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Plant species attractive to beneficial entomofauna in oil palm (*Elaeis guineensis* Jacq.) plantations in Costa Rica

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INTRODUCTION

Weed management on oil palm plantations is achieved through the use of herbicides or by mechanical means. In terms of beneficial entomofauna in the vegetation, manual weed control has the advantage of allowing for the renewal of aging or insect-defoliated tissue as well as maintaining adequate microclimatic conditions for the insect population. In some cases, however, these practices may limit the insects' supply of food (in the form of glandular secretions or pollen), causing the migration of insects to other areas with more readily-available food supplies, or resulting in their death due to inanition.

Manual control may also favor certain fast growing species such as grasses and may change the plant composition of a particular area, which, at the same time, may cause changes in the make-up of the community of natural enemies. Other causes of large changes in plant populations may include the use of herbicides, changes in soil characteristics (e.g., compaction, flooding), sunlight (crop growth), etc.

During the phenological development of the oil palm, it can be seen that as shade conditions increase due to leaf overlapping, ground cover vegetative growth decreases. This situation causes a reduction not only in the number of species but also in the individuals of each species. Many bushy melliferous species slowly disappear with the weeding process, as they are not able to recover or compete with species adapted to the shade.

With the reduction in melliferous vegetation, natural enemy populations also decrease, and, consequently, so do their control over the crop's phytophagous insect populations.

The entomofauna associated with oil palm varies according to the age of the crop. Harmful insects are scarce in young plantations, due to more sunlight, less developed foliage, and the richness (both in numbers and species) of natural enemies. In adult palms, on the other hand, a microclimate favoring an increase in the number of harmful arthropods and a decrease in beneficial species is created.

Within an oil palm plantation, phytophagous arthropods encounter a high density of uniform plants (genetically and nutritionally similar), which provides appropriate conditions for their multiplication and distribution. Outbreaks of pest arthropods can be an acute or chronic problem.

The reasons for these increases in pest populations are not well understood. However, on some occasions, the gradual increase in an insect population until it reaches pest status can be linked with one or more of the following factors:

- Drastic changes in the physical environment.

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- Genetic or physiological changes in individual organisms in the population.
- Trophic interactions between plants and herbivores or prey and predators.
- Qualitative or quantitative changes in the host plants, caused by conditions of stress (water deficit, flooding, nutritional imbalances, etc.).
- Particular strategies in the life history of opportunistic insect species (strategy "r").
- Escape of pest populations from the influence of their natural enemies.
- Cooperation of various species to undermine the defense systems of the host.
- Destruction of food sources and shelter for natural enemies (Berryman 1987).

The aim of this paper is to provide information about the plant species that form part of the associated vegetation in oil palm plantations in Costa Rica, in which beneficial insect species related to the control of defoliating lepidopterous insect species have been found.

Importance of the vegetation associated with crops

The flora associated with the crop may represent competition for space, nutrients, and sunlight, with some species also providing refuge to pest insects or pathogens and their vectors. This vegetation, however, also helps sustain the beneficial entomofauna in which neutral phytophagous insects, predators and parasitoids are found. These arthropods feed on nectareal secretions (intra- and extrafloral) wound exudates, pollen and animal prey that they find in the vegetation and which they need to achieve normal levels of fertility and longevity.

The adult predators and parasitoids can survive on nectar, pollen and sap when their animal hosts are not available, either because their life cycles are not in synchrony or because they are in scarce supply. Thus, the weeds act as bridges between hosts and natural enemies (Altieri 1983).

The nectarial secretions are rich in carbohydrates like glucose, sucrose and fructose, as well as in some essential aminoacids (Baker and Baker 1973); furthermore, pollen is rich in aminoacids and may be an integral part of the insect diet (Leius 1967, Altieri and Whitcomb 1979). Plants also emit chemical signals (kairomones), which are detected by the entomophagous insects that migrate from the surrounding areas in search of the habitat of their prey or hosts.

In plantation crops, complex vegetation can create different microclimates, heterogeneous chemical environments, and a complex structural diversity, inhibiting the incidence of pests due to the presence of numerous natural enemies (Tahvanainen and Root 1972).

On the other hand, phytophagous insects can encounter difficulties in finding hosts in diverse systems due to physical and chemical masking, known as associative resistance. This is a possible reason for which plants of different species joined in a vegetative mosaic sustain less damage than if they were in homogeneous blocks of single species (Tahvanainen and Root 1972).

Theory of insect-plant interaction

This theory, still under development, covers five areas:

- The coevolution of insects and plants.
- The host plants as islands.
- Vegetative appearance.
- Predictability of resources vs. the evolutionary strategies of the insects.
- Natural enemies as part of the vegetative defense against herbivores (Gilbert 1979, Price *et al.* 1980).

Odum (1953), Mac Arthur (1955) and Elton (1958) supported the hypothesis about stability vs. diversity, which indicates that an increase in

the diversity of species in ecosystem increases its stability. The authors based their theory on the criteria that a food chain made up of many species is able to withstand more changes in the abundance of individual species than a simple chain. In this sense, the diversity of species is a form of structural complexity that provides stability to the ecosystem.

A monocrop system limits vegetative diversity, which reduces sources of food and shelter for phytophagous organisms and natural enemies (De Loach 1970), which, in turn, gives rise to increased damage by insect pests.

These concepts have been applied to agriculture by various researchers (Root 1973, Van Emden & Williams 1974, Andow 1991), who noted that herbivorous insects reached higher population levels in simple agricultural systems than in diverse ones.

The importance of plant structure

Plant structure also affects the diversity of species and the relative abundance of individual organisms. Plant structure has many components, among which the principals are: size, growth form, seasonal development and variety of vegetative parts and their persistence (Lawton 1983). These components, individually or in combination, can influence the diversity of insect species.

Lawton & Schroeder (1977) and Strong & Levin (1979) considered plant size to be an important predictor of diversity. They recognized trees, bushes and grasses as the three main groups that differ in structural complexity and diversity of associated insects. Plants in the early stages of development house a lesser number of insect species than those in later stages, with the exception of senescent stages. Also, bushes with dense foliage house a greater number of insect species than plants with sparse foliage or with smaller leaves (Mexzón 1992).

The effects of plant structure on diversity have also been explained through various hypotheses.

Hypothesis of size per se. Large plants house greater total insect populations than small plants over the same period of time. The intuitive belief that size directly influences species diversity was considered by Fenny (1976) in the appearance hypothesis, which linked the concepts of size and longevity of individual plants to the probability of being discovered by herbivorous insects.

Hypothesis of diversity of resources. Plants with a greater variety of resources house more herbivorous species than plants with fewer resources. In that sense, plants with extrafloral glands house more species or more insects than plants with seasonal flowering (Mexzón 1992). Diversity of resources includes among other things:

Diversity of basic nutritional sites. The variety of food available to insects in a specific vegetative host affects the relative abundance of species as well as the number of individual organisms in each species. Many insects make use of very specific parts of their hosts, such as the inside of the stem or the mesophyll of the leaves; however, hosts that flower abundantly over the course of the year or that have extrafloral glands house large insect populations.

Diversity of other resources. In addition to food, herbivores also need places to lay eggs, take refuge and rest. Considering this, trees and bushes are more suitable than grasses. Some insects are actually on the palms, living on the stem or in the bryophytes covering it, while others live in the vegetative species that cover the majority of the area (e.g., *Ipomoea* spp., *Pueraria phaseoloides* and *Vitis sycioides*).

Diversity of escape routes. The ability of a herbivorous or entomophagous insect to survive and reproduce in a vegetative mass depends on the availability of sufficient space free from the presence of enemies (predators or parasitoids). However, as there is no such thing as absolute refuge, adaptations made to provide protection from one species may result in vulnerability to another.

