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REPORT ON A MISSION TO AMERICAN SAMOA FROM 20th MAY TO 1st JUNE 1976 TO INVESTIGATE AN OUTBREAK OF SPODOPTERA LITURA (F.) (LEPIDOPTERA: NOCTUIDAE). AFFECTING TARO.

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South Pacific Commission
Noumea, September 1976

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INTRODUCTION

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PURPOSE OF VISIT

The visit described in this report was made at the request of the South Pacific Commission. Its purpose was to investigate severe outbreaks of army worm on the island of Tau, in the Manua group, the second largest island in Maru'a American Samoa.

Taro being one of the staple foods in Samoa, the outbreak was of immediate concern to the territory's Agricultural Department.

In receiving the writer during his stop in Pago Pago, the Assistant to the Governor, Mr. Brownie Tuiasosopo, showed the importance he attaches to matters affecting the agricultural development of his country. He was happy that the local Department of Agriculture, the SPC and the ORSTOM should co-operate in American Samoa.

ACKNOWLEDGEMENTS

The writer wishes to express grateful thanks and appreciation for the most useful assistance and the friendly hospitality received throughout his stay from the Head of the Agricultural Department, Mr. Pemerika L. Tauiliili, and his staff, and especially to Mr. Sipaia Fatuesi and Mr. Tupulua Tagaloa.

1. DURATION OF VISIT AND PERSONS MET OFFICIALLY

20-21 May: After contacting Mr. P.L. Tauiliili, Head of the Department of Agriculture, departure for Tau with Mr. S. Fatuesi, Public Relations Officer. On arrival at Tau, we were met by the district agricultural officer, Mr. T. Tagaloa, then visited affected plantations where samples of pests and living army worms were collected.

22-23 May: Collection of plant-eating insects and mites in the area surrounding Pago Pago.

24-31 May: Collection of samples and observations throughout the island of Tutuila, assisted by Mr. S. Fatuesi.

- Collection of larvae on taro plants at Aoloaufou.
- Collection and rearing of fruit flies obtained from pawpaw trees at Tafunafou.
- Visit to Taputimu Agricultural Station. (Messrs A. Maina, I. Swan, J.E. Merrick).
- Observation of vegetable crops at Pavaiai.
- Observation of coconut palms at Pago Pago, Aua, Vailoatai and Amanave.
- Collection of plant mites at Nua, Tafunafou and Taputimu.
- Visit to the meteorological office at the International Airport.
- Courtesy call on the Assistant to the Governor, Mr. B. Tuiasosopo.
- Final talks with the Director of Agriculture.

2. GENERAL REMARKS CONCERNING THE ENVIRONMENT

American Samoa is a group of seven volcanic islands with a total area of 76.2 square miles lying south of the Equator (latitude 14^{o} south, longitude 170^{o} west). The group makes up the eastern part of the Samoan archipelago, and is 2,300 miles south-west of Hawaii, and 1,600 miles north-east of New Zealand.

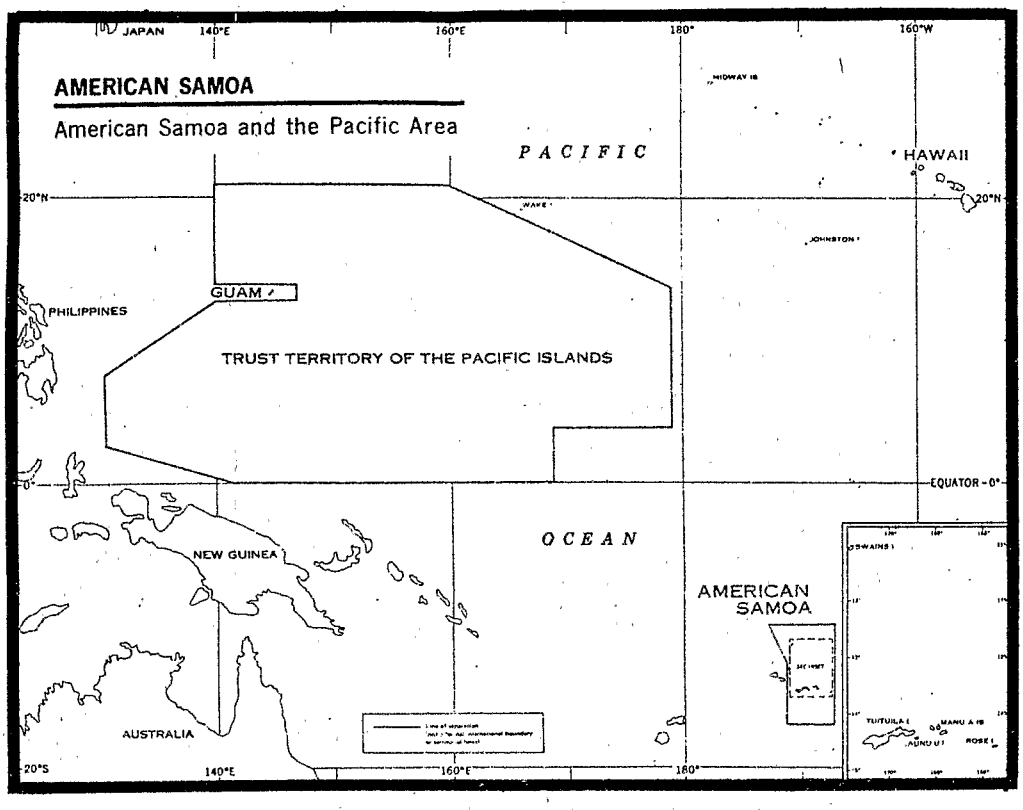
Variegated topography results in sharply differing average annual rainfall throughout the group; 125 inches at the International Airport, 200 inches at Pago Pago, and almost 250 inches near hill and mountain tops. Rainfall is lower from June to September.

