INSECTS INJURIOUS TO ECONOMIC CROPS IN THE ZANZIBAR PROTECTORATE.

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(Plates XIII–XV.)

The following notes on the various insects injurious to the economic crops of the Zanzibar Protectorate are based on investigations made during the last few years.

The chief economic products of the two islands (Zanzibar and Pemba) are cloves and coconuts, the former being of greater importance.

INSECTS AFFECTING CLOVES.

Fortunately no insect pests of the clove tree (*Eugenia caryophyllata*) have been discovered, but it is apparent in many plantations that a number of trees are unthrifty and die. The cause of death still remains uncertain, but most of the evidence points to some physiological condition, such as waterlogging of the roots near swamps, denudation of alluvial soil on slopes, or the tap-root reaching an impervious layer of stone. The bark of certain unhealthy trees is attacked by termites (*Termes bellicosus*) and dead branches are infested with various species of Bostrychid beetles. Some young clove trees from Pemba had been killed by *T. bellicosus* feeding on the bark of the lateral roots.

The adults of a large Tenebrionid beetle, *Pycnocerus passerinii*, Bertol., have been found on several occasions lurking under dead bark on clove trees, while larvae and pupae occur in deep tree-holes filled with decomposing vegetation; I am of opinion that they do no actual damage, but only feed on dead bark, etc.

Several experiments have been undertaken to test whether various omnivorous Lepidopterous larvae, such as those of *Euproctis producta*, would feed on clove trees when deprived of other food, but all died.

INSECTS AFFECTING COCONUTS.

Oryctes monoceros and *O. boas*. These two rhinoceros beetles are common throughout the two islands and are a serious menace to the coconut industry, the former being the commoner species. The damage done to young trees is often very serious; in some plantations more than half of the trees from 2½ to 3 years old are killed, while others are stunted and their productiveness much reduced. A certain number of trees survive initial attacks, but as their growth is retarded, they take a long time to reach maturity. Mature trees rarely succumb to the attacks of the beetles, although a number of felled trees were found to harbour the insects.

The following record of the life-history of *Oryctes monoceros* has been obtained:—

Eggs found in dead coconut trunk	11. viii. 1917.
Eggs hatched	19. viii. 1917.
Larvae started to build pupal cell	5. xii. 1917.
Pupal cell completed and pupa formed	10. xii. 1917.
Adults emerged	28. xii. 1917.

It will be seen from this that the length of the larval life is 113 days, that of the pupa 18 days.

After the mature larvae had built their pupal cell they shrunk considerably in size and became very sluggish before pupating ; this period of inertia lasted 5 days.

Pupae are often found in association with larvae in old coconut trunks, generally among the coarse fibres where disintegration has not yet taken place ; the larvae prefer the centre, where the fibres have been reduced to the consistency of a warm moist debris.

The larvae of *Oryctes boas* are more usually found in rubbish heaps composed of decomposing vegetable matter and manure. I have found manure heaps riddled with larvae of all ages ; horse and donkey droppings seem the most attractive.

The following preventive measures have been tried :—

(1). Traps have been set in various localities filled with rotting coconut trunks, decaying vegetation, etc. ; the addition of a little horse manure enhances their attractiveness and they have given excellent results.

(2). The collection of adults and larvae by natives has been tried in East Africa, but the results were not encouraging.

(3). In small plantations the daily examination of all young trees (from $2\frac{1}{2}$ to 3 years old) for adult beetles should be quite efficacious. The easiest method is to insert a small piece of wire with harpoon points into the entrance hole, transfix the beetle and withdraw it. After a little experience the palms harbouring beetles are easily recognised by the moist tow-like frass protruding from the entry holes. Sprinkling dry earth or sand in the crowns of the young trees may possibly act as a deterrent to adult beetles. There is no doubt that bare plantations and isolated trees are more severely attacked, probably because the beetle being a heavy sluggish flier is able to alight more easily on its food-plant under these conditions. The planting of some tall bushy catch-crop, such as *Cajanus indicus*, around the plantation might be efficacious.

Some imported larvae infected with a fungus (*Metarrhizium anisopliae*) were received, and it was proved that our local larvae are susceptible to the disease ; further, in some control experiments one case of actual indigenous infection was found. A long series of experiments with a view to introducing this fungus was planned, but owing to unforeseen circumstances all work in this direction was abandoned.

