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AN INSECT SURVEY OF THE MARSHALL ISLANDS

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ABSTRACT

A survey has been made of insects infesting crops in the Marshall Islands. The coconut scale, *Aspidiotus destructor*, is a major problem on coconut and breadfruit on Majuro and Likiep, and is reported to be present on other atolls. Lady beetles, *Pseudoscymnus anomalus*, were not found and should be released on all atolls where the coconut scale is present. Many other species of scale insects, as well as mealy bugs, aphids and spider mites were found to be damaging on a wide range of crops. Many were recent introductions. Altogether, 21 pest species were found that are new to Jaluit and Majuro. Of these, 12 are new to the country since 1975. Majuro and Kwajelein are the likely points of entry.

The rate at which insects are entering the Marshall Islands is cause for concern. It appears that they are entering on plant material and aboard aircraft. An urgent review of quarantine procedures is required. Particular attention should be given to the issue of permits, whether the interior of aircraft cabins should be sprayed, maintenance of records dealing with the introduction of biological control organisms, ways to deal with new pest infestations, inter-island quarantine, quarantine training and the appointment of a plant protection officer.

The insects recorded in the Marshall Islands are tabulated alphabetically, and also according to host plant. Information is provided on the biology and control of 40 of the most important insect pests and one spider mite.

RÉSUMÉ

Une étude des insectes qui infestent les cultures aux Îles Marshall a été réalisée. La cochenille du cocotier, *Aspidiotus destructor*, constitue un grave problème pour le cocotier et l'arbre à pain à Majuro et à Likiep, et sa présence a été signalée sur d'autres atolls. Il faudrait lâcher la coccinelle *Pseudoscymnus anomalus*, absente des zones étudiées, sur tous les atolls touchés par la cochenille du cocotier. Il a été constaté que plusieurs autres espèces de cochenilles, des cochenilles blanches, des pucerons et des tétranyques causent des dégâts à un large éventail de cultures. Certaines espèces ont été introduites récemment. Au total, 21 nouvelles espèces d'ennemis des cultures ont été découvertes à Jaluit et à Majuro, dont 12 sont apparues dans le pays depuis 1975. Majuro et Kwajalein sont les points d'entrée probables.

Sans doute introduits sur des végétaux et à bord des avions, ces insectes pénètrent aux Îles Marshall à un rythme inquiétant. Un examen urgent des procédures phytosanitaires s'impose. Il conviendrait d'envisager la désinsectisation des avions et d'accorder une attention particulière à la question de la délivrance d'autorisations, au bon enregistrement des mesures d'introduction d'organismes de lutte biologique, aux méthodes de lutte contre les infestations par de nouveaux ravageurs, de la réglementation phytosanitaire inter-îles, à la formation aux procédures phytosanitaires et au recrutement d'un spécialiste de la protection des végétaux.

Les insectes dont la présence a été relevée aux Îles Marshall sont présentés dans des tableaux par ordre alphabétique et aussi en fonction de la plante-hôte. Des informations sont fournies sur la biologie des 40 espèces de ravageurs les plus importantes et d'une tétranyque, et sur les méthodes de lutte contre ces ennemis des cultures.

CONTENTS

1. INTRODUCTION

A visit was made to Marshall Islands from 20 to 30 June 1989 to examine scale insect problems on coconut and breadfruit, and to conduct a crop pest survey. While there, several other insect problems were investigated, including 'white scales', and a termite and ant problem.

Most of the visit was spent on Majuro, but survey work was also done in the main village on Jaluit (24 June) and on Binglap (25 June). A three-hour visit was also made to Likiep Atoll (27 June) to examine scale insects on breadfruit and coconut.

This report covers the second insect survey done in Micronesia by the author. In 1986, surveys were made in the Federated States of Micronesia and Palau[1].

2. SUMMARY OF RECOMMENDATIONS

2.1 Quarantine and new insects: need for review

Insects are entering the Marshall Islands in alarming numbers on plant material and in aircraft. An urgent review of the Marshall Islands quarantine system is required. Quarantine inspections at major ports of entry may need to be strengthened. Quarantine rules must be applied equitably. All inspectors need to be well trained and motivated.

2.2 Quarantine: permit system

Officials in the Marshall Islands reported that there is a permit system for bringing plant and animal material into the country. This system needs to be reviewed for legal adequacy, penalties for violations, and its applicability to all persons. The training needs of the those administering the scheme should be reviewed. If the risks of allowing entry of particular plants or animals cannot be determined, advice should be requested from the SPC Plant Protection Service, Fiji, the US Department of Agriculture, Honolulu, or the Hawaiian Department of Agriculture. A policy requiring aircraft to be sprayed should be considered.

2.3 Quarantine: entry of biocontrol agents and record keeping

Records for the entry of biocontrol organisms need to be maintained. At a minimum, information on the species introduced, the target pest or pests, the numbers of insects released, the release area(s), and the origin of the beneficial species should be kept. Records should be kept of species introduced into the Marshall Islands as well as those moved between islands. Voucher specimens of the biocontrol agent and the target pest should be sent to repositories in New Zealand (Manaaki Whenua Landcare Research, Auckland), or the United States (Bishop Museum, Honolulu or United States National Museum, Maryland).

2.4 Quarantine: training

The training of quarantine officers should be reviewed. At a minimum, they should attend courses in entomology, plant and animal pathology, economic botany, and the laws and purpose of quarantine. Training could be obtained in Honolulu or possibly through regional institutions. Although staff training is expensive, the costs resulting from the introduction of a single serious pest can far exceed training costs. Preventing the entry of pests will result in major savings.

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[1] Nafus, D.M. 1996. *Report of an entomological survey of the Federated States of Micronesia and Palau.* South Pacific Commission, Noumea, New Caledonia.

2.5 Plant protection responsibilities

An individual should be designated as plant protection officer. This need not be the officer's full-time duties, but there should be sufficient time and funds to visit and train farmers and extension agents on the different atolls. Also, the officer should have sufficient expertise to identify important pests in the Marshall Islands, other important pests in the region and elsewhere, and to receive, introduce, transfer and monitor the establishment of beneficial organisms. A degree in agriculture with training in horticulture, entomology and plant pathology would be a desirable qualification for such a person. Preferably, the person should have good command of Marshallese. It is not recommended that a quarantine officer fill this role. One person could not carry out the duties of plant protection and quarantine, and if he/she attempted to do so there would be the potential for a conflict of interest. Quarantine officers should not have the responsibility of approving biocontrol introductions.

2.6 Quarantine: dealing with new pest infestations

A programme needs to be established which would monitor coconut scale infestations and transfer biological control agents. A public education programme is required that would provide information about the scale, and the need for care when plants are introduced into the country or moved between atolls.

2.7 Quarantine: inter-island

An inter-atoll quarantine system should be developed. This might involve either a mandatory or a voluntary inspection of plants and plant material. If such a system of controls was to be introduced, it would have to be done together with a programme designed to convince the public of the need and the benefits to be gained.

3. OUTBREAK OF COCONUT AND BREADFRUIT SCALES

3.1 Infestation of coconut scale, *Aspidiotus destructor*, Majuro

The coconut scale, *Aspidiotus destructor,* recently entered the Marshall Islands and is present on several atolls. On Majuro and Likiep, large populations are infesting breadfruit and coconut.

3.1.1 Methods of survey

Populations of scale insects were surveyed to determine the extent of the problem. Surveys were done on two crops, coconut and breadfruit. Searches were also made for parasitoids and predators. A number of trees of both species were randomly selected and searched at several sites. On each coconut, 50 leaflets were examined, and on breadfruit trees, 20 leaves; the approximate area of scale-insect colonies was determined and the presence of predacious lady beetles noted. Samples from randomly-selected colonies were collected and preserved for later examination. In the laboratory, these colonies were examined under the dissecting microscope and more accurate records were made of the number of coconut scales per unit area, parasitoids, predacious mites and the larval stages of other predators. This information was then combined with the field data to estimate the numbers of insects present on the trees.

3.1.2 Results: breadfruit survey

On Majuro, the coconut scale was present over most of the atoll. Infestations were most severe between the airport and Laura, but less intense from the airport to Rita. At Laura, the undersides of breadfruit leaves were often completely covered with coconut scales. Estimated populations of scales were about 50,000 per leaf (Table 1). Many trees had dropped their leaves and were in poor health. Some trees had died. In the area between the airport and Laura, populations were only slightly lower, averaging around 30,000 scales per leaf.

Table 1. Numbers of coconut scales, *Aspidiotus destructor*, on breadfruit leaves at various sites on Majuro

Site	No. of trees sampled	No. of *Aspidiotus* per leaf	No. of *?Pharellus* per leaf	No. of *Chilocorus* per leaf	No. of leaves sampled/tree
Rita	5	2,700	0.31	0.03	20
Delap	5	10,800	0.40	0.00	20
4 miles from airport	1	34,200	5.80	0.00	10
Laura	2	48,400	2.33	0.00	20

In the region between the airport and Rita, the infestation was much lower, averaging less than 11,000 scales per leaf. The predatory coccinellid, *Chilocorus nigritus,* was present throughout this area, but absent between the airport and Laura. This lady beetle, along with a second species, *Pseudoscymnus anomalus*, had been introduced earlier by Dr Nelson Esguerra, College of Micronesia, Pohnpei. *P. anomalus* was not found at the time of the survey, although a another lady beetle, *?Pharellus* , was present and widely distributed. Its numbers were highest in the region from the airport to Laura, but it was unclear if it was having any impact on scale populations. On one tree, there were on average 5.8 beetles per leaf, but scale populations were still over 34,000. In all areas, parasitoid larvae and pupae were found inside the coconut scales, but the rate of parasitism was low, averaging less than two per cent.

3.1.3 Results: coconut survey

Infestations on coconut were generally less severe than on breadfruit. Some coconuts, particularly those near the beach, were lightly attacked or free of coconut scale. Those in the interior were generally more heavily attacked. As with breadfruit, the infestation was most severe in the Laura area, where the population averaged over 2,000 scales per leaflet. In other areas the problem was less severe, with infestations reaching only slightly over 300 scales per leaflet (Table 2).

Table 2. Estimated numbers of coconut scales, Aspidiotus destructor, on coconut leaves at various sites on Majuro

Site	No. of trees sampled	No. of *Aspidiotus* per leaf	No. of *?Pharellus* per leaf	No. of *Chilocorus* per leaf	No. of leaves sampled/tree
Rita	5	290	0.032	0.008	50
Reimers	10	115	0.082	0.004	50
Delap	5	1	0.000	0.010	50
Airport	3	300	0.007	0.033	50
2 miles from airport	5	0	0.000	0.000	50
4 miles from airport	5	335	0.012	0.000	50
Laura	5	2,365	0.200	0.000	50

Both *Chilocorus nigritus* and *?Pharellus* were present on coconut. It is likely that *C. nigritus* prefers coconut to breadfruit. Where both types of trees were sampled, it was more consistently found on coconuts.

The other lady beetle, *?Pharellus,* was less common. Again, it was most abundant where scale populations were highest.

On coconut, the levels of parasitism were higher. The average was 13 per cent, with up to 26 per cent on some leaflets. In addition, a predatory mite was found under the scale cover, but this was not reared and remains unidentified. It is likely that the parasitoids are contributing to the lower incidence of scales on coconut compared to the breadfruit, although host preference may also be a contributing factor.

3.1.4 Biological control agents

The lady beetles, *Pseudoscymnus anomalus* and *Chilocorus nigritus*, were released in January 1986 in Laura and at other locations by Dr. Nelson Esquerra. *C. nigritus* has established and was found in low numbers at sites from Rita to the airport. Both adults and larvae were found. No beetles were found in the area from the airport to Laura. Most of the beetles were found on coconut.

P. anomalus was not found. This species is more specific to the coconut scale and should be released on all atolls where the coconut scale is present. *C. nigritus* is less host specific and will attack other scales.

A local lady beetle, probably a *Pharellus* species, was very abundant throughout the atoll. Superficially, this beetle resembles *P. anomalus*, but it is smaller and differs in a number of details which can only be detected under high magnification. Densities of up to 23 beetles per leaf were found on breadfruit. The impact of this species on coconut appears to be minimal.

3.2 Infestation of coconut scale, *Aspidiotus destructor*, Likiep

The coconut scale was extremely abundant on breadfruit on Likiep. Most of the breadfruit trees, except for a few at the village boundary, were heavily infested. The undersides of nearly all the leaves were completely covered with scales and there were even a few on the upper surfaces. Many of the leaves were yellow and both leaves and fruit were falling prematurely. Branches were also dying, and many were infested with cerambycid beetles or other wood-boring species. If the scale is not brought under control soon, trees will die. On coconut, the problem was not quite as severe, although a few trees were heavily infested and in poor health. The scale was also abundant on papaya and some other trees.
The coconut scale is also reported to be a problem in Wotje Atoll. However, this was not verified. The Marshall Islands will continue to have a problem with this scale, as it is moved from atoll to atoll, for some time to come. Plans to deal with this problem must be made and implemented.

3.3 Infestation of coconut red scale, *Furcaspis oceanica*, Majuro

The endemic coconut red scale, *Furcaspis oceanica,* was common on coconut. This scale is found on the undersides of the leaves, and on the flower spikes and fruits. It was distributed throughout the island, but generally infestations were low, although occasionally, trees could be found with leaves that were completely covered with scales.

Most of the heavily-infested trees were located near dusty roadsides. The undersides of the leaves bore a substantial coating of dust, which may have been interfering with parasitoids.

In the Caroline Islands, *F. oceanica* is attacked by the wasp, *Adelencyrtus oceanicus*, which is native to Micronesia, and generally keeps the scale at non-damaging levels. Two species of hyperparasite attack it. Dr Muniappan, University of Guam, is not certain that the parasitoid is in the Marshall Islands.

4. CROP SURVEY, MAJURO

The most intensive part of the survey concentrated on Laura experimental farm and the Laura area. Banana, breadfruit, chili pepper, coconut, corn, cucumber, eggplant, guava, head cabbage, lime, papaya, pumpkin,

radish, soybean, sweet potato, taro and yard-long beans were all sampled. Some non-crop plants which are known hosts of crop pests were also examined.

Outside Laura, the survey concentrated on banana, breadfruit, coconut, pandanus and papaya, as these were the predominant food plants. Lists of pests associated with the crops are given in Sections 7 and 8.

A high percentage of the insects that were previously reported from Jaluit and Majuro (26 of 34 species) was recorded during the present survey. A total of 21 new records was found. These do not include the ant, *Anoplolepis longipes*, for which distribution records are not available. Nine of the new records are due to inter-atoll movements of insects previously found in the Marshall Islands, but on atolls other than Majuro and Jaluit. The remaining 12 are new to the Marshall Islands since 1975. Majuro acquired 17 new records and Jaluit nine. This corresponds to an average of 1.2 new pests per year for Majuro and 0.6 per year for Jaluit. These rates are similar to those for Guam, which has, on average, 1.5 new introductions per year, but more air traffic. It is likely that Majuro and Kwajelein are major entry points for new insects. Once established there, the insects spread to the other islands.

Details on the biology and control of many of these new insects and some of the crop pests are given below.

