NATURAL CONTROL OF INSECT PESTS IN AN ORGANIC GARDEN

By Wayne C. Gagné, Wau Ecology Institute
Morobe Province

INTRODUCTION

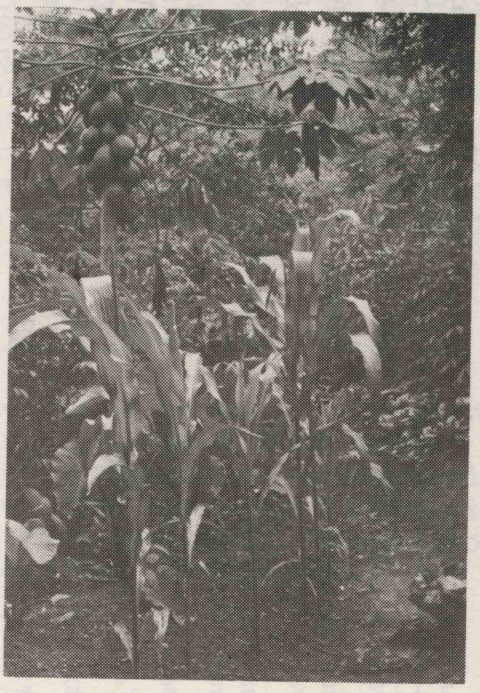
Melanesians have been successful organic gardeners for many millennia in slash-and-burn shifting agricultural systems. By organic, we mean relying on natural pest control and fertilization methods rather than on pesticides and commercial fertilizers.

Recently, however, shifting agricultural systems have been stressed by population growth and urban migration. Fallows are increasingly shortened such that fire climax grasslands are expanding at the expense of forest fallows. This has serious long-term human and environmental implications.

To investigate possible alternatives to shifting agriculture, a site-stable (non-shifting) garden was established at Wau Ecology Institute. The part of the investigation reported here concerns the way in which many of the crop pests are controlled by their natural enemies in the garden. These enemies include parasites, predators and pathogens (disease-causing organisms). Control of pests by their natural enemies is called natural control.

THE GARDEN

The site for the garden was reclaimed from fire climax grassland (kunai grass) at 1 200 m above sea level. The terrain was similar to that under shifting cultivation nearby, varying from almost flat to places too steep for contour mounds to stay in place. Rainfall in this area averages 1 900 mm per year. The average maximum temperature is 27.2°C and the average minimum temperature is 17.2°C (from nine years' observation).



Crops growing in the organic garden

The information in this article was presented in a paper given at the South Pacific Commission Workshop on Biological Control, Noumea, 6-10 August, 1979.

TABLE 1. SOME OF THE CROPS GROWN IN THE SITE-STABLE GARDEN AT WAU (EXCLUDING STAPLE AND HIGH PROTEIN CROPS)

Botanical Name	Common Name	Botanical Name	Common Name	Botanical Name	Common Name
Allium ascalonicum	Shallot	*Brassica pekinensis*	Won bok	*Pastinaca sativa*	Parsnip
Allium porrum	Leek	*Brassica rapa* var. *rapa*	Turnip	*Persea americana*	Avocado
Allium schoenoprasum	Chive	*Capsicum annum* var. *longum*	Capsicum	*Petroselinum crispum*	Parsley
Allium cepa	Onion	*Capsicum frutescens*	Chilli	*Physalis peruviana*	Cape gooseberry
Amaranthus tricolor	Kumu aupa	*Chichorium intybus*	Chicory	*Raphanus sativus*	Radish
Anethum graveolens	Dill	*Citrullus vulgaris*	Watermelon	*Rheum rhaponticum*	Rhubarb
Annona muricata	Soursop	*Coriandrum sativum*	Coriander	*Rungia klossii*	Kumu moku
Annona reticulata	Bullock's heart	*Cucumis anguria*	Gherkin	*Saccharum officinarum*	Sugarcane
Annona squamosa	Custard apple	*Cucumis melo*	Rock melon	*Salvia officinalis*	Sage
Anthriscus cerefolium	Chervil	*Cucumis sativus*	Cucumber	*Sechium edule*	Choko
Apium graveolens	Celery	*Cucurbita maxima*	Squash	*Setaria palmifolia*	Highlands pit pit
Asparagus officinalis	Asparagus	*Cucurbita pepo*	Pumpkin	*Solanum melongena*	Eggplant
Beta vulgaris	Beetroot	*Daucus carota*	Carrot	*Solanum nigrum*	Kumu karakap
Beta vulgaris var. *cicla*	Silverbeet	*Helianthus annus*	Sunflower	*Solanum tuberosum*	Potato
Brassica caulorapa	Kohl-rabi	*Hibiscus esculentus*	Okra	*Spinacia oleracea*	Spinach
Brassica napus var. *naprobrassica*	Swede	*Hibiscus manihot*	Aibika	*Thymus vulagris*	Thyme
Brassica oleracea botrytis	Cauliflower	*Hibiscus sabdariffa*	Roselle	*Vicia faba*	Broad bean
Brassica oleracea capitata	Cabbage	*Lactuca sativa*	Lettuce	*Vigna sinensis* var. *sesquipedalis*	Snake bean
Brassica oleracea italica	Broccoli	*Lepidium sativum*	Cress	*Zea mays*	Maize
		Lycopersicum esculentum	Tomato		
		Ocimum basilicum	Basil		