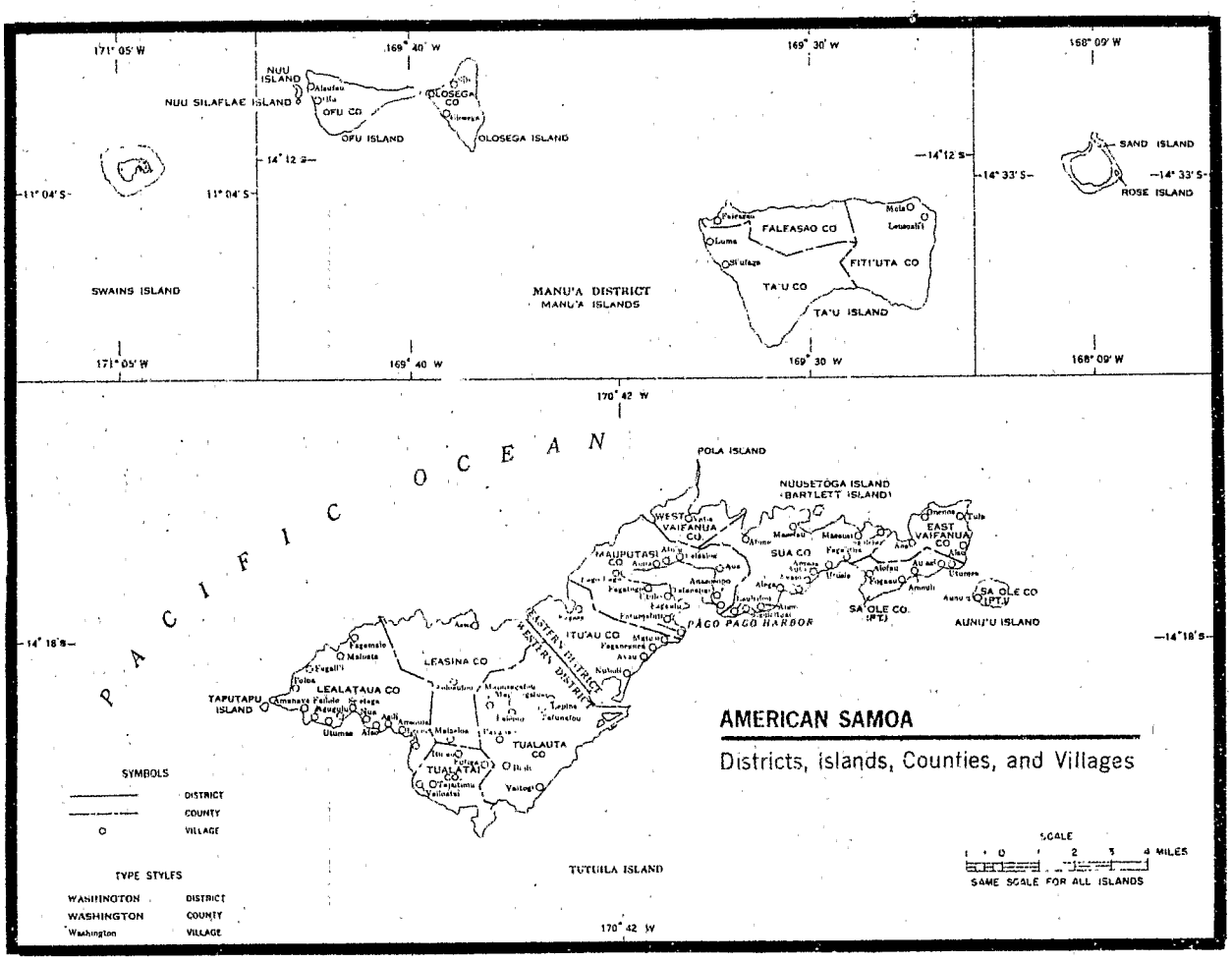
Average annual temperature is almost $27^{o}C$ ($80^{o}F$). Temperature variations during any one day may range to $7^{o}C$ ($12^{o}F$), whereas average monthly temperature variations, taken over a year, are only about $2^{o}C$ ($3^{o}F$).