The most serious pests in the Marshall Islands are coconut scale, *Aspidiotus destructor*, on breadfruit (Majuro, Likiep, and possibly other atolls); spider mites, *Tetranychus* spp., on a wide variety of crops (Majuro); Egyptian fluted scale, *Icerya aegyptiaca*, on breadfruit and ornamentals (Jaluit); termites and the ant, *Anoplolepis longipes*, (Jaluit); inornate scale, *Aonidiella inornata*, on papaya (Majuro); pineapple mealybug, *Dysmicoccus cocotis*, palm mealybug, *Palmicultor palmarum* and coconut red scale, *Furcaspis oceanica*, on coconut (Majuro); orchid mealybug, *Pseudococcus orchidicola*, on *Pandanus* (Majuro, Jaluit); green shield scale, *Pulvinaria psidii*, and urbicola soft scale, *P. urbicola*, on peppers and *Plumeria* (Majuro, Jaluit). There are also several potentially serious pests on sweet potato, but this is not an important crop in the Marshall Islands at this time. Cowpea aphids, *Aphis caraccivora*, can also be a seasonal problem on beans and the bean leaf roller, *Lamprosema diemenalis*, is a pest on soybeans (Majuro), but these are minor crops.

4.1 Breadfruit

A number of insects feed on breadfruit, but only three were abundant enough to cause problems. The main pest was the coconut scale, *Aspidiotus destructor*, for which coccinellid predators have been introduced. Two other important pests were an unidentified cerambycid beetle and the Egyptian fluted scale, *Icerya aegyptiaca*. This was common in some restricted areas and most likely represents a temporary problem. It is attacked by the lady beetle, *Rodolia pumila*, which was found on Majuro and was present at low levels in the outbreak areas. This lady beetle should control these infestations.

Larvae of a cerambycid beetle were found boring in dead or dying limbs of breadfruit which were heavily infested with scale insects. Adults were not found and the beetle could not be identified. It is probable that it is a secondary pest. Primary damage is caused by the coconut scale and the weak or dead branches are then invaded by cerambycids. Most beetle larvae were on trees with heavy infestations of coconut scale. In areas such as Rita, the cerambycid was less of a problem.

The pink wax scale, *Ceroplastes rubens*, was found on Majuro and Likiep for the first time. Previously, Beardsley (1975) reported it from Kwajalein. Evidently it is now spreading to several of the atolls. Densities are not high enough to be damaging at present, but this situation needs to be watched. At Rita, the scales were parasitised, so it is possible that the scale may never be a major problem. On Likiep, the scale was also heavily parasitised.

The mango fruitfly, *Bactrocera frauenfeldi*, attacks ripe breadfruit and is reported to be in the Marshall Islands. It was not found during the survey, but there was no attempt to trap it. It is an important species and one of quarantine significance if breadfruit were to be exported, but of no consequence for processed fruit.

4.2 Papaya

The most serious problem on papaya was the inornate scale, *Aonidiella inornata*, which exhibited heavy infestations on the bark and leaves. In Taiwan, this scale has caused serious damage to certain varieties of papaya. It can infest the fruit, ruining its market value. It can also cause premature death of the plant. In Laura, high densities of the scale were observed on some of the older trees, and natural enemies were found. The variety being grown appeared to have good tolerance to the infestation, despite the bark of the old trees being almost completely covered by scales. If plans to export papaya proceed, farmers should be advised about this scale. It could become a serious problem. It is suggested that old plants, past their peak, be cut down and destroyed. Wild or volunteer papaya should also be destroyed.

Spider mites, *Tetranychus* sp., were also common on papaya. At times, these can become serious pests, causing drying of the leaves and premature leaf drop. Chemical control may be necessary. Biological control using imported predatory mites may reduce populations to a level where chemical control is unnecessary.

On Jaluit, the long brown scale, *Coccus longulus*, was common on papaya, but was heavily parasitised. Densities of the scale were too low to warrant control. Other insect problems were minor. The melon aphid, *Aphis gossypii*, is widely distributed in the Marshall Islands. Care should be taken when importing papaya to make sure that ringspot and papaya mosaic viruses are not accidentally introduced, as this aphid is the vector of both of them.

4.3 Lime

Several species of insects were present on lime, but none were abundant and causing problems. A few of the pests attacking lime (Section 7) have very restricted distributions. The orange tip moth, *Adoxophyes fasciculana*, is only on Eniwetok and the California red scale, *Aonidiella aurantii*, potentially a very serious pest, is only reported from quarantine interceptions from Bikini. Neither were found during the survey.

Purple scale, *Lepidosaphes beckii*, was found on lime in low numbers on Majuro. Previously, this species has been reported from quarantine interceptions from Kwajalein. It was not a problem at the time of the visit.

Planococcus sp. was found in low numbers on lime on Binglap, Jaluit. Previously, *Planococcus* has been reported only from Kwajelein. It is not certain whether the species is *P. citri* or *P. pacificus*. These two mealybug species are very difficult to distinguish as they are closely related and *P. citri* is variable.

4.4 Coconut

There is a long list of insects associated with coconut. Several of these were present in damaging numbers. Excluding the coconut scale and coconut red scale, the major pests were the mealybugs, *Dysmicoccus cocotis* and *Palmicultor palmarum*. *P. palmarum* was often found infesting the flower spikes and young fruits and was present in large numbers. It was also present in leaf axils, on the support spikelets and young fruits. *D. cocotis* was also found in these sites, often intermixed with *P. palmarum*, but it was less commonly found on the flowers. Armoured scale, *Lepidosaphes esaki*, was found on most coconuts, but was never sufficiently abundant to be a problem. It was most common on green fruit and at the base of the petioles. At Laura, on Majuro, a spider mite was abundant on some coconuts and many of the leaves were chlorotic. The undersides of the leaves were covered with white stippling and webbing.

4.5 Sweet potato

Sweet potato is a relatively minor crop on Majuro. It was being grown at the experimental farm at Laura and appeared to be doing well. This crop has several pests, most of which are new to Marshall Islands. Both the sweet potato hornworm, *Agrius convolvuli*, and the black garden fleahopper, *Halticus tibialis*, have been previously reported. Both species feed on leaves. The hornworm was very rare. By contrast, the fleahopper

was common, but was not causing significant damage. At times, however, the fleahopper can be very abundant in Micronesia and causes extensive leaf chlorosis.

The number of new pests found on sweet potato was surprisingly high. The sweet potato flea beetle *Chaetocnema confinis*, the green tortoise beetle, *Metriona circumdata*, the sweet potato weevil, *Cylas formicarius*, and a spider mite, *Tetranychus* sp., were found on either sweet potato or other *Ipomoea* species, such as beach morning glory. Adult *C. confinis* chew track-like holes in the leaves. The larvae tunnel in the roots, damaging the plants and reducing yield. They are a serious problem in the southern United States. This species is relatively new to Micronesia, apparently spreading from Hawaii. The green tortoise beetle has long been found in the Mariana Islands and has spread recently throughout the Caroline Islands. Both the larvae and adults feed on the leaves. On Pohnpei, it was observed to defoliate sweet potato fields, but on other islands, including Guam, populations do not occur at damaging levels. The sweet potato weevil is a serious pest. The larvae tunnel in the stems and tubers, rendering the tubers inedible. The weevil was only found in the Rita area on beach morning glory.

Spider mites are not listed in the reports of the Trust Territory Entomologists as being present in the Marshall Islands . In addition to sweet potato, they were found on a wide variety of plants, including taro (*Colocasia esculenta*), corn, eggplant, yard long beans, papaya and coconut. On several of these hosts, they were present at damaging levels. The possibility of introducing biocontrol agents for these mites should be considered.

4.6 Banana

The banana aphid, *Pentalonia nigronervosa*, was found on Majuro on nearly half the pseudostems searched. This aphid has been reported previously from the Marshall Islands, but not from Majuro. Its primary significance is its potential to transmit banana bunchy top virus. Extreme caution must be taken when importing banana corms or other planting material known to host this aphid.

A number of other insect pests were found on banana in the Marshall Islands, but most were causing little damage. The coconut scale was common and caused some damage in the Laura area, but not elsewhere. Several mealybug species occur on banana and are sometimes abundant on fruits, but at the time of the visit they were uncommon and were not causing any damage.

4.7 Pandanus

Several species of insects were associated with *Pandanus*, the most important being mealybugs infesting the fruit. The mealybug found most frequently was *Pseudococcus orchidicola*, which was present on the fruit in cracks and crevices, and on the stems in the leaf axils. On some plants, it was fairly abundant, but in most cases it occurred in low numbers. Local informants said that large populations of 'white bugs', presumably this species, affect the quality of the fruit. *Lepidosaphes esakii* was also present on many plants, on the leaves, stems and fruits, but it was not sufficiently numerous to cause any damage.

4.8 Beans

A leafroller, *Lamprosema diemenalis*, was found defoliating soybeans. The larvae fold leaves, fastening them together with silk or web, and skeletonise the leaves as they feed. They were also present on yard-long beans, but not at damaging levels as this is not a preferred host.

A leafhopper, *Empoasca* sp., was found on yard-long beans, but not at levels thought to be economically damaging. *Aphis craccivora* was also present, and, although not abundant at the time of the visit, was reported to be a problem at certain times of the year.

Halticus tibialis was present on the lower leaves. This fleahopper can be very abundant on seedlings, causing chlorosis of the leaves, but is rarely a problem on the upper portions of trellised beans. It is easily controlled with a variety of insecticides.

4.9 Other minor crops

The scale, *Pulvinaria urbicola*, was found commonly on chili pepper, eggplant and other hosts. This scale is new to both Majuro and Jaluit. Previously, another scale, *Chloropulvinaria psidii*, was reported from Jaluit. During the present survey, *C. psidii* was found on *Plumeria* on Majuro.

The white peach scale, *Pseudaulacaspis pentagona*, was present on the bark of bell peppers and on *Plumeria*. This scale is new to the Marshall Islands. Elsewhere, it is a serious pest on a variety of hosts. In Majuro, despite being widespread, it was not numerous on any host and is unlikely to become a problem. The oleander pit scale, *Asterolecanium pustulans*, was also present on the stems of the bell peppers. This scale has previously been reported from the Marshall Islands and is not a serious pest.

Several pest insects were found on corn, the most serious of which was a spider mite, *Tetranychus* sp. Many of the leaves in the outside rows were heavily infested by this spider mite.

The black garden fleahopper and the melon aphid were abundant on cucumber. The melon aphid was being attacked by syrphid larvae, but was still abundant on some plants and causing some leaf distortion. Plants can tolerate a large number of aphids. It is likely that coccinellid lady beetles and syrphids would kill most of the aphids, but cucumber needs to be monitored carefully. The use of pesticides should be avoided so as to encourage predators.

4.10 Other pests

The butterfly, *Badamia exclamationis*, was found on Majuro for the first time. This butterfly is not an important pest since the larvae feed on Indian almond, a rare tree on Majuro. It does, however, suggest that adult insects are moving into the Marshall Islands aboard aircraft, as it is unlikely that larval or egg stages could have been introduced this way.

Another new pest is an unidentified snail apparently introduced into the Laura area as a potential food. This species was introduced without review of its pest potential and is now spreading. It is reported to be damaging vegetables and new seedlings. An identification of this species is not yet available.

4. 11 Fruit flies

A search was made for fruit flies during the survey but no traps were set. No dacine fruit flies were found on Majuro or Jaluit. *Bactrocera frauenfeldi* is reported from the Marshall Islands on several of the atolls, including Majuro. Its hosts are breadfruit, *Eugenia*, guava, mango, tangerine and some other fleshy fruits. It is not reported from papaya. However, it may be necessary to prove that it does not attack papaya in the Marshall Islands if fruits are to be exported to Japan.

5. CROP SURVEY, JALUIT

5.1 Crop pests

There were few pests on crops on Jaluit. The main problems were *Icerya aegyptiaca*, *Chloropulvinaria psidii*, *Pulvinaria urbicola*, termites and an ant.

The coconut scale was not present, but another new scale, *Eucalymnatus tessellatus*, was found in low numbers on coconut and *Pandanus*.

I. aegyptiaca was very abundant on breadfruit and several other hosts. The lady beetle, *Rodolia pumila*, repeatedly introduced to the Marshall Islands, was not found, although it may be present at low levels. It is common on Majuro and Likiep. It should be imported from Majuro and released.

C. psidii has been reported previously from Jaluit. It was common on *Plumeria* and *Morinda citrifolia*. On *Plumeria*, *P. urbicola* was also present and both species were sufficiently abundant for the leaves to be covered in sooty moulds.

5.2 Non-crop pests

Termites are a problem on Jaluit and an ant is present on Binglap. The ant, *Anoplolepis longipes*, is extremely abundant. It does not bite, but it is numerous and crawls over people and is a constant annoyance. The island, formerly a centre for copra and other agricultural production, is now uninhabited due to the ant. In Jaluit, the ant is currently restricted to Binglap, but might be a major problem if it is introduced to other islets. The ant was also found on *Pandanus* near the airport on Majuro tending mealybugs, but was not abundant. It has become a problem in other parts of the world after introduction, but after some time populations decline. This may happen on Binglap. Eradication is not a practical option.

6. PEST INFORMATION AND CONTROL PROCEDURES

This section gives information about the biology and control of selected pests.

6.1 *Agrius convolvuli* – sweet potato hornworm

This is a large, greyish, moth with a thick, heavy, body. The wings are long and triangular. The abdomen has alternating stripes of pink and grey on top. The stripes are covered by the wings when the moth is resting. Eggs are laid singly. There are five larval instars, each with a horn at the rear end. The larvae are generally green, but become brown when they are ready to pupate. Pupation takes place underground in a soil chamber. The larval period lasts 3–4 weeks, and the pupal period 2.5–3.5 weeks. The adults fly at night and feed on flowers, particularly those with long calyces. The larvae feed on the foliage of sweet potato, and in some cases, beans.

A. convolvuli is widely distributed and is found in Africa, Asia, Australia, Europe and Micronesia.

In Guam, the sweet potato hornworm is heavily parasitised by egg parasites, primarily *Trichogramma chilonis*, and is rarely abundant. Populations were very low in the Marshall Islands at the time of the survey.

6.2 *Aleurodicus dispersus* – spiraling whitefly

The spiraling whitefly attacks over 100 plant species, including many fruit trees and ornamentals. Favoured hosts are coconut, guava, *Plumeria* and sea grape. The adult whitefly is a small, dusty-white, insect which resembles a tiny moth. Adults are frequently found on the underside of leaves together with immature stages. The latter, called nymphs, are small and white, and covered with waxy secretions. Long, curving, white threads extend beyond the shining, white waxy, covering of the body. The eggs are laid on the lower side of leaves in a characteristic spiral pattern which gives the whitefly its name.

Spiraling whiteflies can be extremely abundant and can cover the entire lower surface of leaves. They suck sap and reduce plant vigour. They also make the plants unsightly by secreting honeydew. Sooty mould grows on the honeydew and forms a black crust on the upper surface of the leaves. Heavy infestations can reduce crop yields.

Biological control offers the best method of control. Two natural enemies have been used: the ladybird beetle, *Nephaspis oculatus*, and the wasp, *Encarsia ?haitiensis*. Home owners can reduce damage from the whitefly by keeping their plants healthy (fertilizing and watering as needed) and by pruning areas where foliage is dense to lessen the amount of shelter for the whiteflies. If insecticides are necessary, malathion and detergent can be used. Care should be taken to prevent the spread of this insect. People should be encouraged not to transport infested plants from one island to another.

