A list of Food Plants and some Implications of the Feeding Behaviour of the Forest Grasshopper, *Coscineuta virens* (Thunberg), in Trinidad.

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Abstract

Seventy-eight species of plants in thirty-three families are listed as food plants of the small forest grasshopper *Coscineauta virens*. Among them are many closely related native and exotic species, including crops, ornamentals, shade plants and weeds. The host range reflects the insects ability to adapt and respond to a changing environment.

Key Words: *Coscineuta virens*; food plants; feeding behaviour.

Introduction

Grasshoppers are important by virtue of the damage they cause by feeding (Chapman, 1976). The small polyphagous grasshopper *Coscineuta virens* (Thunberg), also called the Moruga grasshopper, is an economically important agricultural pest in southeast Trinidad. This paper gives a list of food plants and discusses some implications of its feeding behaviour in a changing environment.

Methods

Field observations were made from 1986 to 1989. Several reference works (Marshall, 1934; Adams, et al., 1968; Williams, 1969; Adams, 1972; Purseglove, 1972 & 1974 and Greesink, et al., 1981) were used for plant identification and other general information. Some plants were identified at the National Herbarium at the University of the West Indies, St Augustine, Trinidad. This survey is continuing with the intention of compiling a comprehensive list of food plants for the insect in its present range.

Results

The insect inhabits an area which includes three major forest rserves: The Victoria Mayaro Forest Reserve, the San Pedro/Poole Forest Reserve and the Southern Watershed. Details of the distribution are given in Fig. 1. Large sections of the forests have been cleared for agriculture, logging, settlements and industrial development.

The area is popular for recreational activities such as hunting and fishing. There is also a Scientific Reserve in the Moruga Forest.

Food Plants of *Coscineuta virens*

Feeding was observed on all the plants listed in Table 1. Food plants in southeast Trinidad included:

(a) economically important plants e.g., cocoa, coffee, citrus and bananas, which are the main cash crops in the area (Table 2).

(b) supplemental crops e.g., vegetables such as brassicas and cucurbits; legumes and root crops such as cassava (Table 2).

(c) plants used as shade for plantation crops e.g., immortelle and banana.

(d) ornamentals e.g., begonia, ixora, hibiscus.

(e) medicinal plants e.g., dite payee, bois canot, black sage.

(f) plants of strong cultural and religious significance e.g., calabash and datura.

The insect is an erratic feeder which may damage some plants repeatedly; other plants remain untouched during some years and are damaged in others. All stages of the insect show a strong preference for dicotyledonous plants, feeding on at least forty-two species in twenty-seven plant families. Feeding may extend to closely related species in the same genera or several members of the same plant families. Both native and introduced species may be damaged. While there is some overlap of plant preference among nymphs and adults, nymphs feed on a wider range of plants. Adults have not been observed to feed on many weeds and shrubs that are commonly eaten by the nymphs.

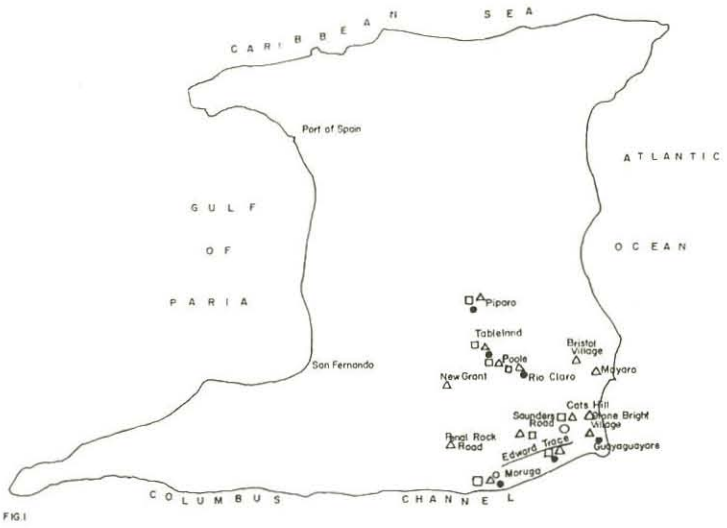

Fig 1. Distribution of *Coscineuta Virens* (1985 - 1988)