The garden had irregularly shaped borders and covered an area of 0.28 ha. At this size, two labourers working a 5½ day week could just maintain a regular routine of composting, planting, weeding and harvesting.

The most locally abundant agricultural waste (a mixture of coffee pulp and hulls) was used to fertilize the garden. It was applied as compost into contour mounds interplanted at 5 x 5 m intervals with a mixture of fruits, nut and wild tree species. One of each of three types of vegetable was planted in each mound:

1) Staples - 2 species of taro, 2 species of yam, sweet potato, cassava.

2) high protein crops - legumes, maize.

3) a great variety of other vegetables and greens (see Table 1).

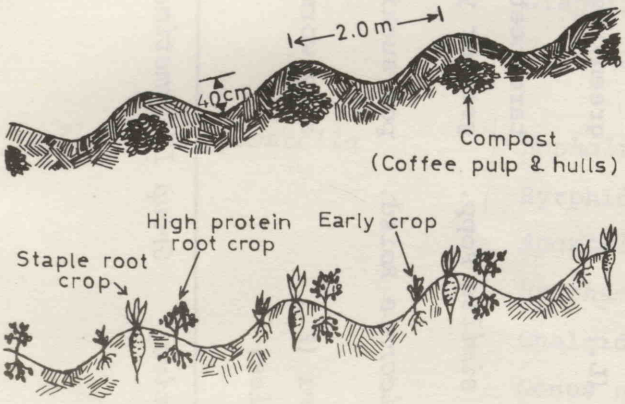


Diagram showing the composting and cropping system in the organic garden

After four to eight months, when the last crop (usually the staple) had been harvested from the mound, the mound was opened. Coffee compost was laid along the centre of the mound at a rate of about 45 kg (1-1.5 full wheelbarrows) for each metre length. At this rate of application, each hectare received about 460 t/year.

The methods of ground preparation, the planting scheme, and other agronomic practices used, follow traditional Melanesian agriculture and other organic gardening methods.

The garden is surrounded by coffee plantations and many types of natural vegetation ranging from old grasslands to young (15+ years) secondary forest with a closed canopy. This great variety of plant life growing nearby is partly responsible for the wide range of pests, parasites, predators and pathogens in the garden. The great diversity of crops grown in the garden itself also contributes to this.

MAJOR PESTS

The pests found in the garden can be divided into three groups depending on how well they are controlled by their natural enemies. These groups are shown in Table 2.

The holes in this kau kau tuber were probably made by a taro beetle (Papuana sp.)

TABLE 2. INSECT PESTS OF CROPS GROWN IN SITE-STABLE GARDEN AT WAU

Group*	Pest Name		Method of attack	Crop(s) attacked
	Scientific	Common		
I	*Crocidolomia binotalis* Zell	center grub or cluster grub	larvae eat leaves	cabbage family
I	*Dacus atrisetosus* complex	fruit flies	larvae bore into fruit	cucumber family
I	*Dacus cucurbitae* Coq.	fruit fly	larvae bore into fruit	cucumber family
I	*Ophiomyia phaseoli* (Coq.)	bean fly	larvae mine seedling roots, stem and leaves	common and adzuki beans
I	*Plutella xylostella* (L.)	diamond-backed moth	larvae eat leaves	cabbage family
II	*Cassena papuana* (Jac.)	leaf beetle	larvae eat roots, adults eat leaves	aibika, beans, peas
II	*Heliothis armigera* (Hb.)	tomato fruit worm	larvae eat leaves and pierce fruits	tomatoes, capsicums
II	*Leucoptera* sp.	winged bean blotch miner	larvae mine leaves	winged beans
II	*Nezara viridula* (L.)	green vegetable bug	nymphs and adults suck fruits	(many)
II	*Papuana* sp.	taro beetle	adults bore into corms	taro
II	*Platypeltocoris similis* Popp.	greater yam plant bug	nymphs and adults suck sap	yams
II	*Riptortus annulicornis* Roisd.	pod-sucking bug	nymphs and adults suck pods	beans, peas
II	*Spodoptera litura* (F.)	army worm	larvae eat leaves	(many)
III	(About 215 species)			

