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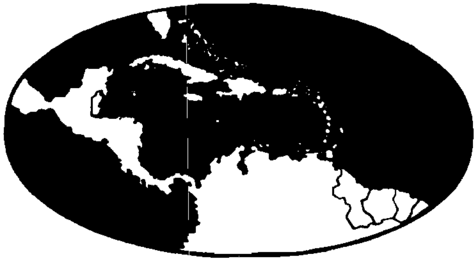

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PRELIMINARY INVESTIGATIONS ON THE BIOLOGY AND ECOLOGY OF THE GREEN CASSAVA MITE *MONONYCHELLUS TANAJOA* (BONDAR) IN TRINIDAD

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Several species of Tetranychid mites - *Monomychellus (Eotetranychus) caribbeanae* (McGregor), *M. mogregori* Flechtmann and Baker, *M. tanajoa* (Bondar), *Tetranychus urticae* Koch and *Tetranychus* sp. - are known to attack cassave (*Manihot esculenta* Crantz) in the neotropics. Of these *M. tanajoa* commonly known as the green cassava mite was accidentally introduced into Uganda during recent years; the first outbreak around Kampala in 1971 was reported by Nyiira (1972). The mite rapidly assumed pest status in the area of discovery and has now become widespread in the Ethiopian Region. Heavy infestations of the mite cause blotching and bronzing of the leaves, the latter become distorted and ultimately drop off prematurely (Lyon 1973). The mite has become a potential threat to cassava cultivation throughout the African tropics. Chemical control is not feasible economically under African conditions and biological control is considered desirable.

The mite in the area of natural distribution except for a few minor and seasonally localised outbreaks in the past has generally been considered of such little economic importance that serious investigations into its biology and ecology have not been warranted. Its populations are maintained below an economic threshold presumably by a combination of natural plant resistance, natural enemies and adverse weather. The present investigations were initiated in April 1974 to carry out a survey for the neotropics and to select promising predators for trial against the latter in Africa. Results of the preliminary investigations in Trinidad are reported herein.

DISTRIBUTION

The mite was first described from Brazil (Bondar 1938). Before the present study distribution of the mite had not been investigated in detail. It occurs in several areas in the tropical South and Central Americas.

In Trinidad cassava fields were surveyed in several localities including Santa Cruz, the Maracas and Caura Valleys, Chaguaramas, Las Cuevas and Toco in the Northern Range; Centeno, Macoya, Pasea, Valsayn in the Northern Plains; St. Mary's Junction and McBean in the

Central Plain; Debe in the Southern Plain and Manzanilla in the East. Mite infestations, of varying densities, were observed in most localities.

Effect of plant age

Plants of different age categories were sampled. The results are given in Table 1. Very small, up to eight or nine week old plants had insignificant numbers of the mite; young plants, up to approximately eight months old had very dense infestations whereas still older plants were not as heavily attacked.

The density of the mite infestation on individual plants varied greatly. Also numbers were greater on the upper part of the plant, the largest numbers usually being present on leaves six to ten. After the tenth leaf the numbers fell sharply due to the depletion of nutrients. Under population stress the infestations diminish on the lower older leaves and the mites move upward onto the younger leaves.

Biology

The biology of *M. tanajoa* was studied by confining individual mites in microcages on leaves of potted plants in the greenhouse. A microcage was constructed by placing a thin plastic ring (6 mm inner diameter) on the ventral surface of a leaf. After introducing a mite into the ring the microcage was closed by placing a plastic coverslip over it. A second coverslip was placed on the dorsal surface of the leaf immediately above the ring and this coverslip as well as the microcage was held in place by an ordinary hair curler clip. As, during the initial trials, some mites escaped due to the uneven surfaces of the ring or leaf, rings of the same diameter made from a thin sheet of synthetic sponge were placed below and above the plastic one. Observations of activities within the cages were made with the aid of a 10x or a 20x magnifying glass.

Studies on the biology of the mite were carried out in June, i.e. towards the end of dry season when the prevailing temperatures ranged between 28 - 31°C and again in December - January towards the end of the wet season when the temperatures ranged from 25 - 28°C.

