Insects and mites attacking Cassava, Manihot esculenta Crantz (Fam. Euphorbiaceae)

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INTRODUCTION

Cassava, the major food for over 300 million people, is grown throughout the tropical regions of the world. It is a crop reproduced vegetatively whose roots are high in starch content and contain little protein . The roots are used for human consumption as well as for industrial purposes It is a crop grown mainly by the small farmer in developing countries and therefore it is difficult to estimate actual yields and areas under cultivation. FAO estimates indicate annual global production of 98 million tons, of which 55 million tons are consumed by humans In many parts of the world, especially West Africa, Cassava appears to be the most economical subsistance crop available to the small farmer.

In recent years, the ever-increasing world population and the limited availability of energy, has prompted a surge in interest in Cassava production The international centers for tropical agriculture in Colombia (CIAT) and Nigeria (IITA) now give priority to cassava in their research programs Cassava yields, under farm conditions are reported as averaging only 5 to 15 tons/ha Under experimental conditions yields as high as 70 tons/ha have been claimed in the Malagary Republic, 47 tons in Colombia, and 34 tons in Brazil (Nestel 1974) Under commercial conditons, yields as high as 40 tons/ha have been

claimed in Colombia. These figures indicate that there are undoubted several limiting factors in attaining consistantly high yields under farm conditions.

It is consistantly reported in the literature that cassava is generally free of insect pest and diseases. Recent studies have shown that cassava suffers from a wide variety of diseases caused by bacteria, viruses and fungi which were reviewed by (Lozano and Booth 1974) that reduce yields. Present research at the International Centers (CIAT and IITA), as well as investigations being realized by various other organizations, is showing that insect pest are also a limiting factor in Cassava production The recent introduction, and consequent outbreak, of the mite Mononychellus tanajoa in West Africa, has caused serious crop losses (Leon 1971). This is ample evidence for the need for extensive research of cassava insect pests, their geographic distribution and potential damage to the crop and the need of strict quarentine measures

There is a limited amount of information on cassava pests available in the literature and what is available is scattered througnout numerous journals and monographs and difficult to collect CIAT is attempting to collect all of tne world literature on cassava and making this available to researchers It is therefore now possible to get a global view of

of cassava pests problems and direct research into those areas of potential damages

Cassava is essentially a crop of warm humid environments which are also conducive to the survival and proliferation of insects. The literature reveals that there are numerous insects that attack cassava and that several of these limit production. These pests represent a wide range of insect fauna and more than 100 species are recorded as attacking cassava Many of these are minor pests and cause l ttle or no economic losses. However several can cause considerable croplosses and must be classified as major pests These include mites, thrips, stemborers, whiteflies, hornworms, scale insects and shootflies.

Many pest outbreaks on cassava appear to occur sporadically or in very localized areas It is therefore difficult to find qualitative measurements of croplosses and this information is greatly lacking in the literature. Also very few statements made in the literature are accompanied by research data.

This review attempts to discuss all of the insect pests of cassava that are reported in the literature available. Emphasis is given to those pests of major importance

MITES

Mites are generally a pest in the dry season. They live on the leaf undersides and can be found in great numbers when environmental conditions are optimal. There are several species that can cause severe damage to cassava. These are listed in Table 1.

Biology

Tetranychus damage shows as yellow dots on leaves, eventually spreading and turning leaves reddish or rusty in color. Leaves severely infested dry and drop, beginning with the basal leaves and under severe attack the plants may die. In the wet season the attack of T bimaculatus deminishes During this period, mites attacked by a fungus were found (2132). Infestations can spread via wind on dropped leaves, active crawling, via the clothes of man or by animals. No direct spread via wind or stakes was observed (2132) Eggs hatch in 5 days and larvae mature in 10-11 days. Each female lays 50 eggs during a 5 day period (2132) Generally Tetranychus attack older leaves while Mononychellus attack younger leaves

Mononychellus damage shows as blotching and bronzing of leaves, leaf distortion and ultimately leaf drop and stunted plants. Bondar, 1938, states that it resembles thrips damage It is an old cassava pest known allready by the Brasilian Indians, who colled it tanajoa (=disease). This mite species mainly

Table 1. Mites of Cassava

Name	Syn.	A ternate hosts	Distribution	Reference
Tetranychus urticae Koch.			Brasil, Uganda	Flechtmann, 1970 Nyiire,pers comm
T. bimaculatus Harvey		Castor beans, cotton, beans, wheat and others.	Colombia, Venezuela, Cuba, Madagaskar, Indonesia	205, 228, 608, 797, 2132.
T. cinnabarinus			Uganda	Nyiire pers.comm.
T. telarius			Brasil, India, Malaysia, Uganda,	604, 1754, 3112, Nyiire pers comm
T. tumidus and T. sp.			Mexico	Bennett 1975.
T. sp			Zanzibar, Peru	226, 583
Mononychellus planki(McG)	Tetranychus planki Eotetranychus planki Mononychus planki		Colombia, Brasil, Venezuela.	205, 511, 765, Paschoal, 1971
Mononychellus tanajoa (Bondar)	Tetranychus tanajoa Mononychus tanajoa	Manihot species	Brasil, Colombia, East Africa.	1543, CIAT 1973, 2879, 2372. Nyiire,pers.comm
Mononychellus bondari			Brasil	2879
Mononychellus mcgregori (McG)	Eotetranychus mcgregori		Colombia	CIAT, 1974
Mononychellus chaemosetosus			Brasil	2879
Mononychellus caribbeanae (McG)	Eotetranychus caribbeanae		Venezuela, Brasil, Caribean Islands	Quiroz, 1974. Paschoal, 1971
Oligonychus peruvianus			Colombia	CIAT, 1973
Oligonychus gossypii Zacher	Paratetranychus gossyp i		Brasil	Flechtmann, 197C
Oligonychus sp			Uganda	Nyiira,pers.comm
Bryobria sp			Rep. Dominicana	795

lives in the bud and on expanding leaves, and young stems. It attacks mainly in the dry season, and heavy rains reduce the attack.Losses of 20-40% are suspected (2879). M. tanajoa attacks in Brasil occur from Nov-April, especially in areas with poor soil fertility (3207) Damage results in death of the growing points and causing excessive branching (765) Some reports state that oviposition occurs mainly on the basal leaves, causing the most damage there (2372) Highest mite counts were made on upper parts of plants on leaves 6 10 and on older plants up to 8 months old. Nyiire (pers.comm) found highest mite populations on leaves 5-7. Bennett (1975) gives the following report on the biology of M tanajoa

Preoviposition time lasts 1 day, while 1-3 days is reported by Nyiire, 1973 . Females, in cage tests oviposite 14-16 eggs in 4 days or about 3,5 eggs per female per day, while Nyiire, (1973,) reported a total of 35-111 eggs per female The egg, larval, protonymphal and deutonymphal periods lasted for 3,1,1 and 2 days respectively From egg to adult is 9-10 days, and adults can live up to 12 days In Uganda they are reported living for 30 days (Nyiire, 1973) Eggs are laid along midrib or other veins or in concavities in the leaf Most eggs are laid on the basal half of the leaf Eggs hatch in 5 1 days at a mean temp of 22°C and in 4 days at 32°C

Light rains had little effect on populations, but heavy rains greatly reduced populations. Mite dispersal was most active on hot days between the hours of 9 to 10 am and 3 to 4 pm The mites migrated from plant to plant via silken threads in light winds. Migration was primarily in the direction of the prevailing winds (Bennett, 1975).

Nyiire (pers.comm.) stated that light winds and temperatures around 25°C between 9-11 am and 4-5 pm, are optimal conditions for dispersal However dispersal via man or animals is also important. Optimal RH for development is around 60% and a temperature of 28°C - 32°C. Nyiire, 1973, states that dry periods, new leaf growth and a high quantity of chlorophyl enhance mite populations There was no significant correlation between mite populations and leafnutrient (N, P, K, Mg and Ca) content.

Oligonychus peruvianus damage shows as white dots of web-bing along leaf veins and margins, under which the adult female places her eggs. These locations show later as brown dots on leaf upper and under surfaces (CIAT, 1973).