□ Hoppers △ Adults
○ Known Oviposition site ● Suspected

Table 1. A list of Food Plants of *Coscineuta virens*

Family	Scientific Name	Common Name
Acanthaceae	*Megaskepasma erythrochlamys* (Lindau)	
Agavaceae (Liliaceae)	Dracaena sp. *Dracaena fragrans* Gawl.	White Rheo
Amarantaceae	*Amaranthus* spp.	Spinach, BhagiAnacardiaceae
	Anacardium occidentale L.	Cashew
	Mangifera indica L.	Mango
	Spondias cythera (Sonn.)	Pommecythere, Golden Apple
	Spondias mombin L.	Hog Plum
Arecaceae (Palmae)	*Cocos nucifera* L.	Coconut palm
	Bactris major (Jacq.)	Roseau palm
Asteraceae (Compositae)	*Bidens pilosa* L.	Railway daisy
	Eupatorium odoratum L.	Christmas bush
	Lactuca sativa L.	Lettuce
Begoniaceae	*Begonia* spp.	
Bignoniaceae	*Crescentia cujete* L.	Calabash
	Tabebuia rosea (Bertol.) DC.	Pink poui
Bombacaceae	*Ochroma pyramidale* (Cav.) Urb.	Bois flot
Boraginaceae	*Cordia collococca* L.	Manjack, lay lay
	Cordia curassavica L.	Black sage
Brassicaceae (Cruciferae)	*Brassica chinensis* L.	Pak choi
	Brassica oleracea capitata L.	Cabbage
	Brassica oleracea verbotritis L.	Cauliflower
Caesalpiniaceae	*Cassia fructicosa* Mill.	Cocrico bush
	Mora excelsa Benth.	Mora
Cannaceae	*Canna edulis* (Ker-Gawl.)	Canna lily
Cucurbitaceae	*Citrullus lanatus* (Thunb.)	Watermelon
	Cucumis sativus L.	Cucumber
	Cucurbita moschata (Dutch.)	Pumpkin
Fabaceae (Papilionaceae)	*Cajanus cajan* L.	Pigeon pea
	Erythrina glauca Willd.	Swamp immortelle
	Erythrina micropteryx (Poepp.)	Mountain immortelle
	Inga venosa (Gr. ex Benth.)	Wild pois doux
	Moghania strobilifera L.	Money bush, Wild hops
	Vigna unguiculata (L.) Walp.	Cow pea, bodi
Euphorbiaceae	*Hevea brasiliensis* Meull.-Ang.	Rubber
	Hura crepitans L.	Sandbox
	Manihot esculenta (Cranz)	Cassava
Lamiaceae (Labiatae)	*Coleus blumei* (Benth.)	Joseph's Coat
Lauraceae	*Persea americana* Mill.	Avocado
Malvaceae	*Hibiscus esculentus* L.	Ọchro
	Hibiscus rosa-sinensis L.	Garden hibiscus
	Hibiscus sabdariffa L.	Sorrel
Maranthaceae	*Calathea lutea* (Aubl.) G.F.W. Myer	Souhari leaf
Melastomataceae	*Miconia officinis* DC.	
Moraceae	*Cecropia peltata* L.	Bois canot
	Artocarpus atilis (Park.) Fosberg	Breadfruit Breadnut (chataigne)
Musaceae	*Musa paradisiaca* L.*	Plantain
	Musa sapientum L.*	Banana
	Musa sp.	Moko
Strelitziaceae	*Heliconia* bihai	Balisier
	Heliconia spp.	
Myrtaceae	*Eugenia malaccensis* L.	Pomerac
	Psidium guajava L.	Guava

