PHYTOPHAGOUS INSECTS ON BROADACRE SUGARCANE IN PAPUA NEW GUINEA

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ABSTRACT

Phytophagous insects associated with sugarcane at the first plantation established in Papua New Guinea (PNG) at Ramu Sugar L td, Gusap are listed, with notes on pest status. Almost all are native to PNG and most do not cause significant loss. Noctuid and pyralid caterpillars and a weevil larva, which bore in sugarcane stems, are the most damaging. Root-feeding cicadids and a white grub also frequently reduce yield. Two plant-hoppers vector are potentially devastating disease organisms, including one that was previously unknown. These insects and three disease organisms place major constraints on production. In the pas,t it was suggested that PNG species that co-evolved with sugarcane - considered to have originated in PNG from the ancestral form Saccharum robustum *- would severely damage commercial plantations. Species present now that large scale production is established seem representative of the families that adapt to sugarcane in the rest of the world. None seem dependent on sugarcane, despite prolonged opportunity for associations to evolve. The adaptive nature of these fauna suggests to us that priority pest lists based on species infesting sugarcane elsewhere are misleading. Perhaps the size of family groupings of pests, and not only from sugarcane, is a more relevant determinant of quarantine risk.*

Keywords: *pests, endemicity, evolution, pest-risk analysis*

INTRODUCTION

Papua New Guinea (PNG) is the centre of diversification of the genus *Saccharum* and the origin of the ancestral forms *S. robustum* and *S. spontaneum* and the cultivated forms *S. officinarum* and *S. edule* (Brandes, 1956). Since 1983, Ramu Sugar Ltd (RSL) has developed the first large-scale sugarcane plantation in PNG. Over 9,200 ha is under cultivation to imported intra-specific *S. officinarum* hybrid sugarcane in the Ramu valley (5°50'S, 145°E). Wild *Saccharum* and close relatives are prolific in the region especially along the Ramu River.

Pemberton and Williams (1969) discussed the origins of sugarcane-pest insects, and noted that "there would seem to be no authentic case of an insect limited either to cultivated sugarcane or to the genus *Saccharum*, although in some environments alternative host-plants seem to be absent." They concluded, particularly for continents and large islands that; "sugarcane insects are generally local insects that have adopted sugarcane as a host consequent to its cultivation". Strong *et al.* (1976) found, from the recorded history of sugarcane introductions around the world and from regional lists of pest species, that "the most obvious bio-geographic pattern among the insects of sugarcane is high endemicity. This pattern is true for regions within Oceania and Asia, where there are wild species of *Saccharum*, and for regions where there is no wild *Saccharum*".

We consider the composition and pest potential of the insect fauna in a modern, commercial sugarcane-production environment, at the source of origin of the crop, whereas previous lists of insect fauna on sugarcane in PNG (Szent-Ivany & Ardley (1962); Bourke 1968; Bourke *et al.* 1973) were from collections in small domestic gardens and in wild canes.

We consider the fauna relative to hypotheses on the origin of sugarcane pests generated by Pemberton and Williams (1969) and Strong (1976), and whether previously unrecognized pest groups have become prominent in this commercial environment. The relevance of lists of priority pests determined through pest-risk analysis (e.g. FitzGibbon *et al.*, 1998) is considered relative to these data.

MATERIALS AND METHODS

During field surveys conducted between 1982 to 1989 in commercial cane at Ramu Sugar, Gusap, Madang Province and also in numerous wild cane stands and village gardens around the sugar plantation and PNG

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Insects were collected from sugarcane stalks, leaves and rhizosphere, and effects on the plants noted. Immature stages were reared to adults. Pupal exuviae of Lepidoptera and Diptera were usually preserved with the adults. Adults were preserved in 80% ethanol, or pinned, or were cleared, fixed, stained, and slide-mounted.

Specimens were identified at Natural History Museum, London, CABIBioscience, London; Bureau of Sugar Experiment Stations, Bundaberg, Australia; Institut voor Taxonomische Zoologie Zoologische Museum, Universiteit van Amsterdam, Amsterdam; University of California, Riverside, USA; Queensland Department of Primary Industries, Indooroopilly, Australia; Department of Agriculture and Livestock , Port Moresby, PNG. Voucher specimens are retained at RSL.

RESULTS AND DISCUSSION

Insect fauna on sugarcane. Insects damaging sugarcane at or near RSL; plus known disease vectors, and species from RSL not causing obvious damage but with pest status for the family in other countries are listed in Table 1. Species not recorded at RSL, but seen damaging domestic sugarcane plants elsewhere in PNG are listed by Bourke (1968) and Bourke *et al.* (1973).

Status. Our estimates of the severity of damage to sugarcane at RSL by various species are summarized in Table 1. Insects that damage internal tissue and / or growing points of semi-mature culms (stalks) are the most severe constraints. Sesamia grisescens, Chilo terenellus, and Rhabdoscelus obscurus, together reduce crop and sugar yield by 15 20% (Kuniata & Sweet 1991). The whitegrub Lepidiota reuleauxi (Kuniata & Young 1992), and nymphs of a cicadid Baeturia papuensis (Kuniata & Nagaraja 1992) together affect 15 - 30% of the production area annually. Both damage roots and stems underground, and cane and sugar yield are reduced, and severely infested plants fail to ratoon (re-generate following harvest).