6.3 *Aonidiella aurantii* – California red scale

Adult females are semicircular, reddish, scales about 1.8 mm x 1.5 mm in diameter. The male scale is smaller, 0.9 x 0.6 mm, and moults to a free-flying adult. Females give birth to first instars called crawlers, two or three each day. They can be dispersed on nursery stock, by winds blowing them from plant to plant, or occasionally on birds or even insects. Once on the host plant, the crawlers wander until they find a suitable spot. They then insert their mouthparts and suck sap. Once settled, they do not move again. Females produce about 150 offspring over 2 months.

The scale attacks breadfruit, citrus, coconut and many other species of trees and shrubs. Citrus is the preferred host. The scale is found on all aerial parts of the host. Heavily-infested leaves become yellow and are shed. Twigs and branches may die back and young trees may be killed. Infested fruit may be tough and pitted, remain small, or fall off. The scale has toxic saliva, and causes a small, yellow spot immediately around the scale on some hosts. This is one of the most serious pests of citrus.

The scale is found throughout the tropics and sub-tropics. In Micronesia, it has been reported from the Mariana Islands and from quarantine interceptions from Bikini in the Marshall Islands. However, no specimens have been collected and verified.

If the quality of fruit is a concern, and if more than a quarter of fruit have at least one scale, then spraying with diazinon or malathion in water, with added white oil, is recommended. It is doubtful that control is necessary if this scale is present in Micronesia. It appears to be rare. Several parasites attack it, including *Aphytis chrysomphali* and *A. lingnanensis*. It is also attacked by several species of coccinellids, including *Rhyzobius satelles*.

6.4 *Aonidiella inornata* – inornate scale or papaya red scale

The adult female is covered by a translucent, circular scale composed of wax. The body can be seen under the scale cover, which has a slight yellowish or brownish cast. Old scale covers are retained and are more or less centrally placed on top of the latest scale cover. Males are smaller than females, yellow-brown, and elongate-oval. Eggs are laid under the scale cover. The scales are sessile after the crawlers settle. There are three moults. Adult males are free-flying.

Hosts of the scale include: banana, breadfruit, citrus, coconut, *Pandanus*, papaya, *Plumeria* and a variety of other trees and ornamentals. The scale occurs on the stems, leaves or fruits. Damage has been reported from Taiwan on sunrise solo and kapoho solo varieties of papaya. On these, the scales reduce the market value of the fruits, weaken the trunks, occasionally causing them to break, and generally reduce tree vigour. Crawlers are most abundant during the period of fruit set. The scale was extremely abundant on papaya in the Marshall Islands at the time of the survey, often completely covering the stem.

The scale has been reported from China, the Philippines and the South Pacific. It is widely distributed in Micronesia. In the Marshall Islands, it has been found on Ailinglapalap, Jaluit, Kwajalein, Lib and Majuro.

Malathion (0.1 per cent) or dimethoate (0.05 per cent) applied at 10-day intervals will control the scale. A sticker or detergent should be added to aid penetration of the scale cover.

6.5 *Aphis craccivora* – cowpea aphid

This aphid is mainly found on legumes, but is polyphagous and can also be found on many other crops. It is a large species, up to 2 mm long, black or brown, with dark cornicles. The nymphs are also dark and have a roundish body shape.

The aphid can be extremely numerous on yard-long (*Vigna* sp.) and *Phaseolus* beans. The pods can be covered with aphids. Wilting can occur in hot, dry weather if populations are high. Plants can usually

tolerate large numbers of aphids and treatment is rarely needed unless virus diseases are present. This aphid is known to transmit at least 14 viruses.

The aphid is present throughout Micronesia and much of the rest of the world. In the Marshall Islands, it has been found in Ailinglapalap, Arno, Eniwetok, Kwajalein, Lib and Majuro.

Outbreaks are generally kept under control by natural enemies. Large infestations are generally controlled within 1–2 weeks. If chemical control is necessary, carbaryl or dimethoate can be used.

6.6 *Aphis gossypii* – melon aphid

The melon aphid is highly polyphagous and commonly found on citrus, cucumbers, eggplant, legumes, melons and taro. Adults are yellow to dark green with a black head and black cornicles. They are found on the undersides of leaves or on young shoots and feed on the sap. This species transmits over 40 virus diseases, including dasheen mosaic virus.

The aphid can be present in large numbers, particularly in dry weather. On taro, it can cause the leaves to wilt and curl downward if populations are high. Generally, populations are controlled by predators such as coccinellid beetles and syrphids.

This aphid is found throughout the world. In the Marshall Islands, it is reported from Ailinglapalap, Arno, Eniwetok, Jaluit, Kwajalein, Lib, Likiep, Majuro, Namu and Ujae.

Chemical treatment is usually not necessary unless virus is present. If treatment is required, diazinon, carbaryl or dimethoate can be used.

6.7 *Aspidiotus destructor* – coconut scale

This is a small, flat, whitish scale with a semi-transparent waxy covering through which the yellowish body can be seen. Females are circular, the males oval. The scale is polyphagous and attacks avocado, banana, breadfruit, cacao, cassava, coconut and other palms, cotton, guava, *Pandanus*, papaya, rubber, sugar cane and tea. It is a severe problem on breadfruit on several of the islands in Micronesia, especially the atolls. It is found underneath the leaves and its position is marked by a yellow, discoulored, spot. Often the entire undersurface of leaves is covered with scales during an outbreak. Heavy infestations on coconut will stunt leaves and arrest nut production.

This scale insect is found worldwide. In the Marshall Islands, it has been recorded from Majuro and Likiep.

Control on young palms can be achieved using an emulsion of soap and kerosene. Malathion can also be used, and is recommended on other plants if chemical control is necessary. On large palms, or trees, chemical control is impractical. Biological control has been used extensively with excellent results and is the preferred method. Coccinellid beetles are the primary biological control agents, but there are also aphelinid wasps, such as *Aphytis chrysomphali*. In Fiji, *Cryptognatha nodiceps* effectively controls the scale. In Vanuatu, *Rhyzobius satelles* and *Pseudoscymnus anomalus* are the principal control agents. The coccinellids, *Telsimia nitida*, *P. anomalus* and *Chilocorus nigritus*, are providing excellent control of *A. destructor* in the Mariana Islands. In the Caroline Islands, *Cryptognatha nodiceps* and *P. anomalus* have been released for biological control.

6.8 *Bactrocera frauenfeldi* – mango fruit fly

This is a black and yellow fruit fly about the size of a housefly. The wings are transparent with two black bands, one through the middle and one close to the body. The thorax is black with two yellow stripes. The larvae are yellowish when older. They tunnel in the fruits of breadfruit, guava, mango, mountain apple (*Eugenia*) and tangerine. Breadfruit is the primary host in Micronesia.

Virtually all fruit flies that have been studied have about the same developmental times: eggs, 1–2 days; larvae, 7–8 days; and pupae 10–11 days at 25°C. These times will vary due to temperature, moisture content of fruit, ripeness, fruit variety and degree of larval crowding. Above 30°C, development slows down and mortality increases.

Fruit flies move readily and migrate long distances. They also have specific diurnal patterns of movement.

Larvae feed on many hosts. However, they need a high-protein diet and rely on bacteria in the fruit to achieve this. The bacteria, which also cause the fruit to rot, are introduced when the fruit is punctured at egg-laying. Most fruits are suitable as food once inoculated, so host specificity is probably due to ovipositional choice. Larvae tunnel towards the centre of the fruit as they mature, ruining its market value. Mature larvae are yellow and can hop. This may be an adaptation to escape ground predators, since the larvae pupate in the soil.

This fruit fly is widely distributed in Micronesia, although it does not occur in the Mariana Islands. It is also reported from Australia, Indonesia, Malaysia, Papua New Guinea and Solomon Islands. It is not reported from Hawaii or mainland USA, and will be of quarantine concern to these countries and the Mariana Islands. In the Marshall Islands, it is reported from Ailinglapalap, Bikini, Jaluit, Kili, Kwajalein, Lib, Likiep, Majuro and Namu.

There are several methods to reduce infestations of fruit flies. General sanitation, including removal and destruction of fallen or infested fruit, will help substantially. Cover sprays with malathion, diazinon, dimethoate or other chemicals will reduce infestations. Bait sprays of yeast hydrolysate and malathion can reduce infestation when used throughout a fruit growing area.

6.9 *Badamia exclamationis* – brown skipper

This is a fast-flying butterfly (skipper) with a wingspan of about 37 mm. The wings are uniformly brown except for two small yellow or white marks on the forewing. The larva is a greenish caterpillar, ringed with bands of yellow. Late instars are about 38 mm long. The head is yellowish-red with black marks. Eggs are laid on new plant growth. The larvae fold the leaves and feed and pupate within the leafroll. This is a highly migratory species.

The brown skipper is host-specific. It has been reported from *Terminalia catappa* (Indian almond) and *T. oblongata*. The larvae can defoliate trees, but adults feed only on nectar. Severe defoliation by the larvae has been observed in Palau and Guam.

The skipper is found from South-East Asia to Australia. In Micronesia, it has been reported from Guam, Palau and the Marshall Islands.

Generally, control measures are not applied because the host trees have low economic value. Insecticides can be used, but there are no approved chemicals or chemicals, or any which have been tested for effectiveness. *Bacillus thuringiensis* (Dipel) is likely to give control.

6.10 *Brontispa chalybeipennis* – Pohnpei coconut leaf beetle

The adult is a slender, flattened, beetle about 10 mm long and 2 mm wide. It is metallic green with two brown spots at the tip of the elytra. The larva is white with a brownish cast. It is flattened and has a pair of pincer-like protuberances at the rear end. Two other closely related species are found in Micronesia, *B. palauensis*, dark with a metallic blue sheen, and *B. mariana,* which is brown.

The larvae and adults feed on the inner side of young coconut leaves whilst they are still furled. As they feed, they leave a long brown track parallel to the midrib. The track of adults is narrower than that of the larvae. Heavy infestations can give the new leaf a brown, scorched, appearance, and they appear very ragged when mature. Although the beetles attack palms of all ages, they are more common on young palms,

particularly those surrounded by dense undergrowth. Young palms may be stunted, and occasionally killed. Heavy feeding weakens the palm and makes it more susceptible to disease, drought or other stresses.

B. chalybeipennis is present in Kosrae, the Marshall Islands and Pohnpei. Recently, it was accidentally introduced into Hawaii. In the Marshall Islands, it is reported from Ailinglapalap, Arno, Ebon, Jaluit, Kwajalein, Likiep, Majuro, Mili, Namorik and Namu.

Young palms should be kept free of tall weeds, and they should be inspected to make sure they are free from *Brontispa* before they are planting. The beetle does not fly long distances, but it is frequently spread on contaminated seedlings or on cut fronds. Sevin can be applied to the central leaf spike to control the beetle. Coconut varieties vary in resistance. Those from South-East Asia, including Federated Malay States tall, Malay red dwarf, and Malay yellow dwarf tend to be susceptible and should not be used. There may be varieties from Yap which are resistant. A good planting practice is to use seedlings from coconuts which are free of damage. A parasite, *Tetrastichus brontispae*, has been widely used for control of related beetles, and has recently been used against this species in Hawaii.

6.11 *Ceroplastes rubens* – red wax scale

The adult scale is covered with a thick, slightly translucent layer of pink to reddish wax which may become gray or slightly brown with age. There are four conspicuous transverse bands of powdery-white wax at the edges of the wax case. These bands, in conjunction with the pink wax and reduced, distorted, legs, are diagnostic for this species.

The female lays several hundred eggs under the wax case and then dies. The crawlers hatch within two weeks, emerge from the scale after about one day, locate a suitable feeding site, usually along a major vein on a leaf, and start to feed. Wax is then secreted, eventually covering the entire body. After a few weeks, the scale may move to another location, on either a twig or a leaf. From then on, it does not move again. Development takes several months. Often, this scale is attended by ants, although this was not observed during the survey. Females have four instars and males five. Males are not common.

Citrus species are the primary hosts. It is also found on breadfruit, coconut, coffee, fig, mango, tea and a few minor hosts. The scale is located on the leaves, particularly near veins, or on twigs. On some hosts, it can be found on the fruit. On mangoes, it has been reported to stop fruit development and cause premature fruit drop. It is considered a major pest of citrus in Australia, Hawaii and Japan. On most hosts, it is usually not an important pest. The primary problem is from sooty mould growing on copious secretions of honeydew.

The scale is found in Australia, China, East Africa and the Pacific, including Hawaii. In Micronesia, it is found in the Mariana Islands, the Western Caroline Islands and the Marshall Islands.

Control is generally not warranted in Micronesia as populations are seldom damaging. If necessary, the scales can be treated with white oil or white oil mixed with carbaryl or malathion. The oil is necessary to penetrate the wax. In Hawaii, several parasites attack the scale, including *Microterys kotinskyi*, *M. flavus*, *Tomocera californica*, *T. ceroplastis* and *Aneristus ceroplastae*. Parasitised scales were noted in the Marshall Islands at the time of the survey.

6.12 *Chaetocnema confinis* – sweet potato flea beetle

The adult is a small, black flea beetle with a shining green cast. Adults feed on the leaves of sweet potato and other related species. They make narrow tracks superficially similar to mines, but open on top. When the beetles are abundant, leaves may be severely damaged. The eggs are laid in the soil. The larvae tunnel in the roots and can reduce tuber yield. This beetle is found on wild and cultivated species of *Ipomoea* and *Convolvulus*.

The sweet potato flea beetle has been present in Hawaii for a number of years. It is a North American species, but recently has begun to extend its range. It was first found in northern Guam in 1986 and has now spread throughout the Mariana Islands. It is also present in Majuro in the Marshall Islands.

Sweet potato varieties differ in their susceptibility to both larvae and adults. Varieties resistant to the beetle are available in the United States. Granular insecticides have been used to control the larvae. The chemicals are highly toxic to man and are not recommended for use in the Marshall Islands.

6.13 *Chloropulvinaria psidii* – guava mealy scale, green shield scale

The adult is a flat, green scale about 3 mm in diameter (somewhat larger than the coffee green scale, *Coccus viridis*). The Malpighian tubules are not visible through the cuticle, although there may be darker patches on the dorsum. Mature females deposit a large, cottony, egg-sac. The egg-sac is short and broadened posteriorly. It is normally wider than the body. The eggs hatch into crawlers, which disperse and then settle. Older instars are capable of changing feeding sites, although they do not move readily. Older instars appear as flat, green scales which are difficult to distinguish from *C. viridis*.

In Micronesia, the green shield scale is often common on guava, *Morinda citrifolia* and *Plumeria*. It is also recorded from avocado, citrus, coffee, pomegranate, star apple and a variety of other hosts. It feeds on leaves and tender young stems. It can distort leaves. Infestations on coffee can cause severe damage. Copious amounts of honeydew are secreted, leading to abundant growth of sooty mould.

The scale is found world-wide in tropical areas, and there are some records from temperate countries. In Micronesia, it is reported from most islands. In the Marshall Islands, it was only reported previously from Jaluit.