Conditions to improve stability in organism populations can be fostered with an increase in plant diversity, which can be achieved through a three-fold management system:

- The classes.
- The arrangement in space.
- The temporal overlap of the plants being combined.

The classes are the different vegetative species growing in an area, which may include:

- Two or more crops.
- A crop with weeds.
- A main crop with a cover crop (Andow 1991).

Vegetation associated with oil palm plantations

In Costa Rica, between 1990 and 1992 more than 63 species of entomofauna-attracting plants were identified. In descending order, the most important species were in the families Asteraceae, Euphorbiaceae, Leguminosae and Malvaceae. The species with a complex leaf structure (some cover plants and dense bushes, perennials, periodically-flowering plants, and those with extrafloral glands) were those attracting more insect families, including: *Byttneria aculeata, Cassia tora, Cassia reticulata, Melanthera aspera, Scleria melaleuca, Solanum jamaicense, Triunfetta semitriloba, Urena lobata and Vitis sycioides*.

The capacity of some of these plants to attract various insect families seems to correspond to the abundance and permanence of nutritional resources. For example, some of these weeds have glandular trichomes on their leaves (*S. jamaicense*), and nectaries in the junction of their veins (*M. aspera*), on their veins (*B. aculeata*, *U. lobata*), in their petioles (*Spermacoce* spp., *Spananthe paniculata*), leaf rachis (*Cassia tora*), fruit (*S. melaleuca*), and modified stipules (*Cassia reticulata*).

In a study of the interactions of visiting insect families to 37 plant species, important links between insects and the degree of complexity of plant structure were found. The main groups of phytophagous insects were sap-feeders (Hemiptera and Homoptera), leaf-feeders (mainly Coleoptera) and sap- and pollen-feeders (Diptera), which were found mainly in weeds of complex leaf structure such as small bushes and leguminous cover crops (Mexzón 1997).

The predators followed the distribution of their prey, such as hemipterans and homopterans in the foliage and flies in the flowers. The parasitoids fed on nectar and gland secretions, forming a compact group associated with the nectaries of plants showing a complex leaf structure. The most abundant species were in the Braconidae, Chalcididae and Ichneumonidae families. There was a close relationship between structural complexity and the abundance of insects: weeds with a simple leaf structure housed a lesser number of insect families compared to those with a complex leaf structure (Tables 1 and 2).

In another study, when four habitats were compared (kudzu, kudzu + wide-leafed weeds, broad-leafed weeds, and grasses), it was found that the broad-leaf weeds and kudzu + broad-leaf weed habitats had a greater number of predator and parasitoid species than the grasses (Table 3).

Phytophagous arthropods and their natural enemies

Most insect pests in oil palm are defoliating lepidopterans such, *as Oiketicus kirbyi* Guilding, *Opsiphanes cassina* F., *Sibine megasomoides* Walker (=*Acharia hyperoche* Dognin), *Stenoma cecropia* Meyrick, *Euprosterna eleasa* Dyar and *Natada pos. michorta* Dyar (Mexzón and Chinchilla 1992). These species rarely flourish on young plantations due to the abundant entomophagous fauna. In adult palms, however, significant defoliations may occur, which are associated with the scarcity of natural enemies (Genty 1989; Mexzón 1994b).

Many beneficial insects live in the ground vegetation associated with oil palm plantations (Delvare & Genty 1992; Mexzón 1992; Mexzón & Chinchilla 1992) and other palms such as the peach palm (*Bactris gasipaes*) (Mexzón 1997). Many insects are bugs of the Pentatomidae family and parasitoid wasps (Table 4). The bugs *Alcaeorrhynchus grandis* Dallas and *Podisus* sp. are common in the kudzu where they prey on other insects, larvae of butterflies such *as Anticarsia gemmatalis* (Hubner) and *Estigmene acrea* Druce, and beetles.

During population increases *of A. hyperoche*, *O. cassina* and *S. cecropia* in Costa Rica, nymph and adult bugs of the Pentatomidae family *A. grandis*, *Mormidea* sp. and *Podisus* spp. were seen preying on the larvae of these butterflies.

Various species of the genera *Brachymeria, Conura, Cotesia, Digonogastra, Horismenus* and others were seen feeding on the vegetation. Delvare & Genty (1992) found these wasps associated with weeds in the families Asteraceae, Cyperaceae, Euphorbiaceae, Malvaceae, Solanaceae and Verbenaceae on plantations in Colombia and Ecuador. A similar situation was seen in Costa Rica (Mexzón & Chinchilla 1990a, 1990b, 1992, Mexzón 1992).

In order for there to be stability in the entomophagous arthropods on a plantation, there must be appropriate conditions for their establishment, such as availability of nutritional resources, places of refuge, and appropriate microclimatic conditions. These conditions can be met by little-disturbed areas of vegetation where populations can stabilize over time.

Table 1. Number of insect families visiting 20 plant species associated with oil palm plantations
Cuadro 1. Número de familias de insectos visitantes de 20 especies vegetales asociadas a palma aceitera

Plant species *Especies vegetales*	**No. of families** *No. de familias*	**Characteristics** *Características*
Blechem brownei	9	erect median weed, no seasonal, dense foliage, with seasonal flowering. *hierba mediana erecta, no estacional, follaje denso, con floración estacional.*
Eclipta alba	9	small weed, prostrate, seasonal, with scarce foliage, with abundant flowering *hierba pequeña, postrada, estacional, con follaje escaso, con abundante floración.*
Justicia comata	11	erect median weed, no seasonal, foliage little dense, with abundant flowering *hierba mediana erecta, no estacional, follaje poco denso, con abundante floración.*
Chamaesyce hyssopiifolia	14	erect small weed, no seasonal, scarce foliage, with abundant flowering *hierba pequeña erecta, no estacional, follaje escaso, con abundante floración.*
Chamaesyce hirta	15	small weed, prostrate, no seasonal, foliage little dense, with abundant flowering *hierba pequeña, postrada, no estacional, follaje poco denso, con abundante floración*
Cassia reticulata	18	small tree, perennial, dense foliage, with extrafloral glands *arbolito, perenne, follaje denso, con glándulas extraflorales*
Solanum americanum	18	weed, annual, erect, seasonal, foliage little dense, with glanded tricoms *hierba, anual, erecta, estacional, follaje poco denso, con tricomas glandulosos*
Amarantus spinosus	19	high weed, annual, foliage little dense, abundant flowering *hierba alta, anual, follaje poco denso, abundante floración*
Crotalaria guatemalensis	19	perennial shrub, dense foliage, with glands in seed capsules, abundant flowering *arbusto perenne, follaje denso, con glándulas en cápsulas de semillas, floración abundante*
Scleria melaleuca	20	weed, perennial, sparse foliage, with extrafloral glands in the aquenios, permanent fructification *hierba, perenne, follaje ralo, con glándulas extraflorales en los aquenios, fructificación permanente*
Baltimora recta	21	high weed, annual, seasonal, dense foliage, with extrafloral glands and abundant flowering *hierba alta, anual, estacional, follaje denso, con glándulas extraflorales y abundante floración*
Lantana camara	22	high shrub, perennial, dense foliage, with abundant flowering *arbusto alto, perenne, follaje denso, con abundante floración*
Ageratum conyzoides	24	small weed, annual, foliage little dense, with abundant flowering *hierba pequeña, anual, follaje poco denso, con abundante floración*
Senna stenocarpoides	26	median shrub, prennial, dense foliage, with estrafloral glands and seasonal flowering *arbusto mediano, perenne, follaje denso, con glándulas extraflorales y floración estacional.*
Solanum jamaicense	26	postrate weed, perennial, dense foliage, with glanded tricoms *hierba postrada, perenne, follaje denso, con tricomas glandulosos.*
Desmodium ovaliofolium	27	median shrub, prostrate, perennial, with dense foliage, with seasonal flowering *arbusto mediano, postrado, perenne, con follaje denso, con floración estacional.*
Triunfetta semitriloba	29	high shrub, perennial, with dense foliage, with extrafloral glands *arbusto alto, perenne, con follaje denso, con glándulas extraflorales.*
Cassia tora	30	prostrate shrub, perennial, dense foliage with extrafloral glands *arbusto postrado, perenne, follaje denso con glándulas extraflorales.*
Pueraria phaseoloides	31	median shrub, prostrate, perennial, with dense foliage, with seasonal flowering *arbusto mediano, postrado, perenne, con follaje denso, con floración estacional.*
Urena lobata	34	high shrub, perennial, dense foliage, with glands *arbusto alto, perenne, follaje denso, con glándulas.*