Table 1 continued

Family	Scientific Name	Common Name
Piperaceae	*Piper tuberculatum* (Jacq.)	Candle Bush
Poaceae (Graminae)	*Axonopus compressus* L.	Gamelot grass
	Paspalum fasciculatum (Willd.)	Bamboo grass, bull grass
	Zea mays L.	Maize, corn
Rubiaceae	*Coffea arabica* L.	Coffee
	Hamelia patens Jacq.	
	Ixora chinensis L.	Ixora
	Vanqueria madagascariensis (J.F. Gmel.)	Chinese tamarind
Rutaceae	*Citrus limona* (L.) Burm. F.	Lemon
	Citrus paradisi Macf.	Grapefruit
	Citrus reticulata Blanco	Portugal, Mandarin
	Citrus sinensis (L.) Osbeck	Sweet Orange
Scrophulariaceae	*Capraria biflora* L.	Ditay payee, Goat weed
Solanaceae	*Capsicum annuum* L.	Sweet pepper
	Dunalia arborescens L.	Wild tobacco
	Datura mollis L.	Datura
	Lycopersicon esculentum Mill.	Tomato
	Solanum melongena L.	Melongene, egg plant
	Solanum stramoniifolium (Jacq.)	Dog teeth, coco chat
Sterculiaceae	*Theobroma cacao* L.	Cocoa
Tiliaceae	*Triumfetta lappula* L.	Burweed, bud bud
Verbenaceae	*Lantana camara* L.	Grater wood
	Stachytarpheta jamaicensis (L.) Vahl.	Vervine
	Stachytarpheta cayennensis (L.C. Rich.)	Vervine
	Tectona grandis L.	Teak
Vitaceae	*Cissus sicyoides* L.	Snake vine, Blister bush.

Feeding Damage

Older nymphs and adults may consume more than 200 mg of plant tissues per individual insect per day. Feeding varied from slight in some families to very intense on several members of other orders or families e.g., Leguminosae (Fabales) - pigeon peas, bodi and wild hops, mora; Solanaceae - sweet pepper, melongene; Graminae (Poaceae) - maize; Rubiaceae - coffee, ixora; Moraceae - bois canot, breadfruit. Many monocotyledonous plants e.g., palms and grasses are barely nibbled. Others such as maize and members of the order Zingerberales - Cannaceae, Marantaceae and Musaceae - may be extensively damaged.

Defoliation is the main form of plant damage, though shoots, buds, flowers and fruits may occasionally be affected. Young nymphs tend to feed on the upper epidermis and mesophyll of younger leaves while leaving the lower epidermis intact. Older nymphs are more general feeders which skeletonize leaves or devour them completely. Adults usually feed selectively on young flush, though buds, flowers and shoots may be damaged from time to time, as has been seen on mango and citrus. Complete defoliation may also occur e.g., breadfruit, chataigne. Occasionally fruits such as citrus and banana may be eaten.

In the forests, *Coscineuta virens* feeds in the forest canopy and on emergent trees at 40-50 metres. Feeding in the lower strata tends to be patchy and on areas where sunlight filters in. In open areas such as at roadsides and where there are breaks in the canopy, as at logging sites, the insect descends to feed on weeds and other herbaceous species. As hoppers march from forests and cultivation, they feed on the wayside weeds e.g. mosquito bush, vervain, dite payee and plants in secondary successions e.g. bois canot, bois flot and heliconia.

The insect also feeds on the perennial tree and shrub crops that predominate in the various mixed cropping systems practised by farmers in southeast Trinidad. These include various combinations of crops listed in Table 2, grown among shade trees near the edge of the forest on mostly small farms ranging in size from approximately 2.2. ha to 18.4 ha (average size = 4.9 ± 1.13 ha; n=70). Damage to some important crops grown by farmers is described below:

Citrus - leaves, buds, flowers and fruits may be severely damaged throughout the year. Leaves may remain on the tree more than a year after damage occurs. Hopper damage to young plants in the dry season can destroy such plants. Older trees may recover from damage to produce lower yield in subsequent years. Damage to

Table 2. Distribution of crops grown by farmers in Southeast Trinidad who reported damage by *Coscineuta virens* to the Ministry of Food Production (1986-1988)