* *Group I always destructive; Group II sometimes destructive; Group III never destructive.*

TABLE 3. NATURAL ENEMIES OF GROUP I INSECT PESTS

Pest	Enemy	Action of Enemy
Crocidolomia binotalis	*Ropalidia bambusae*	predator of larva
	Apanteles sp.	parasite of larva
	Braconidae sp.	parasite of larva
	Palexorista solennis	parasite of larva
	Brachymeria sp.	parasite of pupa
	Xanthopimpla sp.	parasite of pupa
Dacus atrisetosus complex	*Silba* sp.	predator of larva
	Biosteres sp.	parasite of pupa
	Brachonidae sp.	parasite of pupa
Dacus cucurbitae	*Silba* sp.	predator of larva
	Biosteres sp.	parasite of pupa
Ophiomyia phaseoli	Brachonidae sp.	parasite of pupa
	Chalcidoidea sp. No. 14*	parasite of pupa
	Chalcidoidea sp. No. 9	parasite of pupa
	Chalcidoidea sp. No. 8	parasite of larva
	Diapriidae sp.	parasite of larva
	Sphegigaster sp.	parasite of larva
Plutella xylostella	*Rophalidia bambusae*	predator of larva
	Syrphidae sp.	predator of larva.
	Apanteles sp.	parasite of larva
	Brachymeria phya	parasite of pupa
	Chalcidoidea sp.	parasite of pupa
	Genus nr. *Paecilomyces*	pathogen of larva

* *Number refers to catalogue number at Wau Ecology Institute.*

Group I pests always caused over 90% destruction of the crops they attacked no matter how well they had been growing. This group was made up of three species of flies (*Ophiomyia phaseoli*, *Dacus atrisetosus* complex and *Dacus cucurbitae*) and two leaf-eating caterpillars (*Plutella xylostella* and *Crocidolomia binotalis*). The predators, parasites and pathogens observed attacking these pests are listed in Table 3 but biological control of these Group I species was never effective.

Group II pests became destruct-

TABLE 4. NATURAL ENEMIES OF GROUP II INSECT PESTS

Pest	Enemy	Action of Enemy
Cassena papuana	None seen	
Heliothis armigera	*Apanteles* sp. No. 6*	parasite of larva
	Chelisocheles morio	predator of larva
	Carcelia (Senometopia) sp.	parasite of pupa
	Enicospilus sp.	parasite of larva
	Tachinidae sp.	parasite of larva
	Genus nr. *Paecilomyces*	pathogen of larva
Leucoptera sp.	*Apanteles (circumscriptus* group)	parasite of pupa
	Chalcidoidea sp.	parasite of pupa
	Chosterocerus splendens	parasite of pupa
Nezara viridula	Scelionidae sp.	parasite of egg
	Trissolcus basalis	parasite of egg
Papuana spp.	None seen	
Platypeltocoris similis	None seen	
Riptortus annulicornis	None seen	
Spodoptera litura	Chalcidoidea sp.	parasite of egg
	Chalcidoidea sp.	parasite of larva
	Tachinidae sp.	parasite of larva