Table 2. Relative abundance of some entomophagous insect families visiting weeds associated with the oil palm

Cuadro 2. Abundancia relativa de algunas familias de insectos entomófagos visitantes de las malezas en el cultivo de palma aceitera

TAXON	Predators *(depredadores)*												Parasitoids *(parasitoides)*										
	Lygaeidae	Miridae	Pentatomidae	Phymatidae	Reduviidae	Cantharidae	Lycidae	Meloidae	Asilidae	Syrphidae	Formicidae	Vespidae	Tachinidae	Braconidae	Ichneumonidae	Chalcididae	Cynipidae	Eucharitidae	Eucoilidae	Eulophidae	Eurytomidae	Evaniidae	Pteromalidae
Urena lobata	A	P		E	P	E	P		P	A	A	C	A	P	E	A		E				E	E
Vitis syciodes		C	E	P	C				E	P	A	C	P	C	P	A	E			E	E	P	P
Cassia tora	E		P	P	P				P	E	A	C		C	C	A		E	E	E		P	P
Triunfetta semitriloba		C		E	C					C	C	E		C	P	A	E	E	E	E			
Melanthera aspera		C	P		E		E		C	P	A	P		C	C	A				C		C	P
Solanum jamaicense			C	C	P				C	C	P	P		C	P	A		P		E		E	E
Cassia reticulata					P				E	E	A	E		C	E	C		E		C	E		
Senna stenocarpoides			C	E	E				E	E	A	C		E	E	C		E		E		C	P
Bytneria aculeata					E				E	P	C	C		P	P	C	E	E		P	P		P
Baltimora recta		E		P	P				P	C	C	C		E	E	A			P			E	E
Solanum americanum					P				P	C	P		P	E	P	C					E	E	
Physalis angulata				E							C	P		P	P	P							P
Scleria melaleuca			E		E				P		A		P	A	C	A				E			
Priva aspera				E	E			E	E	E	E	A		C	E	P					E		E
Spermacoce laevis		C	E	P	P				P	C	A	P		P	E	C		E	E				E
Geophila repens														A			E		E		A		E
Crotalaria guatemalensis				P	P				P	C	E	C		E	P	A					E		E
Sida rhombifolia	C				E				E		P	P		P	E	C			E				
Justicia comata				E						P	E	A			E	C							
Synedrella nodiflora		E		E	E						P	P		E	E	E			E				E
Blechum brownei	E				E						E	A		C									
Ageratum conyzoides				E	E				P	C	E	C		A	C	P	E		C	E	E		E
Amarantus spinosus				E	E				E	E	C	A		P	E	A		E			E	C	E
Eclipta alba											E	C		E	C	C				E			
Chamaesyce hyssopifolia				E					P	C	P	A	E	P	C	P							
Chamaesyce hirta				P	E					C	C	E	A	P		P							
Phyllanthus niruri		E									E	C				P							
Lantana camara		C	P	P	E				C	P	A	A											
Flemingia congesta					E						C	P		E	C								
Pueraria phaseoloides	P	C	C	A	P	P		P	E	C	C	P		P	C	C		P				P	
Desmodium ovaliofolium		P	C	E	P				E	E	A	C	P	C		E	P	P	E				
Centrosema pubescens			E	E	E					P	C	C											
Piper sp.					C																		
Heliconia latispatha											C												
Calathea insignis								P	C		P												

A=Abundant: more than 15 individuals per plant || *Abundantes: más de 15 individuos por planta*

C=Common: 5-15 individuals per plant || *Comunes: 5-15 individuos por planta*

P=Few: 1-4 individuals per plant || *Pocos: 1-4 individuos por planta*

E=Scarce: 1-9 individuals in 10 plants of the same species ||*Escasos: 1-9 individuos en 10 plantas de la misma especie*

Plant species are ranked according to structure complexity and persistence of vegetative structures.
Las especies vegetales están ordenadas en forma descendente según su complejidad estructural y de persistencia de estructuras vegetales.

Table 3.
Number of insect species found in four habitats of cover plants in oil palm (Coto, 1991)*

Cuadro 3.
Número de especies de insectos en cuatro hábitats de cobertura vegetal en palma aceitera (Coto, 1991).

Habitat *Hábitat*	Phytophagous *Fitófagos*	Predators *Depredadores*	Parasitoids *Parasitoides*	Subtotal
Pueraria	30	4	7	41
Pueraria + broad-leaf weeds *Kudzu + malezas de hoja ancha*	30	17	18	65
Grasses *Gramíneas*	32	18	5	55
Mixture of broad leaf and grasses *Malezas mixtas (zacates + hojas anchas)*	15	14	11	40
Total	107	53	41	201

* Mean of 12 monthly samplings, using an enthomological net (60 strikes) 35 cm diameter.
Promedio de 12 muestreos mensuales, utilizando como unidad de muestra 60 golpes de red entomológica de barrido de 35 cm de diámetro.

Morphological description of weed species attractive to insects

1 *Justicia comata* (L.) Lam. (Acanthaceae) (Fig. 1).

Herbs, (0.1-) 0.3 - 0.6 (-1.0) m tall, erect, internodes from 3-5 cm long; opposing leaves, whole and sessile, without stipules. Lamina from (3-) 10-12 cm long and (2.2-)3- 3.5 cm wide; oblong-elliptical form, acuminate; hexagonal stem in the young sections. The inflorescence is a bunch of axillary or terminal spikes; flower with 5 sepals, gamopetalous corolla with a well-developed tube; bilabiate, white with purple lines; stamens (4) insert in the corolla tube. Fruit clavate 4-6 mm in length.

This plant is common in open, sunny areas with waterlogged soils. It is found near drains and in the weeding circle around adult palms. It flowers several times a year; however, in conditions of prolonged shade it remains in the vegetative state. It reproduces by means of seeds and stolons. The main visiting insect groups are wasps from the families Braconidae, Chalcididae and Vespidae. The greatest number of visits are seen during periods of low rainfall.

2 *Priva aspera* H.B.K. (Acanthaceae)

Herbs, 0.1- 0.4 (-0.7) m tall, erect and sometimes decumbent, stem 4-angular, purple color; internodes from 6-10 cm in length; leaves, opposing, whole and petioled, without stipules. Lamina from (3-) 7 cm long and (2-) 5 cm wide, cordate, acuminate; serrated, with 19 - 24 dentils

Table 4. Plant species hosting natural enemies associated with some specific oil palm insect pests.

Cuadro 4. Especies de plantas que albergan enemigos naturales de varios insectos plaga en palma aceitera.

