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SUBTITLE: INSECTS OF VEGETABLES IN LIBERIA

AUTHOR: DERMOT CASSIDY

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Introduction

The purpose of this document is to provide a context for crop protection in peri-urban agriculture in Liberia for extension staff working in the Food and Enterprise Development Project in Liberia (FED). The definition of peri-urban agriculture used in this document is production of vegetables for sale as fresh produce or minimally processed products such as dried chilis. Of necessity the document is far from complete and entire categories of crop pests such as post harvest diseases and moulds, physiological problems, nematodes and weed species have not been included for lack of time and analytical equipment. As such the document must be treated as a work in progress and the interested reader is invited to help elaborate on and add to the contents. The fact that this document can only be a preliminary draft to a more comprehensive document compiled by all those participating in the FED peri-urban value chain is underlined by the fact that many of the insects and diseases described in this document have not been formally recorded in Liberia before.

All figures and diagrams are those of the author and no permissions are needed for reproducing these elsewhere though the source must be acknowledged. The organization of each section is a work in progress and the interested reader will note inconsistencies from section to section. All the photographs were taken by the author during the course of work on FED related business.

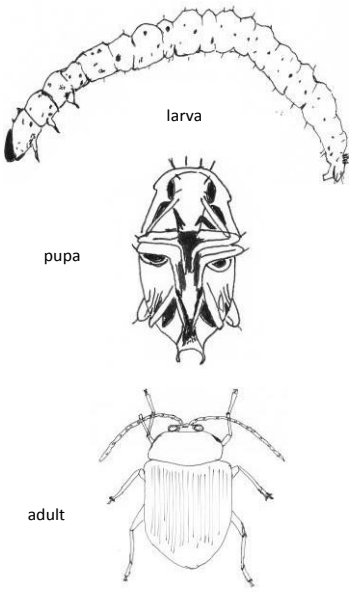
A major point to make is that a publication such as this one can only carry a small fraction of the information that is already available on the internet so the document is really just a starting point for internet searches. A particularly important source is that of the *Infonet-Biovision* which has a vast amount on information on vegetable production in Africa[1]. Any reading on peri-urban crop protection should be done in conjunction with Infonet Biovision website and other sources, some such as the IITA in West Africa.

In the specific context of FED there are two other documents complementary to this one - for pest scouting and chemical/bio-rational crop protection. The first step is the correct identification of living organisms on the crop and what they are doing there - a specific purpose of this document. Some are harmful, but the vast majority are not, or are indeed, actively helping to keep crop feeding organisms under control. Should a crop pest be present it is often the case that they are present at levels that are not economic to control. Therefore it is necessary to put their present in the context of beneficial organisms over time. Any crop protection activity requires systematic scouting over time. Only if it is demonstrated that a pest has got out of control should agricultural remedies be used and even then only those that are soft on beneficial species. A scouting document has been prepared as well as a set of tables for guidance on the use of agricultural remedies.

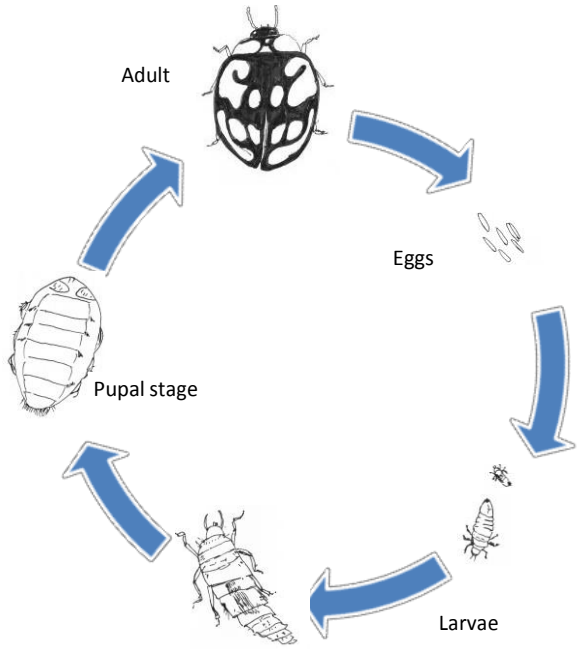
[1] http://www.infonet-biovision.org/

2 Beetles

Beetles are a diverse group of insects characterized by adults with hardened wings and grub-like larvae that are sometimes mistaken for caterpillars. Some beetle larvae live underground (e.g. wireworm, African black beetle). Their life cycle includes the egg, larval, pupal and adult stages (Figures 1a, 1b, 1c).