During June the preoviposition period lasted for one day. Females individually confined in microcages laid 14 - 16 eggs in four days (data on six females). The egg, larval, protonymphal and deutonymphal stages lasted three, one, one and two days respectively. Each active stage is followed by a quiescent period, lasting less than a day, before the mite moults to the next stage. Hence, the total egg to adult developmental period lasted nine to ten days. Adults lived up to 12 days.

TABLE 1. Effect of plant age on levels of infestation

Date		Locality	No. of leaves/sample			Plant category and mites					
			Small	Young	Old	Small		Young		Old	
						Eggs	Active	Eggs	Active	Eggs	Active
April	5	Aranguez	30	10	10	1,127	336	5,642	3,222	1,274	658
	16	Centeno	50	-	-	918	351	-	-	-	-
	18	St. Mary's Junction	30	-	-	692	209	-	-	-	-
	18	McBean	20	20	20	963	282	8,117	3,546	3,281	843
	18	Debe	20	20	20	1,178	791	13,645	4,497	1,523	731
			Av./leaf			33	13	566	225	118	45

During December - January, the preoviposition period lasted one to two days and the females laid 10 - 16 eggs in six to eight days (data on 12 females). The egg, larval, protonymphal and deutonymphal stages lasted four, one, two and two days respectively. Each quiescent stage lasted about a day and the total egg to adult period was compelted in 12 - 13 days. Adult females lived up to 16 days.

In the field the eggs are laid on the sides of the mid-rib or other veins or in concavities on the lower surface of the leaf. The majority of the eggs are laid on the basal half of the leaf.

Dispersal

Several Tetranychids are known to disperse under the influence of wind (see review article by Van de Vrie, McMurtry and Huffaker, 1972). On cassava plants in the laboratory grounds mites frequently suspended themselves on silken threads and were carried away by wind currents. This activity usually occurred during hot calm periods of the day between 9.00 to 10.00 a.m. and 3.00 to 4.00 p.m., when the wind speed is below 5 m.p.h. The mite was not only moved from one plant to another by this means but also from the lower to the upper leaves of the same plant.

To study the extent of wind movement in greater detail a grid of sticky traps was set up in cassava plots situated at the Agricultural Farm, Maracas Valley. The plot, 200 m long from north to south and about 50 m wide from east to west, was planted with cassava variety "Maracas black stick", plants of different ages being present. While the older cassava plants in the northern section were attached, with a moderate density population of mites being present when observations commenced those in the central and southern sections were younger and still free from attack. The prevailing wind in the valley was from the north-east.

Each trap consisted of a plastic cup about 9 cm in diameter and 7 cm in depth fastened to a wooden stake. The lid of the cup was nailed onto the top of the stake so that the body of the trap could be removed and replaced readily. The sides of the trap were marked with wax caryon to form four equal quadrants and then covered by a strip of wax paper coated with a thin layer of "Stickum Special". The trap was then fastened to its lid, each quadrant facing a cardinal compass direction, i.e. East, West, North or South. A portion of the stake was also coated with a layer of stickum to prevent mites or insects from reaching the traps by crawling up the stakes. The traps were replaced weekly or fortnightly and the sticky strips of wax paper from the exposed cups were cut into four equal sections representing the cardinal compass points. To remove the mites and insects the strips were dipped in a solvent to dissolve the stickum. The arthropods obtained were preserved in 70% alcohol for identification and counting.

Thirty sticky traps were set up on May 1 in three rows each containing ten equidistantly placed traps from east to west. The first or northern row was located one meter south of the southern-most infested trees in the northern section. The second, or central, row was 50 meters to the south of the first row and the third or southern row was 50 meters south of the second row. Samples of leaves from five plants from within one meter to the south and from five plants within one meter to the north of each row of traps were taken to attempt to correlate the levels of infestation with the numbers captured on the traps. The data obtained are given in Table 2.

TABLE 2. Mites captured on sticky traps compared with those on neighbouring plants, Maracas Valley, May - July, 1974.