I have on several occasions seen young trees suffering from what might be called bud-rot. The whole of the crown is easily pulled out leaving a hollow depression full of dark fluid with a most foetid odour. It may perhaps be proved later that bud-rot is secondary to the attacks of the beetle.

To summarise the above :—The rhinoceros beetles (*Oryctes monoceros* and *O. boas*) are common throughout Zanzibar and Pemba, and are the most serious pests of the coconut industry. Young trees from $2\frac{1}{2}$ to 3 years old are most usually attacked, many are killed, others greatly delayed in reaching maturity. Trees in isolated positions and on bad soil are more often attacked. Fully matured trees harbour adult beetles, but the damage to them is not serious. The most useful preventive measure is the trapping of larvae in pits filled with rotting coconut trunks, vegetable debris and a little manure.

No insect parasites have been found preying on the eggs, larvae, pupae or adults.

Among mammals the most useful in destroying larvae are the MACROSCELIDAE and SORICIDAE. The following list includes all known to me.

Rhynchocyon adersi. A large elephant shrew, which is somewhat local in its distribution and chiefly found in scrub on the east coast of the island. It has not been observed feeding on larvae under natural conditions, but partook of them greedily in captivity.

Petrodomus sultan. A rare species, concerning the habits of which no observations have been obtained.

Pachyura murina. These small shrews are widely distributed throughout the island and have been found in beetle traps on several occasions.

Two species of crows (*Corvus scapulatus* and *Corvus splendens*) have been noticed feeding on the larvae of *Oryctes boas* in manure heaps. Many species of birds have been collected and their stomachs carefully examined for larvae or fragments of adults, but none have been found.

The following are minor pests of coconut palms :—

Rhynchota.

Aspidiotus destructor, Sign. This dangerous coconut scale-insect has been found occasionally on husks and leaves, but at present does no appreciable damage.

Aspidiotus cyanophylli, Sign., *A. lataniae*, Sign., and *Hemichionaspis minor*, Mask., have all been found on the husks of coconuts in association with *Aspidiotus destructor*.

Cerataphis lataniae, Licht. This cosmopolitan Aphid has been found frequently on the leaves of coconut palms but never in great numbers. Ornamental palms of various varieties are heavily infested.

Coleoptera.

Rhina amplicollis, Gerst. Adults, larvae and pupae of this large weevil were found in a dead coconut tree in Pemba.

Diocalandra frumenti, F. These small Curculionids were found in numbers in crevices on coconut husks. The infested nuts showed in the majority of cases cracks and fissures from which gum was exuding. Attention had been drawn to the trees on account of the shedding of immature nuts and peculiar deformities in the shape of the nut, but it is by no means certain that the injuries were due to the weevils, which were probably secondary visitors.

Rhyncophorus phoenicis, F. This large weevil has been recorded from Pemba. Larvae, pupae and adults were found in an old stump of a coconut tree, others in a dead oil palm (*Elaeis guineensis*). As far as can be ascertained at present it is not a serious pest of coconuts.

Isoptera.

Termes bellicosus, Smeath. Termites often attack seed-beds and cause great havoc among the nuts, in some instances 50% of them having been destroyed. The soaking of nuts in Cooper's dip before planting gave good results. Mr. T. J. Anderson, Government Entomologist in British East Africa, advised watering the seed-beds with sea-water, but as the beds attacked were situated inland a considerable distance from the sea, the method has not been tested.

INSECTS AFFECTING COTTON.

A few experimental plants of the following varieties have been grown, viz., Egyptian :—Abassi, Nubari, Yannovitch, Mit Affifi, Asili, Sakellarides ; American :—Allen's Long Staple and Sunflower.

All the plants were heavily infested by a variety of insects of which the following proved the most injurious.

Lepidoptera.

Pectinophora (*Gelechia*) *gossypiella*, Saunders. This has proved to be the most serious pest, as every variety of cotton was attacked. All stages of development were taken throughout the year. Other food-plants were the silk-cotton tree (*Eriodendron anfractuosum*) and Ladies' Fingers (*Hibiscus esculentus*), the latter plant being always heavily infested.

Pyroderces simplex, Wlsm. Some adults emerged from stored seed.

Earias insulana, Boisd. A few specimens were obtained from all varieties of cotton. A very common pest of *Hibiscus esculentus*.