In 1974 the population was 29,200. Agriculture and fishing provide the major part of income and food resources. Cattle are scarce; livestock farming is restricted to a few domestic animals (poultry, pigs).

More than 96% of the land is collectively owned and farmed by families in accordance with tradition.

The main crops are taro (Colocasia esculenta SCHOTT), ta'amu (Alocasia macrorzhiza (L.) SCHOTT); bananas and coconut palms. All four are generally grown together on small plots.


AMERICAN SAMOA
American Samoa and the Pacific Area
JAPAN
140°E
160°E
180°
160°W
PACIFIC
HAWAII
20°N
GUAM
PHILIPPINES
TRUST TERRITORY OF THE PACIFIC ISLANDS
EQUATOR - 0°
OCEAN
NEW GUINEA
AMERICAN SAMOA
AUSTRALIA
20°S
140°E
160°E
180°


171° 05' W
169° 40' W
169° 30' W
168° 09' W
NUU ISLAND
NUU SILAFLAE ISLAND
OFU CO
OFU ISLAND
OLOSEGA CO
OLOSEGA ISLAND
14° 12' S
11° 04' S
14° 33' S
SAND ISLAND
ROSE ISLAND
SWAINS ISLAND
MANU'A DISTRICT
MANU'A ISLANDS
FALEASAO CO
FITI'UTA CO
TA'U CO
TA'U ISLAND
170° 42' W
OCEAN
PACIFIC
POLA ISLAND
NUUSETOGA ISLAND
(BARTLETT ISLAND)
WESTERN VAIFANUA CO
EASTERN VAIFANUA CO
TAUPUTASI CO
SUA CO
SA'OLE CO
SA'OLE CO. (PT.)
AUNU'U ISLAND
PAGO PAGO HARBOR
ITU'AU CO
WESTERN DISTRICT
EASTERN DISTRICT
LEASINA CO
LEALATAUA CO
TAPUTAPU ISLAND
TUALATAI CO
TUALAUTA CO
TUTUILA ISLAND
14° 18' S
AMERICAN SAMOA
Districts, Islands, Counties, and Villages
SYMBOLS
DISTRICT
COUNTY
VILLAGE
TYPE STYLES
WASHINGTON DISTRICT
WASHINGTON COUNTY
Washington VILLAGE
SCALE
0 1 2 3 4 MILES
SAME SCALE FOR ALL ISLANDS

3. OUTBREAK OF ARMY WORM ON TARO

3.1 The situation in May 1976

Both on Tau and Tutuila, the damage to taro was caused solely by Spodoptera litura (FABRICIUS) (Lepidoptera, Noctuidae) (army worm); a very few Hippotion celerio L. (Lepidoptera, Sphingidae) (taro hawk moth) were noted.

On the island of Tau, infestation was particularly heavy in a recently cleared area above the village of Fituita.

Plots which had received regular applications of Malathion were practically undamaged, although recently laid eggs were found on a great many leaves. Taros in other plantations were severely defoliated, but no further caterpillars are to be found as the plants have since been treated.

In plots between Fituata and Faleasao, which have a long planting history but have received little or no treatment, caterpillars were present in fairly large numbers; damage has, however, in our opinion remained at an acceptable level.

An entirely different state of affairs was observed on the island of Tutuila. Here, taro plantations are adjacent to houses, and farmers customarily keep watch on their fields, taking action at the first sign of a serious attack. Few caterpillars are to be found on taro plants, and most of those we took for rearing purposes were collected on ta'amu.