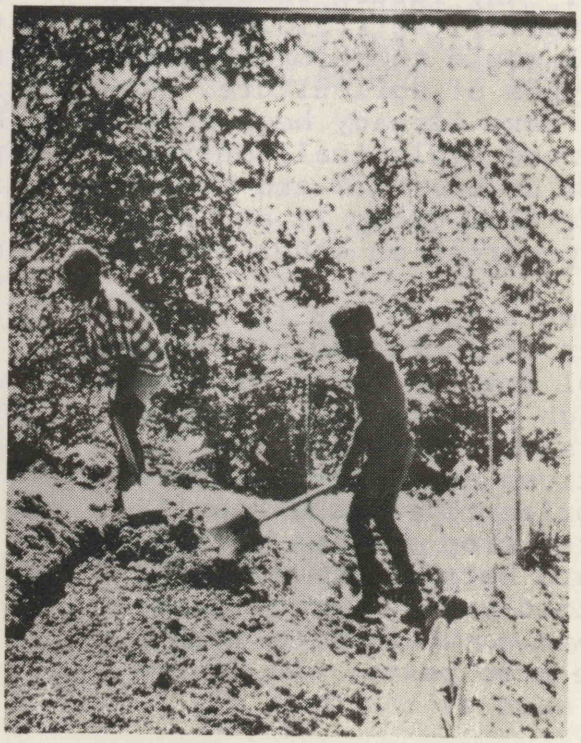
** Number refers to catalogue number at Wau Ecology Institute.*

ive from time to time but generally stayed at tolerable levels especially on otherwise healthy crops. This group contained three sap-suckers (*Riptortus annulicornis, Nezara viridula* and *Platypeltocoris similis*), a fruit boring caterpillar (*Heliothis armigera*), a leaf-mining caterpillar (*Leucoptera* sp.), an army worm (*Spodoptera litura*), a leaf-eating beetle (*Cassena papuana*) and 3 taro beetles (*Papuana* spp.). If certain legumes were grown for their ripe beans rather than for their green pods, then *Riptortus annulicornis* would become a Group I pest. Table 4 lists the predators, parasites and pathogens found to attack Group II pests.

Group III pests were those which

The first step in making a contour mound is to dig a trench.

Coffee pulp or some other sort of compost material is spread along the bottom of the trench.



The coffee pulp is covered with soil to make the mound.

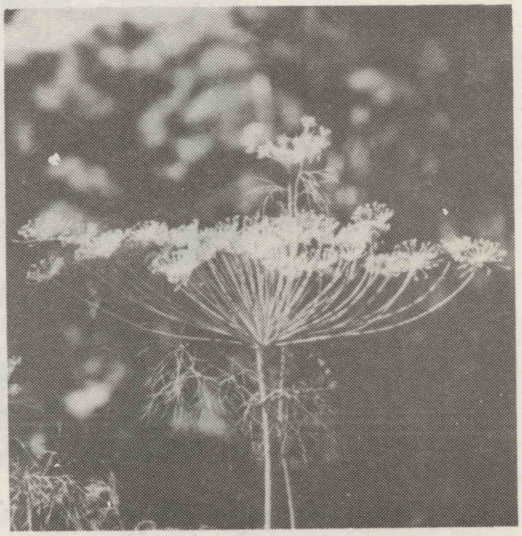
never rose to destructive levels. This was the largest group, containing 215 pest species out of a total of 228 found in the garden (94%). Some of these pests were only ever seen once in the garden while others were always present on certain crops.
Fifty six predators and seventy parasites were found to attack these pests. Group III species are considered likely to remain harmless as long as the agricultural system they live in is not disturbed.

IMPROVING NATURAL CONTROL

It is clear that there is room for some improvement in the level of natural control operating against Group I and II pest species. This improvement could be brought about by introducing new predators, parasites and pathogens into the system or by increasing the numbers of those already present. This is called biological control.

All of the Group I pests and most of those in Group II are destructive in cash crops as well as in gardens in Papua New Guinea. Any future increase in the level of their biological control would therefore benefit both types of agriculture. Attempts have already been made to improve biological control of *Plutella xylostella* and *Nezara viridula* from Group I, and work is in progress on other species.

The best targets for further efforts at increased biological control are the pests of staple and high protein crops, especially since there are few alternatives available in these categories to replace heavily attacked crop species. Thus the taro bettle *(Papuana* sp.*)*, the mirid sap-sucker of yams *(Platypeltocoris similis)*, both staple crop pests, and legume pests such as the bean fly *(Ophiomyia phaseoli)*, the winged-bean blotch miner *(Leucoptera* sp.*)* and the pod sucking bug *(Riptortus annulicornis)* appear to be the most suitable choices for future work in this direction.



This is a dill flower. Dill is grown among the crops in the garden because it is good at attracting parasites of insect pests.

CONCLUSION

If the shifting cultivator is to successfully become a site-specific subsistance gardener, fertilization from the application of large amounts of compost, careful attention to improved biological control and the use of pest resistant crop species will be important factors.

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