1b; Flea beetle - life stages



1b; Ladybird life cycle

2.1 Flea beetles (Nisostra spp., Podagrica spp.)

These are common pests of okra in Liberia. They are tiny to small beetles, with enlarged hind legs that enable them to jump long distances when disturbed. The color of the adult beetles varies from black, brown, black and yellow striped or metallic blue-green depending on the species (Figures 2 and 3). Eggs laid in soil near the bases of plants hatch in about one week. Larvae emerge from the eggs and feed on okro or other roots for 2 to 3 weeks. After developing through three instars, larvae pupate in the soil. The pupal stage lasts 7 to 10 days. Beetles emerge from the pupal skins, make their way out of the soil, and feed on leaves for 2 months or more (Figure 1a). The adults feed on cotyledons, stems and leaves. They make many small holes on okra leaves, known as "shot-holes" (Figure 4). Larvae of flea beetles live in the soil and feed on okra roots, but the damage caused by this stage is not of economic importance. Flea beetles are particularly damaging to young plants. Seedlings may wilt and die under heavy flea beetle attack or may stunt if injury is not severe. Damage to cotyledons and young leaves is the major cause of crop loss, generally leading to uneven crop stand. When large numbers of flea beetles are present they will also feed on flower buds and pods (Figure 2), causing yield loss by injuring the pods. Damaged pods are not marketable. Some species of flea beetles are reported to transmit the Okra mosaic tymovirus (OkMV) in West Africa.

Beetle damage to vegetable crops is regarded as rare. There are no biological control options currently available for their control. If chemicals are required, ensure that you use insecticides that are registered for your crop and strictly observe the label or permit recommendations. You may need more than one treatment.

2.2 Ladybirds

Ladybirds are generally, though not always, beneficial insects that feed on aphids (Figure 5). The ladybird life cycle, in common with other beetles, starts with an egg which hatches to give rise to a larva that goes through four instars and then pupates and metamorphoses into an adult. The larval instars are also predatory often feeding on the same insects as adults (Figures 6 and 7).

Figure 2; Flea beetle (*Nisostra* and *Podagrica* spp) on African okra (Liberia)

Figure 3; Flea beetle (*Podagrica* spp) on African okra (Liberia)

Figure 4; Damage caused by flea beetles (*Nisostra* and *Podagrica* spp) on African okra (Liberia)

Figure 5; Lady bird beetle on watermelon (Liberia)

Figure 6; Ladybird larva feeding on aphids (Liberia)

Figure 7; Ladybird larvae on okra leaf (Liberia)

3 Dipterans (flies)

Dipterans are true flies with a single pair of membraneous forewings with the rear wings modified into halters. Metamorphosis is complete (Figure 8). Two groups of Dipteran crop pests have been noted in Liberia. These are fruit flies (Tephritidae) and leaf miners (Agromyzidae). Other flies are predatory or parasitic. Long-Legged Flies (Dolichopodidae), a family of predatory flies have been commonly observed in vegetable urban gardens in Liberia. Because fruit flies and leaf miners are of high phytosanitary significance species are not listed in this section until definitive surveys and identifications are made and the information formally released by the Liberian Ministry of Agriculture

3.1 Fruit flies

The fruit flies are a well defined group of flies, generally easily recognized, of moderate size and with mottled wings (Figure 9). The larvae are phytophagous, often living inside fruits though some species live in flowers and shoots. The major pest genera are Dacus and Ceratitus though Africa has experienced a number of invasions in the last decade from a number of Bactrocera species originating from Asia. Many species are highly polyphagous. Some fruit fly species are problems in melons, including watermelons, and solanaceous crops.

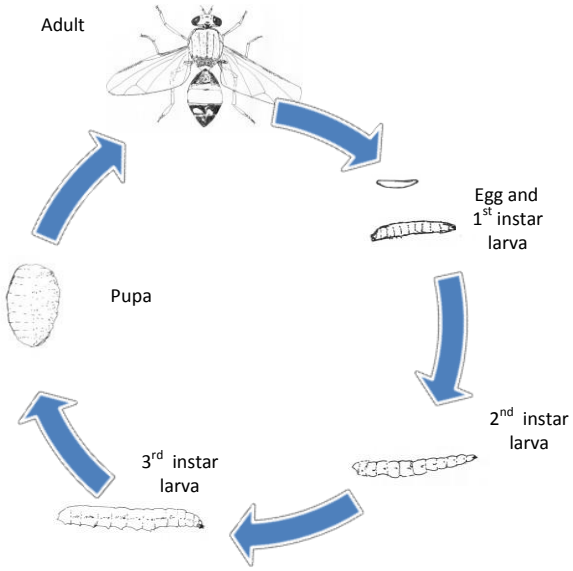


Figure 8; A Dipteran life cycle – in this case of the fruit fly

Biology

The female fly uses her ovipositor to deposit eggs about 5mm beneath the surface the surface of ripening fruits. The eggs hatch in about two days, and larval development can be as short as seven days before the mature maggots drop out of the fruits to pupate in the soil. Pupal development takes about 10 days (Figure 8). The entire life cycle takes about 25 days in the tropics where there may be many generations per year.

Control

Globally the most active controls for fruit flies are international phytosanitary measures – hence the importance of precision in the identification of the occurrence of the species present in any country. Conversely countries should have national fruit fly surveillance systems and actively notify trading partners of any change in national status. Control is difficult and often can only be done by saturation trapping using parapheromones to remove male flies (male annihilation technique). Predation and parasitism is high in the natural environment though natural enemies of recently introduced species may be absent.