Plant *Planta*	Insect pest *Insecto plaga*	Crop *Cultivo*	Natural enemy *Enemigo natural*
Spermacoce laevis	*Automeris rubrescens*	1,2	*Conura* spp. (2 species)
Scleria melaleuca			*Ooencyrtus* sp.
Melanthera aspera			
Ageratum conyzoides	*Acharia* sp.	1	*Cotesia* sp. & *Casinaria* sp
Amarantus spinosus	*Acharia apicalis*	2	
Chamaesyce hyssopifolia	*Acharia hyperoche*	1	
Solanum americanum	*Acharia horrida*	1	
Triunfetta semitriloba	*Euprosterna eleasa*	1,2	
Urena lobata	*Natada* sp.	1	
	Phobetron sp.	2	
	Megalopyge sp.	1,2	
A. spinosus	*Oiketicus kirbyi*	1	*Conura oiketicusi*
Solanum jamaicense			*Conura* spp. (2 especies)
Cassia tora			*Filistina* sp.
Scleria melaleuca			*Digonogastra diversus*
Pueraria phaseoloides	*Opsiphanes cassina*	1,2	*Alcaeorrhynchus grandis*
Melanthera aspera			*Mormidea* sp.
Sida rombifolia			*Podisus* sp.
Baltimora recta			*Conura maculata*
Cassia tora			*Conura inmaculata*
Scleria melaleuca			
Melanthera aspera	*Opsiphanes cassina*	1	*Horismenus* sp.
		1,2	*Telenomus* sp.
		1	*Ooencyrtus* sp.
Cassia reticulata	*Peleopoda arcanella*	1	*Trichospilus diatrae*
M. aspera	*Stenoma cecropia*	1	
Ageratum conyzoides	*Mycetophilidae* u.i.	2	*Pteromalidae* u.i.
S. laevis			
Hyptis vilis			
M. aspera	*Psychidae* u.i.	2	*Filistina* sp.
S. melaleuca			
Chamaesyce hirta	*Saliana* sp.	2	*Brachymeria* sp.
Solanum jamaicense			

ui = unidentified species
especie no identificada

1= oil palm
palma aceitera

2 = peach palm (*Bactris gasipaes*)
pejibaye

on each side; with extrafloral glands on each dentil. The inflorescence is a bunch of axillary or terminal spikes with 12-37 small flowers, bracteate; 5 small pink petals, with two nectar guide

lines. The fruit, on the inside of heart-shaped capsules, hangs along an axle or thin branch.

The plant grows in open spaces alongside roads, normally in poor soils where it can compete with other species. It reproduces by means of seeds and stolons. In order to germinate, the seeds require a vegetative cover and wet soil.

The main groups of insect visitors belong to the families Coreidae, Phymatidae, Chrysomelidae, Braconidae, Chalcididae, Eurytomidae and Vespidae. The species Conura group oiketicusi and Digonogastra diversus, which are parasites of Oiketicus kirbyi, have been observed.

3 *Amarantus spinosus* L. (Amaranthaceae), common name: amaranth. Fig. 2).

Herbs 0.2-1.0 (-1.6) m tall, erect, succulent stem, reddish color, internodes from 4-7 cm long; simple leaves, whole and petioled, with stipules. Lamina from 2-5 cm long and 1.2- 3.5 cm wide, oblong elliptical form; with one central vein and 3-6 lateral veins. The inflorescence is a spike, flowers with big bracts, forming bouquets on the axils of the leaves and a terminal spike. The fruit is a utricule, black, shiny, 1.0 mm in diameter. This species has a thorn at the base of the leaves, from where it gets its common name.

This plant is common in open, sunny spaces, growing on bare soil on recent sediments, often alongside rivers. The main groups of insect visitors are bugs from the families Phymatidae and Reduviidae; beetles from the Curculionidae family and wasps from the Chalcididae, Eurytomidae, Evaniidae and Vespidae families. It is visited by *Conura* species that are parasites of *O. kirbyi* and *Opsiphanes cassina*.

4 *Ageratum conyzoides* L. (Asteraceae) (Fig. 3).

Herbs 0.1-0.4 (-0.8) m tall, soft stem with abundant white pubescence from 3-4 mm long; internodes from (2) 5-7 (10) cm long; erect; with simple leaves, opposing and petioled. Lamina from (2.0-) 3.5-6.0 cm long and (1.5-) 2.0-5.5 cm wide; cordate, serrated edges with 13-27 teeth in each side. The inflorescence is an umbel with 4-12 capitula of light blue flowers.

This plant grows in shaded sites on bare soil; it is an annual plant and flowers throughout the year, mainly between December and April. It reproduces by seeds. The main groups of visiting insects are flies from the Calliphoridae and Muscidae families, butterflies from the Amatidae and Nymphalidae families, bees from the Apidae family and wasps from the Braconidae and Vespidae families. Some Cotesia species feed on its flowers.

5 *Baltimora recta* L. (Asteraceae) (Fig. 4)

Herbs 0.3-0.6 (-1.7) m tall, erect, stem with 4 ribs; purple; internodes from 12 to 18 cm long; simple leaves, opposing, whole and petioled. Lamina from 3- 3.5 (-5.6) cm long and 2.2 - 4.0 cm wide; lanceolated elliptical form, serrated edges with 12-21 teeth on each side; rough to the touch. It has extrafloral glands at the junction of the central and two lateral veins. The inflorescence is a capitulum of yellow flowers, with 5 petals, 12-18 flowers with pistils and a variable number of flowers with stamens.

This plant grows along roads; it is an annual plant, very plentiful between December and April during the dry season. The main groups of visiting insects are flies of the Calliphoridae and Muscidae families; the honeybee *Apis mellifera* and wasps Braconidae, Chalcididae, Pteromalidae and Vespidae. Wasps of the *Conura* genus and those associated with parasitism of flies are frequent visitors.

6 *Clibadium schulzzi* Blake (Asteraceae)

Herbs 0.3- 1.8 (-2.5) m tall; stems from 1.5-3.0 cm in diameter, with a soft, white medulla; internodes from 7-15 cm long; simple leaves, opposing and petioled. Lamina from 4.5 - 14 (-16) cm long and (1.5-) 4.5 - 9.0 cm wide; lanceolate elliptical form; lightly serrated edges with 20-30 (-60) teeth on each side; petioles 2-3 cm long. The inflorescence is a bunch with 2-3 branches bearing umbels of capitula with 9-12 (-32) small white flowers with stamens and pistils; it reproduces by seeds and cuttings.

This plant also grows alongside roads. It has an extrafloral gland per tooth on the leaves. The main groups of visiting insects are beetles from the family Curculionidae, flies from the families Richardiidae and Sepsidae, wasps from the family Chalcididae, and ants.

7 *Melanthera aspera* Small (Asteraceae) (Figs. 5,6)

Herbs 0.5-1.0 m tall, erect and decumbent, forming a dense mass; stem 4-angular; internodes 3.5-9.0 (-19.0) cm long; simple leaves, opposing and petioled. Lamina 5.0-12.0 (-13.5) cm long and 2.0-7.0 (-7.5) cm wide; cordate, asymmetrical, acuminate, serrated edges with 23-45 teeth on each side; one central vein and two branching lateral veins; petioles 2.5 -5.0 (-8.0) cm long. Inflorescence is a capitulum of white flowers.

This is a perennial plant which reproduces by means of seeds and stolons; it forms dense masses along the sides of roads. It has nectaries on the axils of the veins on the abaxial side of the leaf. The main groups of visiting insects are flies of the families Otitidae, Richardiidae, Sepsidae, and Syrphidae and wasps from the families Braconidae, Chalcididae, Evaniidae, Ichneumonidae and Pteromalidae, as well as ants. It is an especially important species because it serves as a refuge for parasitoid wasps that feed on the eggs of bugs and butterflies (Encyrtidae, Mymaridae, Scelionidae and Trichogrammatidae) and on larvae and pupae of dipterans and lepidopterans.