Generally, this scale is kept under control by lady beetles, particularly *Cryptolaemus montrouzieri*. In Hawaii, it is also attacked by the parasitoids, *Microterys kotinskyi* and *M. flavus*. If chemical control is necessary, malathion or diazinon, mixed with a sticker or detergent, are likely to be effective.

6.14 *Coccus hesperidum* – brown soft scale

The adult scales are normally symmetrically oval unless adjacent to a vein or other obstruction. They are mostly flat or slightly convex, ranging from 35 to 40 mm long. The body is yellow-brown flecked with irregular brown spots. Males are known. Females give birth to active crawlers, which remain under the females for a short time and then move about the host until a suitable feeding site is found. These yellow crawlers then settle and remain fixed for life. They moult into second instars which have non-functional legs. These second instars are yellow with splotchy brown or black patches in the middle of the back and along the edges. The life cycle takes about 2 months.

The brown soft scale is found on a wide variety of hosts. In Micronesia, it has been reported on banana, breadfruit, citrus, coconut, *Cyrtosperma*, *Morinda citrifolia*, papaya, *Plumeria* and various ornamental and weeds. The scale is generally found on the leaves and very young, green twigs. Heavy infestations cause wilting and result in sooty mould. In Micronesia, it is not normally a serious pest, although it can be abundant at times.

This scale is widely distributed throughout the world. In Micronesia, it is found in Palau, Saipan, Truk, Yap and various atolls in the Caroline Islands. In the Marshall Islands, it is reported from Eniwetok, Kwajalein, Majuro, Rongelap, Ujelang and Wotho.

This scale is common, but is seldom abundant enough to be a serious pest. It is attacked by a large number of parasitoids, including *Scutellista cyanea* and *Microterys flavus*. In Hawaii, it is attacked by *Aphycus alberti* and *Anicetus annulatus*. Malathion is effective in controlling it when used with a sticker to penetrate the cuticle.

6.15 *Cylas formicarius* – sweet potato weevil

The adult is a small, shiny, black weevil with a brown (tending towards red) thorax. This weevil is quite slender and has an elongate snout on the head. The larvae are curved and white.
Sweet potatoes are the preferred host, but the weevil will also feed on some other species of *Ipomoea*. Adults scrape the epidermis of leaves, petioles and stems and make holes in tubers. The larvae tunnel in the stems and tubers. In response to larval feeding, terpenes are produced in the tuber which make it bitter, even when only a few weevils are present. Feeding in the vine causes cracking and malformation. Damage continues after harvest.

Removal of alternate hosts can be effective, but less so when sweet potatoes are grown continuously. Varieties which produce tubers deep in the soil are less prone to attack. If tubers are exposed they should be covered with soil.

The sweet potato weevil is cosmopolitan and is reported in most countries where sweet potato is grown. However, in Micronesia, it has not been reported from Pohnpei and Kosrae, and in the Marshall Islands its presence is confirmed only from Majuro.

Adults can fly well, but the main method of spread is through infested cuttings. Planting material should be free of weevils. It should be dipped in malathion or diazinon. Foliar sprays will reduce damage, but few chemicals are consistently effective. Lannate is effective, but is not recommended for use in Micronesia because of its high toxicity. Sweet potatoes should be rotated with other crops, or fields should be left fallow for a period. All volunteer sweet potatoes should be removed after harvest. Pigs are very effective in doing this. The Asian Vegetable Research and Development Center has recently demonstrated that pheromones may be used in control programmes against the weevil.

6.16 *Dysmicoccus brevipes* – pineapple mealybug

The pineapple mealybug is an egg-shaped, wingless insect which is covered with a white, mealy wax. Segments of the body are visible through the wax. Around the sides of the mealybug, wax filaments project outwards, forming a skirt. The filaments are short towards the front and longer at the rear. Adults have functional legs and are mobile. The life cycle takes about 90 days. Females give birth to about 250 crawlers.

The pineapple mealybug often lives in dense colonies on roots, leaves or fruits of a wide variety of hosts. All stages of the mealybug may be present. Often, the colonies are covered with pieces of organic matter placed there by attending ants, particularly the big-headed ant, *Pheidole megacephala*. Some of the more important hosts are coconut, grasses, *Pandanus*, pineapple and sugarcane.

The mealybug feeds by sucking the sap of the host plant. On pineapple, a common host, most of the mealybugs live in underground colonies, with only a small number on the leaves. Most occur on the lower leaves, close to the soil. The mealybug is a serious pest on pineapple because it is a vector of pineapple wilt virus. Symptoms of this disease first occur in the roots, which stop growing, collapse and rot. A vigorous crop will show symptoms sooner than one that is slow-growing and in poor condition. Varieties differ in resistance to the virus. Fruits may rot due to mealybug infestations.

The mealybug is distributed throughout the tropics wherever pineapple is grown. In Micronesia, it is found on all the major islands except Pohnpei and Kosrae. In the Marshall Islands, it occurs in Ebon, Jaluit and Majuro.

To control the mealybug on pineapple, the slips should be treated with insecticide before planting, allowing insecticide to accumulate at the base for 24 hours. Natural enemies generally control the mealybug unless ants, particularly *Pheidole megacephala*, are in attendance. On palms, the mealybug can be controlled with malathion or malathion plus oil. Twice the normal dose of spreader/sticker is needed to penetrate the wax covering the insect.

6.17 *Dysmicoccus cocotis* (=*D. saipanensis*) – mealybug

The adult is egg-shaped and covered with a white, mealy wax. It is about 2.8 mm long.

This mealybug is found on coconut, other palms and *Pandanus*. It can be a serious problem on coconut, where it infests the flowers, fruits and leaves, particularly at the base of the petiole near the trunk. It can be present in enormous numbers and has been associated with deformed nuts. During the present survey, it was found on several coconuts on Majuro, generally on flower spikes. On leaves, it was less abundant.

The mealybug is widely distributed throughout the Pacific and South-East Asia. In Micronesia, it is found on most islands except Palau. In the Marshall Islands, it is reported from Ailinglapalap, Jaluit, Lae and Majuro.

No specific chemical control measures are approved for this insect, but those suggested for other mealybugs are likely to be effective. A number of parasites and predators attack it. The coccinellids, *Megalocaria fijiensis* and *Cryptolaemus montrouzieri,* can rapidly eliminate infestations.

6.18 *Dysmicoccus neobrevipes* – grey pineapple mealybug

This mealybug is found on agave, *Annona* sp., banana, *Phaseolus* beans, breadfruit, cacao, citrus, coffee, corn, cucumber, eggplant, pineapple, tomato, yard-long beans and a variety of ornamental plants and weeds. In appearance, it is nearly indistinguishable from the pineapple mealybug. Males are known. Other details of the life history are likely to be the same as those of the pineapple mealybug.

This species is undoubtedly of New World origin, as it is widely distributed in South and Central America. In Micronesia, it is reported from Kiribati, the Mariana Islands and the Marshall Islands (Kwajalein).

For control methods, see the pineapple mealybug.

6.19 *Ferrisia virgata* – striped mealybug

The adult female is covered with powdery-white wax and has a pair of purplish, dorsal stripes along the back. Long, glossy, white wax threads extend from the body and there are two long tails. The mealybug attacks a wide variety of hosts, including cacao, cassava, citrus, coffee, guava and sweet potato. It is common on tomatoes and eggplants, particularly on drought-stressed plants. It feeds on the leaves, shoots and fruits, and will move to the roots in dry weather. If it manages to get under the calyx of fruits it can cause scarring. This can be a serious problem in eggplant. Like most scales and mealybugs, it can occur in great numbers.

In the Marshall Islands, this scale has been reported from Ailinglapalap, Kwajalein, Majuro, Rongelap and Ujelang. During the present survey, it was also found on Jaluit.

If chemical control is necessary, malathion may be used. The addition of a sticker/spreader, at twice normal concentration, is very important when using the insecticide because of the need to penetrate the wax covering the body.

6.20 *Furcaspis oceanica* – coconut red scale

The body of the insect is covered by a hat-shaped, reddish-purple scale. The scale varies from nearly circular to sub-circular or slightly elongated. Previous scale covers and cast skins are retained on top of the adult scale, appearing as small, slightly off-centre, darker-coloured areas. Females are viviparous, i.e. they give birth to living young. Crawlers are flat and roughly oval. They leave the scale of the parent after a few hours and settle within a day. Secretion of the scale cover starts soon after settling. Free-flying males are present. Dispersal is in the crawler stage.

The coconut red scale is primarily a pest of coconut, but is also found on a few other palms and *Pandanus*. On coconut, it infests the leaves, petioles and fruits. Coconuts tolerate damage surprisingly well and even very heavy infestations do not kill mature trees, although older leaves may dry and fall prematurely.

This species is endemic to Micronesia. It is present on all the high islands of the Caroline Islands and has been accidentally introduced into Guam and Saipan. It is also widely distributed in the atolls of the Caroline Islands and Marshall Islands. In the Marshall Islands, the scale has been reported from Ailinglapalap, Arno, Jaluit, Kwajalein, Likiep and Majuro.

Infestations are usually worse on older leaves. Removal of these leaves will aid control of the scale. Chemical control is not recommended. In most areas it is controlled by the parasitoid, *Anabrolepis oceanica*. This parasitoid is widely dispersed in Micronesia and has been introduced into Guam and Saipan. In the Caroline Islands, it is attacked by a hyperparasitoid which may reduce its effectiveness.

6.21 *Halticus tibialis* – black garden fleahopper

The black garden fleahopper is a small, shiny, black bug about 2 mm long. The wings are bent down over the abdomen. It jumps when disturbed. The nymphs resemble the adults, but lack wings and are not shiny. They vary from brown to black.

Both nymphs and adults feed on the foliage of a wide variety of crops, weeds and other low-growing plants. Important hosts include beans, cabbage and related plants, cucurbits, eggplant, lettuce, parsley, sweet potatoes and tomatoes. The fleahoppers kill the cells where they insert their mouthparts, leaving white feeding spots. Severely infested plants may be almost chloritic. All life stages are present on the host. Nymphs tend to be found on the underside of leaves.

This insect is found on most of the islands of Micronesia and throughout South-East Asia. In the Marshall Islands, it is reported from Ailinglapalap, Arno, Ebon, Jaluit, Kili, Kwajalein, Lib, Majuro, Mili and Namorik.

Lower foliage is preferred. Vines growing on trellises suffer heavy damage on lower leaves and little or no damage on upper parts. Prostrate crops, such as sweet potatoes, can be seriously attacked, but there is no information available about the effect on yield. The fleahopper is readily controlled by most insecticides used for other pests.

6.22 *Icerya aegyptiaca* – Egyptian fluted scale

The body of the adult female is orange, and it has black legs. It is covered with tufts of white wax, thus the scale appears white or sometimes very light pink. There are 21 white, waxy processes extending from the body in a fringe. The female scale is wingless, but has functional legs and can move feeding sites. Males are unknown. Females lay a white, waxy, egg-sac which is shorter than the body. This is carried behind. Eggs hatch in about 10 days at 24°C. The crawlers are bright orange. They wander on the plant for about a day, then settle, and secrete a covering of white wax. There are three larval instars. Development takes about 90 days in Micronesia. Adults can live up to 3 months and lay 150–200 eggs.

The Egyptian fluted scale is polyphagous. It is reported from avocado, banana, breadfruit, citrus, coconut, guava, *Pandanus*, taro, tomato, and a wide variety of ornamentals, weeds and other vegetation. On breadfruit, high numbers of scales can cause leaves to turn yellow and drop prematurely. Heavily-infested shoots may die and occasionally mature breadfruit trees can be killed. Yields can be reduced by 50 per cent or more. Honeydew can encourage the growth of sooty mould, thereby reducing photosynthesis. Serious problems have been experienced on some atolls, predominantly on breadfruit. Dry weather seems to favour the development of large infestations.

This scale is widely distributed in most tropical countries, and is found throughout Micronesia. In the Marshall Islands, it is reported from Ailinglapalap, Jaluit, Kwajalein, Likiep and Majuro.

Little work has been done on chemical control and it is not recommended. Satisfactory control has been achieved using predatory coccinellids, including *Rodolia cardinalis* and *R. pumila*. The most successful species in Micronesia is *R. pumila*. It should be noted, however, that *R. pumila* may not be able to maintain itself on small atolls, and periodic replenishment of beetles may be necessary. Direct transfer of adults should not be made between countries to prevent the possibility of transferring parasites.

6.23 *Icerya purchasi* – cottony cushion scale

The cottony cushion scale is similar to the Egyptian fluted scale, but differs in that the body of the adult female is brown rather than orange, and there are conspicuous tufts of setae on the abdomen. Females also secrete a large, white, egg-sac, and this egg-sac has deep rows of furrows and is longer than the body. Egg-sacs usually contains more than 100 red eggs, and a single female may produce 400–1,000 eggs. The eggs hatch in a few days or may take up to 2 months, depending on temperature. In Micronesia, hatching and development rates are probably similar to *I. aegyptiaca*. There are three larval instars. All of the nymphal instars are shiny-red beneath the wax. Males occur, but are rare. They are red with dark wings. Females are hermaphroditic and are capable of self-fertilisation.

The cottony cushion scale is polyphagous, but is primarily a problem on citrus. In Micronesia, it is known from casuarina, citrus and *Scaevola*. In the Marshall Islands, it has only been reported from casuarina. Elsewhere, it occurs on guava, mango and other hosts. On citrus, the nymphs settle along the midrib of the leaves and then move to twigs and shoots when they are mature. Large populations of scales can cause leaves to yellow and drop prematurely. Heavily infested shoots may die and, occasionally, nursery trees can be killed. Large amounts of honeydew may be produced, encouraging the growth of sooty mould, and this can reduce photosynthesis.

The scale is widely distributed in most tropical countries, and is found throughout Micronesia. In the Marshall Islands, it has been reported from Eniwetok, Kwajalein and Majuro.

Chemical control is not recommended. Satisfactory control has been achieved using predatory coccinellids, primarily *Rodolia pumila*. This coccinellid is relatively host specific. However, the comments made under *I. aegyptiaca* should be noted.

6.24 *Lepidosaphes beckii* – purple scale

The purple scale is covered with a slender, waxy, shell which is mussel-shaped. Females are dark purplish-brown and about 2–3 mm long. Immature male scales are about 1 mm long. Males pupate under the scale cover and emerge as free-flying adults. Females remain under the scale; they lack wings and legs. After mating, the female lays 50–100 eggs under the narrow end of the scale covering. The eggs hatch, and the crawlers disperse to suitable sites on the host. They settle and remain fixed thereafter. Female scales moult twice. In Micronesia, development takes about 2 months.

The purple scale is a serious pest of citrus in many parts of the world. It infests leaves, stems, branches and fruits. Severe outbreaks can cause premature leaf-fall and die-back of branches. Chlorosis of the leaves, defoliation, disfigurement and poor maturation of the fruit, and desiccation and weakening of the branches, have been reported. The scale prefers hot, humid conditions and is often found in the interior of tree canopies.

The scale is widely distributed in tropical and sub-tropical regions of the world. In Micronesia, it is reported from the Mariana Islands, Pohnpei and Truk. In the Marshall Islands, it has been reported from Kwajalein. During the survey is was found on Majuro, on lime.