3.2 Leafminers

Major species of leaf mining flies in Africa are mainly from the genus Lyriomyza. They are significant pests of vegetable and ornamental plants worldwide. They are occasional pests of brassicas but the most serious are pests of tomatoes and other solanaceous crops.

3.2.1Biology

Eggs are very tiny (about 1.0 mm long and 0.2 mm wide), and are laid inside the leaf tissue, just below the leaf surface and hatch in about 3 days. Larvae are small yellow maggots (about 2 to 3 mm long when fully-grown). They are found feeding inside the leaf tissue, leaving long, slender, winding, white tunnels through the leaf (Figure 10). They pass through the three larval stages typical of Diptera. After 5

to 7 days the maggots leave the mines and pupate in the soil though occasionally pupation can occur on the leaf surface or within the mines. The pupae are very small, about 2 mm long and 0.5 mm wide varying in color from pale yellow-orange to golden-brown. Adults emerge 4 to 5 days after pupation. Leafminer adult flies are small, about 2 mm long. They vary in color from grayish to black with yellow markings.

3.2.2 Control

Leaf mining flies have a wide range of natural enemies, mainly parasitic wasps, which normally keep them under control but the indiscriminate use of persistent broad spectrum pesticides disrupts the natural control often resulting in major leaf miner outbreaks. Africa has a significant number of indigenous parasitic wasps which have been found attacking newly introduced exotic leaf miners. One of the most efficient parasitic wasps for control of leaf miners, *Diglyphus isaea*, has been provisionally identified in Liberia, and if so gives satisfactory control, probably in combination with local natural enemies, based on field observations to date. Therefore it is important to conserve this and other natural enemies by careful selection of chemical in any peri-urban agricultural system.

Figure 9 (above); Unknown species of fruit fly on a bean plant in Liberia

Figure 10 (right); Leaf miner in bitter ball leaf, Liberia

3.3 Beneficial flies

The Long-Legged Flies or Dolichopodidae consists of more than 7,000 species. They are tiny flies with long legs and big eyes, having metallic green, blue or copper color bodies (Figure 11). Adult flies are predaceous on small mites, aphids, psyllids, thrips, Nematocera (Diptera) and other insects, sometimes playing some regulating role in biological control in agriculture. Larvae of almost all species are predators inhabiting moist substrata. Small-sized species may be saprophages in larval stage. Broad spectrum agrochemicals adversely affect populations in agriculture.

Figure 11; Long-Legged Fly (Dolichopodidae) on bitter ball in Liberia

3.3 Tachinids

Tachnids are flies i.e. belong to the order 'diptera', the superfamily 'Calyptrae' and family 'Tachinidae'. Tachinids are parasitoids, the larvae feeding on the body tissues of immature or adult invertebrates killing their host in the process (Figure 12). The vast majority of species attack the larval stages of their host with eggs are either: injected into or laid on the host.

Figure 12; Tachnid fly on climbing beans in Bong County in Liberia

4 Heteropterans

The Order Heteroptera has a number of plant feeders all with piercing mouthparts. All species have toxic saliva. The forewings, hemelytra have the basal two thirds thickened and the end third is membraneous - the wings held flat over the body.

4.1 Cotton stainer (Dysdercus spp)

Probably *Dysdercus superstitiosus*: Description. Species in the cotton stainer family, Pyrrhocoridae, have a four-jointed antenna and distinct venation in the hemelytra are generally rather large, and are marked with contrasting colors such as red and black. *Dysdercus superstitiosus* has a large distinct spot on each fore wing (Figure 13a). Immature stages are smaller but resemble adults without wings and eggs are small, pale and laid singly on cotton plants or dropped on the ground near cotton plants.

4.1.1 Biology.

Eggs hatch in 5 to 8 days. There are five instars in the immature stage which lasts about 21 to 35 days. First instar nymphs are usually found congregating near the egg shell after emergence. The second and third instars feed gregariously on the okra pods. Later instars wander freely over the plant (Figure 13 b).

4.1.2Nature of damage

The cotton stainer feeds by puncturing the plant and drawing up sap to exude from the feeding site.

Figures 13a (above) and 13b (right). Cotton stainer adults and nymphs provisionally identified as *Dysdercus superstitiosus* on okra in Liberia

4.2 Eggplant lace bug (Urentius hystricellus)

Description; The eggplant lace bug is a small insect (about 3 mm in length), brownish in colour. Its body is covered with spines and the wings show a distinct lace-like appearance. Eggs are embedded in the undersides of leaves or embedded in the soft tissues near the tips of green branches (Figure 14). Nymphs resemble adults, but are initially wingless, developing wings as they grow (Figure 15).

4.2.1 Biology

Both adults and nymphs are usually found in groups on the underside of leaves.

Damage

Lace bugs suck sap from the leaves causing whitish to yellowish mottled patches on the leaves. In case of serious infestations the leaves turn entirely yellow and drop off. Attacked leaves are speckled with small black shiny spots, which are the faeces of the bugs.