8 *Scleria melaleuca* Schlecht. and Cham. (Cyperaceae). (Figs. 7,8).

Herbs 0.15-0.3 (-0.7) m tall, erect; simple leaves, whole. The lamina is long, thin and sharp, 22.0 - 47.0 cm long and 1.0 - 2.0 cm wide. Solid, triangular stem, with sharp edges; the leaf husk wraps around the stem. The plant is cespitose, perennial. The fruit is a black metallic achene.

This plant commonly grows in sunny spots or in the shade of other plants; it reproduces by seeds. The main groups of visiting insects are flies from the Syrphidae family and wasps from the Braconidae, Chalcididae, Eulophidae and Ichneumonidae families. Many wasps from various species of the *Conura* genus feed on the achenes, including parasites of *O. kirbyi* and *O. cassina*.

9 *Chamaesyce hirta* (L.) Millspaugh (Euphorbiaceae) (Fig. 9).

Herbs 0.1-0.4 m tall, decumbent or erect, internodes 0.5-5.0 cm long. Simple leaves, opposing, whole and petioled. Lamina (4-) 7 to 35 (-50) mm long , (3-) 4 - 14 (-18) mm wide; oval elliptical form, often marked with red, serrated edges with 6-30 teeth on each side; short pubescence. Solitary, axillary inflorescences, one per node, reddish, 5-16 x 4-18 mm (width x length); small glands. The oval puberulent fruit is 1.0-1.4 x 0.7-1.2 mm (width x length) .

This plant is common in sunny spots, on bare soil; it is seen in both dry and rainy seasons, and it flowers throughout the year. The main groups of visiting insects are bugs from the Coreidae family, flies from the Muscidae and Tachinidae families and wasps of the *Brachymeria* (Chalcididae) genus, as well as ants of various genera.

10 *Chamaesyce hyssopifolia* (L.) Small (Euphorbiaceae)

Herbs 0.3-0.6 (-1) m tall, erect, internodes 1-3 cm long ; simple leaves, opposing, whole and petioled. Lamina 6-28 (-35) mm long and 3-10 (-

16) mm wide; oblong elliptical form, serrated edges with 6-20 teeth on each side; short pubescence. Terminal or pseudoaxillary inflorescence; oblong or reniform glands. The ovoid fruit is 1.8-2.0 x 1.1-1.5 mm (width x length).

This plant grows in open, sunny spaces; it is seen in both seasons and flowers throughout the year, but mainly in the dry season. The main groups of visiting insects are flies from the Syrphidae family and wasps from the Ichneumonidae family. Large numbers of *Casinaria* sp., parasitoid of larvae of the Limacodidae family, have been observed on this plant.

11 *Crotalaria guatemalensis* Willdenow (Leguminosae). (Fig. 10).

Shrubs; 0.20 - 1.70 (-2.5) m tall; erect, internodes 3.0 - 4.5 cm; trefoil leaves, alternating and petioled. Folioles 2.3 - 3.5 (-8.5) cm long and 1.0- 2.0 (-4.0) cm wide, rhomboid-shaped, the central one being the largest; petioles 3.0-4.0 (-8.0) cm. The inflorescence is a simple bunch of 8 -13 yellow flowers; 5 sepals (one standard, two wings and one keel); standard with numerous black lines; 10 stamens. The fruit is an elongated spherical legume, 4.5 cm long and 1.5 cm thick, with short pubescence; 9-10 (-18) reniform orange seeds.

This plant grows in sunny spots alongside roads and reproduces by means of seeds. The main groups of visiting insects are bugs from the Alydidae family, beetles from the Curculionidae family, and wasps from the Braconidae, Chalcididae and Vespidae families. This species attracts the bug *Hyalymenus tarsatus*, which is associated with damage to macadamia nuts.

12 *Cassia reticulata* Willdenow (Leguminosae) (Fig. 11).

Small tree; 3-7 m high; stem 3-10 cm in diameter; internodes 7-10 (-18) cm long; compound bipinnate leaves, alternating, decussate , with stipules and petioled. 6-12 pairs of folioles, 5.5-14.5 (-15.0) cm long and 1.8-5.5 (-6.5) cm wide; elongated oval form, with rounded end; leaf rachis 27-47 cm long, with dorsal flute; short petioles 0.3- 0.6 cm; orange stipules 13 mm long, two per leaf. Inflorescence is an axillary bunch, with petiole 8-20 cm; yellow flowers, with 5 petals: four 12 x 15 mm with the fifth being a thin keel of 25-30 mm. The fruit is an elongated oval legume, smooth.

This plant grows in sunny places and is common in hedges around pastures and alongside roads and rivers; it reproduces by means of seeds and cuttings. The main groups of visiting insects are flies from the Otitidae, Richardiidae and Syrphidae families and wasps from the Braconidae, Chalcididae, Eulophidae and Eurytomidae families. Ants of the *Solenopsis* genus are heavily associated with the modified stipules which produce a sugary secretion. *Cotesia* wasps and various species of pteromalids have been seen in the stipules and the sap secretions.

13 *Cassia tora* L. (Leguminosae) (Fig. 12).

Shrubs; 0.1-0.5 m tall, erect or decumbent; internodes 1.5-4.5 cm long; compound bipinnate leaves, alternating, with stipules and petioled. 3 pairs of folioles; 3.0-5.0 cm long and (1.2-) 2.7-4.5 cm wide; the distals being larger than the proximals; elongated ovoid form; leaf rachis (2-) 4-7 cm long; petioles 0.3-0.5 cm; stipules 1.5 cm long; short pubescence, soft to the touch. Extrafloral glands between the two folioles, 2-3 mm, yellow or orange. Bright yellow flowers in small bunches. The fruit is a slightly curved legume, 0.5 x 5-7 cm, with 35-43 oval yellow seeds. It reproduces by means of stolons and seeds.

This plant grows in sunny spots like grass lands and the sides of roads. The main groups of visiting insects are flies of the Muscidae, Neriidae and Richardiidae families and wasps of the Braconidae, Chalcididae, Evaniidae, Pteromalidae and Vespidae families. This plant can be used as a cover crop on perennial fruit plantations to replace grass alongside roads. It reproduces by means of seeds and stolons.

14 *Desmodium ovaliofolium* Waller (Leguminosae) (Fig. 13).

Shrubs, decumbent, forming a vegetative mass 0.30 - 0.60 m high, internodes 4.0 - 6.0 cm long; trefoil or simple leaves, alternating, with stipules and petioled. Lamina (3.5-) 5.0-6.0 cm long and (-2.0) 3.0- 4.0 cm wide; glabrous and shiny. The inflorescence is a bunch; flowers with light purple standard and bright purple keel. The fruit is a legume, 2.0 x 0.5 cm, pubescent; with 5 seeds.

This plant is used as a cover crop on oil palm and peach palm plantations; it tolerates shade and grows well in sunny places. It reproduces by means of seeds and stolons. It covers the soil and provides refuge for large numbers of phytophagous and predatory insects.

15 *Flemingia congesta* Willdenow (Leguminosae)

Shrubs; 0.2 - 1.5 (-3.0) m tall; woody stem, in the young parts 3-angular; ribbed; internodes 6-9 (-12) cm long; trefoil leaves, alternating, with stipules and petioled. Folioles, (3.0-) 4.5-15.0 (-21)cm long and 3.0-5.5 cm wide; lanceolated elliptical form, the two lateral ones are asymmetrical and the central one symmetrical; wing-shaped petiole. Axillary inflorescence is a bunch of lilac-colored flowers. The fruit is a pod, 0.8-1.5 cm, spherical , acuminate; with short pubescence, soft to the touch; with 1-2 small black round seeds.