Chemical control

Bidrin (0,5 kg/ha) and Roxion (0.25 kg/ha) gave good mite control, while kelthane at 0.6 kg/ha was unsatisfactory, (115) Additional recommendations are

Kelthane 1 5 - 2 l/ha

Tedion 2-2.5 l/ha

Acricid 1.5 - 2 l/ha

Elosal 200-300 g/100 l water (205)

For control of M tanajoa bests results were obtained with phosalone at 0.07%, followed by Diazinon (0 08%) and Chlorobenzilate (0.05%). Dithane M-45 also gave satisfactory results (1543) Applications every 10 - 14 days of dicafol or chlorobenzilate is effective (2879) Fundal, monocrotophos, dicrothophos, and dimethoate were also effective. Lannate and kelthane were ineffective (511). Nyiire (1973) states that kelthane and roger are effective Good control of M caribbeanae was obtained with chlordimeforn, EC 50 at 0 5 l/ha with a long residual effect, followed by kelthane EC 18.5% at 2 l/ha. (Quiroz, 1974)

Tetranychus telarius control

Monthly sprays with monocrotophos 0.03% is most effective, followed by formothion 0 1% The least effective was chlorfenvinphos, granular by applied to the soil (1754) In another trial 5 applications were made at monthly intervals Best results were obtained with dimetoate (0 05%) (1755) Other control methods are sulphur dusts of 5% and sulphur and lime with soap added. (1785).

Biological control

In Madagaskar Stethorus sp (Coccinellidae) is reported

tc predate Tetranychus sp. (608). It is also present in Trinidad (Bennett, pers. comm) and Uganda (Nyiire,pers.comm.) In Indonesia several ladybeetles as predators of T. bimaculatus are reported These include.

Coccinella sp , Chilomenes, Verania and Chilocorus sp.

Staphilinidae predators were also observed,as well as predacious mites The unidentified predator mite predated eggs, larvae, and adults. It can consume 53 eggs and 8 adults in 9 days. During this period the predator mite laid 15 eggs These eggs hatch in 2-3 days and larvae mature in 4-6 days. The predator could not halt the increase in parasitic mite population. This predator seems to prefer wet season conditions while the prey mite prefers the dry season (2132) From Indonesia the predator mite Amblyseius longispinosus (Evans), is reported, (Denmark after Bennett, pers. comm) Other phytoseiid predator mites are Euseius hibisci (Chant) from the Bahamas and Typhlodromalus limonicus from Trinidad and Mexico, (Bennett, 1974)

Coccinellid larvae consumed 127 eggs and 38 adults per day per larva Releases of 150,000 and 181,000 coccinellid adults, in wind and windless conditions resulted in no increase of coccinellid populations (2132)

From Trinidad Oligota minuta is reported (Staphilinidae) and an Oligota sp. from Colombia and Uganda. In Trinidad it is

the principal mite predator Other natural enemies found there are thrips, a Cecidomyiid, Coccinellids, and the predatory mites Typhlodormalus lironicus and T rapax (Bennett, pers. comm),

Both larvae and adults of O. minuta predate on mites Up to 88 larvae and 32 adults were found per 75 leaf samples from 5 plants (Nyiire found up to 394 adults per 150 leaves) Highest population occurred on leaf 6-10, coinciding with highest mite populations. Nyiire (1973), reports that the highest counts were made on leaves 5 to 8 in the morning hours. The predator mites were less aboundant in the wet season with low prey mite populations. Thrips feed on both eggs and active mite stages After insecticiadal [illegible] with Galecron mite populations rapidly reappeared, however the predators lag in build up of their population (Bennett, 1975)

From Uganda additionally reported are Stethorus sp , Syphus sp , Chrysopa sp and Orius sp (Anthocoridae), Nyiire, 1973

Cultural Control

Strict quarantaine is most important as seen from the disastrous results of the introduction of the M tanajoa into Uganda around 1970 First outbreak was reported in Uganda in 1971 in the dry season The mite has allready crossed lake Victoria, and into Kenya (Nestel, pers comm).

Sticky material around plant stems may prevent some infest-

ation (2132) Leaf clipping and burning (5 times in 2 months) to control mites in Indonesia resulted in heavy yield losses It may be effective to reduce the earlier infestations. It is recommended to avoid growing cassava in areas with prolonyed dry seasons. In addition it is recommended to separate large fielcs with other crops which are non hosts of mites to reduce spread of infestations (2132)

Removal and destruction of infested tips as infestations of Mononychellus are concentrated there is recommended (2879)

Resistance

The following varietal resistance has been observed.

Clones H 3641, showed 40% T. telarius incidence compared with clone M-4 showing 89 3%, (1754) In another trial H 97 showed 39 1% mite incidence (1755). In Brazil 41 clones were found with some resistance to Mononychellus sp and Tetranychus sp. This was the second evaluation, in the first 45 clones were found, 4 appeared to be escapes (3207) In Venezuela 25 varieties were evaluated for M planki resistance No immunity was found Resistance was based on defoliation grade (1-10) and on degree of sprouting of sidebuds, (1-10) Both are not similar in all varieties. Three varieties UCV 2103, 2110, and 2125 showed grade 3, 4 or 5 for sprouting and were classified as resistant (765) Bennett (1975), in preliminary studies observed large differences

in population levels on different varieties This was also reported by Nyiire (1972) Most resistant varieties were Kru, 46 301-15 and K-Kawanda He counter during a heavy mite attack about 3 times as many leaves on tolerant varieties as compared with the susceptible varieties. And leaves developed on susceptible varieties about 4 times slower compared with the resistant varieties Rootyield on the resistant varieties was about twice that of the susceptible varieties

THRIPS

Distribution

Thrips are a cassava pest in South and Central America, and are reported as present on cassava in Africa in Zanzibar (366) and Uganda (Nyiire, pers comm.) All reported species belong to the Family Thripidae. (Table 2)

Table 2. Thrips reported on cassava.

Species	Alternate hosts	Distribution	Reference
Corynothrips stenopterus Williams		Surinam, Colombia,	67, 1583
Euthrips manihoti		Brasil	56
Scirtothrips manihoti Bondar		Brasil	604
Frankliniella williamsi Hood		Colombia	CIAT,1974
Frankliniella sp	Amaranthus spinosus, cotton	Colombia, Mexico	3319, 1583,3013.

Damage Symptoms

Leaves do not develop well, leaflets are deformed, and show irregular chlorotic yellow spots. These spots are imperfectly developed leaftissue, due to stylet damage. Tension during expansion causes deformation and distortion of the leaves, with parts of leaflobes missing Brown wound tissue appears on the stems and petioles Leaves expand poorly, internodes remain shortened, the growing points may die and cause vigorous growth

of lateral buds. These may also be attacked and give the plants a witchesbroom like appearance (232, 1583, 3013). Symptoms are somewhat similar to certain symptoms of witchesbroom disease or mosaic disease symptoms (3013) (604).

Biology

Very little information is reported on the biology of thrips in cassava Larvae and adults of Euthrips manihoti and most other species live in the growing points and on the young leaves where they extract sap from unexpanded leaves (230,. Adult thrips can also be found on older leaves C. masculinus is found mainly on expanded leaves of young plants (CIAT, 1973)

Ecology

Thrips occurs as a pest mainly in the dry season, during the wet season plants recover (232).

Damage

It is reported that thrips can cause a 15% root yield reduction (3013) but losses may be greater where there is extensive foliar reduction

Control

Plant resistance High levels of resistance were found among the CIAT germplasm bank of 2200 clones to Frankliniella sp and Corynothrips stenopterus. Approx 20% of the clones showed no damage symptoms Thrips were encountered on all cultivars

No relationship was found between thrips damage and leafcyanide content But increasing hairyness of young leaves increased thrips resistance (1583). High levels of resistance were also reported against Franklıniella sp. (3319)

Cultural

Farmers break off growing points to stimulate new shoots, but these will be attacked too and therefore this practice is discouraged (56) Cutting weeds is recommended, esp. Amaranthus (230)

Biological

Thrips are reportedly controlled by Entomopthera in Trinidad (232).

Chemical

Treating stakes in a tobacco extract (230) or using 125-150 cm^3/ 100 lt. water of nicotine sulfate as a steak treatment for 15 minutes is recommended for control (783) However this cannot be effective in view of tne biology of thrips Best control was obtained by systemic insecticides because of their longer residual effect in the growing points· Roxion E 38 (160 cc a.i./ha) and thiometon E 25 (113 cc a.i./ha), metasystox E 25 (175 cc a.i /ha) Sevin (1 kg a.i./ha) malathion (450 cc a.i /ha) and dipterex (420 gr a.i./ha) as foliar sprays also gave effective control. (3319).