Figure 14; Egg cluster, possibly of *Urentius hystricellus* on bitterball in Liberia

Figure 15; Lace bug nymphs tentatively identified as *Urentius hystricellus* with black frass on bitterball

4.3 Family: Coreidae (tip wilters)

Tip wilters are so called because they suck out the plant juices just below the tip of a new branch causing it to droop and wilt soon afterwards primarily because their saliva is toxic. They are a common pest species in Africa attacking many crop plants though it is not clear that they are agriculturally important (Figure 16).

Figure 16; Tipwilter bug on an unidentified weed in Nimba county in Liberia

5 Leafhoppers (family Cicadellae = Jassidae)

The leafhoppers are included in this review because they are commonly observed in peri-urban plots in Liberia and they may be important pests.

5.1 Introduction

Leafhoppers are a large family of true bugs second in number to the Aphididae. They are slender small insects with thin tapering antennae. They jump very readily when disturbed. Hind tibiae are elongate with a series of regularly spaced stout setae along the anterior edge.

5.1.1 Life cycle

.The females embed their eggs into the midribs or veins of the leaves and these take about about a week to hatch. The resulting nymphs resemble the adults except that they lack wings and are much smaller. They grow bigger with each instar. There are five moults taking about two to three weeks before adulthood is reached (Figure 17 and 19). Adult females, which are often bright green in colour, lay up to 60 eggs in their lifetime of a few weeks.

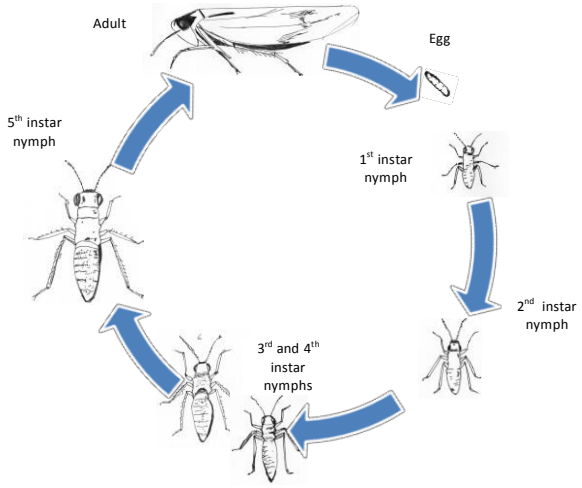


Figure 17; Jassid life cycle of egg, five nymphal instars and adult

5.1.2 Control

Jassids have been a problem in the past on cotton but with the development of resistant (hairy leaved) cultivars they are less of a problem. Leafhoppers occasionally damage seedlings and new growth but prefer to feed on the upper surface of mature leaves from flowering onwards. Damage appears as a pale silvery stippling often in wiggly lines (Figure 18). Leafhoppers are unlikely to reduce yield unless in very high numbers and are generally controlled by natural enemies including predatory bugs and spiders.

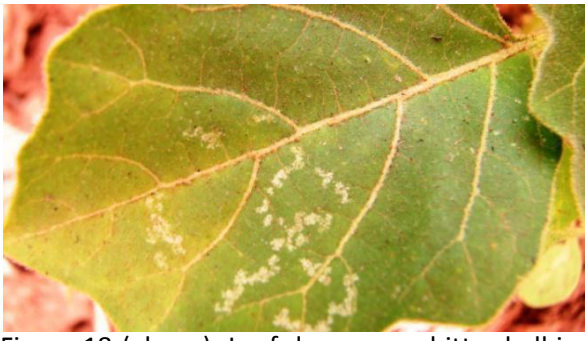


Figure 18 (above); Leaf damage on bitter ball in Liberia – possibly caused by leafhopper feeding

Figure 19 (right); Adult Jassid on okra in Liberia

6 Lepidopterans (butterflies and moths)

6.1 Introduction

Moths and butterflies are grouped together in the order Lepidoptera, which means 'scaly wings'. The main difference between moths and butterflies is that moths do not fly during the day unless disturbed. Butterflies also have clubbed antennae and the habit of holding their wings vertically when at rest, whereas moths sit with their wings flat. Two species are considered in this section though neither has been formally observed in peri-urban plots to date

6.2 Life cycle

Moths and butterflies undergo a complete life cycle that includes four stages: egg, caterpillar (larvae), pupae and adult (Figure 1). It is the caterpillar stage that is usually the most damaging.