Flemingia grows well in sunny as well as moderately shady places. The main groups of visiting insects are beetles from the Curculionidae family and the ant *Solenopsis* sp. When it flowers it is very attractive to wasps from the Braconidae, Chalcididae and Ichneumonidae families. The wasp, *Digonogastra diversus*, a parasitoid on *O. kirbyie*, is a common visitor to this plant.

16 *Pueraria phaseoloides* Bentham (Leguminosae), common name: kudzu.

Herbs 0.1-0.6 m tall, creeping, forming a vegetative mass; internodes 17-26 cm long, pubescent; trefoil leaves, alternating, with stipules and petioled. Folioles (5-) 10-12 cm long and (5-) 10-12 cm wide, cordate, of equal dimensions. Inflorescence is a bunch of 6-10 white flowers with purple pistils. The fruit is a thin elongated pubescent legume.

This plant grows better in sunny spots. It is used as a cover crop on oil palm plantations and it provides refuge to a large number of phytophagous and predatory insects. This plant can be very useful in terms of replacing grassy spots alongside roads and serving as a refuge for beneficial entomofauna. It houses predatory bug species from genera like *Alcaeorrhynchus* and *Podisus* (Pentatomidae).

17 *Senna stenocarpoides* (Styley) Britton (Leguminosae) (Fig. 14).

Shrubs; 0.30 - 0.50 (-1.50) m tall; erect or decumbent, woody stem, compound pinnate leaves, alternating, with stipules and petioled. Lamina 4.0-6.0 cm long and 1.5-3.0 cm wide, lanceolated, with 16 pairs of elongated oval folioles. At the base of the lamina are 1-3 extrafloral glands, reddish, cupped. Individual yellow flowers; corolla with 5 equal petals, 5 stamens shorter than the pistil. The fruit is a pod, 5.0 x 0.5-cm, with 12-15 flat quadrangular seeds.

This plant grows in areas exposed to sunlight, generally alongside roads, and is commonly seen during the dry season. It dies after bearing fruit, and the seeds germinate during the rainy season. The main groups of visiting insects are bugs from the Coreidae and Pentatomidae families, flies from the Otitidae and Richardiidae families and wasps from the Chalcididae, Evaniidae and Ichneumonidae families.

18 *Hyptis capitata* L. (Lamiaceae)

Herbs 0.5-0.6 m tall, erect or decumbent, stem 4-angular, with stiff ribs; purple; internodes 6-10 cm; whole leaves, opposing, decussate and with stipules. Lanceolated oval lamina serrated with 22-27 teeth on each side; with extrafloral glands on the teeth. Th inflorescence is a capitulum with plentiful small white flowers, with purple dots on the petals; calyx of 5 sepals; corolla of 5 petals fused in 2+3; 5 stamens shorter than the pistils. The fruit is black, 1.0 x 0.5 mm. It reproduces by means of seeds and stolons.

This plant grows in bare soils in sunny places. The main groups of visiting insects are wasps of the Braconidae, Eucharitidae, Pteromalidae and Vespidae families.

19 *Urena lobata* L. (Malvaceae) (Figs. 15,16).

Shrubs; 0.1-1.70 (-2.5) m tall; erect; internodes 4.0-6.0 cm long; with simple leaves, whole, alternating, with stipules and petioled. Oblong lamina, slightly lobed, 4.0-9.0 (-10.0) cm long and 3.0-7.5 (-13.5) cm wide; with 7 longinal veins that radiate from the petiole, each of the three central ones with an extrafloral gland; abundant long, soft pubescence. Solitary flowers on the leaf axils, short petiole; calyx with 5 sepals and corolla with 5 pink petals, 0.8-1.5 cm long; pistil 0.1 cm, red, style base of the same color; short stamens attached to the style. The fruit is a pentamerous drupe with hard pubescence by which it adheres.

This is a perennial plant that grows in sunny spots, generally in grasslands, reproducing by means of seeds and cuttings. The main groups of visiting insects are bugs (Lygaeidae), beetles from the Chrysomelidae and Elateridae families, flies from the Muscidae, Otitidae, Richardiidae and Tachinidae families and mainly wasps from the Braconidae, Chalcididae and Vespidae families. When it is flowering, it is frequently visited *by Apis mellifera*.

20 *Spermacoce laevis* (Burm.) D.C. (Rubiaceae) (Fig. 17)

Herbs 0.2-0.5 m high; stem 4-angular; internodes (1.4-) 3-4 (-5) cm long; prominent nodes; succulent appearance; simple leaves, whole, opposing and with stipules. Lamina 3.0-4.5 cm long and 1.5 -2.3 cm wide; elliptical form. Leaf husk wraps around the stem. Tubular flowers 4-5 mm, with 4 white or violet petals, bracteate, forming dense bouquets on the leaf axils.

This is an annual plant that grows during the rainy season, forming a dense cover, 25-40 cm high. It reproduces by means of seeds. The main groups of visiting insects are flies from the Syrphidae familiy and wasps from the Braconidae, Chalcididae and Sceliomidae families.

21 *Hamelia patens* Jacquin (Rubiaceae)

Shrub or small tree, 1.7- 3.0 (7.0) m tall; glabrous or pubescent branches, 4-angular in early stages; simple leaves, 3 (-4) alternating, whole and petioled, 5-17 (-23) cm long and 1-7 (-10) cm wide, oblong-elliptical form with an acuminate apex; glabrous, soft to the touch; reddish in the senescence; long internodes. Solitary terminal inflorescence, an open orange or coral panicle, measuring 9-15 x 12-20 cm; sessile flowers, hypanthium 1.5-3.0 mm long, tubular corolla, orange or red. The fruit is subspherical, red, turning black when it matures; 6-13 x 4-10 mm.

This plant is common in areas of secondary succession, in sunny spots where it can grow to shrub size. It reproduces by means of seeds. It flowers throughout the year and its attractive appearance makes it valuable as an ornamental plant. The main groups of visiting insects are dipterans of various families and wasps of the Braconidae and Vespidae families.

22 *Solanum americanum* Miller (Solanaceae) (Fig. 18).

Herbs 0.2-0.5 m tall; purple stem, with significant branching; simple leaves, whole, alternating, with stipules and petioled. Lamina 3.5-8.0 cm long and 2.0-4.5 cm wide, lanceolate ; with young axillary buds. 5-8 white flowers, with yellow stamens wrapped around the pistil. Fruit in bunches; berries 1 cm in diameter, green, turning purple when they mature; large numbers of small seeds.

This is an annual plant that grows in sunny spots on bare soil. The main groups of visiting insects are flies from the Richardiidae family and wasps from the Chalcididae, Ichneumonidae, Evaniidae and Vespidae families.

23 *Solanum jamaicense* Millspaugh (Solanaceae) (Fig. 19)

Herbs, 0.3-0.6 m tall, decumbent; interno-des 7.0-15.0 cm long; leaves whole, opposing or in 3-leafed verticils, with stipules and petioled. Lamina 4.5 - 11.0 (-17.0) cm long and 1.5- 4.5 (-7.5) cm wide; lanceolate, with irregular edges, acuminate, measuring 6 x 12 cm. The stem and the leaves are covered with thorns. 5-8 white flowers, with conspicuous yellow stamens. The fruit is a berry, 1.2-1.5 cm in diameter, orange when mature. It is a perennial, reproducing by means of seeds and stolons.