WHITEFLIES

Whiteflies (Fam. Aleyrodidae) are distributed over the cassava growing areas of South and Central America, Caribbean, Africa, including Madagaskar and India They are vectors of the cassava mosaic disease, (2494) reviewed by Lozano and Booth (3136). No direct damage due to feeding is suspected. The only damage is the transmission of mosaic disease in Africa and India. Fungal growth on whitefly excretions can be damaging

Species reported in the literature are listed in Table 5.

Table 5. Whiteflies reported on Cassava

Name	Alternate hosts	Distribution	Reference
Trialeurodes variabilis (Quaint)		Brasil, Colombia	604,205
T manihot Bondar		Brasil	604
Aleurotrachelus sp		Colombia	205
Bemisia manihotis Frappa		Madagaskar	2297,2296
B nigeriensis Crob *	rubber, M glaziovii, Euphorbia heterophylla	Nigeria	229, 1830
B gossypiperda		Sudan	3009
B. tuberculata Bondar		Brasil	604
B. tabaci		Brasil, India Colombia, Nicaragua	604, 1754 205, 744
Aleurotnrixus aepim Goeldi		Brasil	605, 1774
Asterochiton manihoti Bondar		Brasil	1774

* B nigeriensis may be synonym to B gossypiperda (3009)

Biology

B. nigeriensis. Eggs are laid on young leaves on the underside on a pedicel, usually in a circle The newly hatched larvae are mobile but legs and antennae are lost after the first molt, giving them a scale-like appearance Adults are almost only found on developing leaves (219). Adults emerge in the morning hours and become more active at increasing light intensity, so that at noon less adults are found per plant than in the morning. Adults are attracted to yellow paint, and more adults and pupae were found in plants with yellow petioles than on those with darker petioles (1895).

Populations in Nigeria were highest from mid August to the end March, with evidence that heavy rains destroyed many adults (229). In Brazil they are most important in the rainy summer (646). In the rainy season plants are more vigorous and giving more young tissue for the adults to feed on Adults were observed to live for 10-12 days but most died in 4-5 days

Control

Chemical

Chemical control of B. tabaci after 6 treatments at montly intervals was most effective with dimethoate 0.03% and monocrotophos E.C. 0 03% These also showed lowest pupal counts However their control was not correlated with mosaic disease incidence (1754)

In a subsequent study whitefly population and disease incidence was lowest following 6 treatments at monthly intervals with dimethoate 0.03% and endrin 0.03% (1755)

Other recommendations are

Diostop 50 E. 250-400 cc/ha

Metasystox 400-600 cc/ha

Dimecron 50 E 250-400 cc/ha (205).

Cultural

It is suggested to rotate cassava with maiz to avoid whitefly problems

Resistance

A great varietal difference in number of whiteflies adults and inmature stages per leaf was found with the lowest populations being on varieties Ibadan (19) Sierra Leone (69) and Trinidad (75) Most varieties with low adult populations also had low inmature counts of B. nigeriensis. The varieties with lowest whitefly counts were also least infested with mosaic (229) A strong adult non preference was observed for the resistant varieties, but it was concluded that absence of mosaic was not due to insect resistance. It appears that bitter varieties with green petioles are most resistant (229)

Biological control

Coccinellids Serangium cinctum Wse predates larvae and

pupae. Mites Typholodromite sp. feeds on adults, reducing populations. Hymenoptera. Prospaltella sp. (Encyrtidae) parasites whiteflies. About 12.3% is parasitised.

SHOOTFLIES

Several species of Dipterons attack the growing points of the cassava plants. Silba pendula and Lonchaea chalybea both fam. Lonchaeidae, are the most important species (Table 6). However recent findings at CIAT indicate that Anastrepha sp. may also be important as a shootborer. This species will be reviewed with the fruit attacking insects.

S. pendula is found in various fruits (Table 6), where it occurs as a secondary pest. In many cases attack in these fruits follows previous attack of Anastrepha sp. or other fruit-flies. S. pendula uses their damage to oviposit in the fruits In each lesion it places one egg, up to 4 mm deep. However each lesion may be visited by several females (1710) Korytkowski (1971) lists a number of fruits previously attacked by Anastrepha sp. or Scrobipalpula sp. from which S. pendula was collected. He opened the possibility that S. pendula attack in cassava might by secondary to Anastrepha attack However in our experiences in CIAT these flies attack cassava at different sites in the growing point and each may occur as a primary pest (See also 1710)

Biology of L. chalybea and S. pendula

The adult fly is active in the daytime, especially on sunny days. It places its eggs between the unexpanded leaves in the growing points. However it is reported also that eggs are put in

Table 6. Shootflies in Cassava

Species	Synonyms	Host plants	Distribution	References
Silba pendula	Carpolonchaea pendula	Mammea americana	Central and South America	227, Korytkowski 1971
	Lonchaea pendula	Mangifera indica		1710, 744, 777 234
		Inga feuillei		
	Lonchaea batesi	Eugenia sp.		3013, 585, 646,
		Capsicum frutescens		
	Lonchaea aenea	Citrus sp.		3011, CIAT'73
	Lonchaea glaberrina	Others		
Lonchaea chalybea			Central and South America	147, 228, 227, 232, 233, 404, 452, 2448, 3011
Silba perezi			Puerto Rico	391
Antherigona excisa			Brasil	3011, 538
Euxesta eluta			Brasil	3011
Phaonia sp. (Muscidae)			Nicaragua	744

a small cavity made by the ovipositor in the tissue, from which it protrudes about three fourth (1710). Up to 22 eggs per shoot were encountered but 3-8 per shoot is more common (228).

The eggs hatch in about 4 days and the young larvae tunnel in the soft tissue, eventually killing the growing point In some cases only part of the tip is killed. The shoot continues to grow and leaves on one side of the stem are damaged. The larval presence causes the formation of a whitish exudate, which, it is stated gives protection against parasites and insecticides (228) The larvae are fullgrown in about 23 days when they leave the growing points and enter into the soil to pupate Approximately 26 days later the adult fly emerges (232).

The mortality of the shoots break the apical dominance of the cassava plant and causes sidebuds to germinate. This causes symptoms similar to witches broom disease, but can be easily distinguished (3013). Under successive intensive attacks the plants can remain stunted

Although damage can sometimes be severe, in Cuba 5 month old plants had up to 86% of the shoots affected (228). No yield reduction due to shootfly attacks are reported in the literature Artificial shootremoval up to 100%, to simulate shootfly attack, at periodic intervals did not reduce the rootyield (CIAT, 1974)

Ecology

It is generally stated that younger plants are more attacked

than older plants (3011, 232). In Brasil the most severe attack occurs from Nov. - December (602) or from December - January (3011) and in Cuba from September - December (228) while in other areas the attack occurs throughout the year (2448). It is also reported that most severe attacks occur in the beginning of the rainy season (232).

Control

Cultural Practices.

Various cultural practices may have an effect on shootfly populations. Destruction of infested shoots at weekly intervals is often recommended (3011, 1710). This however may not reduce the population as there are several other hosts. Planting dates can be adjusted sc as that the younger growing stage is passed in the period of low shootfly populations (3011).

Resistance

Distinct difference in susceptibility of cassava varieties has been observed (646) (744). In Guadeloupe the varieties Petit Bel Air 4, Rais Blanc, Campestre 10, and Isabela 9 were the most resistant to L. Chalybea (2448)

Chemical

Larvae are generally difficult to control Ekatin (744) azodrin and nuvacron at 0.5 - 0 7 l/ha or basudin and malathion at 10-1 5 l/ha during early attacks are recommended (205) DDT 50% at 3 kg/ha may (2448) or may not be effective (2186). Dieldrin

50% at 200 X g/100 l. water mixed with 5 kg sugar sprayed on the plants is also listed as a bait formula to control the adults. (744). Fly traps with baits (decomposing fruits, casein, or yeast with insecticides) for adult control is also suggested (234) (1710).

Biological control

S. pendula and other dipterous larvae in fruits are predated by Belonuchus formosus (Fam Staphylinidae), however these larvae were never found in cassava attacked by the shootflies (1710).

CASSAVA STEMBORERS

Numerous insect species have been reported as feeding on and damaging stems and branches of the cassava plant. Although nearly world wide in distribution, they appear to be of particular importance in the Americas and more specifically in Brasil They are generally considered as causing sporadic or localized damage and none could be classified as an universal pest.