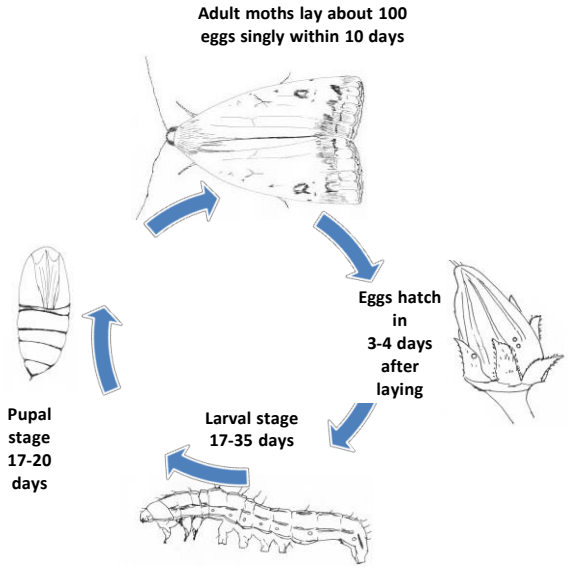


Figure 20; Diagram of the African bollworm life cycle.

6.3 African Bollworm

The African bollworm (*Helicoverpa armigera*) is a pest of major importance in most areas where it occurs which is most of sub-Saharan Africa though there appear to be no formal records for Liberia. It damages a wide variety of crops and is a major pest due to the secretiveness of adults, high mobility, ability to feed on many species of plants, and high fecundity/reproductive rate. Because the later instar caterpillars often feed inside the fruiting parts of plants they are less easy to control.

6.3.1 Life cycle

Moths lay a large number (100-200) of eggs singly, and the life cycle may be completed in a short time under warm conditions. Eggs hatch in 3 to 5 days. Larval and pupal periods last 17 to 35 and 17 to 20 days, respectively. The life cycle is completed in 25 to 60 days depending on temperature (Figure 20).

6.3.2 Control

Management is multilayered but essentially starts with scouting. The basic premise is that control is by a combination of natural enemies, cultural methods and targeted sprays. The interventions are;

1. Scouting based on an action threshold
2. Building up natural enemies in the soil through management system that promotes biological activity
3. Crop picking which may only be feasible in small plots
4. Habitat management by intercropping and trap crops as well as crops that attract natural enemies
5. Crop rotation (an additional reason for this practice)
6. Building up natural enemies of which there are a large number in Africa
7. Care with spraying using biopesticides where possible
8. Plant crops that are attractive to natural enemies
9. Ants are important predators of the African bollworm and can be encouraged

6.4 Diamondback moth

Diamondback moth (*Plutella xylostella*) is a major caterpillar pest of brassicas in Africa though there are no formal records of its presence in Liberia or adjacent countries though it is recorded from Senegal and Ghana. The pest causes damage by feeding on leaves, buds, flowers and seed-pods. The level of damage varies greatly depending on the plant growth stage, the numbers, size and density of grubs.

6.4.1 Life cycle

Adult moths are 8 to 10 mm long and fold their wings over their body, forming a tent-like shape. Wings are light brown with three pale diamond shapes. Caterpillars hatch from eggs and are pale yellowish green. They feed on the surface of the leaves. Mature caterpillars are 10 to 12 mm long and pupate in white mesh cocoons attached to leaves or stems.

6.4.2 Control

Cultural and other control practices are based on monitoring/scouting and include;

1. Sanitation with seedling beds away from production fields and destruction of crop residues

2. Pest avoidance
3. Crop rotation
4. Intercropping (e.g. chili), trap cropping e.g. mustard and collards which can also augment beneficial insects
5. Biological pest control
6. Encouraging natural enemies of which there are a
7. A number of biopesticides are effective

6.4 Cutworms

Cutworms are caterpillars belonging to Agrotis spp. Moths (*Agrotis segetum* and *A. ipsilon*). Cutworms attack a range of cultivated plants including okra, cabbage, cauliflower, pepper, maize and cotton. Damage to leaves by young caterpillars results in the presence of very tiny round 'window panes' whereas feeding on leaves, stalks and stems results in falling leaves, small holes in the stems or cut stems respectively. Larger caterpillars can cause whole leaves to fall off the plant after being cut through at the base or small holes may be found on the stems and roots at the soil surface. A characteristic sign of cutworm activity is the presence of leaf pieces or whole young plants partly pulled down into the soil. The activity of the fully-grown caterpillars is very obvious. Whole plants fall over and on root crops deep holes become visible at and above the soil surface

6.4.1 Life cycle

Eggs are laid singly or in small groups on moist soil, weeds or the stem and lower leaves of crop plants with a single female laying as many as 2000 eggs. Hatching occurs in 10 to 28 days. Young caterpillars are pale, yellowish-green with a blackish head and feed on leaves and stems. . Older caterpillars are plump with variable color from grey, dark green to brown or black with a shiny, greasy-looking skin. When fully-grown caterpillars are 4 to 5 cm in length.

Older caterpillars feed at the base of plants or on roots or stems underground mostly at night hiding in soil, under stones or plant debris by day. When ready to pupate they build tunnels in the soil about 2.5 to 5 cm deep near the host plant and make an earthen cell. Pupae are about 1.7 to 2.5 cm long, smooth and shiny reddish-brown with two dark spines at the tip of the abdomen.

The adult is a medium-sized moth, about 2 cm long with a wingspan of 4 to 4.5 cm with greyish-brown forewings having black lines or kidney-shaped markings along the side margins. Hindwings are pearly white with dark brownish margins and veins. In warm conditions the life cycle is completed in 6 weeks.