Date	Total mites on traps												Females/leaf					
	Row 1				Row 2				Row 3				Row 1		Row 2		Row 3	
	E	W	N	S	E	W	N	S	E	W	N	S	N	S	N	S	N	S
May 1	-	-	-	-	-	-	-	-	-	-	-	-	9	-	-	-	-	-
9	2	-	3	-	-	-	-	-	-	-	-	-	11	5	-	-	-	-
22	11	2	15	1	-	-	-	-	-	-	-	-	16	3	-	-	-	-
June 7	7	2	17	-	3	-	5	-	-	-	-	-	12	7	7	7	-	-
21	2	-	7	1	5	-	8	-	-	-	-	-	16	15	11	8	-	-
July 4	-	-	5	-	6	1	3	-	-	-	-	-	9	12	10	12	-	-
16	2	-	1	-	-	-	5	-	-	-	-	-	7	9	8	11	-	-
23	1	-	3	-	2	-	2	-	1	6	-	-	6	5	5	7	8	5

As can be seen from Table 2, the spread of the mite extended gradually through the plots in the direction of the wind and most of the mites were captured on the windward (northern and eastern) sectors of the traps and very few on the leeward. On the whole the general level of infestation remained very low, especially during the wet season in

July; however, the observations indicated a correlation between the numbers of mites trapped and those on the cassava plants.

Population studies

Initially the sampling techniques of Nyiira (1972) were adopted but when it was found that the greatest numbers of the mite were concentrated on leaves six to ten (measured from the newest leaf), only these leaves were sampled. Counts made on four varieties of cassava are presented in Table 3.

TABLE 3. Counts of Mononychellus on four varieties of cassava based on mean numbers on leaves six to ten (monthly rainfall, in inches, in brackets).

Locality	Variety	May	June	July	Aug.	Sept.
Debe	Whitestick	2,474 (2.04)	2,784 (2.33)	1,130 (8.67)	1,123 (7.86)	403 (4.82)
McBean	Butterstick	918 (2.04)	701 (2.33)	553 (7.67)	209 (7.86)	46 (4.82)
Manzanilla	Brownstick	487 (2.85)	562 (3.36)	632 (15.85)	47 (11.20)	17 (8.31)
Maracas Valley	Maracas Blackstick	148 (2.19)	281 (3.63)	237 (8.96)	33 (10.96)	14 (5.53)

These data suggest differences in population density on different varieties of cassava. However, as these four varieties were sampled from readily available fields located in separate areas with varied amounts of rainfall, the data are not conclusive. Accordingly, a plot with ten varieties of cassava has now been set up and mite populations are being monitored regularly.

Several factors, e.g. age of the plant, its physiological condition, temperature, rainfall and natural enemies are involved in regulating mite populations. In Trinidad, rainfall was found to be the factor which most drastically affected the numbers of the mite. While light showers are not particularly detrimental sustained heavy rains rapidly reduce mite populations.

Natural enemies

The natural enemies encountered in Trinidad during the first year were *Oligota minuta* Cam. (Staphylinidae), an as yet unidentified thrips (Thysanoptera), a Cecidomyiid, two unidentified Coccinellids and two Phytoseiid mites, *Typhlodromalus limonicus* (Garman and McGregor) and *T. rapax* De Leon.

(a) *Oligota minuta*

O. minuta was the dominant and most widespread predator. Both larvae and adult prey on all stages of the mite.

To assess seasonal abundance and correlation with host density, counts of *Oligota* were made at two sites, Mohess Road and Manzanilla, from May until September by sampling leaves 1 - 15 on 5 plants. Counts were then discontinued because the host mites were scarce and *Oligota* disappeared. The data are tabulated in Table 4.

The distribution of predators on leaves 1 - 15 based on data from these counts is summarised in Fig. 1. There is a good correlation between mite and predator distributions, i.e. the high concentration of predators on leaves 6 - 10 coincides with the higher mite population on these leaves. The relationship between the predator and the host numbers is shown in Fig. 2.