3.2 The pest and its life cycle

S. litura was reported on Tutuila as early as 1941 (SWEZEY). The species is widespread in Asia, and also in Australia and the Pacific islands. The larvae feed on a wide variety of plants, attacking taro, ta'amu, bananas and coconut palms, as well as vegetable crops such as eggplants and onions.

The moth has a body length of 15 to 20 mm and a wingspread ranging from 35 to 40 mm. The forewings are dark brown and feature kidney-shaped spots and small, light-coloured bands, whereas the hind wings are light in colour with a narrow dark border.

Amongst the many authors who have studies the life cycle of S. litura, special mention should be made of Dale and Herring (1958) in Samoa. Detailed biological information was collected in 1973 by R.C. Patel et al. (1973) in India.

The eggs are laid on the leaves, in clusters of five to six hundred. The white piles thus formed are 12 to 15 mm in diameter and are protected by a layer of downy silk. Each may contain up to seven successive layers of eggs.

The young larvae are greenish in colour. They emerge after four or five days (four days at a temperature of 26.7°C, $\pm$ 1°) and feed together in the immediate vicinity of the eggs they have just left, attacking one leaf surface only. They grow rapidly and turn brown; during this period light-coloured stripes appear on their sides. They then begin to attack the edges of the leaves and tend to separate, moving from one plant to another.

The larvae pass through six stages of growth. They are active day and night at the beginning but, on reaching the final stage, feed only during night time. Fully grown larvae remain dormant during daytime in a hollow stem or in the brittle earth at the foot of the host plant, but cause substantial damage during the night.

Two to three weeks after hatching, the larvae forms a glossy black pupa in an earthen cell. Ten to twelve days after pupation, the adult emerges by night.

The adult is nocturnal; its activity reaches a peak between 11 p.m. and 3 a.m. Mating most frequently occurs towards 11.30 p.m. (Miyashita and Fuwa, 1972). Each female lays an average of 2,500 eggs, 90% of them between the second and the fifth day after emergence.

The average life of a generation can consequently be reckoned at 35 days; in other words, there are approximately ten generations yearly in Samoa.

3.3 Natural Enemies

Swezey (1941) states that on Tutuila, larvae are attacked by a Euplectrus (Chalcidoidea, Elachertidae), and Dale and Herring (1958) note the frequent occurrence in Samoa of an Apanteles (Ichneumonoidea, Braconidae, Microgastrinae). During my brief stay, I was unable to confirm the presence of either of these two natural enemies of S. litura on Tau or Tutuila.

On untreated plantations on Tau, egg clusters are covered with large numbers of small Hymenoptera (Proctotrupoïdea, cf Scelionidae), which are still being identified.

A parasite tachinid fly (Diptera, Tachinidae) and another parasite Hymenoptera (Braconidae, Macrocertripae) were reared from larvae in the last two stages of growth collected on both Tau and Tutuila.

Large numbers of ants were observed in the plantation; they certainly contributed to the destruction of larvae before pupation.

In plots lying near housing, domestic poultry also plays an important part in destroying the pest, both at larvae and at pupal stage.

There are relatively few birds in American Samoa, and the two Asian Sturnidae, Aethiopsar fuscus ("field Mynah bird") and Acridotheres tristis ("house Mynah bird") have not been introduced. These two species are very active in controlling army worm communities (Perkins, 1913, in Zimmerman, 1958; Swain 1971); unfortunately however, they attack other birds and in addition, by the seeds contained in their excreta, contribute to the spread of weeds such as Lanatana camara MOLD.

There are of course natural factors which curb the spread of army worm; frequent rain showers for example tend to simply wash young larvae off the leaves.

High relative humidity contributes to the development of fungal diseases which probably plays a large part in the larvae mortality we noted in the field.

3.4 Observations on the Origin of the Outbreak

As all the main crops grown in Samoa can act as hosts, the local environment is highly conducive to the development of S. litura.

Natural predators are already present, and it would therefore seem pointless to introduce new species. In addition, other regions do not seem capable of supplying predators or parasites which could be expected to have spectacular results. Importing Sturnidae would be less of a help than a hindrance.

At present only taro is treated; the remaining crops, with their tougher and more abundant leaves, withstand pest damage fairly well. Thus, a substantial community of S. litura is maintained, as is also a chain of natural parasites to the insect.

The insecticide used at present (Malathion = Maldison) remains effective.