6.4.2 Control

Cultural and other control practices are based on monitoring/scouting and include;

1. Cultural practices including crop breaks
2. Biological pest control

7 Orthopterans

Insects in the order Orthoptera are medium to large sized insects with modified leathery front wings known as tegmina though some have reduced or absent wings. The hind legs are usually enlarged for jumping. Mouthparts are modified for biting and chewing. Metamorphosis is only slight and the female usually has a well developed ovipositor. There are a number of families in Orthoptera including crickets but only the short horned grasshoppers in the Acrididae appear to be serious vegetable pests in West Africa.

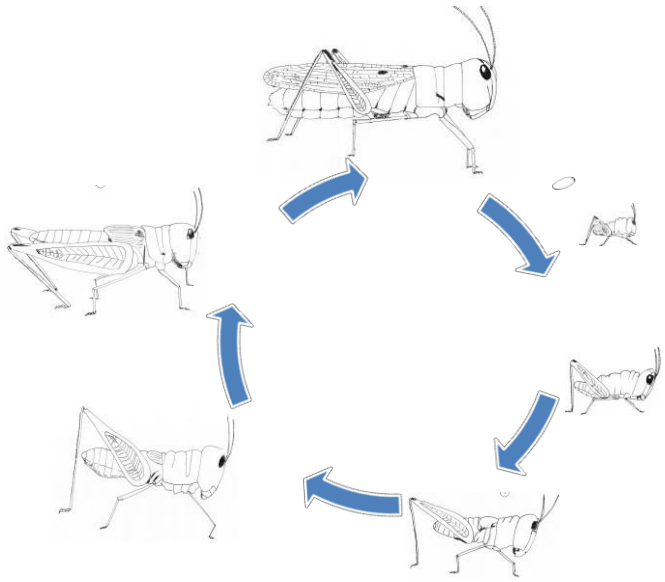


Figure 21; Typical life cycle of a short horned grasshopper.

7.1 Elegant / variegated grasshoppers

Biology

Eggs are 6mm long and 1.5mm wide, sausage shaped, laid in the soil in masses of froth which harden to form sponge like packets about 2.5 cm long. Each female can lay about 300 eggs. Nymphs are typical short horned grasshoppers about 3 cm long, black with appendages ringed in yellow or white (Figure 21). The adults are handsome grasshoppers about 3.5 cm long generally dark greenish, but with much of the body patterned in black, yellow and orange. The adult life span is about 3 - 4 months. They have a characteristic unpleasant smell and are sometimes referred to as 'stink grasshoppers'.

Damage

The main hosts are cassava and finger millet though they will attack a range of crops in the seedling stage and are found on coca, castor, cotton (and therefore probably okra), and sweet potato. The leaves are eaten leaving ragged edges. Infestation is sporadically severe, especially in seedling crops.

Figure 21; Variegated grasshopper *Zonocerus variegatus* (Acrididae) final instar nymph on cassava in Liberia

Control

The most popular method of control of variegated grasshoppers is by hand picking them off crops.

8 Sternorrhyncha

There is some confusion in the nomenclature of the suborders of Hemiptera which contains the aphids, whiteflies, and scale insects, groups which were traditionally included in the order Homoptera. For convenience the term Sternorrhyncha is used for the insect pests in this section and refers to the rearward position of the mouthparts relative to the head. Distributed worldwide, all members of this group are plant-feeders (phytophagous), and many are major crop and ornamental pests. Many exhibit modified morphology and/or life cycles, including phenomena such as flightless morphs, parthenogenesis, sexual dimorphism, and eusociality. Well-known groups in the Sternorrhyncha include aphids, (Aphididae and allied families) whiteflies, (Aleyrodidae), jumping plant lice (Psyllidae and allied families), as well as the Superfamily Coccoidea (scale insects)

8.1 Aphids

Aphids are small, soft-bodied insects that grow up to 1 to 4 mm long. They are sap suckers and form colonies on the new shoots of a wide range of crops. Species range from yellow to green to black. Colonies include mostly wingless and some winged individuals. Most vegetable crops are attacked by aphids and they often have a wide host range and may be found on all vegetable crops. Aphids can stunt and distort the growth of plants and cause wilting and bud drop, resulting in poor flowering and fruit set and are often vectors of plant viruses. Aphid species that affect vegetable production in West Africa, and probably present in Liberia include:

Cotton aphid (*Aphis gossypii* Glover), always female

Black bean aphid (*Aphis fabae* Scop.), always female

Cowpea aphid, (*Aphis craccivora* Koch), always female

Spirea aphid (*Aphis spiraecola*), no males in tropical climates

Green citrus aphid/mustard aphid (*Lipaphis erysimi* Kalt.), no males in tropical climates