Sylepta derogata, F. This leaf-roller occurred abundantly on all varieties and was responsible for serious damage.

Prodenia litura, F. Remarkably few larvae were found. Other food-plants are *Hibiscus esculentus*, young tobacco plants, castor plants, and on one occasion a ripe tomato fruit.

Acrocercops bifasciata, Wlsm. Cotton plants of all ages were attacked by this leaf-miner. The attacked leaves have a very characteristic appearance, the whole of the upper epidermis being raised to form one large blister.

Bucculatrix loxoptila, Meyr. Larvae were taken feeding on the upper epidermis of Abassi cotton ; they construct a tough white cocoon shaped like an upturned boat on the leaf.

Orgyia vetusta, Hmp. One small swarm of larvae appeared, completely defoliating the attacked plants.

Euproctis producta, Wlk. Larvae occasionally swarm on cotton ; they are omnivorous, moving from one food-plant to another, castor oil plants seeming to be their favorite food.

Rhynchota.

Dysdercus fasciatus, F. This stainer was prevalent during the bolling season and caused much damage to the lint ; all varieties of cotton were attacked, especially Caravonica. These insects were observed plunging their proboscis into young oily seeds in bolls which had opened prematurely. They were also seen on many occasions feeding with avidity on fresh mammalian carcases, skins and skulls.

Dysdercus superstitiosus, F. This has been taken occasionally, but is by no means a common species.

Oxycarenus albidipennis, Stål. All instars are common in well matured open bolls. In neglected crops they occur in vast numbers, although the actual damage done seems to be negligible.

Pseudococcus obtusus, Newst. At times this is a serious pest. It is one of the commonest Coccids of the island and feeds on a variety of hosts. Many experimental plants of cotton were completely covered, the main stem being smothered.

Pseudococcus virgatus, Ckll. Found occasionally on leaves and beneath the sepals. This Coccid is very abundant on a number of ornamental plants and shrubs.

Pseudococcus citri, Risso. A rare species on cotton.

INSECTS AFFECTING CEREALS.

The principal cereals cultivated are rice, maize, and millet (*Sorghum vulgare*), none of them in any great quantity.

Lepidoptera.

Cirphis loreyi, Dup. The larvae of this Noctuid are common in all maize fields. They bore and tunnel through the main stalk, attack the base of the cob, and occasionally feed on unripe seeds. Pupation takes place either in the stalk or in the cob. The moist white excrement, very typical of the presence of the larva, is generally found at the base of the leaves or cob. The large exit holes of the imago are easily detected. The species also attacks millet.

Sesamia calamistis, Hmp. Very similar in its habits to *Cirphis*. In young cobs the tassel is often attacked, the larvae working downwards into the cob ; it likewise feeds on millet.

Busseola fusca, Hmp. Larvae and pupae were found in the main stalk of millet, but never in great numbers.

Chilo suppressalis, Wlk. This species is the commonest borer of maize and the most harmful, as in some instances it will destroy a full half of the crop ; it also attacks millet.

Parnara mathias, F. Larvae of this butterfly have been found occasionally feeding on the leaves, but as a pest it is insignificant.

Rhynchota.

Peregrinus maidis, Ashm. A field of imported maize (Hickory King) was found heavily infested with this cosmopolitan pest ; but the common native variety of maize is rarely attacked.

INSECTS INJURIOUS TO VEGETABLES.

Cabbages.

Crocidolomia binotalis, Z. Cabbages are always heavily infested with the larvae of this moth and several valuable crops have been completely ruined. Pupation takes place on the leaf under a light silken web or in the rolled end of a leaf. The pupal stage averages 10 days. Other food-plants are turnip, watercress, radish and nasturtium.

Plutella maculipennis, Curt. The small brilliant green larvae of the diamond-back moth were taken in conjunction with those of the former species. Pupae are found on the leaf in a silken web.

Phytometra signata, F. This moth is a minor pest.

EGG PLANT (*Solanum melongena*).

Acanthocoris fasciculatus, F. This bug is a serious pest. In many market-gardens these useful plants are smothered with it; the tips of the young shoots wilt quickly when heavily infested. It occurs as a minor pest of the chilli (*Capsicum* sp.).

CUCURBITACEAE.