Crop [Common Name]	% of Farmers Growing Crops in			Combine %	Origin of Plant*
	Moruga	Tableland	Rio Claro		
Cocoa	43.75	35.29	33.33	38.01	S. America
Citrus	21.88	52.94	52.38	30.86	S. E. Asia
Bananas & Plantains	31.25	41.18	38.10	28.00	S. E. Asia
Coffee	34.88	47.05	42.86	20.08	Ethiopia
Cassava	9.38	9.52	9.52	10.00	T. America
Mango	12.25	5.88	—	7.14	Indo-Burma
Pigeon Peas	6.25	5.88	9.52	5.71	Africa
Pumpkin/squash	12.25	—	—	5.71	C. America
Bodi	9.38	5.88	—	4.43	East Indies
Cucumber	9.38	—	—	4.29	India
Sweet Pepper	9.38	—	—	4.29	T. America
Dasheen**	—	—	9.62	2.86	S. E. Asia
Avocado	3.13	—	4.76	2.86	C. America & Mexico
Maize	6.25	—	—	2.86	C. America
Watermelon	6.25	—	—	2.85	Africa
Melongene	6.25	—	—	2.85	Indian
Breadfruit/chataigne	3.13	4.76	—	2.85	Polynesia
Cabbage	6.25	—	—	2.86	Europe
Ochro	3.13	—	—	1.43	T. America
Sugar Cane**	5.88	—	—	1.43	Asia & Pacific
No. of farmers interviewed	32	17	21	70	

* Reproduced from Purseglove 1972 & 1974 ** Feeding damage on these crops not verified

buds and new flush can cause stunting and inhibit flowering. Leaf damage in the rainy season may cause shedding of marble-sized fruits if they are present. Defoliation in the dry season may also cause maturing fruits to drop. Direct fruit damage, though rare, may also occur.

Coffee - Coffee leaves are often severely damaged in the dry season (January - June). The trees often shed any remaining leaves as a response to the combined effects of feeding damage and water stress owing to the lack of irrigation. Young plants may succumb, but established trees recover to produce new flush with the first rains. Yields may be lower owing to the production of fewer inflorescence and fewer flowers per inflorescence.

Cocoa - Only slight foliage damage has been observed on cocoa; such damage does not seem to adversely effect the plant.

Bananas and Plantain - These are very prone to extensive defoliation by hoppers. Scarring of the fingers, though rare, may also occur and reduce the marketability of the crop. The Sucrier variety is apparently more susceptible to attack than other varieties. Farmers claim that extensive foliage damage may result in poor yields through the production of smaller hands with fewer fingers. This may be a valid claim but it has not yet been verified. Defoliation of mature plants could cause abortion of developing bunches (Williams, pers. comm.)

Mango - Selective feeding was observed in some fields of mixed varieties. In one field the Blackman variety was completely defoliated while Julie remained untouched. In pure stand Julie fields feeding may occur on all the trees. Damage to leaf, shoot and bud during the rainy season produces a pruning effect, to which the trees respond with heavy vegetative growth. Flowering can be suppressed for at least the two following seasons, but can be induced sooner by removing excessive shoots from the bushy crown.

Breadfruit & Chataigne - Adults in particular feed extensively on breadfruit and chataigne which may produce new flush within three weeks of complete defoliation.

Cassava - Both adults and nymphs feed extenively on cassava. Leaf regeneration occurs within 2-3 weeks of defoliation in the rainy season. There is no leaf regrowth following hopper damage in the dry season under the conditions that cassava is grown in Trinidad. There may be deterioration in the cooking qualities and marketability of the tubers following defoliation.

Vegetables - Many vegetables and legumes are extremely vulnerable to damage from which they hardly recover. 100% defoliation has been observed on pigeon peas, bodi, melongene and sweet peppers.

Discussion

Coscineuta virens as a general feeder is unlike the many grasshoppers that specialize in certain host

categories (Mulkern, 1967: Gangwere et al ., 1989) This list of food plants, which has been upgraded from the modest lists of Laurence (1974), COPR (1982), and Popov, (1986), is impressive, even though food plants in the forest have not yet been fully explored. Tables 1 and 2 show that the insect is capable of modifying its food choice to include a wide variety of native and introduced plants in its diet. The various stages of the insect feed on different stages of the growth cycle of many plants. Further studies may show hosts among plants with future economic potential in Trinidad.