Diazinon, carbaryl and malathion will control this scale. White oil or sticker should be added to help penetrate the scale cover, especially if diazinon and malathion are used. The use of natural enemies is the preferred method of control. *Aphytis lepidosaphes* is the most important natural enemy in most citrus-

growing areas. It is very host-specific. Other parasitoids have also been found attacking the scale. In Hawaii, the lady beetle, *Chilocorus circumdatus*, is an effective biological control agent. In the Marshall Islands, the scale was uncommon at the time of the survey.

6.25 *Lepidosaphes esakii* – armoured scale

This scale is similar to the purple scale, but is brown and at the wide end, is nearly as broad as it is long. The scale is most common on *Pandanus* and coconut, but also occurs on *Plumeria*. It infests the fruit and bases of the petioles. During the present survey, it was not found in sufficient numbers to be considered damaging .

Micronesia is the type locality of this species. It is only known from the Eastern Caroline Islands, Kiribati, the Mariana Islands and the Marshall Islands. In the Marshall Islands, it is recorded from Eniwetok, Jaluit, Kwajalein, Lib, Likiep, Majuro, Namorik and Ujelong.

It is unlikely that control will be necessary.

6.26 *Metriona circumdata* – green tortoise beetle

This is a round beetle with an iridescent green and black pattern on the back. The larvae are dull-green and carry their cast skins from previous instars curved above their backs. Both the adults and the larvae feed on the leaves of sweet potatoes and other related plants, such as morning glory. Irregular holes are made in the leaves. Plants can be defoliated, but in most areas of Micronesia the beetles are not very abundant. However, recent reports indicate that they are becoming a problem in Pohnpei.

The green tortoise beetle is found throughout Micronesia, except Kosrae.

The beetles can be controlled with malathion or carbaryl, if necessary.

6.27 *Palmicultor palmarum* – palm mealybug

Females are oval mealybugs with a pale, reddish-brown body covered with dense, white wax. The wax is dense enough to cover the segmentation and obscure the outline and colour of the body. There are short, stout tufts of wax around the margin. The posterior tufts are longer, up to 1 mm, and sometimes curve upwards. Often, the tufts are not very distinct as they are obscured by the general abundance of wax. The life history is similar to other mealybugs. Females are viviparous. Both apterous and winged males are known.

The mealybug is found on various species of palms. In Micronesia, it is common on coconut. Like all mealybugs, it feeds on sap. Dense colonies occur on the fruit and leaves, but mature palms show little evidence of damage. Very young palms can be killed.

The palm mealybug is recorded from several islands in the Pacific and Caribbean. In Micronesia, it is widely distributed, occurring throughout the Caroline Islands and Kiribati, but is not present in the Mariana Islands. In the Marshall Islands, it is recorded from Ailinglapalap, Jaluit, Kwajalein, Lib, Likiep, Majuro and Namorik.

In Hawaii, the parasitoid, *Anagyrus nigricornis*, and the predacious fly, *Gitona perspicax*, attack it. No chemicals have been tested specifically against the mealybug, but those listed for other mealybugs will probably control this species.

6.28 *Parasaissetia nigra* – nigra scale

The nigra scale is dark brown or black, oval, about 2–3 mm long and 1.5–2 mm wide. However, both shape and colour are variable. The shape is influenced by location: on leaves, the scales tend to be more oval;

while on twigs, they tend to be narrower, more elongate and convex. Proximity to leaf veins or other obstructions can result in irregularities of shape. Wax plates may be present on old adults. Nymphs are lighter in colour than adults. The scales reproduce parthenogenetically and males are unknown. Eggs are laid under the scale. They hatch into crawlers which disperse to other parts of the plant.

This scale is found on a wide variety of hosts, including anthurium, bamboo, bougainvillea, cassava, coconut, coffee, corn, cotton, citrus, croton, eggplant, fig, ginger, guava, hibiscus, nutgrass, *Pandanus*, *Plumeria,* pineapple, rubber, soursop and taro. The scales occur on leaves or twigs which contain chlorophyll. They can cause leaf distortion, and they secrete honeydew which leads to deposits of sooty mould.

The scale is distributed throughout the old world except for the Palearctic regions; it also occurs in Australia, the oceanic Pacific, and California in the USA. It is widely spread in Micronesia, although it is not reported from Pohnpei. In the Marshall Islands, it is reported from Kwajalein.

Chemical control is generally unsatisfactory. The first instars are the only stages susceptible to insecticides, necessitating frequent sprays. Natural enemies are the preferred method of control. A number of parasitoids attack the scale, including *Microterys kotinskyi*, *M. flavus*, *Tomocera californica*, *Scutellista cyanea* and *Aneristus ceroplastae*.

6.29 *Pentalonia nigronervosa* – banana aphid

This is a distinctive, reddish or black aphid. The winged forms of the adult have bands of dark colour along the wing veins, a characteristic which makes the aphid relatively easy to identify. It feeds on banana, taro, tomato and several ornamental plants. On banana, the aphids can be found on the suckers, between the sheaths of the petioles, on fruit, and below soil level at the base of the pseudostems. It feeds on sap. Large populations of the aphids can stunt or kill young plants, but this is unusual. Honeydew near the base of the leaves can ferment and cause the leaves to rot. Feeding marks on the fruit can reduce market value.

The main concern with this aphid is the transmission of banana bunchy top virus, a fatal disease. Infected plants are stunted with broken streaks of green on the veins, midribs and petiole. The leaves of the crown become bunched and progressively smaller. The leaves are also brittle. Fruit production ceases or only small, deformed fruits are produced. Currently, banana bunchy top does not occur in the Caroline Islands or the Marshall Islands. It is present in the Mariana Islands and Hawaii. Planting material from infected areas should not be allowed into the Marshall Islands, the Federated States of Micronesia or Palau. The aphid also transmits cucumber mosaic virus.

The banana aphid is widely distributed in the tropics and is found throughout Micronesia. In the Marshall Islands it was reported previously from Arno and Lib. During the survey it was recorded on Majuro.

Chemical control is not recommended because aphids colonise parts of the plant which are difficult to access. Measures to exclude the introduction of banana bunchy top are very important. If an outbreak occurs, infected plants should be removed immediately and sprayed with diazinon, kerosene, or mineral oil to kill all the aphids. The aphids on the plant and those below ground must be killed to prevent their dispersal to neighbouring mats. Removal of adjacent plants is recommended. All infested plant material should be burned. Two varieties, Gros Michel and Veimama from Fiji, are moderately resistant to banana bunchy top. Good sanitation (prompt removal and destruction of infested plants) and good weed control will control the disease in plantations. Also, bananas should not be intercropped with vegetables which can harbour cucumber mosaic virus. There are a number of natural enemies which keep the aphid populations in check, but they will not reduce numbers sufficiently to prevent the spread of viruses.

6.30 *Pinnaspis strachani* – lesser snow scale

The males and females of the lesser snow scale are very different in appearance. The female scale is mussel-shaped, whitish-grey or white, 3–4 mm long. Males are snow-white, 1–2 mm long, with two distinct, deep

furrows running longitudinally through the scale cover. The males are often very conspicuous and more abundant than the females.

The lesser snow scale is polyphagous. In Micronesia, it has been found on coconut, cotton, eggplant, hibiscus, *Ipomoea* and some non-cultivated species. In other areas, it occurs on avocado, banana, beans, cassava, citrus, cucumber, ginger, *Plumeria,* soursop, taro, *Terminalia catappa,* yams and a wide range of other species. Generally, this is a bark-inhabiting species, although it has been found occasionally on coconut leaves. Infestations may cover the stem of hibiscus.

The lesser snow scale is a cosmopolitan species. It is widely distributed in the Pacific. In Micronesia, the only high island where it has not been found is Kosrae. In the Marshall Islands, it is reported from Ebon, Kwajalein and Namorik. During the survey it was found on Majuro.

In Hawaii, the parasitoids, *Aphytis* spp. and *Aspidiotiphagus citrinus*, have been reported to kill at least 90 per cent of scale populations. The mealybug was not abundant on Majuro at the time of the survey, and it is probably under biological control.

6.31 *Planococcus citri* – citrus mealybug

The citrus mealybug is egg-shaped with a brownish-yellow body. It is covered with white, mealy wax. A fringe of short, white wax filaments surrounds the body. The filaments at the rear are slightly longer than the ones at the front. Females lay spherical egg-masses filled with about 600 amber-yellow eggs. The eggs hatch in 6–10 days, and the crawlers move about the plant seeking a suitable place to rest. Development takes about 2 months in Micronesia. Females can reproduce sexually or parthenogenetically.

The citrus mealybug has been found on cabbage, citrus, cocoa, giant swamp, guava, *Leucaena,* mango, pumpkin, squash, sweet potato, taro and other hosts. It generally encrusts the roots, but one strain is found on the leaves of citrus and cotton. It is less damaging than root-inhabiting strains. On coffee, roots can be stunted and are often encased in greenish-white fungus, with the mealybugs living beneath. Heavily infested plants wilt and turn yellow.

The mealybug is found throughout the tropics and its range extends into sub-tropical areas. The distribution in Micronesia is uncertain because of recent division of the species into *P. citri* and *P. pacificus*. Re-analysis of Micronesian specimens is needed.

To treat subterranean infestations, diazinon, malathion, or dimethoate should be applied around the roots and collar of the tree. A sticker or white oil should be used to ensure penetration of the wax layer of the mealybug. Damaged trees need fertilizer and plenty of water. Deep mulching may also be useful. Some control might be achieved by using a sticky material ('Tanglefoot' is one commercial material) to stop ants from tending the mealybugs.

The citrus mealybug is attacked by the lady beetle, *Scymnus notescens* and by the parasitoids, *Pauridia peregrina* and *Lepidomastidea abnormis*, in Hawaii.

6.32 *Planococcus pacificus* – mealybug

This mealybug is very similar to *Planococcus citri* and has been confused with that species until recently. There are no differences in general appearance. It is highly polyphagous. Hosts include *Amaranthus, Anacardium*, avocado, betel nut, breadfruit, cabbage, citrus, coconut, cucurbits, eggplant, giant taro, ginger, jackfruit, passionfruit, potato, soursop, sweet potato, tomato, yams and many other species. This mealybug has been recorded as seriously damaging flowers of coffee, causing 70–75 per cent reductions in yield. More often, it is a pest of the roots, causing damage similar to that of *P. citri*. Frequently, it occurs in colonies with other mealybugs.

This is probably the most widely-distributed mealybug in the Pacific islands. The distribution in Micronesia is uncertain because of recent division of the 'citri' species complex into *P. citri* and *P. pacificus*. Re-analysis of Micronesian specimens is needed. It is known from Guam, but is probably more widespread.

See *P. citri*, for comments on chemical control. In Papua New Guinea, the coccinellid, *Cryptolaemus affinis*, gives control.

6.33 *Pseudaulacaspis pentagona* – white peach scale

The female is covered by an almost circular, white scale with a reddish-brown tip on one side. The scale cover is about 2–2.5 mm in diameter. The body is yellowish or pink. Adult males are orange and have functional wings, eyes, legs and antennae, but lack mouthparts. Female scales are sessile and capable of only limited movement. Females must mate to produce eggs. Mating takes place under the scale cover. Egg-laying begins about 2 weeks after mating and about 125 eggs are laid under the scale. The eggs hatch in 4–5 days into first instar nymphs called crawlers. The small, oval-shaped, crawlers have large antennae and well-developed legs. The females wander on the plant for several hours and tend to settle some distance from the mother scale. Males wander little, and may settle under the shell of the mother scale. The scale is secreted in the second instar. The white scale cover of the males is smaller, more flattened, and more elongated than that of the female. Development takes about 19–20 days from egg to adult. Males are non-feeding and live only 1 day. Adult females may live several weeks.

The white peach scale infests leaves and fruit, but is most common on bark. It is a serious pest with a very wide host range. Some important hosts are breadfruit, cassava, citrus, cotton, hibiscus, orchids, passionfruit, papaya, pepper, potato, sweet potato, *Plumeria*, soybeans and yard-long beans. Host-specific strains occur. It some areas, the scale kills papaya and passionfruit, in other areas it does not. It is also a serious pest of many ornamentals. Because of the presence of damaging strains with different host preferences, this scale should be of quarantine concern, even if it is already in the country.

The scale is found in temperate, sub-tropical and tropical areas. In Micronesia, it has been reported from the Mariana Islands, Palau, Truk and various atolls in the Caroline Islands. During the survey it was recorded from Majuro.

Diazinon and malathion control most strains of this scale, but some strains are difficult to control with insecticides. White oil or a sticker should be used to assist the penetration of the scale cover. This waxy cover provides substantial protection from chemical sprays. A large number of natural enemies are reported for this scale. The coccinellid, *Chilocorus nigritus*, common in Micronesia, attacks it, as do species of *Telsimia* and *Scymnus*. *Encarsia berlesei* has been widely used as a control agent. In the Marshall Islands and on Guam, the scale is not abundant. Whether this is due to climatic conditions or to the presence of natural enemies is not known. The scale is normally a pest of temperate areas rather than those in the tropics.

6.34 *Pseudococcus orchidicola* – orchid mealybug

The orchid mealybug is up to 3.3 mm long, oval, and covered with powdery-white wax. Most host records in Micronesia are on *Pandanus*, but it has also been found on banana, *Cyrtosperma* and orchids. In the South Pacific, it has been found on a wide range of hosts, including coconut, fig, giant taro, jackfruit, pepper, taro, *Terminalia catappa*, and a variety of ornamental plants and other species. On *Pandanus*, it is found typically in the axils of the leaves and in the crevices between the fruit. It is seldom numerous or damaging in the leaf axils, but dense populations may occur on the fruits. In the Marshall Islands, it is a local belief that infestations affect fruit quality.

This species is known only from the Pacific region. It is widely distributed throughout the South Pacific and Micronesia. In Micronesia, it has not been found in Palau, Pohnpei or Yap. In the Marshall Islands, it is present on most atolls.

There is a lack of information on the control of this mealybug, although it is likely that chemicals used against other mealybugs will also be effective against this insect too.

6.35 *Pulvinaria urbicola* – urbicola soft scale

This is a small scale, brown or greenish-brown, about 2.5 mm long. It is soft, unsclerotised and may become quite wrinkled with age. Mature females deposit an elongated cottony egg-sac, which may push the rear part of the body off the leaf. The egg-sac is long and parallel-sided. It is about the same width as the body of the scale and, unlike that of *Chloropulvinaria psidii*, is not broadened posteriorly.

The scale is present on pepper, eggplant, sweet potato, *Plumeria* and several other hosts. It feeds primarily on leaves. Heavy infestations may result in deposits of sooty mould due to the secretion of large amounts of honeydew. The effect on yield and plant health is not known. Ornamentals such as *Plumeria* may become unsightly.

The species is thought to have originated in the Caribbean, where it occurs on several islands. It spread to Hawaii by 1909. In Micronesia, it is found in the Mariana Islands, various atolls of the Caroline Islands, and is now reported from Jaluit and Majuro in the Marshall Islands.

This scale is attacked by the lady beetle, *Cryptolaemus montrouzieri*. If chemical control is necessary, malathion or diazinon, mixed with sticker or detergent, may be effective. No formal insecticide testing has been done on this species.