Dacus vertebratus, Bezzi. The larvae of this fruit-fly are extremely common in all varieties of native gourds and cause a large amount of damage. Other food-plants are *Luffa acutangula* and various squashes. Market-gardeners have attempted to grow melons and cucumbers, but very few reach maturity owing to the ravages of this fly.

Two other species of *Dacus* also occur in gourds, *D. brevistylus*, Bezzi, and *Dacus punctatifrons*, Karsch.

PIGEON PEA (*Cajanus indicus*).

Rhynchota.

Pseudococcus obtusus, Newst. This insect, one of the commonest Coccids of the island, is found in enormous numbers on this useful plant.

Coleoptera.

Tragocephala variegata, Bert. Adults of this Longicorn are prevalent during the hot season from October to March. Eggs found in the field in April hatched in 10 days; larvae have been kept in captivity for 3 months without pupating; pupae taken in the field produced imagos in 12 days. The female gnaws a small hole in the bark of a lateral branch and there deposits an egg. The larvae feed for a short time in this branch, then tunnel down the main stalk, making many vent holes during their transit and eventually pupating in a plugged cell low down in the trunk or even in the root. A large exit hole denotes the escape of the adult.

Lyprops breviusculus, Gerst. Numbers of these beetles have been found feeding on the peas. All instars are present in the pods. They are generally found in neglected fields where old pods have been left on the trees.

Several species of MELOIDAE feed on the leaves but are only minor pests. The following have been identified;—*Mylabris dicincta*, Bert., *Mylabris amplectens*, Gerst., and *Coryna ambigua*, Gerst.

Lepidoptera.

Marasmarcha atomosa, Wlsm. These small delicate moths have been taken towards dusk hovering around the pods. The characteristic larva, studded with spines and hairs radiating from tubercles, feeds through a hole on the pea. The pupa closely resembles the larva and is generally found on the outside of the pod.

Deudorix antalus, Hopff. The large flat conspicuous larvae of this butterfly are an occasional pest of the pigeon pea. They are voracious feeders and attack the seeds in young green pods with avidity, at times causing a considerable amount of damage. Pupation takes place in the pod.

Diptera.

Agromyza sp. The larvae of this fly attack the young green seeds in the pod, making a ring-like track around the seed ; the pupae are formed within the pod.

LADIES' FINGERS (*Hibiscus esculentus*).

These useful plants harbour a number of important insect pests of which the following have been recorded :—*Pectinophora gossypiella*, *Earias insulana*, *Sylepta derogata* and *Prodenia litura* ; as previously mentioned all of these occur on cotton.

Nisotra weisei, Jac. Numbers of these small flea-beetles swarm on the leaves, giving them a typical shot-hole appearance. The same species has been found on roselle (*Hibiscus sabdariffa*).

SWEET POTATO (*Ipomoea batatas*).

Cyclas formicarius, F. This cosmopolitan weevil is a common pest throughout the two islands, many tubers being completely riddled and destroyed. All instars are found in the tubers.

Aspidomorpha puncticosta, Boh. The leaves are often severely attacked by the larvae of this Cassidid beetle, which are conspicuous on account of their long anal process.

CASSAVA (*Manihot utilissima*).

This useful plant, the chief food supply of the natives, is exceptionally free from pests.

Pseudococcus (*Dactylopius*) *virgatus* var. *madagascarensis*, Newst. A few plants have been observed to be infested with this Coccid.

Tetranychus sp. This small red mite is abundant in some plots, and causes wilting and curling of the leaves.

INSECTS INJURIOUS TO FRUIT TREES.

CITRUS.

Rhynchota.

Lepidosaphes beckii, Newman. This scale-insect is the worst enemy of *Citrus*, and in many plantations the trees are thickly encrusted. The main stem and laterals are the favourite sites, but leaves and fruit are also attacked. I have seen numbers of oranges packed ready for export infested with this scale.

Icerya purchasi, Maskell. Fortunately very few trees are attacked by this Coccid, which at present is quite a minor pest.

Icerya seychellarum, Westw. Has been observed on lemons.

Pseudococcus obtusus, Newst. This Coccid has been taken on all varieties of orange, in addition to its other food-plants.

Pseudococcus citri, Risso. A minor pest which has never been found in abundance.

Ceroplastes rubens, Maskell. One record from a young orange tree.