On the island of Tau, the only places to suffer heavy damage were those where cultivation had been considerably extended in 1974 (shipment of tubers to Tutuila rose three-fold). The clearing operations involved in bringing this new land under cultivation brought about a complete disruption of the existing biological balance.

On Tau, planters unused to handling large areas are insufficiently inclined to take action, preferring to rely on the Department of Agriculture. The Department however, which advised the extension of cropping, does not have a sufficient number of motorized mist blowers.

3.5 Possible control methods

3.5.1 Biological control

Predators: a number are already present in American Samoa. Since taro is the only plant under treatment, the pest and its parasites subsist on many other hosts.

Trapping by UV traps and sexual attractants.

These two methods, by providing an estimate of population level (Otake and Oyama, 1974), help to predict outbreaks. They also make it possible to capture a good proportion of adults (Miyashita et al. 1974) and alter the sex ratio (Oyama, 1974).

A significant step forward has been made with the synthesis of the attractive component of the sex pheromone of S. litura (Tamaki et al. 1973). However, trapping methods, while promising, are still expensive, and require a large and painstaking personnel.

Gamma sterilization of males

By releasing very large numbers of sterile males it should be possible to totally eradicate S. litura from these small and isolated islands, provided that the operation is undertaken on a sufficiently large scale. The only results available at present are those obtained under laboratory conditions. (Kiyoku and Tsukuda, 1973 - Mochida and Miyahara, 1974).

Microbiological control

Only the use of Bacillus thuringiensis BERLINER appears suitable for widespread use. Spraying a mixture made from this bacteria eliminates second and third stage larvae of S. litura (Babu and Subramaniam, 1973). Although certain researchers (Asano et al., 1973) contest the effectiveness of the product on S. litura, it would be useful to run trials since it is entirely without adverse effects on non-harmful fauna.

3.5.2 Insecticide control

We do not consider that soil treatment is necessary for the control of S. litura in Samoa. Though this method is widely used against borer attacking vegetable crops in other countries, it has a draw back; it destroys a good part of animal life for a long period.

The insecticides currently used on taro against S. litura and against Delphacidae (leafhopper): Tarophagus proserpina (KIRK.) are all organophosphates: Malathion (maldison), diazinon and trichlorphon (dipterex).

There is a danger that resistant strains will soon develop, and the Department of Agriculture should therefore organise trials of the following new products without delay:

- Endosulfan (Thiodan), an organochlorine compound harmless to bees.
- Methomyl (Lannate), of the carbamate group.

Endosulfan acts by contact and ingestion. Methomyl has, in addition, systemic properties. Both have a greater residual activity than Malathion; they are active against aphids, and thus should also be efficient on Tarophagus.

Ingram (1975) suggests Methamidophos (Tamaron) as an alternative for methyl-parathion against Spodoptera littoralis (BOIDS.). Although it too is an organophosphate, this insecticide, with it systemic properties, remains active for two to three weeks after application.

Unfortunately, these three insecticides are far more toxic to man than is Malathion.

L.D. 50 in rats, by ingestion:

Methomyl: 20 mg/kg

Methamidophos: 30 mg/kg

Endosulfan: 50 mg/kg (oil solution)
110 mg/kg (water solution)

compared to 2,800 mg/kg for Malathion.

4. OTHER PROBLEMS INVESTIGATED

4.1 Other taro pests

After S. litura, Tarophagus proserpina is the second most harmful pest to taro. It pierces the plant both to feed and to lay its eggs, causing a flow of sap which forms a reddish crust at the foot of the stem.

Its eggs are often destroyed by the predator Cytorhinus fulvus KNIGHT (Heteroptera: Miridae).

Aphis gossypii (Aphididae) is rare. In a small community of this aphid, on Tau, several predators were noted: larvae of Coccinellidae and a Syrphidae larva.

Tetranychus marianae McGREGOR (Acarina, Tetranychidae) is often mentioned as attacking taro in this area. Only at Pago Pago did we find tetranychids on taro and ta'amu, and the species turned out in fact to be Tetranychus neocaledonicus ANDRE.

4.2 Pawpaw fruit fly

Notodacus xanthodes (BROUN) (Diptera, Trypetidae) attacks pawpaw on Tutuila. We discovered no parasites of this species, which also attacks breadfruit, pineapple, citrus fruit, the fruit of Inocarpus fagiferus (PARK.) FOSB. ("ivi") and, in particular, that of Barringtonia edulis SEEM. ("vutu").

Before any other form of control measure is attempted, all "vutus" in the immediate vicinity of pawpaw plantations must be eliminated, since the fruit of this tree swarms with N. xanthodes. In addition, all pierced and fallen fruit should be picked or collected daily and buried at a depth of at least 20 inches.