The literature available reveals that approximately 37 species are described as stemborers on cassava. For many of these there is little information available other than the report that they were observed feeding on or boring into cassava stems. All species are Coleopterous Lepidopterous, or Hymenopterous The dipteran species described earlier, Anastrepha sp. and Silba sp are not classified here as stemborers The stemborers appear to be highly host specific and few are reported as feeding on alternate hosts.

The stemborer species, together with their distribution and classification, are listed in Table 7 In the Americas, those most destructive and widely distributed are of the genera Coelosternus and Lagochirus The Hymenopterous stemborers are identified as pests only in Africa However, few other stemborers are reported as pests from Asia, but indoubtedly this is because there has been a minimum of investigation of these pests in this area

Table 7.

Genus species	Synonyms	Additional hosts	Distribution	Order	Family	Reference
Coelosternus rugicolis Bok		Manihot glaziovii (2302)	Brazil	Coleoptera	Curculionidae	1772,783,3095, 646,181,0839, 0052
Coleosternus tarpides Bok	Coelosternus sulcatulus		Guadeloupe, Mexico,Central America, Puerto Rico,Trinidad	Coleoptera	"	181,256
Coelosternus granicollis Pierce			Venezuela, Brazil,	Coleoptera	"	2291,2397,1772, 783,646,3095, 0839,181,0052
Coelosternus manihoti Mshl			Brazil, West Africa	Coleoptera	"	646,1772,783, 3095,839,0052, 181
Coelosternus notaticeps Mshl.			Brazil	Coleoptera	"	1772,646,783, 3095,0839,0052
Coelosternus alternans Boh			Brazil,Guadeloupe West Indies, Trinidad	Coleoptera	"	181
Eulecriops manihoti Monte			Brazil, Colombia,	Coleoptera	"	205,181,1772

Table 7. (Cont)

Genus species	Synonyms	Additional hosts	Distribution	Order	Family	Reference
Leptostylos biustus Leconte			Cuba	Coleoptera	Cuculionidae	228
Lagochirus arancıformıs			Antillas	Coleoptera	Cerambycidae	3185
Acanthoderers nigricans Lammeere			Colombia	Coleoptera		0205
Megasoma elephas L. Tuber feeding			Venezuela	Coleoptera	Scarabeidae	2291
Heterogostrychus grunneus			Africa			0839
Syllepta gordialis Kuen			Venezuela	Lepidoptera	Pyralidae	2291
Chilozela bifilalis (Hampson)			Venezuela	Lepidoptera		1851
Chilomina clarkei (Amsel)		Pyrausta clarkei	Venezuela	Lepidoptera		1851
Crypthorhynchus sp			St. Vincent	Coleoptera		1768

Table 7 (Cont.)

Genus species	Synonyms	Additional host	Distribution	Orden	Family	Reference
Eldana saccharina Walk.		sugar cane maiz Eleusine coracana Gants	Sierra Leone Mozambique Nigeria Senegal	Lepidoptera	Pyralidae	0696
Ceratina sp.			Sierra Leone	Hymenoptera	Apidae	0696
Stephanoderes sp.			"	Coleoptera	Curculionidae scolytidae	696
Calandra oryzae L		rice Maiz sorghum	USA Kenya Tanganika	Coleoptera	Curculionidae	0696
Sinoxylon brazzai Lesne						0696
Aeterobostrychus brazzai Lesne						0696
Sternotomis virescens (Westw.)			Zaire	Coleoptera	Cerambicidae	5095
Petrognatha gigas			Zaire	Coleoptera	Cerambicidae	3095
Inesida leprosa (F.)			Zaire	Coleoptera	Cerambicidae	3095
Heteronychus sp.						608

Table 7. (Cont.)

Genus species	Synonyms	Additonal hosts	Distribution	Orden	Family	Reference
Eubulus sp.			Colombia	Coleoptera	Cucullionidae	205
Ecyrus insularis			Puerto Rico	Coleoptera	Cerambicidae	3185
Ecyrus hircipes			Lesser Antillas	Coleoptera	Cerambicidae	3185
Ozineus proixus			Brazil	Coleoptera	Cerambicidae	3185
Acanthoderes nigricans Lan			Colombia	Coleoptera	Cerambicidae	3185
Lagochirus obsoletus Thomas			Cuba, Nicaragua	Coleoptera	Cerambicidae	3185,3095 228
Lagochirus sp.			West Indies, Brazil, Florida, Indonesia			
Phlyctaenodes bifilialis Hamp.			Colombia	Lepidoptera	Phyralidae	3185,205
Asciodes spp.			Venezuela	Lepidoptera	Pyralidae	3185
Opogona Chlorophanes Meyr.			Tanzania	Lepidoptera		0100
Xylocopa senior			Zaire	Hymenoptera	Apidae	0696

Only a minimum of information about their life information is available.

Life history Damage and Control.

Coleosternus sp.·

There are 7 species of Coelosternus that are described as attacking cassava in the Americas. Only C. manihoti Mshl is recorded as a pest in Africa. The larvae of these weevils damage cassava by penetrating the stems and tunneling in the center or pith region They can seriously damage plants and reduce root production (727, 256). Their economic importance can vary from year to year and with locality (839) Many larvae may attack the same stem or branch but they have never been observed as attacking roots. (1772). The boring into the stems by the larvae can weaken the plant and stems and branches may eventually dry and break. (2291, 181) Frass and exudate from the stem-wood ejected from burrows by larval feeding can be found on infested branches or on the ground below the plant (181). Larvae of C sulculutus have been observed feeding on underground parts of the stem. This weaknes the whole plant and reduces the size and quality of roots (256). Weevil attacks are known to cause considerable losses in Brazil (2302) It is claimed that the roots do not receive their natural nutrition and this lowers rootyield as well as a loss of planting material (839, 1772)

Adult weevils have been observed feeding on the tips of young shoots or stems and this may retard growth (839,1772,2302)

Adult females may oviposit on various parts of the cassava plant but generally eggs are oviposited on the tender parts of the plant (602) In C alternans oviposition has been observed near broken or cut ends of branches or beneath the bark in cavities escavated by the probasics (181). In C. grandicollis oviposition begins 3 days after copulation and a female penetrates the stem to oviposit, up to several hundred eggs, but usually only one egg per day (2302) (783) Eggs are usually white in color.

Larvae may vary in size depending upon species. The fully grown larvae of C. alternans are 15 to 17 mm in length and a maximum width of 4 mm while those of C tarpipes are 9 mm in length and a maximum width of 2.5 mm (181) The larvae of C sulcutulus are described as 10 mm in length with their body strongly curved, yellowish white to pale brown with their head capsule reddish brown and black mandibles (256) In C rugicolis only a single larvae occurs in each stem, unlike the other species where several larvae may occur in one stem (181) The larval estimates are in a range of 30 to 60 days (2302, 783) The fully grown larvae of all species pupate within a cell constructed in the pith region of the stem

The pupae is held securely in place in its chamber at one

end of the larval burrow with larval frass (256,181) The size of the pupae will vary between species but are in proportion to larval size Pupae are initially white to cream colored and changing to a brownish yellow to brown (256,181) The duration of the pupal period is about one month (181).

Upon emerging from the pupal case the adult may remain within the pupal chamber for several days before leaving the stem (181). Adults range in size from 6 mm in length for C granicollis to 12 mm for C alterans and C. rugicolis The adults are clear to dark brown in color and may be nearly completely covered with yellowish scales (1772, 181) Adults appear active throughout the entire year but activity may decrease during cooler months in some areas (2302)

Control

Chemical Pesticidal control appears impracticial since adults are difficult to kill and the larvae feed within plant stems (727, 181) However dusting with DDT (5%), Dieldrin (2%) or Lindane is recommended (0052,2397) Systemic insecticide may be effective.

Cultural There are several cultural practices that will reduce pest populations. Infested plant parts should be removed and destroyed by burning after harvest (2302,1772,3321,181) Crop rotation is also recommended (181,839)

Resistant Varieties Varieties listed as resistant to Coelosternus sp are 103-Brava de Itu and 192 Itu (727)

Eulecriops manihoti monte.

This weevil is smaller (2.8 mm) and more active than Coelostermus They are usually found in numbers just beneath the bark not far above the soil level (181) but may also attack the upper part of the stem (1772) The adults are densely covered by scales. Infested plants present holes in the stems and a reduction in yield has been reported from Colombia (0205)

Lagochirus sp.