6.36 *Saissetia coffeae* – hemispherical scale

This yellow-brown to dark-brown scale is found on leaves, small twigs, shoots and fruits. The scale is shaped like a half-sphere: dome-shaped with the base varying from circular to elongated. It is between 1.5 and 3 mm long when mature. The female scale lays 600–700 eggs under the scale cover, and then dies. Newly-hatched nymphs are greenish-brown and flattened. The nymphs move around the plant and find a place to settle. They go through three moults. Young scales are green, but become dark brown when older. Immature females have a yellow H-shaped mark on the body. This is lost with age. Normally they remain attached to the spot at which they settle, but immature scales are able to move to a new site. Adult females do not move. Males are unknown. The life cycle is relatively long, taking up to 6 months. The life span is 8–10 months.

The scale has many hosts, including banana, citrus, coffee, cotton, egg plant, guava, okra, mango, soursop, sweetsop and tea. This scale also has several wild hosts and attacks a range of ornamental species.

The scales feed on sap and secrete honeydew, on which sooty mould grows. This turns the leaves black and blocks photosynthesis. In temperate zones this is an important greenhouse pest.

The scale is found throughout the tropics and in some sub-tropical areas. It is present in Hawaii, the Mariana Islands, and most other islands in Micronesia except Kosrae and some atolls. It is reported from Eniwetok, Kwajalein and Majuro in the Marshall Islands.

This scale is usually heavily parasitised. In Hawaii, it is attacked by at least six species of parasitoids, including *Encyrtus infelix*, *Scutellista cyanea*, and *Aneristus ceroplastae*. Attendant ants should be killed in order to encourage parasites. Fertilize (but do not over-fertilize) or mulch trees to increase resistance to scales. Cut off heavily-infested branches and put them on the ground. This will allow any parasites present to emerge. White oil can be used as a drench to kill young scales, but it is not effective against the tough-skinned adults. Two treatments at 3–4 week intervals will be necessary. Carbaryl may also be used.

6.37 *Saissetia neglecta* – Caribbean black scale

Recently, the *S. oleae* complex was split into three species, including the Caribbean black scale. Females are dark brown or black and have an H-shaped mark on the back. Adults are circular in outline and highly convex. The surface of the scale is rough and has tiny lumps of white wax unless weathered. Old adults are very highly sclerotised.

In Micronesia, this scale has been found on guava. During the present survey, scales resembling it were found on *Plumeria* and *Morinda citrifolia*. It has been reported from other hosts, including citrus. On citrus, it infests twigs, shoots and fruit, damaging vegetation and lowering the market value of the fruits.

This scale is found in Central America, Florida, Hawaii, Puerto Rico, South Africa and the West Indies. In Micronesia, it is known from Palau, but probably has a wider distribution. Scales resembling this species were found in the Marshall Islands during the survey, but verification of their identification is needed.

Scutellista cyanea, a hymenopteran parasitoid, provides good control of this scale in some areas. Chemical control can be difficult and is not recommended. Damaging populations of this scale have not been seen in Micronesia, suggesting that it is being controlled by natural enemies. In the Marshall Islands, parasitised scales were common at the time of the survey, but the adult stage of the species attacking them was not collected, so its identity could not be determined.

6.38 *Spodoptera litura* – rice cutworm

This is a brown moth with patterned forewings and white hind wings that are somewhat transparent. The larvae vary in colour. Young larvae tend to be blackish-green. Older larvae are grey and blackish-green with yellow stripes and black spots on the sides. They have a black head.

The larvae feed on the leaves or fruits, attacking cabbage, cotton, rice, taro, tomato and many other plants. They can defoliate crops if in sufficient numbers. This is rare in Micronesia, although individual plants can be severely damaged by the large clusters of larvae that feed gregariously before dispersing. The larvae bore into the heads of cabbage or into the fruit of tomatoes.

This is a difficult pest to control as outbreaks are sporadic and difficult to predict. In Western Samoa, it is mainly a pest in large plantings, in newly-cleared areas, where natural enemies have not yet arrived. It has a large number of natural enemies throughout its range. In general, broadleaf weeds are good alternate hosts for *Spodoptera* and weedy fields tend to have more problems with this pest.

6.39 *Tarophagus proserpina* – taro leafhopper

This is small, whitish-yellow and black, delphacid. Adults are mostly brachypterous, that is they have short non-functional wings, although at certain times of the year winged forms may become prevalent. Crowding and plant senescence can cause the appearance of winged forms. Nymphs look like smaller versions of the adults.

The leafhoppers live clustered together on the underside of taro leaves and on the petioles. All ages feed on sap and exude excess sugars onto the surface of the leaf. Severe outbreaks cause stunting and wilting. Young leaves are not attacked. The leafhopper is the vector of dasheen (taro) bobone rhabdovirus. Eggs are laid in holes cut in the petiole and midrib. Those at the base of the petiole can serve as a source of infestation for new plantings.

The taro leafhopper is found throughout Micronesia. In the Marshall Islands, it has been found in Kili, Majuro and Namorik. It was not found during the recent survey, indicating that it is probably uncommon or rare, at least at some times of the year. *Colocasia* taro, the preferred host, was also uncommon, being found only at the experimental station in Laura.

This leafhopper is under good control by natural enemies in Fiji, Guam, and Hawaii, but is a serious pest in some places. The mirid bug, *Cyrtorhinus fulvus*, feeds on the eggs and is reported to control the leafhopper in Hawaii. This predacious bug has been released in Guam and Pohnpei with good results. Outbreaks occur when chemicals for control of the cluster caterpillar interfere with *Cyrtorhinus*.

6.40 *Tetranychus* sp. – spider mites

Tetranychus cinnabarinus – carmine spider mite

A positive identification of the mite in the Marshall Islands has not been made, but is assumed to be this species.

The mite is present everywhere in the tropics. Its distribution in Micronesia is not known, except it is present in Guam.

The adults spin silk webbing and lay most of their eggs beneath it. A few eggs are laid elsewhere on the leaves. The white eggs are spherical and quite large in relation to the size of the mites. They hatch after 4–7 days. Mites pass through a larval stage which has only six legs, and two nymphal stages which have eight legs. Nymphs spend most of their time in the area of the webbing. The total immature stage lasts 9–15 days, depending on temperature. The adult females are reddish or sometimes dark green. Males are similar, but somewhat smaller.

The carmine spider mite attacks a very wide range of plants, including cassava, cucumbers, beans and papaya. It tends to attack leaves near the midribs or major veins, and is always found on the underside of the leaf. Damage is first seen as yellow spotting near the veins; if severe, the leaf dries up and falls off.

Spider mites are readily controlled by a variety of miticides or insecticides, such as dimethoate, ethion and wettable sulfur. Some insecticides promote outbreaks as they destroy natural enemies of the mites. Two species of predatory mites (*Phytosieulis* sp. and *Amblysieulis* sp.) have been identified on Guam.

6.41 *Xyleborus perforans and X. similis* – shot-hole borers

These are small (4–5 mm) compact beetles, cylindrical in shape and dark coloured. Adults bore into woody stems and excavate a system of tunnels which become infested with fungus. Eggs are laid in the tunnels. The larvae feed on the fungus rather than on the tissues of the host.

Xyleborus perforans is a minor agricultural pest in many regions of the world. It occurs in nearly all tropical and sub-tropical areas. It is widely distributed throughout Micronesia, but in the Marshall Islands it has been found only on Arno, where it has been found under the bark of breadfruit. Elsewhere, it is known to bore trunks of coconut.

X. similis is found from Malayasia to Australia and eastward into the Caroline Islands and Mariana Islands. It is reported by Wood (1960) to be on Ailinglapalap, Arno and Wotje. This beetle is known from oil palm and cocoa in other areas of the world.

Control is difficult. Infestations were not seen during the survey, so the seriousness if this insect in Marshall Islands is not known.

7. INSECT PESTS ASSOCIATED WITH CROPS IN THE MARSHALL ISLANDS

Scientific name Order: Family	Common name	Crop	Habits	Status	Reference	At UG
Adoxophyes fasciculana (Walker) Lepidoptera: Tortricidae	orange tip moth	Papaya	web & bore tips	x	Clarke, 1976	
		Citrus	web & bore tips			
		Sweet potato	web & bore tips			
Agrius convolvuli L.) Lepidoptera: Sphingidae	sweet potato hawk moth	Sweet potato	larvae eat leaves	x	TT records	Y
		Beans	larvae eat leaves			
Aonidiella aurantii (Maskell) Homoptera: Diaspididae	California red scale	Breadfruit	on leaves	x?	Beardsley, 1966	
		Citrus	on leaves			
		Banana	on leaves			
		Screw pine	on leaves			
		Guava	on leaves			
		Papaya	on leaves			
Aonidiella comperei Mckenzie Homoptera: Diaspididae	false yellow scale	Citrus	on leaves	x	Beardsley, 1966	
		Coconut palm	leaves, flower stalks			
		Breadfruit	on leaves			
		Papaya	on leaves			
Aonidiella inornata Mackenzie Homoptera: Diaspididae	inornate scale	Breadfruit	on leaves		Beardsley, 1966	Y
		Citrus	on leaves	x		
		Coconut palm	on leaves			
		Papaya	on leaves			
		Banana	on leaves			
Aphis craccivora Koch Homoptera: Aphididae	cowpea aphid	Breadfruit	on leaves	x	Essig, 1956	Y
		Citrus	on leaves			
		Cucumber, etc.	on leaves			
		Beans	on leaves			
Aphis gossypii Glover Homoptera: Aphididae	cotton or melon aphid	Cabbages, etc.	on leaves	x	Essig, 1956	Y
		Red, bell peppers	on leaves			
		Taro	on leaves			
		Cucumber, etc.	on leaves			
		Tomato	on leaves			
		Banana	on leaves			
		Eggplant	on leaves			
		Potato	on leaves			
		Breadfruit	on leaves			
		Papaya	on leaves			
		Citrus	on leaves			
		Beans	on leaves			
		Guava	on leaves			
Aspidiella sacchari (Cockerell) Homoptera: Diaspididae	sugar-cane scale	Sugar-cane	on stem	x	Beardsley, 1966	
Aspidiotus destructor Signoret Homoptera: Diaspididae	coconut scale	Breadfruit	on leaves, fruits	n		Y
		Papaya	on leaves, fruits			
		Citrus	on leaves, fruits			
		Tomato	on leaves			
		Cassava	on leaves			
		Coconut palm	on leaves			
		Taro	on leaves			
		Cucumber, etc.	on leaves			
		Banana	on leaves			
		Screw pine	on leaves			
		Guava	on leaves			
		Sugar-cane	on leaves			
		Eggplant	on leaves			
Asterolecanium pustulans (Cockerell) Homoptera: Asterolecaniidae	oleander pit scale	Breadfruit	on leaves	x	Beardsley, 1966	Y
		Red, bell peppers	on leaves			
Bactrocera frauenfeldi (Schiner) Diptera: Tephritidae:	mango fruitfly	Breadfruit	larvae bore in fruit	x	Hardy&Adachi, 1956	
		Guava	larvae bore in fruit			

Scientific name Order: Family	Common name	Crop	Habits	Status	Reference	At UG
Badamia exclamationis F. Lepidoptera: Hesperiidae	myrobalan butterfly	Tropical almond	larvae eat leaves	n		Y
Brontispa chalybeipennis (Zacher) Coleoptera: Chrysomelidae	Pohnpei coconut leaf beetle	Coconut palm	scour new leaves	x	Gressitt, 1955	
Ceroplastes cirripediformis Comstock Homoptera: Coccidae	barnacle scale	Guava	on leaves	x	Beardsley, 1966	
Ceroplastes rubens Maskell Homoptera: Coccidae	red wax scale	Breadfruit Citrus Guava	on leaves on leaves on leaves	x	Beardsley, 1975	Y
Chaetocnema confinis Crotch Coleoptera: Chrysomelidae	sweet potato flea beetle	Sweet potato	chews tunnel-like tracks in leaves	x		Y
Chrysomphalus dictyospermi (Morgan) Homoptera: Diaspididae	dictyospermum scale	Citrus Banana Screw pine Guava Eggplant	on leaves, fruit on leaves, fruit on leaves, fruit on leaves, fruit on leaves, fruit	x	Beardsley, 1966	
Coccus hesperidum L. Homoptera: Coccidae	brown soft scale	Breadfruit Citrus Coconut palm Taro Banana Guava	on leaves on leaves on leaves on leaves on leaves on leaves	x	Beardsley, 1966	Y
Coccus longulus (Douglas) Homoptera: Coccidae	long brown scale	Papaya Citrus Coconut palm	on leaves on leaves on leaves			
Cylas formicarius (F.) Coleoptera: Curculionidae	sweet potato weevil	Sweet potato	larvae bore tubers	n		Y
Daealus sp. Coleoptera: Curculionidae	weevil	Citrus Sweet potato	on leaves	?	TT records	Y
Dysmicoccus brevipes (Cockerell) Homoptera: Pseudococcidae	pineapple mealybug	Pineapple Coconut palm Taro Screw pine Sugar cane	on fruit, leaves; causes pineapple wilt on leaves on leaves on fruit, leaves on leaves	x	Beardsley, 1966	Y
Dysmicoccus cocotis (Maskell) Homoptera: Pseudococcidae	Saipan mealybug	Coconut palm	trunk, flowers, leaves	x		Y
Dysmicoccus neobrevipes Beardsley Homoptera: Pseudococcidae	grey pineapple mealybug	Pineapple Banana	on leaves on leaves	x	Beardsley, 1975	
Empoasca sp. Homoptera: Cicadellidae	green leafhopper	Beans	suck sap on leaves	n		
Eucalymnatus tessellatus (Signoret) Homoptera: Coccidae	tessellated scale	Coconut palm Banana Guava	on leaves on leaves on leaves	n		Y
Ferrisia virgata (Cockerell) Homoptera: Pseudococcidae	striped mealybug	Papaya Citrus Taro Cucumber, etc. Tomato Banana Beans Guava Eggplant Maize or corn	infest fruits on leaves, stems on leaves, stems on leaves, stems on leaves, stems infest fruits infest fruits leaves, stems, fruits leaves, stems, fruits on leaves, stem	x	Beardsley, 1966	Y
Flaccia dione Fennah Homoptera: Derbidae	derbid hopper	Coconut palm	on leaves	x	Fennah, 1956	Y
Furcaspis oceanica Lindinger Homoptera: Diaspididae	coconut red scale	Coconut palm Screw pine	on leaves, fruit on leaves, fruit	x x	Beardsley, 1966	Y