Coccus viridis, L. This scale is very prevalent on young trees in some plantations and shows a marked partiality for imported species of *Citrus*.

Aspidiotus (*Pseudaonidia*) *trilobitiformis*, Green. Occasionally met with; this Coccid has a variety of hosts.

Cerataphis lataniae, Licht. This is another of the commonest citrus pests; the leaves of many trees both old and young were found to be heavily infested. This Aphid is also abundant on many varieties of ornamental palms.

Aphis tavaresi, del G. The black cotton aphis is extremely seasonal in its occurrence and is generally found on the leaves and young tender shoots.

Lepidoptera.

Argyroploce leucotreta, Meyr. (Citrus Codling Moth). Larvae have been found on several occasions in mandarins, but not in oranges.

Papilio demodocus, Esp. A very common pest on all young citrus trees. Many young plants are completely defoliated, and the larvae are occasionally found feeding on tender shoots of mature trees.

Coleoptera.

Tragocephala variegata, Bert. The habits of this Longicorn have been described under pests of the pigeon pea. It attacks all varieties of *Citrus*.

Porphyronota maculatissima, Boh. A few adults of this unimportant Cetoniid beetle have been taken from time to time feeding on the leaves.

Gyponychus cervinus, Gerst. A number of adults of this weevil have been obtained, they attacked the leaves of young orange trees; a minor pest.

Diptera.

Ceratitis capitata, Wd. This serious pest does not seem to be very widespread. Oranges and mandarins of imported varieties were found to be infested, but indigenous trees (oranges, mandarins and lemons) are far less susceptible to the attacks of this fruit-fly.

Mangos.

Sternochetus (*Cryptorrhynchus*) *mangiferae*, F. Adults are commonly found in the stone of the fruit, larvae and pupae in fallen immature fruit.

The following Coccidae have been found on the leaves and fruit:—*Aspidiotus* (*Chrysomphalus*) *dictyospermi*, Morg., *Aspidiotus destructor*, Sign., *Pseudococcus obtusus*, Newst., *Lecanium adersi*, Newst., *L.* (*Saissetia*) *nigrum*, Nietn., *L.* (*Saissetia*) *punctuliferum*, Green.

Of these the only one of importance is *Pseudococcus obtusus*, which heavily infests both the leaves and fruit of many trees.

Bananas.

Aspidiotus destructor, Sign. Has been found occasionally both on the fruit and leaves.

Soursop.

Ceratitis rosa, Karsch. One fruit was found to harbour larvae of this fly.

INSECTS AFFECTING SHADE TREES.

Lepidoptera.

The African almond (*Terminalia catappa*) is common throughout the two islands and is much appreciated for its ornamental foliage and shade properties. In certain situations, especially in the town, it is severely attacked by bag-worms (PSYCHIDAE). Unthrifty trees are heavily infested, most of the leaves being almost skeletonised.

Miresa melanosticta, Baker. A minor pest of the African almond. The large green slug-like larvae with lateral tubercles are not easily detected in spite of their size. They have the peculiar habit of arranging themselves in circles on the leaves, their heads facing inwards. Pupation takes place in the soil in a hard round cocoon, with a distinct lid.

Cirina forda, Westw. The larvae feed on young casuarina trees (*Casuarina equisetifolia*) and are easily detected by their conspicuous yellow markings. Pupation takes place in the soil at a depth of about 3 inches. Another food-plant is the naseberry.

Asura saginaria, Wlk. The larvae of this moth have have been taken occasionally on cinnamon trees, but it is quite a minor pest.

Rhynchota.

Pseudococcus obtusus, Newst. When in poor soil casuarina trees are often heavily infested with this scale-insect, the lower branches being principally attacked.

Aspidiotus (*Pseudaonidia*) *trilobitiformis*, Green. Many rubber trees (*Ficus elastica*) are heavily infested with this Coccid.

Dysdercus superstitiosus, F. The open bolls of the silk-cotton tree (*Eriodendron anfractuosum*) are often attacked by this common cotton-stainer, and *D. fasciatus* is found in conjunction with it.

INSECTS AFFECTING TIMBER.

Coleoptera.

Macrotoma palmata, F. The larvae of this Longicorn are a serious pest in the mangrove wood rafters in native huts. On one occasion several larvae were extracted from large tunnels which they had made in a piano case. Numbers have been found in the field in old dead mango stumps.