The larvae of these long horned beetles, perforate and bore into stems and branches of cassava Larvae of L obsoletus are reported as occasionally reducing branches to sawdust (228) Strong winds or parting branches while walking through a cassava field will cause branches to break easily. During dry periods branches may lose their leaves or die and under heavy infestation plants can completely die The roots are not affected

Adults oviposit white eggs in stems and branches about 2 5 cm below the bark surface. The eggs hatch in 5 to 6 days. The larval development period is about two months and larvae can measure up to 29 mm Larvae may feed at the base of the plant and many can be found boring in one plant Larvae of a Lagochirus sp are described as usually attacking the main stem and rarely higher up They measure 20 to 30 mm in length and tunnel into the wood and pith producing much sawdust and broken stems on the ground

with the insect inside

Pupation period is about one month and takes place in sawdust in the larval chambers of the stem The adults are described as nocturnal insects, being active and fly rapid at night. They are brown in color, about 17 mm long and feed on leaves and bark Adults are active throughout the year (228)

Control

Chemical Stomac poisons are recommended to control adults while they are feeding on the foliage

Cultural practices Populations can be reduced by choosing uninfected stakes for planting and burning infested material. (228)

Table 8. Miscelaneous stemborers of less importance on Cassava

Species	Description and damage
Coleopterous	
Acanthoderes nigricans Lammare	Black beetles with long antanae. Larvae and adults feed in the centers of stems and can reduce yield consideralby (205).
Eubulus sp.	Small weevil found in the Llanos Orientales and Cauca Valley of Colombia. Larvae and adults feed in the pith region and can cause serious damage (205).
Leptostylus biustus Leconte	Eggs deposited under the bark and larvae found feeding between the bark and wood or may perforate the stem. Usually not very abundant and generally found in branches that were dying from another pest. Destruction of dried stems recommended (228).
Stephanoderes sp.	Dark colored weevils about 2 mm long and 2 mm in width. Cassava stems show a series of holes about 2 mm in diameter and their presence may be easily noted by sawdust at the base of the plant (696).
Calandra oryzae	Dark colored weevil about 4 mm long with 4 yellow spots on the elitras (696).
Lepidopterous	
Eldana saccharina Walk.	Adult oviposits small yellowish to reddish eggs in groups of varying numbers on the leaves or empty pupal case The agile larvae feed on the interior of the cassava stem Pupation is in a vertically placed silken cocoon in the larval cell (696).
Phlyctaenodes bifiliale Hamp	The larvae of this butterfly bore into the stem and settle in the pith region. Found in the Llanos Orientales of Colombia (205)

Table 8 (Cont.)

Species	Description and damage
Lepidopterous	
Syllepta cordiules Zien	Larvae bore into the stem wood (2291).
Chilomimia clarkei (Amsel)	Larvae bore into stems (1851).
Hymenoptera	
Xylocopa senior	The female constructs a spacous, vertical nest with its mandibles and places an egg with a honey or pollen paste for the larvae to feed on in it Several cells may be constructed with an egg and food in each The larvae tunnels up and and and develops rapidly to maturing in about 16 days After pupation the adult makes an exit hole by the pupal cell and leaves (696).

Scale insects

The species of scale insects named in the literature that attack cassava are listed in Table 9. On most of these species no investigations are reported.

Biology

A. albus The adult female scale is musselshaped, covered with a white scale of a waxy nature The castskins of the first and second nymphal stages are incorporated in the scale. Males, unlike females, have well developed legs and wings. The male to female ratio is ca 1:1. The female produces between 27 and 76 eggs, with an average of 47. These are placed between the upper scale covering and the lower corrony secretion During oviposition the female shrinks and shrivels up. The eggs hatch in 4 days. The first nymphal instar, referred to as crawler, has locomotory capabilities, and can disperse. These crawlers settle after 1-4 days, covers themselves with numerous fine threads, molts in 11 days, and becomes immobile After 4 days the adult female appears and oviposition commences after 1-2 days One generation is passed in 22-25 days (for the females). Dispersal takes place by wind, via active crawling or via infested cuttings The most important spread is via infested cuttings, bundled with healthy ones (2039)

Some notes are given on the biology of Eurhizococcus and

Table 9. Scale insects on cassava

Name	Synonyms	Family	Other hosts	Distribution	Reference
Aonidomytilus albus	Coccomytilus dispar Lepidosaphes dispar	Diaspididae	Solanum sp.	America, Africa Asia (Formosa and India	2221
Lepidosaphes alba		Diaspididae		Cuba	228
Pinnaspis minor	Hemichionaspis minor	Diaspididae		Peru	583
Saissetia hemispherica	Lecanium hemisphericum	Coccidae	Coffee, cotton, olives	Madagaskar, Maurice	2297,591
S. nigra		Coccidae		Madagaskar, Malaya Indonesia	1785
S. coffeae		Coccidae		Madagaskar	608
S. miranda		Coccidae		Colombia	CIAT,1973
Coccus viridis		Coccidae		Madagaskar	608
Pseudococcus virgatus	Ferrisiana virgata Dactylopius virgatus	Pseudococcidae		Madagaskar, Zanzibar	3009, 226
P. citri		Pseudococcidae		Madagaskar	3009
P. adonium	Pseudococcidae	Pseudococcidae		Madagaskar	3009
Phenacoccus gossypii		Pseudococcidae		Brasil Colombia	1715,CIAT,197

Table 9. (Cont.)

Name	Synonyms	Family	Other hosts	Distribution	Reference
Mytilaspis dispar				Madagaskar	2297
Eurhizococcus sp.				Brasil	615
Monophebus sp.				Brasil	615

Monophebus (615). The first instar nymph molts after 6-7 days and the second instar is passed in 9-10 days. During this instar it looses its mobility. The next molt takes place after 10-12 days and the females appear. No males were found. Females are very mobile. They enter into the soil and after 5-7 days the ootheca with eggs appears on the soil surface. Pseudococcus citri reportedly attacks cassava roots (3009).

Damage and economic importance

A. albus attacks branches of cassava, especially in the dry season, thus aggravating droughtstress The damage depends on the intensity of attack and plantage during attack Attacked stems can cause leaves to yellow and drop. The plants are stunted and stems can dessicate, causing plant mortality. Quality of the planting materials is greatly reduced and increased intensity of attack decreased stake germination (CIAT, 1973) Roots will be poorly developed and unpalatable (2039). After attack by Mytilaspis dispar rootyields of only 2-3 tons/ ha are recorded in Brasil (2297) Eurhizococcus and Monophebus also attack in the dry season, aggravating drought stress (615)

Cassava stakes can be lost due to A albus attack while in storage (1754).

S coffeae attacks leaves. Damage shows as leafcurling

Control

The most effective means of control is the use of uninfested

planting material, and to cut and burn infested plants to prevent the spread of the infestation. Crawlers will migrate from cut plants to healthy plants if not burned

Biological control is highly effective for some species Heavy predation of A. albus is reported by Chilocorus distigma (Coccinellidae) (696), but this lady beetle is only effective under high scale populations.

In Cuba, Hymenopterous parasites of the Aphelininae group Aspidiotiphagus citrinus and Signiphora sp, are reported (228)

Chemical control

Control on plants Chemical control is practiced primarily in the dry season with systemic insecticides. The most effective control means, as measured in percentage adults killed, was achieved by metasystox (0 1%) parathion (0 05%) malathion (0.1%) and ekatin (0.1%) (2041), in that order.

Additional recommendations are parathion (1 oz/2½ or 5 gallon), DDT-kerozene emulsion (1 oz/1/2 or 1 gallon), HETP (1 oz/3 gallon), and systox (1 oz/4 gallon). However parathion gives the best results. DDT-kerosene emulsion gives phytotoxic effects and is not recommended (2040). Also effective is 8-10% carbolineum plantarium and 0 02% Folidol 47%.

Control on cuttings Dipping stakes infested with crawlers for 5 minutes in DDT emulsions ranging from 0 1 - 2.0% reduced

infestations However, heavily infested stakes still germinated poorly after dip-treatments (1-2%) (2039, CIAT, 1973)

Preventive control of bundled stakes in storage was best achieved by parathion (0 03%), followed by endrin (0 05%), dimetoate (0.05%) and monocrotophos (0.05%) (1754).