Green peach aphid (*Myzus persicae* Sulzer), no males in tropical climates

Mango aphid (*Toxoptera odinae*), no males

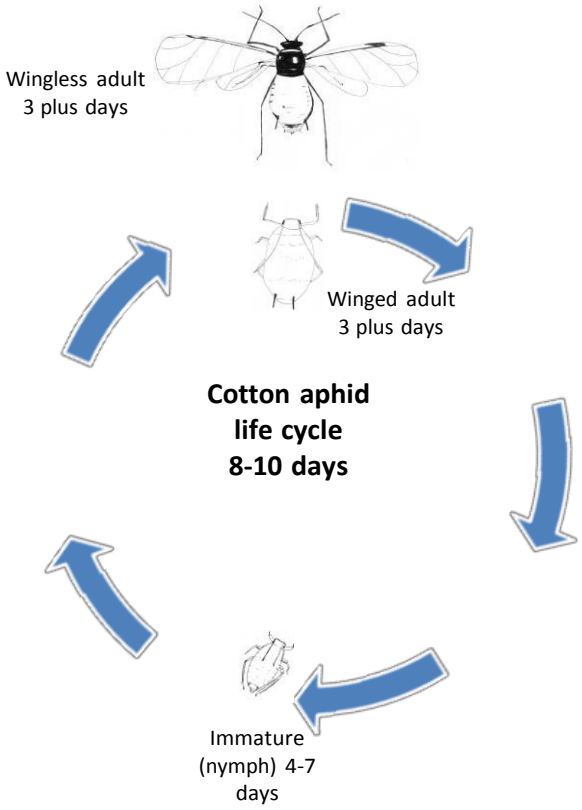


Figure 22; Morphotypes of cotton aphid including winged and wingless types Figure 23; Life cycle of the cotton aphid which is typical of aphids in the tropics

Life cycle of aphids

The biology of aphids in tropical climates is unique. All adults are females. These females live and produce young on growing plants year round reproducing rapidly. One female may produce as many as 80 young females that mature within 8 to 10 days. Thus, it is possible for aphids to have as many as 50 generations per year. In optimum conditions life cycle generations occurs every 5 to 7 days (Figures 22 and 23).

Figure 24; Aphids, probably the cotton aphid, on okra being tended by ants (Liberia)

Figure 25; Infestation probably of black bean aphid on beans in Liberia

Aphids, where they occur, are easily observed on plants. They commonly appear on the underside of leaves where they suck the sap, causing leaves to curl and sometimes shed (Figures 24 and 25). Cotton aphids cause leaves to curl downward and "cup under. Aphids excrete honeydew, a sticky substance easily seen on leaf surfaces and often becomes moldy with black sooty mold. Ants often tend aphid colonies, collecting the honeydew and protecting them from natural enemies (Figure 24). Feeding aphids may cause malformed plants or even kill seedling plants.

Control

Beneficials include naturally occurring insect predators such as ladybirds and hoverfly larvae. Natural enemies identified in the region, mainly Benin, were the predators *Cheilomenes propinqua* (Mulsant), *Cheilomenes sulphurea* (Olivier) and *Ischiodon aegyptius,* (Wiedemann), the obligate entomopathogen Neozygites sp., and the parasitoids *Lysiphlebus testaceipes* (Cresson) and *Aphelinus ficusae* Prinsloo & Neser. The adult female stings the aphid and lays its eggs directly inside the body, causing it to swell and turn bronze. Chemical control options should be managed carefully to reduce the development of resistance and harm to beneficial. Ensure that insecticides are registered for the crop and strictly observe the label or permit instructions.

8.2 Whiteflies

Adult whiteflies resemble tiny moths, with four wings covered by a white dusting of mealy material that resembles the wing scales in butterflies and moths (Figure 26). A typical whitefly lifecycle is shown in Figure 27.

The pest most often observed to date in Liberia is the spiralling whitefly (*Aleurodicus dispersus*), a major pest of agricultural crops in the tropics. Spiralling whitefly is not a fly but a true bug, a member of the order Hemiptera who all feed on liquid food via stylets, modified tubular mouthparts. The common name spiralling whitefly arises from the adult females laying eggs in spirals of waxy material.

Figure 26; Whitefly of unknown species on bitter ball in Liberia (probably the Spiralling Whitefly)

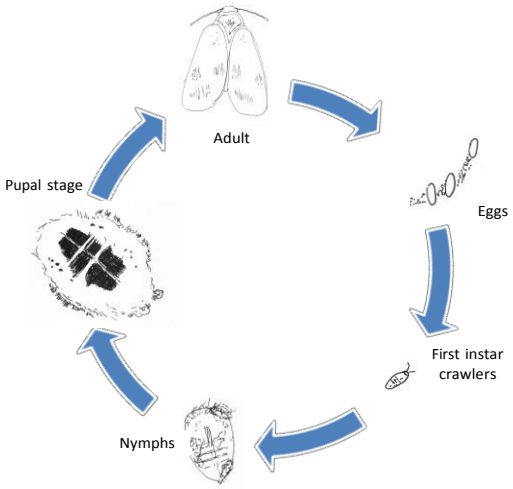


Figure 27; Life cycle of the Spiralling Whitefly

All whiteflies are plant feeders and the spiralling whitefly is highly polyphagous, feeding on many plant species, in many plant families. The wide host range of the spiralling whitefly is the major reason it is able to spread so quickly from one crop to another across the tropics.

