

6. MISRA, C.S. *Oxycarenus lactus*, the dusky cotton bug. Proceeding 4th Ent. Meet. Pusa pp. 84-92. 1921.
7. SNEDECOR, G.W. and W.G. COCHRAN. Statistical methods, 6th Edn, Ames, Iowa State University Press. 1967.
8. SWEET, M.H. The seed bugs. A contribution to the feeding habits of the Lygaeidae (Hemiptera: Heteroptera). Annals Entomology Society American. 53(3):317-321. 1960.
9. THANGAVELU, K. Some notes on the host specificity of dusky cotton bug, *Oxycarenus laetus* kirby (Heteroptera: Lygaeidae). Journal Natural History 12:481-486. 1978.
10. WILSON, K.J. Cotton pests and their control in Northern Rhodesia. Govt Printer, Lusaka, 1978. pp. 15. Plates IV. 1955.
11. WOODSTOCK, L.W. Seedling growth as a measure of seed vigor, International Seed Test. Abstract Proceedings. 34:273-280. 1969

The frequency of occurrence and geographical distribution of plant parasitic nematodes associated with *Theobroma cacao* in Nigeria.

Resumen. En este estudio se informa sobre la frecuencia de aparición y la distribución geográfica de nematodos asociados al cultivo del cacao en Nigeria. Se examinaron 1 500 muestras colectadas en 72 fincas en las cuales se encontraron 25 especies pertenecientes a 17 géneros. Por primera vez fueron encontradas en cacao *Xiphinema basilense*, *Paralongidorus* sp., *Longidorus* sp. y *Euthylenchus africanus*. Los géneros más comunes fueron *Helicotylenchus*, *Xiphinema*, *Scutellonema*, *Meloidogyne* y *Hemicycliophora*.

The earliest report of cocoa nematodes was that of Ritzema Bos (12) who found root-knot nematode, *Heterodera radicola* (= *Meloidogyne* sp.) on cocoa in 1900. He, however, did not indicate the locality.

In 1921, Ghesquire (8) reported the occurrence and close association of *Meloidogyne* sp. with the die-back disease of cocoa in Belgian Congo. Many

other reports of the occurrence of nematodes on cocoa have since been published (3, 10, 14, 15, 19). Forty-seven species of nematodes belonging to twenty-seven genera have been reported in the literature to be associated with *Theobroma cacao* roots (18).

This survey was undertaken in order to find out the frequency, the distribution of each species and to document any new records of the plant-parasitic nematodes associated with cocoa in Nigeria.

Materials and methods

Soil samples were taken within a 50 cm radius from the base of cocoa trees as the largest number of nematodes were recovered from that region. Samples were taken with augers of 2.5 cm diameter to a depth of 24 cm. The samples were stored in polythene bags and transferred to the laboratory for nematode extraction.

Soil samples were washed through Cobb sieves (5) of 500 and 53 micron pore sizes respectively before extracting nematodes for 18 hours from the resulting suspension by the Whitehead and Hemming (20) tray method. This combination was found to be effective for the recovery of Longidorid nematodes.

Nematode suspensions were concentrated to a 20 – 25 ml sample using the settling-siphon method of Caveness (4). The samples were examined under the dissecting and compound microscopes immediately or preserved in TAF solution (6).

Sampling was done during the wet season in all cases over a period of 24 months. The six cocoa-growing states in Nigeria – Bendel, Benue, Cross River, Ogun, Ondo and Oyo were covered in the survey. A total of 1 500 samples covering 72 farms were investigated. Depending on size 10 – 20 soil samples were taken from each farm.

Tomato indicator plants were also employed to detect the presence of *Meloidogyne* spp. in farms where cocoa establishment had been difficult or impossible at the Gambari Experimental Station of the Cocoa Research Institute of Nigeria (CRIN).

Results and discussion

Table 1 shows the nematodes encountered in the six states covered. Twenty-five species belonging to 17 genera were identified. The frequency of their occurrence is expressed as a percentage of the total

Table 1. Plant-Parasitic nematodes found associated with *Theobroma cacao* in Nigeria