WHITEGRUBS

Whitegrubs attack planting material, roots, of young plants or roots and tubers of older plants. They are especially a problem in areas of Indonesia. (Table 9) In Indonesia occur Leucopholis rorida F. and Lepidiota stigma F. with the former being most important. The other species mentioned are of less importance.(2131)

Biology of Leucopholis

Adults become active after the rains have started and 4-6 months later most of the damage occurs. The beetles mate approximately 23 days after pupation, and start laying eggs 9 days thereafter Eggs are laid singly, up to 37 per female, 50-70 cm deep in the soil, and even as deep as 90 cm. They hatch in 24 days, and the larval stage lasts 10 months. The larvae are very cannibalistic (2131)

Damage of grubs is evidenced by wilting of the leaves. Larvae attack planting material roots, and swollen roots The most damaging are the 4-6 month old larvae, which live 20-30 cm deep in the soil Additional hosts are maize, rice and sweet potato. Pupation takes place at a depth of 50 cm The prepupal stage lasts 14 days and the pupal stage 32 days. Lepidiota stigma is much less damaging than Leucopholis Their adults are not attracted to Capsicum annuum. Larval development period is similar to Leucopholis

Table 10. Whitegrubs on cassava

Name	Family	Distribution	Reference
Leucopholis rorida F.	Scarabeidae	Indonesia	2131
Lepidiota stigma F	Scarabeidae	Indonesia	2131
Euchlora viridis	Scarabeidae	Indonesia	2131
E. nigra	Scarabeidae	Indonesia	2131
E. pulchripes	Scarabeidae	Indonesia	2131
Anomala obsoleta	Scarabeidae	Indonesia	2131
A archaralis	Scarabeidae	Indonesia	2131
Inesida leprosa F.	Cerambycidae	C. Africa	3095
Petrognatha gigas	Cerambycidae	C. Africa	3095
Sternotomis virescens	Cerambycidae	C Africa	3095
Heteronychus plebejus	Dynastinae	Madagaskar	608
Opatrum micans		Madagaskar	608
Corphopilus marginellus		Madagaskar	608
Dactylosternum sp		Madagaskar	608

Biological control

Several Dielis species (D lectuosa, D. tristis, D. thoracica, D. javanica, D formosa and D. annulata) are reported as parasites of whitegrubs in Indonesia Adults dig in the soil, and place an egg on the grub Eggs hatch in 5 days and the larvae fastens itself to the grub,matures in 8 days,spins a cocoon and pupates in 1½ month. In one study about 26% of the grubs were parasitized. In the laboratory the grubs contained mites which were destroying the parasite eggs. Other parasites identified were Tiphia sp. and Prosena siberita and a Tachinid and a Sarcophagid fly.

Diseased grubs were frequently found Grubs artificially infested with Metharrhizium anisopliae died (2131).

Chemical control

Paris green at 1% on soil weight basis as soil treatment, stake treatment with contact poisons, CS_2 and KCN were effective in killing grubs but were too expensive or phytotoxic (2131).

Biology of H. plebejus

In Madagaskar the most important species is Heteronychus plebejus Klg. (Dynastinae) (608) The larvae live subterraneously on decaying organic matter Additional adult hosts are maiz, sugarcane and cassava The adults attack or girdle stakes,or tunnel into the stake causing seedling mortality. Control is

achieved by applying or incorporating 25 kg/ha HCH 25%, 4 days after planting. This reduced standlosses from 70% to 20% (608) Submerging cuttings in 6% lindane was ineffective. Proper soil preparation kills many larvae, and planting at optimal times reduces the exposure time to insect attack.

Whitegrubs, as with termites, are possibly controlled by dipping wet cuttings in 10% Aldrin powder. A 40% powder killed many cuttings (2059)

Cultural control

Adult males are attracted by fruit of Capsicum annuum, smeared on stones Male beetles were collected this way Also adults can be collected from the soil upon emergence after the first rains, or by collecting mating beetles from the soil after sunset.

Crop rotation with Agava was succesfull as well as collecting grubs after plowing in heavily infested areas Infestation occur year after year in certain areas (2131).

CUTWORMS

Cutworms in addition to their many foodplants, also clip young cassava shoots after they emergence from the soil. They also girdle cuttings. Prodenia litura (=Hadema littoralis) (Noctuidae), is reported from Madagaskar and la Reunion The females oviposit in October on the underside of leaves near the soil. They lay 1000-1200 eggs in masses within a few days The eggs hatch in 6-8 days and the larvae mature in 25-30 days The pupal stage is passed in 8-11 days and about one week after emergence the female starts oviposition In Madagaskar 3-5 generations are passed during the warm season. Chemical control as well as the promotion of parasites is necessary (2207).

In Brasil Prodenia eridania (=Xylomyges eridania) Fam. Noctuidae, is a pest of cassava, sweet potato and many other crops. In cassava it is mainly a foliage feeder, however it may damage the stakes or girdle stems, leaving only the woody part. The female starts oviposition 6-8 days after mating and lays approximately 400 eggs in masses. Larval development is in 16-28 days, and pupation is in the soil or under plant debris A generation lasts about 2 months. The heaviest attack occurs in April in Rio Grande do Sul. A high percentage of larval parasitism by a Tachinidae is reported Chemical control with BHC and Toxaphene is most effective in bait formula, but is

much less effective when dusted or sprayed. The bait formula - tion used was 4 kg. Toxaphene 40%, 30-35 kg wheat flour, 1.5 kg. molasse and 15 l water per ha. The bait was applied as a broadcast application in the afternoon, when rains are not likely to occur, (2109). Longer cuttings show better regrowth after simulated cutworm damage than short cuttings, but this is variety dependent (CIAT, 1974).

CRICKETS

Crickets damage cassava plants by clipping young shoots after emergence. They also can damage the base of cassava plants, rendering them more susceptible to wind - lodging (779).

Gryllotalpa africana in West Africa cuts and pierces roots and basal parts of the stems. Their presence is noted in little heaps of soil near their underground galleries. They should be collected and destroyed (20004).

Brachytripses achatinus is reported from Malaya (3112).

TERMITES

Termites are troublesome in lowland tropical areas mainly, attacking planting material, roots or growing plants. They can prevent establishment of cuttings and could probably be controlled preventively by dipping wet stakes in a 40% aldrin dust However, a 40% dust did kill many cuttings (2059) They are reported from Zanzibar (366) and Nigeria (442) From Malaysia is reported the rubber tree termite Coptotermes curvignathus Holmgr, which should be controlled by persistent chlorinated hydrocarbons, applied between planting rows (708).

Dead cassava stalks are attacked in Madagaskar by species of the Coptotermes termites, it is not sure if they also attack living material. Two species were identified namely C voeltzkowi and C paradoxis In areas with a strong dry season termites may be more a problem (2297). In India clones H 1843, H 2398, H 3641 and H 4, are considerably resistant to termite attack (1754).

GALLMIDGES

Gallmidges (Cecidomyiidae) have only been reported on cassava from South and Central America. The species reported from cassava are listed in Table 11

Biology

These fragile flies are usually found on the leaf undersides, and on plants in the centre of the fields that are protected by winds. (1838) The flies lay their eggs individually in the leaf tissue (232). Generally not more than 4-5 eggs are laid per leaf. The newly emerged larvae penetrate in the parenchyma, causing abnormal cellgrowth and the formation of a gall. The larvae pass then 3 instars. During the first instar the gall is formed, and the 2nd and 3rd instars are passed in this gall. The fullgrown yellow larvae measure about 1,8 x 0,7 mm. The duration of the larval stage is about 15-21 days and then it pupates in the gallThe pupa measures 2.1 x 0.8 mm and this stage is 10-15 days The larvae, prior to pupation enlarge the exithole. The adults emerge from the galls in the early morning, and usually drags the pupal skin halfway through the exit hole (1838) Only one larvae is found per gall (1838), however fused galls with common or separate openings can occur (1750)

Damage and Damage Symptoms

Leafgalls on the upperside of the leaves are from yellow

Table 11 Gallmidges on Cassava

Name	Synonyms	Other hosts	Distribution	Reference
Iatrophobia brasiliensis	Jatrophobia brasiliensis Eudiplosis brasiliensis Clinodiplosis brasiliensis	Cotton Manihot aipi M dichotoma	South and central America	56,230, 156,230 797,1750 Gagne 1968
Hyperdiplosis sp.			Peru	1838
Dasineura sp			Peru	583
Cecidomyiia cecropia			Colombia	233
Schizomyia manihoti			Brasil	Gagne 1968
Phaenolauthia sp	Lasioteryx		Trinidad and Tobago	232

green to red, narrower at the base and often curved. On the leaf underside the exit hole, surrounded by a ring of elevated tissue is visible (1838) The galls measure 5-15 mm. by 3-5 mm (230) When opened, the galls show a cylindrical tunnel with the larvae inside. Two types of galls, differing in color and shape are reported from Trinidad (225).