Scirpophaga excerptalis which destroys meristems of moderately grown stems causing profuse side-shooting, is occasionally a severe pest. Pyralid shoot-borers and shoot flies (Pont, 1988) that infest and kill the meristem of young shoots are minor pests. Secondary shoots usually compensate for loss of large primary shoots, but damage kills very small primary shoots.

Stem-sucking mealy-bug and scale insects can be moderately damaging. Populations are normally relatively low, but large populations do develop, particularly where plants are severely moisture-stressed. Enormous populations of woolly aphids, *Ceratovacuna lanigera*, which frequently blacken the leaf canopy with 'sooty mould', usually decline rapidly under the influence of natural control, and cause little yield loss.

Two *Lophops* spp. are common, and we suspect cause the condition "Ramu leaf-scorch" (Waller *et al.* 1987), although this does not appear to cause crop loss. Several froghoppers (Aphrophoridae and Cercopidae) cause minor leaf-blights, but do not reduce yield. The plant-hopper *Perkinsiella vitiensis* vectors the viral agent of Fiji disease, which is a constraint at RSL. Also *Eumetopina* spp. planthoppers vector "Ramu stunt" disease (Waller, *et al.* 1987; Kuniata *et al.* 1994), a major constraint on yield.

Armyworms occasionally defoliate plants but the ability of sugarcane to compensate by prolific leaf production, combined with the effect of parasitic insects and insect diseases that reduce their populations, usually nullifies any effect on yield.

Natural enemies appear to maintain reasonable control of some of the potential 'pest' species, and attempts to accentuate the effectiveness of some of these agents are part of the integrated management plan at RSL (Kuniata *et al.* 2001).

Relativity to previous records and theories of pest origin: All the pest species appear to be endemic to PNG and all of the major or intermediate pests were identified in preliminary surveys before commercial production commenced (Szent-Ivany & Ardley 1962); Bourke 1968; Bourke *et al.* 1973). However, Kumar (2001) recently listed up to 155 species of insects found on sugarcane in PNG. A high proportion of species found in Bubia/ Lae and in the Markham valley were similar to those collected at RSL suggesting that these pest species were already here when commercial sugar production began. Recognition of *S. grisescens* as "the most important sugarcane pest in PNG" (Szent-Ivany & Ardley 1962) proved so for RSL though, it would be mistaken to assume this relativity is entirely attributable to the pest. Past cultural practices contributed significantly to the severity of losses to this pest, until a range of cultural tactics were researched and integrated into a management package (Kuniata 1999; Kuniata *et al.* 2001). The integration of insecticide spraying, time of planting, variety resistance and augmentative releases of parasites has resulted in *S. grisescens* attaining a lesser pest status. Likewise, some of the currently 'less-severe' pest species may have much greater impact in the absence of effective management plans.

For example, the cicadid B. papuensis was a minor pest before the use of carbofuran in 1988 for the control of S. grisescens. However, cicadids became a severe problem in 1989-1991 following this insecticide, especially in areas with histories of carbofuran use. The withdrawal of carbofuran and the cultural methods used resulted in this pest re-assuming a minor pest status in sugarcane [Kuniata & Nagaraja 1992].

The pest fauna at RSL conforms to Pemberton and Williams' (1969) and Strong *et al's* (1976) hypotheses on endemicity. There are no families at RSL from which species have adopted sugarcane, that are not represented on sugarcane in other parts of PNG or the world. This conforms with findings by Strong *et al* (1976), that numbers of insect species utilizing a host plant do not increase with the time of association even for this region where the > 3,000 years association between sugarcane and the insect fauna is far older than any suggested by Strong *et al* (1976).

Relativity of pest records for pest-risk analysis and quarantine purposes: Eight species feeding on sugarcane at RSL are present in four or more widely dispersed sugarcane regions (Box, 1953); *R. obscurus* (weevil-borer), *S. sacchari* (mealy-bug), *N. bergii* (white-fly), *A. tegalensis* (scale), *C. lanigera* (wooly aphid), *M. loreyi* (armyworm), *S. inferens* (shoot-borer), *C. infuscatellus* (shoot-borer). The cryptic habits of the weevil, mealy-bug, white-fly, scale, and possibly