Counts were also made to determine the incidence of adults of *O. minuta* on cassava plants at different periods of the day. This was undertaken so that counts taken elsewhere during brief visits, possibly at different times of the day could, if necessary, be corrected to compare with counts taken in Trinidad. Counts were made during three 1½ hour periods in a patch of cassava (variety Whitestick) at Debe on August 7, 1974 (Table 5).

Additional data must be accumulated before definite conclusions can be drawn but these results, supported by other observations, suggest that *Oligota* adults are more abundant in the early part of the morning.

(b) Phytoseiids

The Phytoseiids *Typhlodromalus limonicus* and *T. rapax* are also important predators of *Monomychellus*. Both were abundant in late June but during the wet season, with the decline of *Monomychellus*, there was a related reduction in the numbers of the predators.

TABLE 4. Seasonal abundance of *Oligota* on cassava plants at Mohess Road and Manzanilla.

Locality	Date	No. of plants	No of leaves	*Oligota* Larvae	*Oligota* Adults	Density of mite infestation	Weather
Mohess Road	May 2	5	75	71	35	Heavy	Dry
	15	"	"	88	32	"	"
	31	"	"	57	18	"	"
	June 26	"	"	46	27	"	"
	July 10	"	"	41	34	"	"
	25	"	"	29	19	Medium	Rainy
	Aug. 7	"	"	14	15	"	"
	27	"	"	–	2	Low	
	Sept. 16	"	"	–	–	Very low	"
Manzanilla	May 29	"	"	17	11	Medium	Dry
	June 6	"	"	23	21	"	"
	July 18	"	"	21	18	"	Rainy
	Aug. 8	"	"	–	7	Low	"
	20	"	"	–	–	Very low	"
	Sept. 9	"	"	–	–	"	"

TABLE 5. Relative abundance of *Oligota minuta* during different periods of the day

Time	*Oligota* adults	Temperature	R. H.
9.00 - 10.30 a.m.	134	86°C	78%
1.00 - 2.30 p.m.	125	88°C	62%
4.00 - 5.30 p.m.	93	82°C	76%

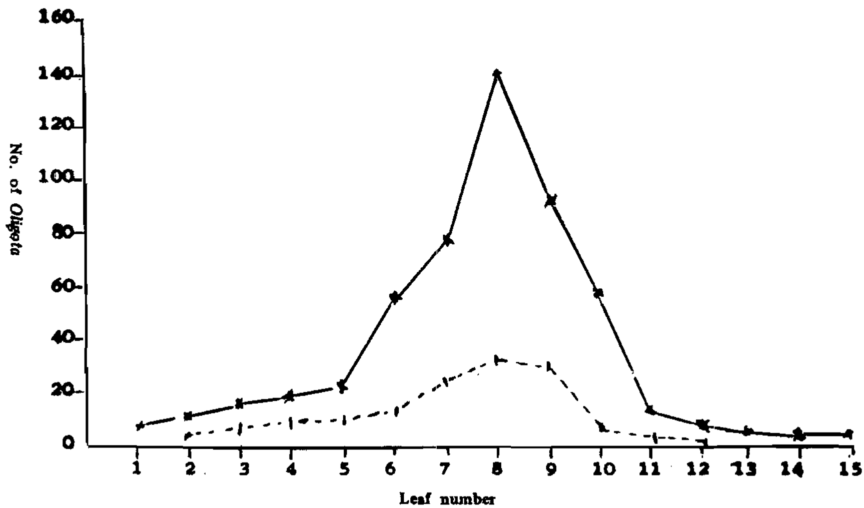

Fig. 1. Distribution of *Oligota* on leaves 1-15 of cassava plants at Manzanilla (----, and Debe (______)