Generally the gallmidges are considered of little economic importance, however in Peru 6-7 months old plants were totally deformed and measured only 20-30 cms due to gall midge attack. The plants were yellow and showed dye back in severe cases The roots of these plants were thinner and more fibrous (1838) Retarded plant growth is also reported from Trinidad (1750) The cassava plants are attacked from 2-3 months after planting, most severely in spring and autumn and in the centre of the fields

Control

Collection and destruction of affected leaves at weekly intervals may reduce the pest status (233)

In Brasil of 189 varieties evaluated for resistance to I brasiliensis 38 showed resistance The next year 14 of these were eliminated as being susceptible, leaving 24 resistant varieties Resistance was also encountered among plants grown from natural seeds (3207).

The level of biological control is generally high (232,233

and 1838) Several Chalcidoidae were found as parasites. Up to 50% parasitism occurred in Peru The parasites encountered were Tetrastichus sp (Tetrastichidae) and Dimeromicrus auriceps (Torymidae), with the former the most important species Both are larval parasites The adult wasp deposits her egg through the gallwall in the gallchamber (1838)

From Trinidad (225 and 1750) high parasitism is reported from Tetrastichus fasciatus Ashm, which is also reported from Brittish Guyana Also reported from Trinidad are Aprostocetus fidius Gir and Aprostocetus sp (225) Occasionally two eggs of the parasites per gall were found After the parasite had oviposited through the gall a small latex drop appeared Several punctures were sometimes made per gall Usually the eggs were found attached to the head of the midge larva. The parasite larva is free crawling in the gall chamber They pupate in the gall (225)

Lacebugs

Vatiga (Leptopharsa) manihotae (Drake) is reported from Colombia and (205) can cause considerable damage to cassava foliage. Leaves show yellowing spots which turn to reddish brown, resembling mite damage The nymphs and adults live on the leaf undersides. One generation is passed in about 42 days A strong varietal resistance was observed (CIAT, 1974). An unnamed Tingid is reported from Trinidad and Tobago (232).

Flower and fruit attacking species

Cassava flowers and fruits have no economical importance, however insects attacking them can be a serious hindrance for the plant breeders. The principal species involved are

Flower attacking

Teleocoma crassipes Aldrich, which attacks male flowers, is reported from Brazil (538).

Fruit attacking

Anastrepha manihoti Costa Lima which attacks stems and fruits is reported from Brazil (234, 1710) and Colombia (CIAT, 1974), and A pickeli Costa Lima attacks both fruits and stems (CIAT, 1974) Attacked fruits turn yellowish and drop. This is also reported, with Anastrepha sp, from Brasil (538) A. striata Schiner is reported on cassava in Peru (Korytkowski, 1968)

Teleocoma attacks in Brasil vary in intensity with the seasons In April it was difficult to find a male flower without a larva. Larvae consume the pollen (538) The fly also attacks the shoots In certain areas cassava carries virtually no fruits due to the attack of the fly. There is a relationship observed between Teleocoma attack and number of seeds obtained The lack of male flowers can be a limiting factor in cassava hybridization It is suggested to place a bag over the flower buds, pollinate and replace the bag for fruitfly protection (538) In Brazil 90%

parasitism was found by Microhymenoptera mainly Opius sp (3207) which also attacks Anastrepha sp. in Colombia (CIAT, 1974)

Control may be achieved by killing the adults with 0.1% dieldrin with sugar added (3207)

Attacks of Anastrepha in the stem occur about 10-15 cm below the apex. There is a small entrance or exit hole visible Often a whitish fluid is excreted originating from secondary infestations. In a few occasions the growing point dies. Usually one can find the larvae by breaking the stem open and locating them in the tunnels. Often secondary infestations cause rotting On older stakes the tunnels stay visible as brown lines in the stem tissue The secondary rotting may cause a reduction in yield and a loss of stake planting material (CIAT, 1974).

PESTS OF DRIED STORED CASSAVA

Several insects attack dried cassava chips, pellets, topioca pellets, etc Most of these pest are polyphagous and cassava is only one of their hosts Cotton (1956) gives detailed reference or information of the biology of these insects Most of the insects attacking stored cassava products are Coleopterous and a few are Lepidopterous or Psocids.

The insect species present in cassava imported from different areas into Germany differs greatly. The cassava from Indonesia is mainly attacked by L serricorne, L oryzae and T castaneum, cassava from Thailand is most heavily infested with Cryptolestes sp, L serricorne and T. castaneum and that from Arica with L oryzae, R. dominica and T castaneum Only T. castaneum and L. oryzae can under favorable condition develop in Germany The Cleridae listed in Table 12 are predators on other stored grain insects The species D minutus, Rh dominica, L. Oryzae and T. castaneum lay less eggs and larvae develop much slower when breeding in cassava, as compared with mixed food as breeding medium or maize or rice (rice was not tested for Rh dominica and D. minutus)

Indications are that cassava is not a good nutrional medium for insects,due to lack of N, vitamins and microelements, No hydrocyanic acid could be detected upon arrival in Germany in cassava products. Optimal developmental conditions are 75% RH

Table 12. Coleoptera in dried cassava products.

	Name	Family	Distribution or country into which imported	Reference
*	Stegobium paniceum L.	Anobiidae	India	875
	Lasioderma serricorne (F)	Anobiidae	Germany	43
	Lasioderma sp.	Anobidae		1601
	Anthicus floralis	Anthicidae	Germany	43
*	Araecerus fasciculatus (de G)	Anthribiidae	India	875
			Germany	1817, 43
			Madagaskar	2298
*	Rhizopertha dominica (F)	Bostrichidae	India, Madagaskar	875, 2298
			Angola Germany	43, 1817
*	Dinoderus minutus	Bostrichidae	Angola,Colombia	43, CIAT,74
	Dinoderus bifoveolatus W	Bostrichidae	Germany, Madagaskar,	2298
	Minthea obsita Woll.	Bostrichidae	Madagaskar	2298
	M ruqicollis Walk	Bostrichidae	Madagaskar	2298
	Sinoxylon conigerum G.	Bostrichidae	Madagaskar	2298
	Bruchus sp	Bruchidae	Angola	2004
	Necrobia rufipes (De G)	Cleridae	Madagaskar,Germany	2298, 43

Table 12. (Cont.)

Name	Family	Distribution or country into which imported	Reference
Thaneroclerus buqueti (L)	Cleridae	Germany	43
* Oryzaephilus surinamensis	Cucujidae	India, Germany	875, 43
O mercator	Cucujidae	Germany	43
Cathartus advena (Wlk).	Cucujidae	Madagaskar	2298
Ahasverus advena (W.)	Cucujidae	Germany	43
Cryptolestes pusillus	Cucujidae	Germany	43
Sitophilus oryzae	Curculionidae	Madagaskar	2298
S. zeamais Motsh	Curculionidae	Angola, Germany	43
S. exarata	Curculionidae		1817
Lyctus brunneus (S.)	Lyctidae	Madagaskar	2298
L. africanus	Lyctidae	Madagaskar	2298
Typhaea stercorea	Mycetophagidae	Germany	43
Carpophilus dimidiatus	Nitidulidae	Germany	43
Tenebroides mauritanicus (L)	Ostomatidae	India, Madagaskar	875, 2298
Tribolium ferrugineum F.	Tenebrionidae	Madagaskar	2298

Table 12. (Cont.)

