of thick-walled cells towards the centre of the stele was noticed by the same Botanist. It will be worthwhile to look for the existence or otherwise of a necrosis of the phloem and other tissues. A species of Rhizoctonia was isolated from the infected root samples.

Certain diseases on other plants in the disease-belt : A sound knowledge of the diseases affecting other plants within the disease belt is expected to throw more light on the nature of the coconut diseases. Search for alternate hosts for transmission studies will also be made easy if diseases on other plants are studied.

Holmes (1961) believes that the incidence of Cadang-Cadang did not show a corresponding increase with the increased sources of potential inoculum in coconuts. This non-autocatalytic trend in disease incidence made him believe that there were many other sources of inoculum independent of diseased coconut palms. He (Holmes, 1961a) correlated the intensity of disease in certain weeds, especially the compositae weed, Elephantopus mollis Hbk., and Cadang-Cadang in coconuts.

The following plants in the coconut tract of Ceylon were seen affected by one or more diseases. Some of the symptoms exhibited in a few of these plants as for example, Chrysalidocarpus lutescens, Areca catechu, Elaeis guineensis, resembled those on the withering coconuts. Others are the palm species, Areca catechu, Elaeis guineensis, Chrysalidocarpus lutescens, Ptychosperma macarthuri and Oreodoxa regia; a compositae weed, Ageratum conyzoides, a leguminous cover crop, Pueraria sp., Musa Sapientum and a grass. While I could not locate Elephantopus mollis in Ceylon, no symptom was observed on Strachytarpheta sp., although Calica reported symptoms on it in the Cadang-Cadang area of the Philippines.

The Root (Wilt) affected areas in India have a large number of diseases affecting innumerable species of plants. The species most common and which exhibit almost identical symptoms is the areca palm (Areca catechu). The main disease affecting this palm is suspected to be of virus origin (Radha, Menon, 1960, 1961; Radha, Menon and Kalyanikutty, 1961). Bunchytop of the banana is also prevalent in the coconut disease-belt. Other palm species such as Elaeis guineensis, Chrysalidocarpus lutescens, Caryota urens etc., responded to inoculations with diseased coconut sap. Pulses are the next main group which show leaf curling, vein clearing and mosaic symptoms. Shanta and Menon (1960) were successful in transmitting the coconut wilt virus on to cow pea (Vigna sinensis). Sunnhemp (Crotalaria juncea), a common green manure plant, also shows certain virus symptoms. Certain cucurbitaceous plants - the snake gourd, bitter gourd, pumpkin - also show one or more diseases. Papaya, Jatropha, chilli, brinjal and tomato are a few others showing symptoms of certain diseases.

4. PROBABLE ORIGIN OF COCONUT WITHERING

I do not wish to allege that Coconut Witherihg is an infectious disease and that it had its origin in India. Nevertheless, considering its gradual spread, the great similarity of this disease with the Root (Wilt) and the availability of several agencies that could favour the transport of the disease from a near locality in India, one may conjecture