Table 1. **Organisms damaging or feeding on sugarcane at RSL plantation,**

ORDER / family	Name	Status[1]	Association with sugarcane
COLEOPTERA			
Ceranbycidae	*Prosoplus* sp		Larvae boring in semi-dry stalks, Sogeri (HN[2])
Chrysomelidae	*Rhyparida coriacea* Jacoby		Larvae burrowing in shoot tissue
Curculionidae	*Rhabdoscelus obscurus* (Boisduval)	***	Larvae bore stem internode tissue
Elateridae	unidentified		Larvae tunnel in roots
Scarabaeidae	*Lepidiota reuleauxi* Brenske	**	Larvae feed on roots, loss of yield and ratooning ability
	Papuana woodlarkiana (Montrouzier)	*	Adults eat root mass and burrow into underground stem
Scolytidae	*Xyleborus perforans* Wollaston		Adults and larvae boring base of stems, Bubia (Kimoto, et al., 1984)
	Xyleborus sp		Adults and larvae boring base of stems, Sausi (HN & LK)
Tenebrionidae	*Casnonidia* sp		Feeding inside shoot-tissue
DIPTERA			
Muscidae	*Atherigona orientalis* Schiner		Larvae bore into and kill young shoots
	A. ramu Pont	*	Larvae bore into and kill young shoots (Pont 1988)
HEMIPTERA			
Aleyrodidae	*Neomaskellia bergii* (Signoret)		Colonies on leaves, all plant stages
Aphididae	*Ceratovacuna lanigera* (Zehntner)	*	Colonies on leaves, semi-mature plants, blackened by sooty-mould
	Longiunguis sacchari (Zehntner.)		Infestation on leaves (Bourke, *et al.* 1973)
Margarodidae	*Promargarodes australis* Jakubski		Encysted nymphs on roots
Pseudococcidae	*Saccharicoccus sacchari* (Cockerell)	*	Infest stems at nodes, behind leaf bases
Diaspididae	*Aulacaspis tegalensis* (Zehntner)	*	Encrustations of scales on mature stalks
Cicadidae	*Baeturia papuensis* De Boer	***	Nymphs feed on roots; shoots die, or plants fail to ratoon after harvest
	B. valida Blote	*	Nymphs feed on roots; shoots die, or plants fail to ratoon after harvest
	Gymnotympana sp	*	Nymphs feed on roots; shoots die, or plants fail to ratoon after harvest
Aphrophoridae	*Clovia* sp		On leaf, semi-mature plants. May cause leaf-blight symptoms?"
Cercopidae	*unidentified*		On stems & leaves of mature plants. May cause leaf-blight symptoms
Delphacidae	*Eumetopina flavipes* Muir	***	Vectors phytoplasma causing Ramu Stunt disease, a severe constraint.
	Eumetopina sp		
	Perkinsiella vitiensis Kirkaldy	**	On leaves and stems. Vectors viral agent of Fiji disease, a major constraint
Lophophidae	*Lophops* spp #1		Feeds and oviposits on leaves; probable cause of "Ramu leaf-scorch" symptoms
	Lophops spp #2		Feeds and oviposits on leaves, probable cause of "Ramu leaf-scorch" symptoms
Colobathristidae	*Phaenacantha* sp		Adults & nymphs feed on leaves, all plant stages. Purpling discolouration
ISOPTERA			
Termitidae	*Microtermes* sp		Hollowing underground and above-ground stems
LEPIDOPTERA			
Hesperiidae	*Arrhenes aschiplus* Plotz		Larvae rolling & cutting leaves
Elachistidae	*Elachista solena* (Bradley)		Larvae mining in leaf (midrib / lamina??)
Noctuidae	*Agrotis interjectionis* (Guenee.)		Larvae eat leaf lamina
	Agrotis sp		Larvae eat leaf lamina
	Hydrilloides sp		Larvae eat leaf lamina
	Mythimna loreyi (Duponchel.)	*	Larvae eat lamina, young plant stages
	Sesamia grisescens (Warren)	***	Larvae tunnel unopened leaf spindle, meristem, and stems of young and semi-mature stems
	S. inferens (Walker)	*	Larvae bore stem, meristem and unopened leaf spindle of young plant stage
	Spodoptera exempta (Walker)	*	Larvae eat leaf lamina, all stages
Pyralidae	*Bleszynskia malacelloides* (Bleszinski)		Larvae bore stems, young plant stage
	Chilo infuscatellus (Snellen)	*	Larvae bore stems, young plant stage

Status[1] ;occassional and slight pest status unless otherwise stated; * minor; ** intermediate; *** severe.

the aphid would have allowed those species to be transported with growing sugarcane plants, or with a range of other plants such as palms, particularly to isolated islands. However records from Asia, India and Indonesia, particularly for the moths and aphid, could be due to natural dispersal.

Our data suggest three remarks pertinent to quarantine and risk assessment. Firstly, it is obvious that quarantine is necessary to prevent species known to be adapted to sugarcane spreading to new locations, particularly where the local predators or parasites may be unable to maintain control. Six of the RSL species are potential quarantine risks, having already been spread by man. Secondly, the other species recorded at RSL are probably no more of a quarantine risk (FitzGibbon *et al*, 1999) than numerous other insects never before or only occasionally recorded on sugarcane. The generality of sugarcane pests suggests that any species able to adapt to sugarcane is a potential risk. This leads to a third comment, that perhaps the real value in pest lists is to indicate the *families* most likely to contain species that could constitute a risk in a foreign environment.

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