Nematode	Where found					
	Benue State	Bendel State	Cross River State	Ondo State	Ogun State	Oyo State
<i>Aphelenchoides</i> sp			*			
<i>Aphelenchus avenae</i>	*	*	*	*	*	*
<i>Criconemoides limitaneum</i>			*		*	*
<i>Eutylenchus africanus</i>						*
<i>Helicotylenchus dihystrera</i>	*	*	*	*	*	*
<i>Helicotylenchus erythrinae</i>			*			
<i>Helicotylenchus multicinctus</i>	*	*	*	*	*	*
<i>Hemicriconemoides</i> sp						*
<i>Hemicycliophora</i> sp						*
<i>Heterodera</i> sp (adult male & (larvae)			*			
<i>Hoplolaimus pararobustus</i>			*	*	*	*
<i>Longidorus</i> sp			*			
<i>Meloidogyne</i> sp (larvae)				*	*	*
<i>Paralongidorus</i> sp	*					*
<i>Paratylenchus</i> sp						*
<i>Scutellonema brachyurum</i>						*
<i>Scutellonema clathricaudatum</i>			*	*	*	*
<i>Scutellonema validum</i>	*			*		*
<i>Trichodorus</i> sp				*		*
<i>Xiphinema bergeri</i>						*
<i>Xiphinema brasiliense</i>	*			*	*	*
<i>Xiphinema ebriense</i>	*	*		*	*	*
<i>Xiphinema ifacolum</i>				*	*	*
<i>Xiphinema longicaudatum</i>						*
<i>Xiphinema nigeriensis</i>	*	*		*	*	*

number of samples (Table 2). *Xiphinema brasiliense*, *X. nigeriensis*, *X. ebriense*, *Helicotylenchus dihystrera*, *H. multicinctus* and *Aphelenchus avenae* were the most ubiquitous. *Xiphinema* spp. and *Helicotylenchus* spp. were the commonest, occurring in 56% and 66% of the samples respectively. It was only in the Cross River state that *Xiphinema* spp. were not encountered, except for one individual of *Xiphinema longicaudatum* at Ikom. These finding of few *Xiphinema* spp. east of the Niger River agree with those of Caveness (3). *Helicotylenchus* spp were found everywhere and in large numbers. *Xiphinema* spp. and *Helicotylenchus* spp. were also found in larger numbers than most other types. *Hemicriconemoides* spp., *Paratylenchus* spp. and *Hemicycliophora* spp. occurred most frequently in Oyo state. *Heterodera* spp., *Aphelenchoides* spp and *Longidorus* sp. occurred most frequently in Cross River state. Species of *Heterodera*, *Hemicriconemoides*, *Eutylenchus*, *Paratylenchus*, *Trichodorus*, *Paralongidorus*, and *Longidorus* were rare.

As far as we are aware, this is the first record of *Longidorus* sp., *Paralongidorus* sp., *Eutylenchus afri-*

Table 2. Frequency of occurrence of nematodes associated with cocoa in Nigeria.

Nematode	*Frequency of Occurrence (% of samples examined)
<i>Aphelenchoides</i> sp.	0.8
<i>Aphelenchus avenae</i>	5.0
<i>Criconemoides limitaneum</i>	2.0
<i>Eutylenchus africanus</i>	0.2
<i>Helicotylenchus</i> spp.	66.1
<i>Hemicriconemoides</i> sp	0.4
<i>Hemicycliophora</i> sp.	6.5
<i>Heterodera</i> sp. (larvae)	0.2
<i>Hoplolaimus pararobustus</i>	3.6
<i>Longidorus</i> sp	0.8
<i>Meloidogyne</i> spp.	8.6
<i>Paralongidorus</i> sp.	0.2
<i>Paratylenchus</i> sp.	0.4
<i>Scutellonema</i> spp.	8.2
<i>Trichodorus</i> sp.	0.8
<i>Xiphinema</i> spp	56.5

* Expressed as percentage of total number of samples examined.

canus, *Xiphinema brasiliense*, *Xiphinema bergeri** on cocoa

Xiphinema spp., *Helicotylenchus* spp., *Meloidogyne* spp., and *Scutellonema* spp., which occurred more frequently than others in the survey, are established pathogens of other crops. *Trichodorus* spp. are particularly difficult to extract from the soil (11). They may be present in the cocoa rhizosphere more frequently than this survey reveals. *Meloidogyne* spp. were found in some plots where cocoa establishment has been difficult or impossible at the main experimental station of CRIN by the use of tomato indicator plants.

Some species of *Xiphinema* and *Longidorus* transmit nepoviruses while tobnaviruses are transmitted by species of *Trichodorus* and *Paratrichodorus*. There are also reports that they transmit viruses that cannot be classified into either group (11, 17). The Cocoa Swollen Shoot Virus (CSSV) does not belong to either group, but causes very devastating damages in West Africa (9). The Cocoa Necrosis Virus (CNV), a nepovirus (11), is also present in the sub-region, but it is not regarded as a serious disease yet (9).

Recent investigations in Brazil (7, 13), Costa Rica (16), and Ghana (2) have shown that the establishment, growth and productivity of cocoa could be hampered by pathogenic nematodes. This is also indicated in Nigeria for *Meloidogyne* on cocoa seedlings (Afolami, unpublished data).

The Cocoa Research Institute of Nigeria has therefore initiated investigations into the role of nematodes in the establishment, growth and productivity of *Theobroma cacao* and also in the virus disease complex of the crop in Nigeria.