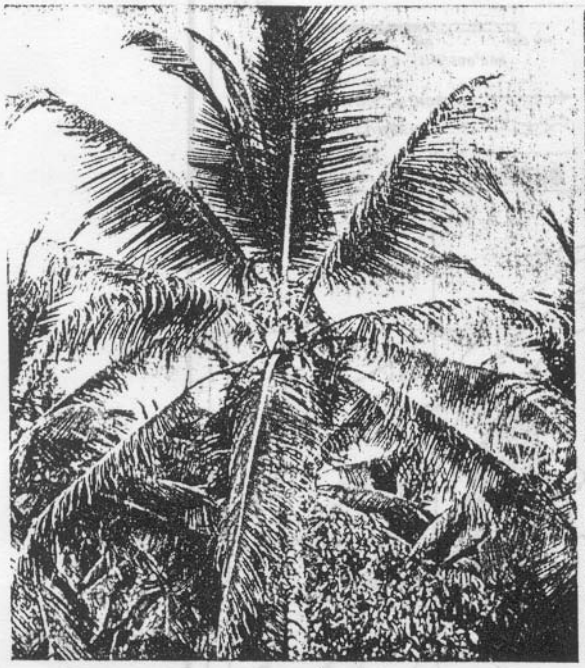

Fig. 1 Coconut Withering—early stage

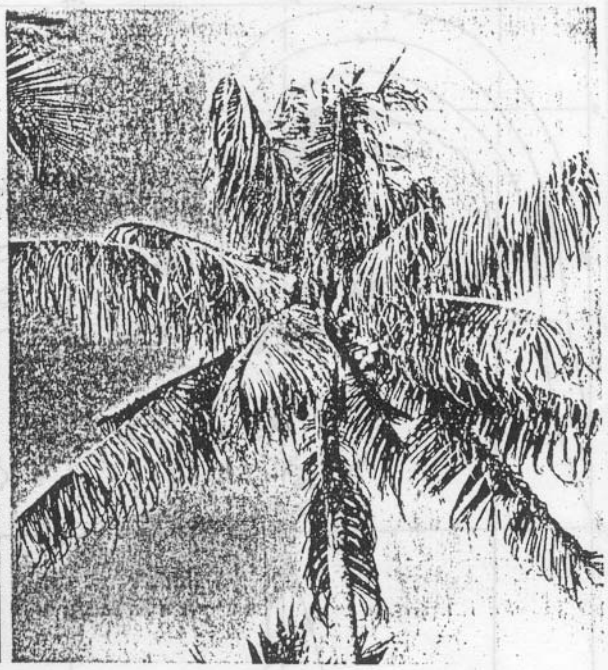

Fig. 1a Indian Root (wilt)—advanced stage

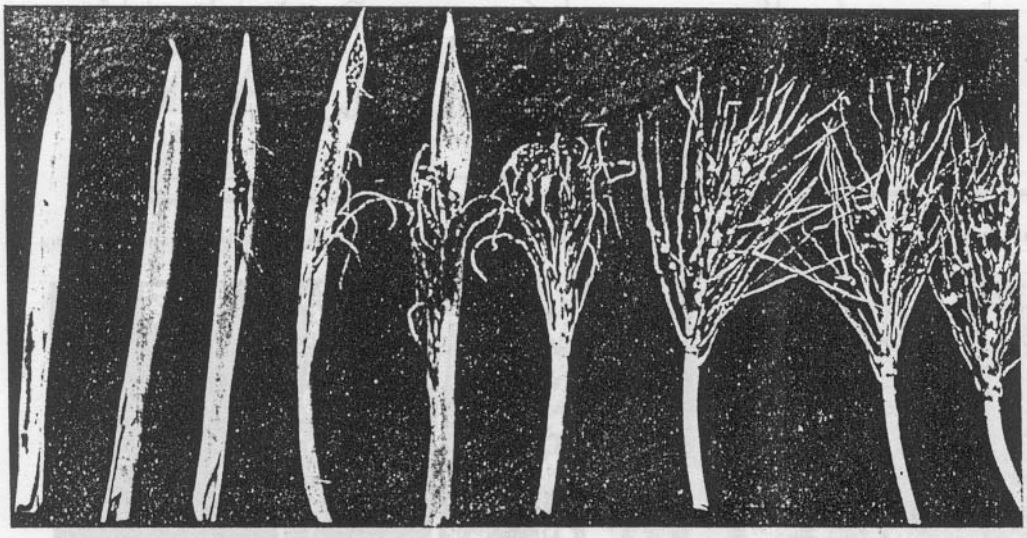

Fig. 4 Nine successive spadices of a Root (wilt) diseased palm showing shedding of young nuts, withering of flowers, wilting of spikes and rotting of young nuts, flowers, spikes and spathes.

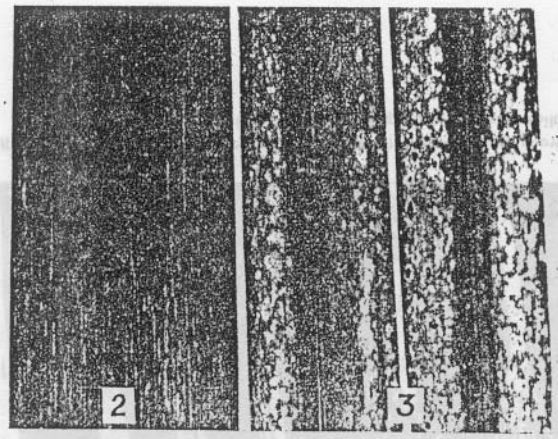

Fig. 2 Necrotic streaks on a leaflet. Fig. 3 Yellow mottlings on leaflets.

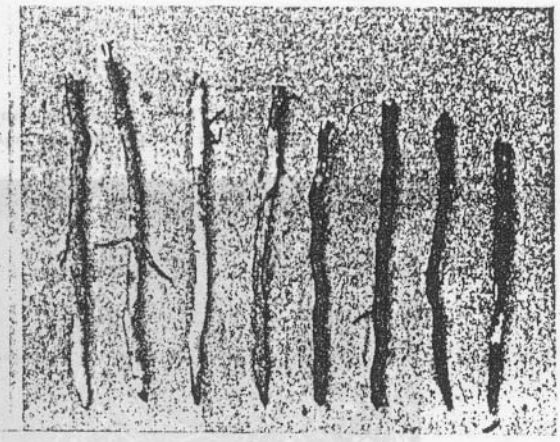

Fig. 5 A root-tip of a healthy tree along with those of a diseased palm with hardened tips.