The feeding behaviour has been influenced by modification of the natural forest through human activity. Clearing of the forest for many purposes, degradation to wasteland, logging and farming practices such as the establishment of plantations/orchards and shifting cultivation, serve to alter the environment, to create conditions the insect can exploit. Hunters and loggers recall that many years ago C. *virens* was encountered only in the deep forest, mainly in areas where the natural vegetation was characterized as a predominantly mora association by Beard (1946). Older residents attribute what is apparently an expanded range of the insect to clearing of the forest. The introduction of exotic crops and other plants, many of which are attrctive to C. *virens*, to replace the natural vegetation - described by Beard (1946) - may be the most important factor contributing to the present pest status of the insect. A comparable situation has been observed in Australia, where clearing of woodlands for pasture has favoured short, tussocky grasses which provided food for the Australian Plague Locust (Chapman, 1976). There are instances where practices such as grazing of sheep and cattle (in Australia) resulted in expansion of habitats suitable for locust development, especially in the less arid grasslands that were previously unsuitable for the species. Over-grazing has also produced habitats favouring the development of the South African brown locust. In Indonesia, deforestation has provided a habitat for *Locusta*, where previously none existed (Chapman, 1976). Elsewhere, in Brazil, infestations of *Rhamonatocerus pictus* (Bruner) have extended to regions where forests have practically disappeared, to be replaced by large scale farms (Skaf, 1985).

Coscineuta virens and other polyphagous grasshoppers, are probably of economic importance both as beneficial insects and as crop pests. It has been suggested that chewing insects such as grasshoppers may effectively prune plants, resulting in plants with increased vigour and growth (USDA, 1977). Their grazing habit may influence plant productivity by producing organic litter of faecal and plant origin (Mitchell and Pradt, 1974). Organic matter may also be generated from decomposition of eggs and eggpods and bodies of the insects. In this way they probably influence biological processes in the ecosystem.

The dramatic effects of feeding damage in the dry season might be closely linked to water stress, since field irrigation is not practised. For instance, it has been shown that in cassava, water stress associated with the loss of vegetation cover could cause deterioration in tuber quality (Seesahai, pers. comm.).

Ordinarily in agro-ecosystems the practice of mixed-cropping tends to reduce many adverse conditions associated with monoculture, which could lead to insect population build up and insect damage. In multiple cropping systems, one crop may be spared from damage by the more vigorous defoliation of an alternate host (Ruthenberg, 1980). Such an advantage is lost in this situation where the crops cultivated, shade plants and other associated vegetation are all hosts. In afforested areas in Trinidad, exotic timber such as teak, grown in pure stands to replace native forest trees, may also be important hosts. *Coscineuta virens* may well pose a serious threat to any agricultural diversification effort in southeast Trinidad which includes inceased production of vegetables and ornamentals. There is also the real possibility that with changing patterns of land use, the insect could spread to other parts of the island if it is not properly managed. Clearly it is a situation where, to quote Bacon (1978), "living things are surprisingly adaptable and human activity has produced new habitats for colonization by a species restricted in natue to a particular habitat."

The insect has been successfully exploiting these new habitats created in the agro-ecosystems and adjacent wastelands of southeast Trinidad, by expanding its range to areas where it had not been known to occur before there was extensive clearing of the forests (Mc Comie et al., 1989). It does this by taking advantage of the new feeding opportunities that become available with the planting of tree and shrub crops in place of the native climax forest vegetation in its expanding range. These crops, which are grown in an environment that is similar to the forest ecosystem, provide continuous vegetation cover where the insect finds shelter over a period of several decades. Since tree crops occupy the same land for many years, they constitute an abundant, uninterrupted supply of food. Their canopy provides a stable environment and shelters undisturbed soil that is suitable as breeding sites. Here the insect completes its life cycle successfully; adults mate and oviposit and eggs hatch to give rise to new generations.

The long-term impact of *Coscineuta virens* in a changing environment in southeast Trinidad needs to be quantified in relation to the impact on both the forest

ecosystems and the agro-ecosystems. This might be difficult to express in economic terms, given that yield records so necessary for such an exercise are painfully lacking. In a general way, crop loss undoubtedly leads to loss of revenue. There is loss in yield associated with loss in photosynthetic leaf area, poor flower set and fruit production, fruit damage or fruit drop. There are also undetermined costs associated with rehabilitation of affected fields, an activity requiring time and a drain on already limited financial resources.

The future management of this insect must therefore involve:

[a] an evaluation of the impact of feeding by hoppers in the dry season as compared to feeding by adults in the rainy season.

[b] a better understanding of its feeding behaviour and the mechanism of food plant selection and

[c] pest management strategies that are appropriate for and compatible with the new environments that have been created.

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