This plant grows in sunny sites and can form a vegetative cover often considered undesirable due to its thorns. The main groups of visiting insects are bugs from the Pentatomidae family, beetles from the Chrysomelidae and Curculionidae families, flies from the Otitidae and Richardiidae families and large numbers of wasps from various families such as Braconidae, Chalcididae, Ichneumonidae, Pteromalidae and Vespidae.

24 *Solanum quitoense* Lam (Fig. 20)

Shrub, 0.5 - 1.0 m tall; with simple leaves, alternating on two levels, with stipules and petioled. Lamina (2.5-) 46.0 cm long and (1.8-) 38.0 cm wide; hollow, 5-8 extensions located on either side of the central vein, which branches once. Petioles 30-50 mm long. With reddish-brown tomentum covering stems and branches. Flower with calyx with 5 light green petals, yellow stamens, 8.0-10.0 mm, covering the style, hard to the touch; corolla with five sepals. The fruit is a false berry, yellow or orange when ripe; measuring 50-60 mm long and 70-80 mm thick, flat, with five protuberances or carpels. The small white seeds adhere to an aril and are found in carpel chambers.

This plant grows in sunny spots and is susceptible to water deficit. The main groups of visiting insects are wasps from the Braconidae and Chalcididae families (the most numerous) and flies from the Dolichopodidae, Micropezidae, Otitidae and Richardiidae families. The ants are attracted by secretions from the glandulous trichomes and may form agglomerations at the base of the fruit.

25 *Solanum schlechtendalianum* Walpers (Solanaceae)

Shrub or small tree; 0.1-2.0 (-4.0) m tall; internodes 3.5-4.0(-8.0)cm long; with whole leaves, alternating on one level, with stipules and petioled. Lamina 2.5-7.5 (-19.0) cm long and 1.0-3.2 (-10.5) cm wide; lanceolate, acuminate. Short petioles 5.0 mm. The flower is white with conspicuous yellow stamens. The fruit is a green berry, 1.0-1.5 cm in diameter.

This plant grows in sunny sites. The leaf has glandulous trichomes in the abaxial side. The main groups of visiting insects are ants from the genus *Solenopsis*, flies from the Richardiidae family and wasps from the Braconidae, Chalcididae, Ichneumonidae and Vespidae families. *Hyalymenus tarsatus* has, on occasion, been linked to this plant.

26 *Byttneria aculeata* Jacquin (Sterculiaceae), common name: (Fig. 21,22)

Herbs 0.3-1.5 (-2.0) m tall, erect or decumbent, stem 5-angular, with stiff ribs, soft or hollow medulla; internodes 4-7 (-12) cm long; whole leaves, alternating, with stipules and petioled. Lamina 9-12 cm long and 5-6 cm wide; cordate acuminate form, subserrated; with a central vein and two branching lateral veins; 1-3 extrafloral glands on the veins. Spines on the ribs, petioles and the central vein of the leaves. Bisexual flowers with 3-5 sepals, small reduced petals. It reproduces by means of seeds and stolons.

This plant grows in sunny sites alongside roads, forming a vegetative cover approximately one meter high. The main groups of visiting insects are ants living inside the stem and parasitoid wasps from the Braconidae, Chalcididae, Eulophidae and Eurytomidae families; wasps from the *Cotesia* (Braconidae) and *Conura* (Chalcididae) genera, which are parasites of Limacodidae and Nymphalidae species, are common in this plant.

27 *Triunfetta semitriloba* L. (Tiliaceae)

Shrubs; 1.5-3.5 m tall; stems 1.5-3.0 cm in diameter, woody; internodes 2.0-3.0 (-4.5) cm long; with whole leaves, alternating, with stipules and petioled. Lamina 3.0-8.0 (-15.0) cm long and 2.0-6.5 (-13.0) cm wide; oblong form with distal end trilobated, with the central lobe being the largest; subserrated, with 21-47 (-111) teeth on each side; one extrafloral gland per tooth; 5 longinal veins; petioles (1.0-) 1.5-6.0 (-12.0) cm; soft pubescence with abundant mucilage. Bisexual flower, 5 petals, commated on the base, light yellow or whitish; 10 or more stamens. Fruit is a hard drupe, with hard pubescence by which it adheres. It reproduces by means of seeds and cuttings.

This plant grows in sunny sites as well as in the shade and is cultivated because the mucilage is used to prepare a drink for human consumption. It reproduces by means of seeds and, to a lesser extent, cuttings. The main groups of visiting insects are ants from the *Ectatomma* and *Solenopsis* genera, which act as allelopathic organisms against vertebrate defoliators; flies from the Otitidae and Richardiidae families and wasps from the Braconidae, Chalcididae, Pteromalidae and other families.

28 *Lantana camara* L. (Verbenaceae) (Fig. 23)

Shrub; 0.4-1.5 (-3.0) m tall; stem 4-angular, with spines, purple, woody; internodes 8-13 cm long; whole leaves, opposing or verticilate, with stipules and petioled. Lamina 4.5-12.0 (-24.0) cm long and 3.0-5.0 cm wide; lanceolate elliptical, serrated with 23-39 teeth on each side; petiole 2-5 cm long. Bisexual flowers, arranged in a capitulum of 20-30 flowers; calyx of 5 persistent sepals, tubular red corolla with 5 petals, the distal part is orange; with 5 stamens. The fruit is a drupe arranged in bunches. It reproduces by means of seeds.

This plant grows in sunny places like the borders of roads and grasslands. The main groups of visiting insects are sap-feeders like bugs from the Alydidae family, homopterans from the Cercopidae, Cicadellidae and Membracidae families, beetles from the Chrysomelidae and Curculionidae families and lepidopterans from the Hesperiidae, Nymphalidae and Pieridae families.

29 *Lantana trifolia* L. (Verbenaceae)

Shrub; 0.3-1.5 (-3.0) m tall; stem 5-angular, with stiff ribs; woody; internodes 8-13 cm long; whole leaves, 3 verticils, with stipules and petioled. Lamina 4.5-12.0 (-24.0) cm long and 3.0-5.0 cm wide; lanceolate elliptical, serrated with 25-35 teeth on each side; petioles 2-5 cm long. Inflorescence is a spike with bisexual bracteate flowers; calyx with 5 sepals in the fruit. Tubular pink corolla with 5 petals; with 5 stamens. The fruit is a hard purple drupe, 3.0 mm in diameter. It reproduces by means of seeds.

This plant grows in sunny areas, like the sides of roads, brushy areas and grasslands. The visiting entomofauna is similar to that of *L. camara*. The

association of some species of homopterans that produce honeydew (a sugary excretion) with *Lantana* spp could be important as a nutritional source for parasitoids.

30 *Vitis sycioides* L. (Vitaceae) (Fig. 24)

Herbs 0.2-0.5 m tall, prostrate, internodes 6.0-8.0 cm long; prominent nodes, with tendrils; young parts are reddish or purple; whole leaves, alternating, with stipules and petioled. Lamina 7.5-15.0 (-22.0) cm long and 6.0-10.0 (-18.0) cm wide; asymmetric, oblong or cordate, subserrated, with 18- 27 teeth on each side, each one with an extrafloral gland. Inflorescence is a highly-branched umbel, with small light yellow flowers, reduced petals. The fruit is a berry, 0.5-1.0 cm in diameter, purple when mature. It reproduces by means of seeds and stolons.

This plant grows in sunny spots and encroaches on to other plants. It reproduces by means of seeds and stolons. Among the main groups of visiting insects are beetles from the Chrysomelidae, Curculionidae, Cantharidae and Meloidae families; flies from the Otitidae, Richardiidae, Syrphidae and Tachinidae families and wasps from the Braconidae, Chalcididae, Eulophidae, Evaniidae, Ichneumonidae, Pteromalidae and other families.