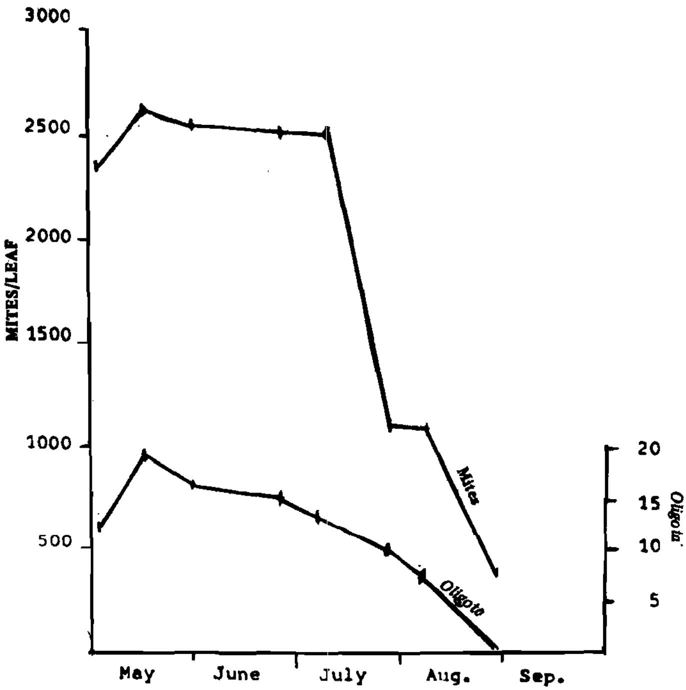

Fig. 2. Predator-prey relationship between *Oligota* and *Mononychellus*

(c) Unidentified thrips

The larvae of a thrips feed on both the eggs and the active stages of *Mononychellus*. The habits of the thrips have not yet been investigated in detail although predation continues when nymphs are confined to cages.

(d) Unidentified Cecidomyiid

This species occurs sporadically when populations are high but it has also been found with low density mite populations.

(e) Coccinellids

The two Coccinellids (identifications pending) are probably casual predators, their main hosts being coccids and/or aphids. Their role as mite predators has not been studied in detail to date.

In addition to *O. minuta* and *T. limonicus*, two other species of *Oligota* and a predaceous mite *Euseius hibisci* (Chant) (Phytoseiidae) have been encountered preying on Tetranychid mites infesting cassava during the present surveys outside Trinidad (F.D. Bennett, pers. commun.).

Acaricide treatment

During January 1975, when the activity of *Mononychellus* was generally very low elsewhere, unusually heavy attacks were occurring in a large experimental cassava plot at the Field Station of the University of the West Indies. This field has been routinely treated with a preparation of the acaricide Galecron at the rate 2.2 g/gal. every three to four weeks. To determine the effect of the treatment on the mite populations and on predator activity counts were made one day before and again ten days after treatment with the acaricide. Samples were also taken from a nearby untreated plot. The results of counts made before and after treatments in January and February are given in Table 6.

The preliminary results suggest that while the populations of the mite are reduced initially they build up again fairly rapidly but the predators do not reappear during the first ten days after treatment, whereas in the untreated plot where the environment of the mite was not distrubed both the mite and the predator populations remained fairly stable. Investigations are still in progress and final conclusions will be drawn after obtaining fruther data.

TABLE 6. Effect of treatment with the acaricide Galecron on *M. tanajoa* and its predators (based on mean of leaves 6 - 10).

	Treated				Untreated			
	Before treatment		10 days after		Before		10 days after	
Date	Mites	Predators	Mites	Predators	Mites	Preadators	Mites	Preadators
Jan.	286	0.8 *Oligota* larva	91	Nil	102	0.6 *Typhlodromalus*	86	0.9 *Typhlodromalus*
		1.2 *Typhlodromalus*						
Feb.	227	0.7 *Typhlodromalus*	89	Nil	78	0.5 *Typhlodromalus*	96	0.6 *Typhlodromalus*
		0.1 *Cecidomyiid*						

Discussion

The initial surveys of the cassava mites and natural enemies carried out in Trinidad suggest that natural enemies of *M. tanajoa* and related mites are of sufficient importance to merit introduction into East Africa. Of the predators, *O. minuta* seems to be the most important especially when dense host populations occur during the dry season. An unidentified species of this genus already occurs in Uganda. While there is no assurance that the Neotropical species will be a more effective predator the fact that it has a longer association with cassava mites than its African counterpart suggests that it may be better adapted to the microhabitats supplied by the cassava plant.

Both the Phytoseiid mite predators *T. limonicus* and *T. rapax* merit further investigations.

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