Summary

The frequency of occurrence and geographical distribution of plant-parasitic nematodes associated with cocoa in the six cocoa-growing states of Nigeria are reported. One thousand, five hundred samples taken from seventy-two farms were examined. Twenty-five species belonging to 17 genera were identified: *Xiphinema brasiliense*, *Paralongidorus* sp., *Longidorus* sp. and *Eutylenchus africanus* were found for the first time on cocoa. The commonest genera were *Helicotylenchus*, *Xiphinema*, *Scutellonema*, *Meloidogyne*, and *Hemicylophora*.

September 6, 1982

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Literature cited

1. ASARE-NYAKO, A. and OWUSU, G. K. *Meloidogyne incognita* infection of cocoa seedlings. Proceedings of the 7th International Cocoa Research Conference, Douala, Cameroon, 4-12 Nov. 1979 (in press).
2. CAVENESS, F. E. End of tour progress report on the nematology project. Ibadan; Ministry of Agric. and Natural Resources: USAID/Nigeria Project. 620-11-110-050. 1967.
3. CAVENESS, F. E. The distribution of plant-parasitic nematodes in Nigeria. Journal of the Association for the Advancement of Agricultural Science in Africa. 1. 35-40. 1971.
4. CAVENESS, F. E. A simple siphon method for separating nematodes from excess water. *Nematologica* 5(2):30-32. 1975.
5. COBB, N. A. Estimating the nema population of the soil. *Agric. Tech. Circ. Bur. Pl. Ind. U. S. Dep. Agric. No. 1*, 48 p. 1918.
6. COURTNEY, W. D.; POLLEY, D. and MILLIER, V. L. TAF. An improved fixative in nematode technique. *Plant Disease Reporter*, 39, 570-571. 1955.
7. EDUARDO, J. S. and ANTONIO De BRITO, I. B. Tolerancia del cacao (*Theobroma cacao* L.) al nematocida 1, 2-dibromo-3-cloropropana. *Revista Theobroma* 1(1):30-36. 1971.
8. GHESQUIRE, J. Nouveaux parasites de cacaoyer. Maladie vermiculaire de cacaoyer (*Tylenchus (Heterodera) radicolica* Greef)

* *Xiphinema bergeri* = *Xiphinema* "x" of Caveness (2).

- et sa relation avec la maladie de Diplodia (Coup de soleil, Die back). Bull. agric. Congo belge 12:709-718. 1921.
9. LANA, A. F. and ADEGBOLA, M. O. K. Important virus diseases in West African crops. Review of Plant Pathology 56(10): 849-868. 1977.
 10. LUC, M. and DE GUIRAN, G. Les nematodes associés aux plantes de l'Ouest Africain. Liste préliminaire. Agron. trop; Nogent 15:434-439. 1960.
 11. MARTELLI, G. P. Some features of Nematode-borne viruses and their relationship with the host plants. In: Nematode Vectors of Plant viruses. Edited by F. Lamberti, C. E. Taylor and J. W. Seinhorst. Plenum Press. London, New York. 1975.
 12. RITZEMA BOS, J. Les nematodes parasites des plantes cultivées. VI Cong. int. Agric. Paris II, pp. 306-313. 1900.
 13. SHARMA, R. D. and MARCO, A. A. M. Pathogenicity of the root-knot nematode *Meloidogyne incognita* on cacao. Revista Theobroma 6(2):55-65. 1976.
 14. SHARMA, R. D. and SHER, S. A. Nematodes of the cocoa region of Bahia, Brazil II — Occurrence and distribution of plant Parasitic nematodes associated with cocoa (*Theobroma cacao* L.) Revista Theobroma 3(3):17-24. 1973.
 15. TARJAN, A. C. Some interesting associations of parasitic nematodes with cacao and coffee in Costa Rica. Nematropica 1(1):16. 1971.
 17. TAYLOR, C. E. and ROBERTSON, W. M. Acquisition, retention and transmission of viruses by nematodes. In: Nematode vectors of plant viruses. Edited by F. Lamberti, C. E. Taylor and J. W. Seinhorst. Plenum Press. London and New York, pp. 253-276. 1975.
 16. TARJAN, A. C. and JIMENEZ, M. F. Debilitation of cacao in Costa Rica by plant nematodes. Nematropica 3(1):25-28. 1973.
 18. THOROLD, C. A. Diseases of cocoa. Clarendon Press. Oxford 423 p. 1975.
 19. TIMM, R. W. A preliminary survey of the plant parasitic nematodes of Thailand and the Philippines, pp. 1-71, SE Asia Treaty Organisation Secretariat-General; Bangkok. 1965.
 20. WHITEHEAD, A. G. and HEMMING, J. R. A comparison of some quantitative methods of extracting small vermiform nematodes from soil. Annals of Applied Biology 55:25-38. 1965.