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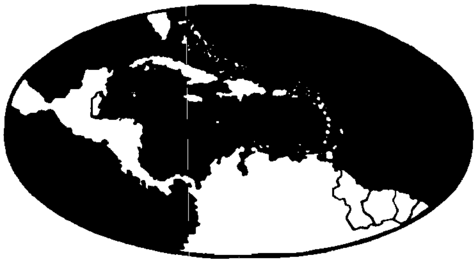

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THE SUSCEPTIBILITY OF THE PALM WEEVIL TO THE RED RING NEMATODE

(Related to transmission)

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Palm weevils which, during their development and metamorphosis, are capable of housing several hundred juvenile red ring nematodes, transmit these nematodes from diseased coconut trees to healthy ones. Such palm weevils are homozygous for the factor which allows them to house such large quantities of nematodes. The subsequent presence of the nematode in the insect reduces the size of the developing larvae. The relationship between the nematode and the susceptible palm weevil is one of antagonistic symbiosis. In this circumstance intensity of parasitism between the microsymbiote and its host is important for the transmission of the nematode.

The nematode has not been seen to multiply in the insect which, in the terms of parasitologists, may be considered as the intermediate host; whereas the coconut palm, in which the nematode multiplies, might be considered the definitive host. The prognosis of this plant-nematode relationship is fatal with the surviving nematode being an obligate plant parasite. The extent of parasitism of the palm weevil, which is genetically susceptible to the presence of the nematode, is critical and bears, therefore, an essential correlation to its survival.

Vector palm weevils spend, on the average, about 2 months as larvae developing in a diseased coconut tree where they feed on diseased tissue containing over 2,000 nematodes per gram. Some of these nematodes enter the body-cavity of the larva and remain in the haemocoel. The fact that this obtains naturally as was shown (Griffith 1974) by breeding experiments with homozygous larvae, can easily be demonstrated using samples of field-collected larvae. 0.1 ml. of percentage streptomycin sulphate solution were injected into samples of field-collected larvae.

Within 24 hours palm weevil larvae, which were capable of removing the nematodes from their haemocoel, would have destroyed more than 25,000 nematodes. The susceptible larvae did not remove the nematodes (Table 1).

TABLE 1. The removal of neamtodes, *R. cocophilus*, from the Haemocoel of Field - collected palm weevil larvae, *R. palmarum* in 24 hours.

Concentration of Nematodes per 0.1 ml solution	No. of Insects injected	Percentage of insects Resistant	Percentage of insects Susceptible
17,000	34	82.35	17.65
17,000	24	100.00	0.00
17,000	35	97.14	2.86
17,000	57	100.00	0.00
20,000	33	93.94	6.06
25,000	74	43.24	56.76
25,000	29	86.21	13.79
51,000	10	50.00	50.00

It is a well-known situation that a varying percentage of non-vector adult palm weevils are often found in the field with a small quantity of nematodes in their haemocoels. Various authors have reported several figures. Hagley (1963) examined 108 insects and found 21 carrying nematodes. The average number of living nematodes per weevil was 58. This was the general picture.

During experimental inoculations with field insects at all concentration of nematodes a small percentage of insects tolerated small quantities of the nematode in an active condition in the haemocoel after the majority of nematodes had been removed. Table 2 shows, experimentally, when 17,000 nematodes are injected into larvae, some nematodes remain unaffected by the insect.

TABLE 2. Tolerance of small quantities of *R. cocophilus* by the larvae of *R. palmarum* - injection experiments.

Concentration of Nematodes per 0.1 ml suspension	No. of Nematode Remaining in Haemocoel after 6 days	Insect containing nematodes		Total No. of insect injected
		No. of insects	Percentage	
17,000	1 - 10	29	19.33	150
	10 - 20	6	4.00	
	20 - 50	9	6.00	
	50 - 100	3	2.00	

The response to the injected nematodes by the resistant insects in the majority of cases is complete removal. In some instances death of the insect occurs during the attempt. This is particularly so when large quantities of nematodes are injected. 16,000 nematodes may be completely destroyed without a trace in 3 - 4 hours.

In some situations death of the insect precede the removal of the nematode. In these later situations one presumes that these insects are unable to remove the nematodes and their death is due to the over abundance of the organism.

When experimentally produced susceptible larvae are allowed to develop in diseased tissue, mortality is always high. Such a high rate of mortality may be due, in some measure, to the effects of the nematode in the insect. It is conceivable that as an insect feeds on diseased tissue, more and more larvae enter its haemocoel. If these nematodes are not removed, they accumulate in the susceptible insects. The extent of their accumulation and activities may determine their effect on the longevity of the larvae and the rate of mortality of the insect.

The most obvious result of the presence of large quantities of nematodes is the reduction in the quantity of fat-body of the adult insect. Normal size or non-vector palm weevils always have an abundance of fat-body. Vector insects have almost none. To some extent this relates to the longevity of the insect in the field as the adult insects eat very little. A non-vector female may deposit between 200 - 400 eggs during 30 days. Many non-vector insects may oviposit over 500 eggs. Very few vector insects oviposit more than 50 eggs. On an average 20 + 13 eggs are produced.

Therefore, apart from the limiting of the population size due to death resulting from large numbers of nematodes in the haemocoel, the reproductive potential of the insect is affected through reduced fecundity. In such circumstances the susceptible insects, though homozygous for the trait, do not tend to build up an effective population of their own readily, especially when natural environmental resistance is increased. Drought conditions, which do not destroy the palm weevil population, effectively aid in the removal of vectors and so reduce the spread of the disease.

The third stage juvenile nematode is the infective stage to the larvae of the palm weevil and to the coconut palm. The question of virulence and infectiousness is not related to the palm weevil but to the coconut tree since the nematode only subsists in the insect. The exact cause of mortality in vector weevils by nematodes might shed some light on the trends of selectivity between the palm weevil and the nematode.

A plant pathogenic organism is regarded as a problem to the plant, but it can clearly be a problem to its insect vector. The pathogen has to enter the body of the insect, must be able to counter the toxic actions of the host and it must obtain certain conditions for its maintenance. It is a well-known feature that some plant pathogenic viruses have deleterious effects on their vectors and may even reduce, significantly, the life-span of the vector.

The mechanism of insect defence, as it relates to transmission of a pathogen, often shows hereditery lapses; thus many known cases of insect transmission of plant pathogen result from genetic factors, allowing for susceptibility of the host to the pathogen. Numerous examples may be cited from the literature. But the overriding deleterious effect of the pathogen on the insect can often determine the balance for transmissibility.

Female palm weevils may oviposit eggs which are not fertilized. This is most apparent with some vector weevils of small size, since mating with the larger insects around may not be always successful. Therefore, a vector insect, having transmitted the pathogen may not, by its own device, allow for its continuity by placing fertile eggs in the infected tree.

Transmission, therefore, depends on the attractiveness of the diseased tree to palm weevils which can produce fertile eggs with the genetic requirements for susceptibility to the nematodes.

In red ring disease, the balance of suceptibility of the palm weevil to the red ring nematode is critical. This depends upon the extent of parasitism of the vector by the nematode. The vector population, because of the effects of the nematode, are not efficiently self-propagating even though they are homozygous recessive for the susceptibility of the nematode. The replenishment of vectors comes from the homozygous recessive and heterozygous insects not yet infected with the nematode.

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