Eggs are smooth, yellow to tan, oval shaped and 0.3 mm in length. The irregularly spiralling patterns of the deposited eggs are associated with trails of white wax (Figure 28). Upon hatching, crawlers (first-instar larvae) move to find an appropriate leaf vein for feeding, where they settle. As the larvae mature, they develop waxy tufts. The first instars are mobile, while the last three instars are permanently attached to the leaf (sessile). Adult males are 2.2 mm long and adult females are 1.7 mm. Adults are free moving and able to fly (Figure 29).

Damage

Damage is caused by all stages of the whitefly piercing the leaf and sucking the sap leading to premature death of the plant when infestations are high. Indirect damage is caused by the accumulation of the honeydew and the waxy, white, fluffy, woolly material produced by the whiteflies. Honeydew serves as a substrate for sooty moulds, which blacken the leaf, retarding photosynthesis and reducing plant health.

Figure 28; Egg spirals on the underside of hibiscus leaves. Eggs are covered by white wax.

Figure 29; Three puparia of spiralling whitefly, with highly characteristic waxy secretions together with an adult and nymph

Control

Control of the Spiralling whiteflies include eradication of the growth of a low lying weed *Sida acuta* which serves as refuge for the population of this insect in the wetter season when the whitefly populations decrease. Stenthonus sp., a small dark beetle, was found to prey on the pest serving as a biological control for this plant vector. Two parasitic wasps *Encarsia guadaloupe* and *Encarsia haitiensis* have provided control of the spiralling whitefly in West Africa. Several fungi (e.g. *Verticillium lecanii*, *Beauveria bassiana*, *Paecilomyces fumosoroseus*) attack whiteflies and can be useful control agents in situations where the crop is grown in high humidity conditions.

9 Thysanoptera (thrips)

Introduction

Thrips are a common and little known pest for growers of vegetables. Species listed on vegetables in West Africa include:

African bean flower thrips (*Megalurothrips sjostedti*)
Blossom or Cotton bud thrips (*Frankliniella schultzei*)
Tomato thrips (*Ceratothripoides brunneus*)
Onion thrips (*Thrips tabaci*)
Western flower thrips (*Frankliniella occidentalis*)

Thrip life cycle

Typically thrips are small elongated insects usually 1-1.5mm long with strap-like wings (Figure 30). Most species are black, brown or yellow. Eggs are very tiny often only 0.25 mm long and 0.1 mm wide. Eggs are usually laid singly inside the plant tissue, and are therefore not visible. The first and second instar larvae are very small (0.5 to 1.2 mm), elongated, slender, and vary in color from pale-yellow, orange or red according to the species. They have asymmetric piercing-sucking mouthparts and resemble the

adults but without the wings. The prepupa and pupae instars are intermediate forms between the nymph and the adult. They have short wing buds but no functional wings. During these stages thrips are inactive non feeders. Pupation may occur on a plant or in the soil beneath, depending on species. Many plant eating species pupate in the soil.

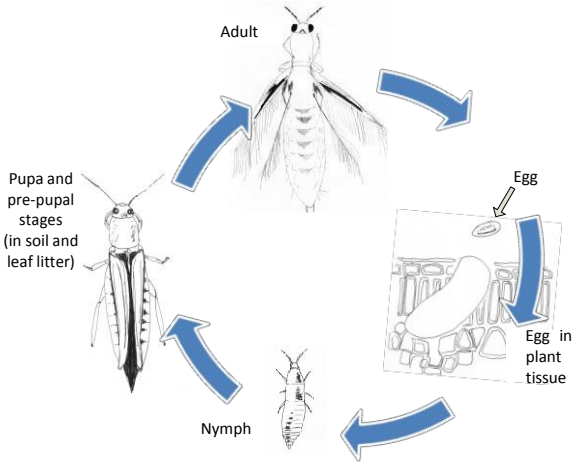


Figure 30 (above); Typical thrip life cycle showing portion spent in soil.

Figure 31 (right); Thrip feeding damage on okra in Liberia

Figure 33 (above); Thrip feeding damage on beans in Liberia

Figure 32 (left); Thrips on climbing bean flowers in Liberia

Damage

The damage caused by thrips is out of proportion to the small size of the insect because it feeds on young growing tissue, generally developing fruit inside the flower (Figure 32). As a result the scarring can be quite severe in mature fruit (Figures 31 and 33)

Pirate bugs (Orius spp) are prominent predators of thrips. *Orius a/bidipennis,* which is present in Benin, for example feeds on *M. sjostedti, Ceratothripoides cameroni* and *Frankliniella schultzei* but its effectiveness is not reported as being very significant. Other natural enemies, include predatory thrips, predatory mites ground beetles, lacewings, hoverflies, and spiders but there are few reports from West Africa. They are important in other areas for the natural control of thrips.