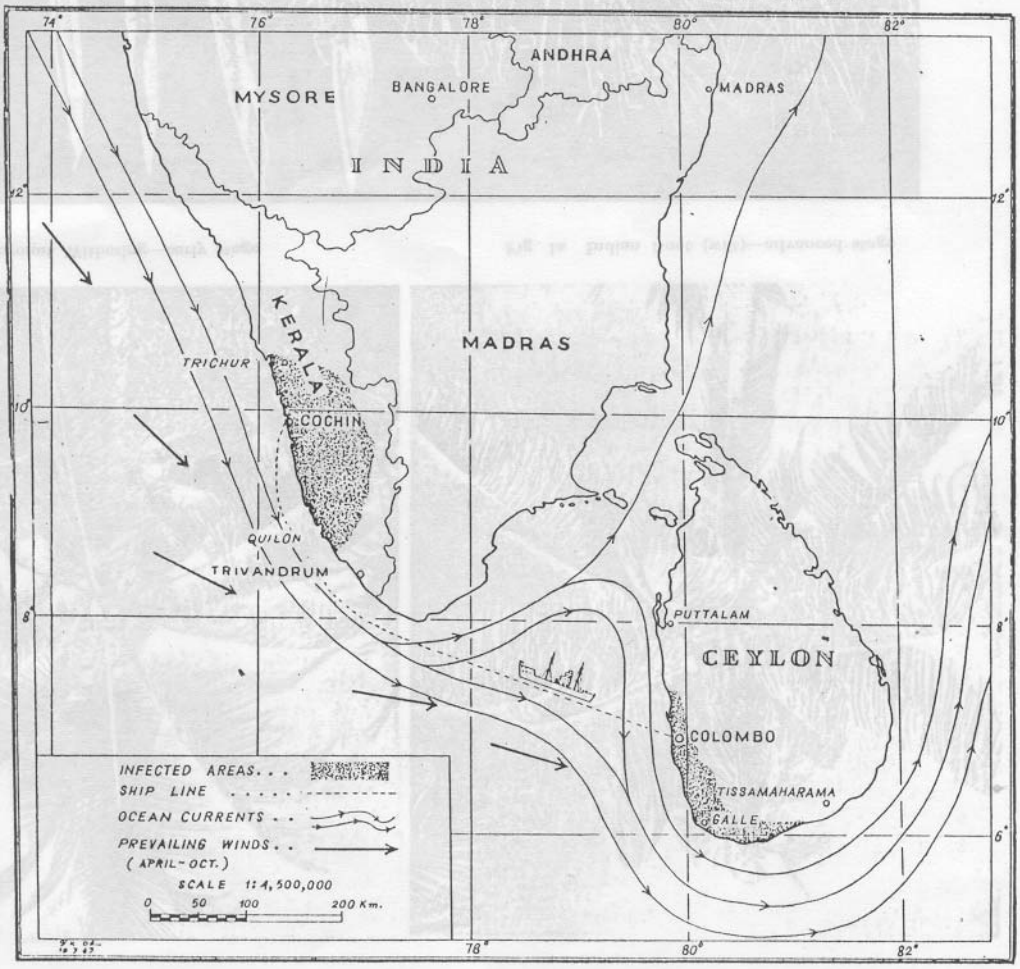

Fig. 6 Southern peninsular India and Ceylon showing Root (wilt) and Coconut Withering affected regions.

that the disease had its origin in India in the event of the disease being proved to be an infectious one.

The Root (Wilt) has been prevalent in Kerala for the past 80 years or more and during this period plenty of opportunities could have existed for some organ or other of the diseased palms, or the organisms or animals associated with them reaching Ceylon. There is regular steamer service from Cochin to Colombo (distance 310 nautical miles). Although passenger traffic is restricted, there is still a heavy cargo service plying between these ports. Cochin is in the heart of the disease-belt and all sorts of perishable and other materials largely drawn from the diseased tract have been periodically shipped from Cochin to Ceylon. Unauthorised shifting of a few seed coconuts or seedlings from India by interested people could very well be surmised. This suggests that even if the Root (Wilt) is proved solely due to a soil transmissible virus (Menon and Shanta, 1962), still its spread across the sea is possible. The trade winds prevailing during March-May and September-November move from the coast of Kerala towards the South-West coast of Ceylon (Fig. 6). The withering disease is so far observed along the South-West coast of Ceylon, although coconut is present almost throughout the entire coast of the island at varying intensities. The fact that the coconut growing areas along the East coast of India are still free from the Root (Wilt) may also support the trade wind theory to a great extent. Fragments of affected leaves, fungal spores, pollen grains etc., could conveniently be carried by swift winds to far distant places. Another factor that may help to drift certain affected portions or disease causing organisms is the powerful ocean currents which move towards Ceylon along the West Coast of India. The capacity of coconut fruits to float on water to far distances is an undisputed one. Seasonal birds, bats and even insects drifted by wind or wave may help as well in the transference of disease causing organisms, even if they are not vectors themselves. It is appropriate to refer here to Holmes' report (1961 b) on the spread of Cadang-Cadang which has shown its ability to jump from island to island where intervening distances are only of the order of 20 km. to 50 km. But long jumps are possible if the disease carrying organisms are the weed seeds since they can be dispersed to long distances by the agencies of seed-eating birds or by man by his unrecognised transportation of such weeds.

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WORKING PAPER NO. XXX

'LEAF SCORCH' OF COCONUT - A PRELIMINARY NOTE

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Not included here