Scientific name Order: Family	Common name	Crop	Habits	Status	Reference	At	UG
Halticus tibialis Reuter Hemiptera: Miridae	black garden fleahopper	Cabbages, etc.	white spots on leaves	x	Carvalho, 1956		Y
		Cucumber, etc.	white spots on leaves				
		Sweet potato	white spots on leaves				
		Beans	white spots on leaves				
Hemiberlesia cyanophylli (Signoret) Homoptera: Diaspididae	scale	Breadfruit	leaves	x	Beardsley, 1966		
Hemiberlesia lataniae (Signoret) Homoptera: Diaspididae	latania scale	Breadfruit	on leaves	x	Beardsley, 1966		Y
		Coconut palm	on leaves				
		Banana	on leaves				
		Screw pine	on leaves				
		Citrus	on leaves				
		Guava	on leaves				
Hemiberlesia palmae (Cockerell) Homoptera: Diaspididae	palm scale	Breadfruit	on leaves, fruits	x?	Beardsley, 1966		
		Citrus	on leaves				
		Coconut palm	on leaves				
		Guava	on leaves				
Icerya aegyptiaca (Douglas) Homoptera: Margarodidae	Egyptian fluted scale	Breadfruit	on leaves	x	Beardsley, 1966		Y
		Papaya	on leaves				
		Citrus	on leaves				
		Coconut palm	*on leaves*				
		Taro	on leaves				
		Cucumber, etc.	on leaves				
		Tomato	on leaves				
		Banana	on leaves				
		Screw pine	on leaves				
Icerya purchasi Maskell Homoptera: Margarodidae	cottony-cushion scale	Breadfruit	on leaves, twigs	x	Beardsley, 1966		Y
		Papaya	on leaves, twigs				
		Citrus	on leaves, twigs				
Lamenia caliginea Stål Homoptera: Derbidae	derbid planthopper	Taro	on leaves	x	Fennah, 1956		Y
		Banana	on leaves				
Laminicoccus pandani (Cockerell) Homoptera: Pseudococcidae	pandanus mealybug	Screw pine	on leaves, flowers	x	Beardsley, 1966		
Lamprosema diemenalis (Guenée) Lepidoptera: Pyralidae	bean leaf-roller	Beans	larvae roll leaves & eat them	n			Y
Lepidosaphes beckii (Newman) Homoptera: Diaspididae	purple scale	Citrus	on leaves	x	Beardsley, 1966		Y
Lepidosaphes esakii Takahashi Homoptera: Diaspididae	armoured scale	Coconut palm	on leaves	x	Beardsley, 1966		Y
		Screw pine	on leaves				
Megacrania batesii Kirby Orthoptera: Phasmatidae	pandanus stick insect	Screw pine	eat leaves	x	TT records		
Metriona circumdata (Herbst) Coleoptera: Chrysomelidae	green tortoise beetle	Sweet potato	larvae, adults eat leaves	n			Y
Nysius pulchellus (Stål) Hemiptera: Lygacidae	lygeid bug	*Sweet potato*	*sucks sap*	x	*Barber, 1958*		
		Beans	sucks sap				
Palmicultor palmarum (Ehrhorn) Homoptera: Pseudococcidae	palm mealybug	Coconut palm	leaves, fruit	x	Beardsley, 1966		Y
Parasaissetia nigra (Nietner) Homoptera: Coccidae	nigra scale	Papaya	on leaves	x	Beardsley, 1975		Y
		Citrus	on leaves				
		Coconut palm	on leaves				
		Cassava	on leaves				
		Screw pine	on leaves				
		Guava	on leaves				
		Eggplant	on leaves				
		Tropical almond	on leaves				
Pentalonia nigronervosa Coquerel Homoptera: Aphididae	banana aphid	Taro	between leaf sheaths	x	Essig, 1956		Y
		Tomato	on leaves,				
		Banana	between leaf sheaths vector bunchy top				

Scientific name Order: Family	Common name	Crop	Habits	Status	Reference	At UG
Pinnaspis strachani (Cooley) Homoptera: Diaspididae	lesser snow scale	Coconut palm Eggplant	on leaves on stem	x	Beardsley, 1966	Y
Planococcus citri (Risso) Homoptera: Pseudococcidae	citrus mealybug	Pineapple Papaya Citrus Cucumber, etc. Tomato Cassava Banana Beans Guava Eggplant	on roots on roots on leaves, roots on leaves, roots on leaves, roots on leaves, roots on leaves, roots on leaves, roots on leaves, roots on leaves, roots	x	Beardsley, 1966	Y?
Pseudaulacaspis pentagona (Targioni-Tozzetti) Homoptera: Diaspididae	white peach scale	Breadfruit Red, bell peppers Cassava	on stems on stems on stems	n		Y
Pseudococcus marshallensis Beardsley Homoptera: Pseudococcidae	Marshall mealybug	Breadfruit	not known	x	Beardsley, 1966	Y
Pseudococcus microadonidum Beardsley Homoptera: Pseudococcidae	mealybug	Coconut palm Banana Screw pine	on leaves on leaves on leaves	x	Beardsley, 1966	
Pseudococcus orchidicola Takahashi Homoptera: Pseudococcidae	orchid mealybug	Swamp taro Banana Screw pine	on leaves on leaves on leaves, fruit	x	Beardsley, 1966	Y
Pseudonapomyza spicata (Malloch) Diptera: Agromyzidae	maize leafminer	Maize or corn	larvae mine leaves	x	Spencer, 1963	
Pulvinaria psidii Maskell Homoptera: Coccidae	green shield scale	Guava	on leaves	x	Beardsley, 1966	Y
Pulvinaria urbicola Cockerell Homoptera: Coccidae	urbicola soft scale	Red, bell peppers Sweet potato Eggplant	on leaves on leaves on leaves	n		Y
Saissetia ?oleae (Bernard) Homoptera: Coccidae	black scale	Citrus Guava	on leaves on leaves	x	Beardsley, 1966	Y?
Saissetia coffeae (Walker) Homoptera: Coccidae	hemispherical scale	Citrus Cucumber, etc. Banana Guava Eggplant	on leaves, twigs on leaves, twigs on leaves, twigs on leaves, twigs on leaves, twigs	x	Beardsley, 1966	Y
Saissetia neglecta DeLotto Homoptera: Coccidae	Caribbean black scale	Guava	on leaves	n?		Y
Spodoptera litura (F.) Lepidoptera: Noctuidae	rice cutworm	Red, bell peppers Taro Tomato Banana Beans Sugar cane Eggplant Maize or corn Cabbages, etc. Cucumber, etc.	larvae eat leaves larvae eat leaves larvae eat leaves larvae eat leaves larvae eat leaves larvae eat leaves larvae eat leaves larvae eat leaves larvae eat leaves larvae eat leaves	x	TT records	Y
Tarophagus proserpina (Kirkaldy) Homoptera: Delphacidae	taro leafhopper	Taro Swamp taro	leaves/virus vector leaves/virus vector	x	Fennah, 1956	
Tetranychus sp. Acari: Tetranychidae	spider mite	Papaya Coconut palm Taro Cucumber, etc. Cassava Beans Maize or corn	under leaves under leaves under leaves under leaves under leaves under leaves under leaves	n		Y

Scientific name Order: Family	Common name	Crop	Habits	Status	Reference	At UG
Xyleborus perforans (Wollaston) Coleoptera: Curculionidae	coconut shot-hole borer	Breadfruit Coconut palm	bore in twigs bore in trunk	x	Wood, 1960	
Xyleborus similis Ferrari Coleoptera: Curculionidae	shot-hole borer	Coconut palm	bore in trunk	x	Wood, 1960	

x = previously reported in literature cited.
x? = based on quarantine interception.
n = no record in known literature, but found in this survey.
? = identification needs checking.
Y = In the University of Guam Collection. Specimens reported by various authors are housed in the following museums: United States National Museum, Bernice P. Bishop Museum, Museum of Comparative Zoology, Chicago Natural History Museum, and the California Academy of Sciences. None of the publications list which specimens are housed in which museums. The Bernice P. Bishop Museum probably has the most complete collection except for the Coccids, most of which are housed in the United States National Museum.

8. HOST PLANTS WITH INSECTS FOUND IN THE MARSHALL ISLANDS

Ananas comosus (Bromeliaceae) Pineapple

Dysmicoccus brevipes (Cockerell)	pineapple mealybug	on fruit, leaves; causes pineapple wilt	Homoptera: Pseudococcidae
Dysmicoccus neobrevipes (Beardsley)	grey pineapple mealybug	on leaves	Homoptera: Pseudococcidae
Planococcus citri (Risso)	citrus mealybug	on roots	Homoptera: Pseudococcidae

Artocarpus altilis (Moraceae) Breadfruit

Aonidiella aurantii (Maskell)	California red scale	on leaves	Homoptera: Diaspididae
Aonidiella comperei Mackenzie	Falce yellow scale	on leaves	Homoptera: Diaspididae
Aonidiella inornata Mackenzie	inornate scale	on leaves	Homoptera: Diaspididae
Aphis craccivora Koch	cowpea aphid	on leaves	Homoptera: Aphididae
Aphis gossypii Glover	cotton or melon aphid	on leaves	Homoptera: Aphididae
Aspidiotus destructor Signoret	coconut scale	on leaves, fruits	Homoptera: Diaspididae
Asterolecanium pustulans (Cockerell)	oleander pit scale	on leaves	Homoptera: Asterolecaniidae
Bactrocera frauenfeldi Schiner	mango fruitfly	in fruit	Diptera: Tephritidae
Ceroplastes rubens Maskell	red wax scale	on leaves	Homoptera: Coccidae
Coccus hesperidum L.	brown soft scale	on leaves	Homoptera: Coccidae
Hemiberlesia cyanophylli (Signoret)	scale	leaves	Homoptera: Diaspididae
Hemiberlesia lataniae (Signoret)	latania scale	on leaves	Homoptera: Diaspididae
Hemiberlesia palmae (Cockerell)	palm scale	on leaves, fruits	Homoptera: Diaspididae
Icerya aegyptiaca (Douglas)	Egyptian fluted scale	on leaves	Homoptera: Margarodidae
Icerya purchasi Maskell	cottony-cushion scale	on leaves, twigs	Homoptera: Margarodidae
Pseudaulacaspis pentagona (Targioni-Tozzetti)	white peach scale	on stems	Homoptera: Diaspididae
Pseudococcus marshallensis Beardsley	Marshall mealybug	not known	Homoptera: Pseudococcidae
Xyleborus perforans (Wollaston)	coconut shot-hole borer	in twigs	Coleoptera: Curculionidae

Brassica (Cruciferae) Cabbage & related crops

Aphis gossypii Glover	cotton or melon aphid	on leaves	Homoptera: Aphididae
Halticus tibialis Reuter	black garden fleahopper	white spots on leaves	Hemiptera: Miridae
Spodoptera litura (F.)	rice cutworm	larvae eat leaves	Lepidoptera: Noctuidae

Capsicum (Solanaceae) Red, Bell pepper

Asterolecanium pustulans (Cocherell)	oleander pit scale	on leaves	Homoptera: Asterolecaniidae
Aphis gossypii Glover	cotton or melon aphid	on leaves	Homoptera: Aphididae
Pseudaulacaspis pentagona (Targioni-Tozzetti)	white peach scale	on stems	Homoptera: Diaspididae
Pulvinaria urbicola Cockerell	urbicola soft scale	on leaves	Homoptera: Coccidae
Spodoptera litura (F.)	rice cutworm	on leaves	Lepidoptera: Noctuidae

Carica papaya (Caricaceae) Papaya

Adoxophyes fasciculana (Walker)	orange tip moth	in tips	Lepidoptera: Tortricidae
Aonidiella aurantii Maskell	California red scale	on leaves	Homoptera: Diaspididae
Aonidiella comperei Mckenzie	false yellow scale	on leaves	Homoptera: Diaspididae
Aonidiella inornata Mackenzie	inornate scale	on leaves	Homoptera: Diaspididae
Aphis gossypii Glover	cotton or melon aphid	on leaves	Homoptera: Aphididae
Aspidiotus destructor Signoret	coconut scale	on leaves, fruits	Homoptera: Diaspididae
Coccus longulus (Douglas)	long brown scale	on leaves	Homoptera: Coccidae
Ferrisia virgata (Cockerell)	striped mealybug	infest fruits	Homoptera: Pseudococcidae
Icerya aegyptiaca (Douglas)	Egyptian fluted scale	on leaves	Homoptera: Margarodidae
Icerya purchasi Maskell	cottony-cushion scale	on leaves, twigs	Homoptera: Margarodidae
Parasaissetia nigra (Nietner)	nigra scale	on leaves	Homoptera: Coccidae
Planococcus citri (Risso)	citrus mealybug	on roots	Homoptera: Pseudococcidae
Tetranychus sp.	spider mite	under leaves	Acari: Tetranychidae

Citrus aurantifolia (Rutaceae) Lime

Adoxophyes fasciculana (Walker)	orange tip moth	in tips	Lepidoptera: Tortricidae
Aonidiella aurantii (Maskell)	California red scale	on leaves	Homoptera: Diaspididae
Aonidiella comperei Mckenzie	false yellow scale	on leaves	Homoptera: Diaspididae
Aonidiella inornata Mackenzie	inornate scale	on leaves	Homoptera: Diaspididae
Aphis craccivora Koch	cowpea aphid	on leaves	Homoptera: Aphididae
Aphis gossypii Glover	cotton or melon aphid	on leaves	Homoptera: Aphididae
Aspidiotus destructor Signoret	coconut scale	on leaves, fruits	Homoptera: Diaspididae
Ceroplastes rubens Maskell	red wax scale	on leaves	Homoptera: Coccidae
Chrysomphalus dictyospermi (Morgan)	dictyospermum scale	on leaves, fruit	Homoptera: Diaspididae
Coccus hesperidum L.	brown soft scale	on leaves	Homoptera: Coccidae
Coccus longulus (Douglas)	long brown scale	on leaves	Homoptera: Coccidae
Daealus sp.	weevil	on leaves	Coleoptera: Curculionidae
Ferrisia virgata (Cockerell)	striped mealybug	on leaves, stems	Homoptera: Pseudococcidae
Hemiberlesia lataniae (Signoret)	latania scale	on leaves	Homoptera: Diaspididae
Hemiberlesia palmae (Cockerell)	palm scale	on leaves	Homoptera: Diaspididae
Icerya aegyptiaca (Douglas)	Egyptian fluted scale	on leaves	Homoptera: Margarodidae
Icerya purchasi Maskell	cottony-cushion scale	on leaves, twigs	Homoptera: Margarodidae
Lepidosaphes beckii (Newman)	purple scale	on leaves	Homoptera: Diaspididae
Parasaissetia nigra (Nietner)	nigra scale	on leaves	Homoptera: Coccidae
Planococcus citri (Risso)	citrus mealybug	on leaves, roots	Homoptera: Pseudococcidae
Saissetia ?oleae (Bernard)	black scale	on leaves	Homoptera: Coccidae
Saissetia coffeae (Walker)	hemispherical scale	on leaves, twigs	Homoptera: Coccidae