	Name	Family	Distribution or country into which imported	Reference
	T. confusum DuV.	Tenebrionidae	Madagaskar, Germany	2298, 43
*	T. castaneum	Tenebrionidae	India, Germany	875, 43
	Alphitobius diaperinus	Tenebrionidae	India, Germany	875, 43
	A piceus (O)	Tenebrionidae	Madagaskar	2298
	Lophocaterus pusillus (Klug),	Tenebrionidae	Madagaskar	2298
*	Latheticus oryzae	Tenebrionidae	Germany	43
	Gnathocerus cornutus (F)	Tenebrionidae	Germany	43
	Palorus subdepressus (W.)	Tenebrionidae	Germany	43
*	Ephestia cautella	Pyralidae (Lepidoptera)	India	875
	Liposcelis sp.	Liposcelidae (Psocoptera)	Germany	43

* Species reported to breed in cassava. The remainder may or may not breed in cassava.

and 35°C for D minutus and R. dominica 85% RH and 30°C is optimal for L oryzae and 75% RH and 30°C for T. castaneum D minutus and R. dominica need a solid medium to tunnel in Generally in Germany Rh dominica and A fasciculatus are the principal species which are found in stored imported cassava (1817).(43).

In India A fasciculatus is the most important pest of dried cassava products followed by S. paniceum (875).

The species S oryzae and Bruchus sp. in Angola are troublesome in the hot period April to July, than they go into hibernation (2004).

Damage

Dried cassava chips can be reduced to dust in 4-5 months in India due to stored product insects (875)

Control

The most important control measure is proper sanitation Cleaning and desinfecting warehouses prior to restocking is necessary. It is also important to rapidly consume or remove infested material as this will deteriorate rapidly (2004) Bitter varieties, when sundried stayed a year or more free of weevils, while sweet varieties rapidly became infested (803)

Chemical control

Fogging stores with DDT before filling them is recommended (2004) Dried cassava in bags can be protected by treating the bags with pesticides Jute bags, treated with lindane-dieldrin

mixture (35 35 mg/sq foot bag) gave complete protection for 6 months from stored grain insect attack However when the treated bags contained infested chips no control was obtained (875)

Fumigation of infested bags was effective in killing adults and nymphs of A fasciculatus and S paniceum.

Complete control in stored chips is obtained by fumigation with

1½ lb/1000 c ft of Methylbromide (MB)

or 4 lb /1000 c ft of Ethylene dibromide (EB)

or 40 lb /1000 c ft of 3:1 Ethylene dichloride and carbon-tetrachloride (EDCT).

To kill larvae of both A. fasciculatus and S. paniceum the quantities had to be 2,4 and 40 lb. respectively of the products The quantity of EDCT needed, may be too high to be economically feasible EB is safer to handle and may be a better product than MB Both leave residues at levels of 3-15 ppm, which is considered acceptable (875)

OTHER INSECTS REPORTED AS PESTS CN CASSAVA

Other insects reported on cassava are listed in Table 13 Of the insects mentioned below some information is given in the literature.

Lepidoptera

Phlyctaenodes bifilalis (Loxostege = Chilozela) (Hemp) (Fam. Pyralidae) Reported from Surinam(67) Young larvae fold one finger of a leaf upwards along the midrib, and secures the margins with silk. Later instars fold several fingers together and the larvae live within this shelter Larvae may bore into young stalks The larval period is about 11 days and pupation takes place in the soil (1851).

Phoenicoprocta vacillans Wlk and P sanguinea (Wlk). These species feed on cassava leaves in Surinam, causing only minor damage. The hairy larvae in their last stages have many conspicuous tubercles (67)

Tiracola plagiata Wlk is a pest of cassava, bananas, rubber, castor bean and dry bean in Malaya (3112) Eggs are laid in masses on the leaf underside and they hatch in 5 days The larvae pupate after 16-18 days in the soil The pupal period is 10 days Larvae will migrate from wild vegetation to cassava This facilitate control with baits in ditches along cassava fields. The Tachinids Sturmia inconspicua and Blepharipoda ophirica are reported as parasites of this pest (3112).

Table 13. Other insects reported on Cassava.

Name	Family	Order	Type of damage	Distribution	Reference
Euproctris proeucta Wlk.	Liparidae	Lepidoptera	leaffeeder	Madagaskar	2056
Aegocera rectilinea	Noctuidae	Lepidoptera	leaffeeder	Central Africa	696
Stigmatrachelus concinnus B.	Cucrculionidae	Coleoptera	leaffeeder	Madagaskar	2297
Corigetus corbetti M	Curculionidae	Coleoptera	Leaffeeder	Malaya	1745
Criptocephalus commutatus S.	Chrysomelidae	Coleoptera	Leaffeeder	Cuba	228
Diabrotica sp.	Chrysomelidae	Coleoptera	Leaffeeder	Colombia	CIAT, 1974.
Maecolaspis poeciloptera	Chrysomelidae	Coleoptera	Leaffeeder	Colombia	CIAT, 1974.
Inesida leprosa	Cerambycidae	Coleoptera	cassava remnants	Central Africa	3095
Petrognatha gregas	Cerambycidae	Coleoptera	cassava remnants	Central Africa	3095
Sternotomis virescens	Cerambycidae	Coleoptera	cassava remnants	Central Africa	3095
Stenodontes downesi	Cerambycidae	Coleoptera		Central Africa	14
Bruchus sp.	Bruchidae	Coleoptera	cassava remnants	Cuba	228
Opatrum micans	Tenebronidae	Coleoptera	cassava remnants	Madagaskar	2056
Carpophilus marginellus	Nitidulidae	Coleoptera	cassava remnants	Madagaskar	2056

Table 13. (Cont.)

Name	Family	Order	Type of damage	Distribution	Reference
Dactylosternum sp	Hydrophylidae	Coleoptera	cassava remnants	Madagaskar	2056
Clytra fasciata	Scarabeidae	Coleoptera	leaffeeder	Ghana	673
Lagria villosa	Scarabeidae	Coleoptera	leaffeeder	Ghana	673
Finotina radama	Scarabeidae	Coleoptera	leaffeeder	Madagaskar	2435
Megymenum brevicorne	Pentatomidae	Hemiptera	Sucks shoots and leaves	Malaya	3112
Asponqopus sp.	Pentatomidae	Hemiptera	Sucks shoots and leaves	Malaya	3112
Homoeocerus sp.	Coreidae	Hemiptera	Sucks shoots and leaves	Malaya	3112
Amblypelta qallegonis	Coreidae	Hemiptera		Br Solomon Isl.	3074
Erythroneura cassavae	Cicadellidae	Hemiptera	leaves	East Africa	
Empoasca sp.	Cicadellidae	Hemiptera	leaves	Colombia	CIAT, 1974
Leafminers		Diptera	leaves	Africa	2116

Pieris mesentina is found in great numbers feeding on cassava, Up to 128 larvae were found per plant in Central Africa. Pupae are attached to the leaves. The adults disappeared after a heavy rain. Pupae are paratised by Brachymeria sp. (Chalcidae) and by Sturmia sp. (Tachynidae). Sturmia parasitized 8-9% of the pupae

Coleoptera

Curculionidae

Pachnaeus litus Schh.

This bright blue beetle is mainly a pest of oranges and citrus in Cuba Larvae feed on roots of many plant species, among them cassava, while the adults feed on cassava leaves. It is only a pest in cassava near orange plantations. Chemically they are difficult to control (228).

Scarabeidae

Serica castanea Bl. feeds at night on many plants including cassava leaves. Adults hide in the daytime in the soil. It is a pest of cassava in Madagaskar from October to February (2297)

Hemiptera,Miridae

Anoplocnemis curvipes, damaging the growing points.

Helopelis bergrothi and H westwoodi, attack leaves and growing points of cassava in Central Africa. Damage to the leaves shows as angular spots, bordered by the leafveins (3095). They are mainly a cotton pest (3009)

From Indonesia the Coreid Dasynus manihotis Bloete (1743) is reported. Damage of D. manihotis shows because the insect puncture the tip of cassava shoots The tissue shrinks and leaves wither These spots show brownish on older stems The stems may die under heavy attack The adult oviposits on the leaf underside or on the stem Eggs hatch in 7 days and 55 - 57 days later adults appear The insect could not be reared on cassava It is concluded that cassava is not its usual host plant (1743).

Other Arthropoda A diplopoda, Orthoporus fuscipes can cause damage to cassava roots Cleaning fields of debris of previous crops will reduce this damage (3188) A Milliped Harpurostreptus sp is reported from India (3327) They feed on young roots and shoots of cassava cuttings Chemical control is most effective with baits containing 0 6% endrin or 5% sevin. Baits of 5% BHC (0 2% spray) showed contact toxicity. Drenching soil 5-7 5 cm deep with 0 2% BHC emulsion is also effective (3327)