4.3 Coconut pests

Serious damage by Graeffea crouani LE GUILLOU (Phasmidae) (Coconut stick insect) on a few groups of coconut palms on Tutuila, was noted.

Brontispa longissima GESTRO (Coleoptera: Hispidae) was found on practically all coconut palms examined at Vailoatai, Amanave, Pago Pago and Aua, but very few individuals were present in each case. We failed to find pupae attacked by Tetrastichus brontispae FERR. (Eulophidae), a chalcid introduced to three of the four above mentioned areas. On the other hand a a number of pupae are attacked by a pathogenic fungus (cf Metarrhizium), as was noted by I. Swan in 1974. The predator Chelisoches morio (F.) (Dermaptera: Forficulidae) is found in abundance in the crowns, and is probably responsible for confining Brontispa to a few folioles tightly enclosed in the fronds of the terminal bud.

4.4 Fruit-piercing moth

Citrus fruit are rare in American Samoa, with the result that attacks by Othreis fullonia CLERK (Noctuidae) are harmful only to tomatoes. We examined only a few larvae of Othreis in the terminal growth stage, taken from Erythrina; none of them bore any external parasites, nor eggs of Winthemia caledoniae MESNIL (Diptera, Tachinidae), despite the fact that the latter has been introduced to the island.

4.5 Phytophagous mites

Eleven collections of plant mites were made on ten different crops on Tutuila. Although Tetranychus communities are relatively rare as a result of the high rainfall, it represents a potential danger of some significance.

We listed:

1. 4 Tetranychidae
   - Tetranychus neocaledonicus ANDRE
   - Tetranychus marianae McGREGOR
   - A new species of Tetranychus
   - A species of Oligonychus; though we were unable to find a male, the species is probably new.
2. 1 Tenuipalpidae
   - Brevipalpus phoenicis (GEIJSKES)
3. 1 Tarsonemidae
   - Polyphagotarsonemus latus (BANKS)

Table 1 lists the host plants and predators of the species.

Table I: Phytophagous mites collected from crops on the island of Tutuila

HOST PLANT	LOCALITY	MITES	PREDATORS OBSERVED
Alocasia macrorhiza	Pago Pago	T. neocaledonicus	
Artocarpus altilis	Pago Pago	Oligonychus sp.	Phytoseiidae
Carica papaya	Nua	T. neocaledonicus	Cecidomyiida Phytoseiidae
	Tafunafou	T. neocaledonicus	Phytoseiidae
Cocos nucifera	Pago Pago	Tetranychus sp.	Phytoseiidae Staphylinidae : Oligota sp.
Colocasia esculenta	Pago Pago	T. neocaledonicus	
Hibiscus rosa sinensis	Taputimu	Brevipalpus phoenicis; Polyphagotarsonemus latus	
Hibiscus sp.	Pago Pago	T. marianae	
Manihot utilissima	Nua	T. neocaledonicus	Cecidomyiidae Phytoseiidae
Musa paradisiaca	Pago Pago	T. marianae	Phytoseiidae
Phaseolus vulgaris	Pago Pago	T. neocaledonicus	

CONCLUSION

The only problem in American Samoa calling for immediate action is that of attack by S. litura on taro. Biological control would be the most attractive solution.

Traps and sterilization by gamma radiation, the two main biological control techniques, have not yet undergone sufficient testing in this field to be of immediate practical applicability. Trials with Bacillus thuringiensis should be organized on experimental plots; if successful, this would be an excellent means of control.

For the moment, treatment with Malathion is effective. A further advantage is its low toxicity to man; however, its residual effect is also low.

On the island of Tau, infestation occured after new land had been brought under cultivation. Farmers were taken by surprise and failed to apply counter-measures in time. Each planter, or at least a large number of them, should be persuaded to purchase a portable sprayer, either of the knapsack or compressed air type, so as to be able to hold invasions of caterpillars in check.

Intensifying treatment for no specific reason is of course out of the question. The chain of predators is such that pests remain at a tolerable level, except for one or two periods of the year which it is difficult to forecast in this region where climatic variations are minimal.

Treatment should be commenced only when a certain threshold is reached, as defined by the Department of Agriculture; however, the most progressive planters on Tutuila are already well aware of the critical level.

As cases of resistance to Malathion may suddenly appear, several alternative products should be tested, and an emergency stock of the selected insecticides be built up as soon as possible.

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