Cocos nucifera (Arecaceae) Coconut palm

Aonidiella comperei Mckenzie	false yellow scale	on leaves, flower stalks	Homoptera: Diaspididae
Aonidiella inornata Mckenzie	inornate scale	on leaves	Homoptera: Diaspididae
Aspidiotus destructor Signoret	coconut scale	on leaves	Homoptera: Diaspididae
Brontispa chalybeipennis (Zacher)	Pohnpei coconut leaf beetle	on new leaves	Coleoptera: Chrysomelidae
Coccus hesperidum L.	brown soft scale	on leaves	Homoptera: Coccidae
Coccus longulus (Douglas)	long brown scale	on leaves	Homoptera: Coccidae
Dysmicoccus brevipes (Cockerell)	pineapple mealybug	on leaves	Homoptera: Pseudococcidae
Dysmicoccus cocotis (Maskell)	Saipan mealybug	trunk, flowers, leaves	Homoptera: Pseudococcidae
Eucalymnatus tessellatus (Signoret)	tessellated scale	on leaves	Homoptera: Coccidae
Flaccia dione Fennah	derbid hopper	on leaves	Homoptera: Derbidae
Furcaspis oceanica Lindinger	coconut red scale	on leaves, fruit	Homoptera: Diaspididae
Hemiberlesia lataniae (Signoret)	latania scale	on leaves	Homoptera: Diaspididae
Hemiberlesia palmae (Cockerell)	palm scale	on leaves	Homoptera: Diaspididae
Icerya aegyptiaca (Douglas)	Egyptian fluted scale	on leaves	Homoptera: Margarodidae
Lepidosaphes esakii Takahashi	armoured scale	on leaves	Homoptera: Diaspididae
Palmicultor palmarum (Ehrhorn)	palm mealybug	leaves, fruit	Homoptera: Pseudococcidae
Parasaissetia nigra (Nietner)	nigra scale	on leaves	Homoptera: Coccidae
Pinnaspis strachani (Cooley)	lesser snow scale	on leaves	Homoptera: Diaspididae
Pseudococcus microadonidum Beardsley	mealybug	on leaves	Homoptera: Pseudococcidae
Tetranychus sp.	spider mite	under leaves	Acari: Tetranychidae
Xyleborus perforans (Wollaston)	coconut shot-hole borer	in trunk	Coleoptera: Curculionidae
Xyleborus similis Ferrari	shot-hole borer	in trunk	Coleoptera: Curculionidae

Colocasia esculenta (Araceae) Taro

Aphis gossypii Glover	cotton or melon aphid	on leaves	Homoptera: Aphididae
Aspidiotus destructor Signoret	coconut scale	on leaves	Homoptera: Diaspididae
Coccus hesperidum L.	brown soft scale	on leaves	Homoptera: Coccidae
Dysmicoccus brevipes (Cockerell)	pineapple mealybug	on leaves	Homoptera: Pseudococcidae
Ferrisia virgata (Cockerell)	striped mealybug	on leaves, stems	Homoptera: Pseudococcidae
Icerya aegyptiaca (Douglas)	Egyptian fluted scale	on leaves	Homoptera: Margarodidae
Lamenia caliginea Stål	derbid planthopper	on leaves	Homoptera: Derbidae
Pentalonia nigronervosa Coquerel	banana aphid	leaves, between leaf sheaths	Homoptera: Aphididae
Spodoptera litura (F.)	rice cutworm	on leaves	Lepidoptera: Noctuidae
Tarophagus proserpina (Kirkaldy)	taro leafhopper	on leaves; virus vector	Homoptera: Delphacidae
Tetranychus sp.	spider mite	under leaves	Acari: Tetranychidae

Cyrtosperma (Araceae) Swamp taro

Pseudococcus orchidicola Takahashi	orchid mealybug	on leaves	Homoptera: Pseudococcidae
Tarophagus proserpina (Kirkaldy)	taro leafhopper	on leaves; virus vector	Homoptera: Delphacidae

Cucumis spp., *Cucurbita* spp. (Cucurbitaceae) Cucumber, pumpkin, & other cucurbits

Aphis craccivora Koch	cowpea aphid	on leaves	Homoptera: Aphididae
Aphis gossypii Glover	cotton or melon aphid	on leaves	Homoptera: Aphididae
Aspidiotus destructor Signoret	coconut scale	on leaves	Homoptera: Diaspididae
Ferrisia virgata (Cockerell)	striped mealybug	on leaves, stems	Homoptera: Pseudococcidae
Halticus tibialis Reuter	black garden fleahopper	white spots on leaves	Hemiptera: Miridae
Icerya aegyptiaca (Douglas)	Egyptian fluted scale	on leaves	Homoptera: Margarodidae
Planococcus citri (Risso)	citrus mealybug	on leaves, roots	Homoptera: Pseudococcidae
Saissetia coffeae (Walker)	hemispherical scale	on leaves, twigs	Homoptera: Coccidae
Spodoptera litura (F.)	rice cutworm	on leaves	Lepidoptera: Noctuidae
Tetranychus sp.	spider mite	under leaves	Acari: Tetranychidae

Ipomoea batatas (Convolvulaceae) Sweet potato

Adoxophyes fasciculana (Walker)	orange tip moth	web & bore tips	Lepidoptera: Tortricidae
Agrius convolvuli (L.)	sweet potato hawk moth	larvae eat leaves	Lepidoptera: Sphingidae
Chaetocnema confinis Crotch	sweet potato flea beetle	in tunnel-like tracks in leaves	Coleoptera: Chrysomelidae
Cylas formicarius (F.)	sweet potato weevil	in tubers	Coleoptera: Curculionidae
Daealus sp.	weevil		Coleoptera: Curculionidae
Halticus tibialis Reuter	black garden fleahopper	white spots on leaves	Hemiptera: Miridae
Metriona circumdata (Herbst)	green tortoise beetle	larvae, adults on leaves	Coleoptera: Chrysomelidae
Nysius pulchellus (Stål)	lygeid bug	on stems, leaves	Hemiptera: Lygaeidae
Pulvinaria urbicola Cockerell	urbicola soft scale	on leaves	Homoptera: Coccidae

Lycopersicon esculentum (Solanaceae) Tomato

Aphis gossypii Glover	cotton or melon aphid	on leaves	Homoptera: Aphididae
Aspidiotus destructor Signoret	coconut scale	on leaves	Homoptera: Diaspididae
Ferrisia virgata (Cockerell)	striped mealybug	on leaves, stems	Homoptera: Pseudococcidae
Icerya aegyptiaca (Douglas)	Egyptian fluted scale	on leaves	Homoptera: Margarodidae
Pentalonia nigronervosa Coquerel	banana aphid	on leaves	Homoptera: Aphididae
Planococcus citri (Risso)	citrus mealybug	on leaves, roots	Homoptera: Pseudococcidae
Spodoptera litura (F.)	rice cutworm	on leaves	Lepidoptera: Noctuidae

Manihot esculenta (Euphorbiaceae) Cassava

Aspidiotus destructor Signoret	coconut scale	on leaves	Homoptera: Diaspididae
Parasaissetia nigra (Nietner)	nigra scale	on leaves	Homoptera: Coccidae
Planococcus citri (Risso)	citrus mealybug	on leaves, roots	Homoptera: Pseudococcidae
Pseudaulacaspis pentagona (Targioni-Tozzetti)	white peach scale	on stems	Homoptera: Diaspididae
Tetranychus sp.	spider mite	under leaves	Acari: Tetranychidae

Musa (Musaceae) Banana

Aonidiella aurantii (Maskell)	California red scale	on leaves	Homoptera: Diaspididae
Aonidiella inornata Mackenzie	inornate scale	on leaves	Homoptera: Diaspididae
Aphis gossypii Glover	cotton or melon aphid	on leaves	Homoptera: Aphididae
Aspidiotus destructor Signoret	coconut scale	on leaves	Homoptera: Diaspididae
Chrysomphalus dictyospermi (Morgan)	dictyospermum scale	on leaves, fruit	Homoptera: Diaspididae
Coccus hesperidum L.	brown soft scale	on leaves	Homoptera: Coccidae
Dysmicoccus neobrevipes Beardsley	grey pineapple mealybug	on leaves	Homoptera: Pseudococcidae
Eucalymnatus tessellatus (Signoret)	tessellated scale	on leaves	Homoptera: Coccidae
Ferrisia virgata (Cockerell)	striped mealybug	infest fruits	Homoptera: Pseudococcidae
Hemiberlesia lataniae (Signoret)	latania scale	on leaves	Homoptera: Diaspididae
Icerya aegyptiaca (Douglas)	Egyptian fluted scale	on leaves	Homoptera: Margarodidae
Lamenia caliginea Stål	derbid planthopper	on leaves	Homoptera: Derbidae
Pentalonia nigronervosa Coquerel	banana aphid	on leaves, between leaf sheaths; vector bunchy top	Homoptera: Aphididae
Planococcus citri (Risso)	citrus mealybug	on leaves, roots	Homoptera: Pseudococcidae
Pseudococcus microadonidum Beardsley	mealybug	on leaves	Homoptera: Pseudococcidae
Pseudococcus orchidicola Takahashi	orchid mealybug	on leaves	Homoptera: Pseudococcidae
Saissetia coffeae (Walker)	hemispherical scale	on leaves, twigs	Homoptera: Coccidae
Spodoptera litura (F.)	rice cutworm	on leaves	Lepidoptera: Noctuidae

Pandanus (Pandanaceae) Screw pine

Aonidiella aurantii (Maskell)	California red scale	on leaves	Homoptera: Diaspididae
Aspidiotus destructor Signoret	coconut scale	on leaves	Homoptera: Diaspididae
Chrysomphalus dictyospermi (Morgan)	dictyospermum scale	on leaves, fruit	Homoptera: Diaspididae
Dysmicoccus brevipes (Cockerell)	pineapple mealybug	on fruit, leaves	Homoptera: Pseudococcidae
Furcaspis oceanica Lindinger	coconut red scale	on leaves, fruit	Homoptera: Diaspididae
Hemiberlesia lataniae (Signoret)	latania scale	on leaves	Homoptera: Diaspididae
Icerya aegyptiaca (Douglas)	Egyptian fluted scale	on leaves	Homoptera: Margarodidae
Laminicoccus pandani (Cockerell)	pandanus mealybug	on leaves, flowers	Homoptera: Pseudococcidae
Lepidosaphes esakii Takahashi	armoured scale	on leaves	Homoptera: Diaspididae
Megacrania batesii Kirby	pandanus stick insect	on leaves	Orthoptera: Phasmatidae
Parasaissetia nigra (Nietner)	nigra scale	on leaves	Homoptera: Coccidae
Pseudococcus microadonidum Beardsley	mealybug	on leaves	Homoptera: Pseudococcidae
Pseudococcus orchidicola Takahashi	orchid mealybug	on leaves, fruit	Homoptera: Pseudococcidae

Phaseolus (Fabaceae) Beans

Agrius convolvuli (L.)	sweet potato hawk moth	larvae on leaves	Lepidoptera: Sphingidae
Aphis craccivora Koch	cowpea aphid	on leaves	Homoptera: Aphididae
Aphis gossypii Glover	cotton or melon aphid	on leaves	Homoptera: Aphididae
Empoasca sp.	green leafhopper	suck sap leaves	Homoptera: Cicadellidae
Ferrisia virgata (Cockerell)	striped mealybug	infest fruits	Homoptera: Pseudococcidae
Halticus tibialis Reuter	black garden fleahopper	on leaves	Hemiptera: Miridae
Lamprosema diemenalis (Guenée)	bean leaf-roller	in leaf rolls	Lepidoptera: Pyralidae
Nysius pulchellus (Stål)	lygeid bug	sucks sap	Hemiptera: Lygaeidae
Planococcus citri (Risso)	citrus mealybug	on leaves, roots	Homoptera: Pseudococcidae
Spodoptera litura (F.)	rice cutworm	on leaves	Lepidoptera: Noctuidae
Tetranychus sp.	spider mite	under leaves	Acari: Tetranychidae

Psidium guajava (Myrtaceae) Guava

Aonidiella aurantii (Maskell)	California red scale	on leaves	Homoptera: Diaspididae
Aphis gossypii Glover	cotton or melon aphid	on leaves	Homoptera: Aphididae
Aspidiotus destructor Signoret	coconut scale	on leaves	Homoptera: Diaspididae
Bactrocera frauenfeldi Schiner	mango fruitfly	larvae in fruit	Diptera: Tephritidae
Ceroplastes cirripediformis Comstock	barnacle scale	on leaves	Homoptera: Coccidae
Ceroplastes rubens Maskell	red wax scale	on leaves	Homoptera: Coccidae
Chrysomphalus dictyospermi (Morgan)	dictyospermum scale	on leaves, fruit	Homoptera: Diaspididae
Coccus hesperidum L.	brown soft scale	on leaves	Homoptera: Coccidae
Eucalymnatus tessellatus (Signoret)	tessellated scale	on leaves	Homoptera: Coccidae
Ferrisia virgata (Cockerell)	striped mealybug	on leaves, stems, fruits	Homoptera: Pseudococcidae

Hemiberlesia lataniae (Signoret)	latania scale	on leaves	Homoptera: Diaspididae
Hemiberlesia palmae (Cockerell)	palm scale	on leaves	Homoptera: Diaspididae
Parasaissetia nigra (Nietner)	nigra scale	on leaves	Homoptera: Coccidae
Planococcus citri (Risso)	citrus mealybug	on leaves, roots	Homoptera: Pseudococcidae
Pulvinaria psidii Maskell	green shield scale	on leaves	Homoptera: Coccidae
Saissetia ?oleae (Bernard)	black scale	on leaves	Homoptera: Coccidae
Saissetia coffeae (Walker)	hemispherical scale	on leaves, twigs	Homoptera: Coccidae
Saissetia neglecta DeLotto	Caribbean black scale	on leaves	Homoptera: Coccidae

***Saccharum officinarum* (Poaceae) Sugar-cane**

Aspidiella sacchari (Cockerell)	sugar-cane scale	on stem	Homoptera: Diaspididae
Aspidiotus destructor Signoret	coconut scale	on leaves	Homoptera: Diaspididae
Dysmicoccus brevipes (Cockerell)	pineapple mealybug	on leaves	Homoptera: Pseudococcidae
Spodoptera litura (F.)	rice cutworm	larvae on leaves	Lepidoptera: Noctuidae

***Solanum melongena* (Solanaceae) Eggplant**

Aphis gossypii Glover	cotton or melon aphid	on leaves	Homoptera: Aphididae
Aspidiotus destructor Signoret	coconut scale	on leaves	Homoptera: Diaspididae
Chrysomphalus dictyospermi (Morgan)	dictyospermum scale	on leaves, fruit	Homoptera: Diaspididae
Ferrisia virgata (Cockerell)	striped mealybug	on leaves, stems, fruits	Homoptera: Pseudococcidae
Parasaissetia nigra (Nietner)	nigra scale	on leaves	Homoptera: Coccidae
Pinnaspis strachani (Cooley)	lesser snow scale	on stem	Homoptera: Diaspididae
Planococcus citri (Risso)	citrus mealybug	on leaves, roots	Homoptera: Pseudococcidae
Pulvinaria urbicola Cockerell	urbicola soft scale	on leaves	Homoptera: Coccidae
Saissetia coffeae (Walker)	hemispherical scale	on leaves, twigs	Homoptera: Coccidae
Spodoptera litura (F.)	rice cutworm	larvae on leaves	Lepidoptera: Noctuidae

***Solanum tuberosum* (Solanaceae) Potato**

Aphis gossypii Glover	cotton or melon aphid	on leaves	Homoptera: Aphididae

***Terminalia catappa* (Combretaceae) Tropical almond**

Badamia exclamationis F.	myrobalan butterfly	larvae on leaves	Lepidoptera: Hesperiidae
Parasaissetia nigra (Nietner)	nigra scale	on leaves	Homoptera: Coccidae

***Zea mays* (Poaceae) Maize or corn**

Ferrisia virgata (Cockerell)	striped mealybug	on leaves, stem	Homoptera: Pseudococcidae
Pseudonapomyza spicata (Malloch)	maize leafminer	larva in leaf mines	Diptera: Agromyzidae
Spodoptera litura (F.)	rice cutworm	larvae on leaves	Lepidoptera: Noctuidae
Tetranychus sp.	spider mite	under leaves	Acari: Tetranychidae

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