Dinoderus minutus, F. Extremely common and destructive to dried bamboo and a very serious pest. Adults have been found in Madagascar teak, a slight attack. On one occasion the bark of an avocado pear (*Persea gratissima*) was found to be heavily infested with it.

Isoptera.

Termes bellicosus, Smeath. Ubiquitous in its distribution, the white ant is the worst timber pest of the two islands. Imported European soft woods are reduced to ruin in a few years, though Indian teak is rarely attacked. The structural timber of the native huts (mangrove, *Ceriops candolliana*) and the roofing made of plaited coconut leaf are often attacked.

Termites have been reported as injuring the following living trees :—Seed and seedling coconuts, young avocado pears (the roots badly attacked), and cloves.

INSECTS INJURIOUS TO MISCELLANEOUS PLANTS.

Lepidoptera.

Thalassoides digressa, Walk. The larvae occasionally feed on the leaves of the castor plant.

Duomitus capensis, Wlk. The larvae have been found tunnelling in the main stem of the castor plant.

Brithys pancratii, Cyr. The caterpillars are voracious feeders on all species of lilies; when young they are gregarious and feed under the epidermis of the leaf, later they separate and devour the whole plant. Pupation takes place in the soil or at the base of the leaves, the pupal stage averaging from 8 to 10 days.

Euchromia formosa, Guér. The larva is clothed with tufts of hairs, dull-coloured and inconspicuous, and forms a cocoon of silk and hairs on the branches of the food-plant. It is common on all species of creepers belonging to the genus *Ipomoea*.

Glyphodes sericea, Drury. The larvae are common on gardenias. Adult larvae are of a transparent green colour with four black spots on the dorsum. They are leaf-rollers and live and pupate in twisted leaves, their pupal stage averaging 9 days.

Coleoptera.

Entyposis impressa, Kolbe. Larvae of this weevil have been recorded as feeding on the roots of castor plants and caladiums.

Brachycerus atrox, Gerst. Great numbers of adult weevils have been taken in the soil around the tubers of lilies (*Amaryllis* sp.). During the day they hide in burrows near their food-plant and come out to feed on the leaves at night. Larvae feed on the tubers, eating into the centre.

Mausoleopis amabilis, Schaum. Adults of this Cetoniid are common in the blossoms of various ornamental plants, especially roses.

Rhynchota.

Aspidiotus (*Chrysomphalus*) *aonidum*, L. A common scale-insect on rose stalks.

Pseudococcus virgatus, Ckll. Has been recorded from various ornamental creepers, etc.

Orthoptera.

Chrotogonus hemipterus, Schaum. A very troublesome grasshopper; one experimental field of castor was ruined by its depredations.

INSECTS INJURIOUS TO STORED PRODUCTS.

In the tropics, where food is abundant throughout the year, insects attacking stored grain are more in evidence than in Europe. Owing to the custom of storing grain in loose receptacles and exposing it in open bins for sale nearly every sample showed evidence of insect attack.

Coleoptera.

Calandra oryzae, L. This cosmopolitan pest of grain is extremely common in rice, and is also found in maize and sorghum.

Laemophloeus pusillus, Schönh. Very abundant in maize.

Tribolium castaneum, Hbst. Common in maize and occasionally found in rice.

Silvanus surinamensis, L. Abundant in maize.

Tenebroides mauritanicus, L. An occasional pest of maize.

Bruchus chinensis, L. A serious pest of all beans and pulses. Numbers are always to be found in *Phaseolus mungo* and *Cajanus indicus*.

Bruchus ornatus, Fhs. Not so common as *B. chinensis*, but has been recorded from beans.

Carpophilus humeralis, F. Very common in maize cobs in the field, generally in those attacked by fungus.

Cossonus suturalis, Boh. An occasional pest of stored sweet potatoes.

Dermestes vulpinus, F. Abundant in dried fish.

Latheticus oryzae, Waterh. An occasional pest of maize.

Rhizopertha dominica, F. Occasionally in maize.

Necrobia rufipes, de G. Both larvae and adults are abundant in dried copra, feeding on the kernels; the former bore long cylindrical tunnels into the dried copra.

Lepidoptera.

Ephestia cautella, Wlk. Larvae very common in rice and various flours.