Management of beneficial vegetation

An increase in structural diversity in a monoculture can be achieved by favoring the growth of certain other plants. In various crops associated with weeds, a decrease in problems with phytophagous insects has been demonstrated (Risch *et al.* 1983). The concept of weed management in oil palm requires the evolution of the chemical combat scheme into one of reasonable crop-weed management. The advantages for the grower include a lesser investment in herbicides and in mechanical weed control, along with the conservation of a combination of biotic factors favorable to resident organism populations.

The spaces in which weeds can grow such as strips of land, along roads and primary drains, could serve as "biological corridors," through which insects could be drawn towards the interior of the plantation. Sowing spaces which have been left empty by dead palms with specific plants could create "biological islands," providing food and refuge for the insects.

Janzen (1968) considered plants to be islands in space and time for the insects, and areas with weed mixtures could also be visualized within the plantations, like islands where the insects could move, feed or take refuge.

The size and number of islands necessary per area unit to achieve good natural control of problematic insects is difficult to know without experimental tests using different sizes and numbers of islands per hectare. On adult plantations, however, empty spaces can provide refuge for the insects. In practice, this would only consist of a substitution of the grasses that grow in some of these spots for broad-leaf weeds highly attractive to insects.

While still subject to experimental verification, four islands of 100 square meters (10m x 10m) per hectare may be enough to sustain the entomofauna within the crop. In practice, it may even be enough to sow 7 x 7m areas (49 m^2). In areas with such dimensions, there could be a high insect immigration rate, a low emigration rate and an increase in chances for survival and reproduction.

There are various ways to bring about such corridors and islands:

- The careful selection of plant species of interest.
- Selective chemical and manual weed control.
- Collection and dispersion of seeds in specific sites on the plantation, or the sowing of plants that are easily reproduced asexually (cuttings, stolons, rhizomes, etc.).

- Establishment of nurseries of promissory species in order to ensure easy distribution on plantations.
- Training of agricultural personnel in the management of these species.
- Training through presentations, as well as didactic material such as a field guides with color photographs, photographic murals, and technical pamphlets.

Part of the personnel training could be achieved through the planting of a "weed garden." With this plant collection, the worker could learn which species of plants are valuable from an agroecological point of view and could pass this knowledge on to the people under him.

The investment in establishment of corridors and islands, installation of weed nurseries and training programs for agricultural workers is gradual and is made over a period of several years. Mid-range benefits of such programs can be seen in terms of savings on herbicides and manual weeding. Other benefits are not so easily quantified, such as soil conservation, the increase in natural enemy populations, the greater number of microclimates (Risch *et al.* 1983; Letourneau & Altieri 1983), greater control over unwelcome weeds through the use of leguminous ground covers, and a series of biotic conditions not taken into account here.

An important part of the program is carrying out the ecological studies that allow for the evaluation of the effect these measures have on the insect populations and on the health and productivity of the crop, in order to make the necessary corrections.

This is a gradual process that cannot be implemented in a short time; the results obtained in each particular region with each particular crop are not necessarily applicable to other regions and other crops, and there is a need for further studies to be conducted.

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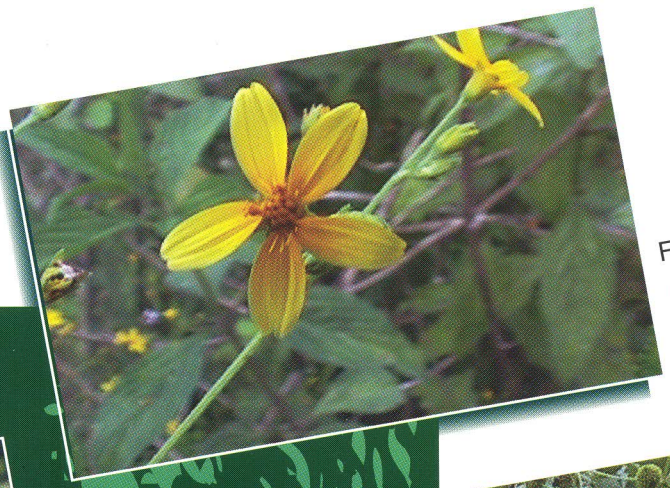

Figura 4
Baltimora recta
(florecilla)

Figura 1
Justicia comata
(justicia)

Figura 5
Melanthera aspera
(paira)

Figura 2
Amarantus spinosus
(amarantus)

Figura 6
Melanthera aspera
(paira)

Figura 3
Ageratum conyzoides
(Santa Lucía)

Figura 10
Crotalaria guatemalensis
(chipilín)

Figura 7
Scleria melaleuca
(navajuela)

Figura 11
Cassia reticulata
(saragundi)

Figura 8
Scleria melaleuca
(navajuela)

Figura 12
Cassia tora
(candelillo)

Figura 9
Chamaesyce hirta
(golondrina)

Figura 16
Urena lobata
(urena)

Figura 13
Desmodium ovaliofolium
(Desmodio)

Figura 17
Spermacoce laevis
(chiquizacillo)

Figura 14
Senna stenocarpoides
(falsa dormilona)

Figura 18
Solanum americanum
(hierba mora)

Figura 15
Urena lobata
(urena)

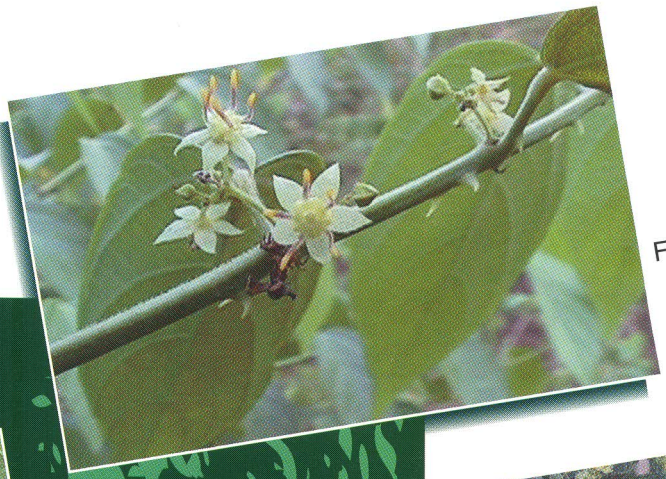

Figura 22
Byttneria aculeata
(uña de gato)

Figura 19
Solanum jamaicense
(uña de gato)

Figura 23
Lantana camara
(cinco negritos)

Figura 20
Solanum quitoense
(naranjilla)

Figura 24
Vitis sycioides
(uva cimarrona)

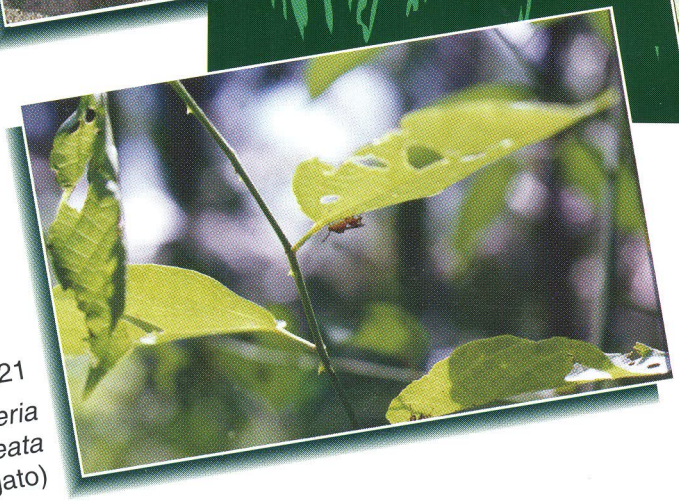

Figura 21
Byttneria aculeata
(uña de gato)