BUREAU OF SUGAR EXPERIMENT STATIONS

QUEENSLAND, AUSTRALIA

BSS249 PREPAREDNESS FOR BORER INCURSION
ELDANA SACCHARINA INCURSION MANAGEMENT PLAN
VERSION 1

by

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PR02009

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IF YOU SUSPECT A NEW PEST

IMMEDIATELY NOTIFY:
In Queensland
Keith Chandler, BSES Meringa, 07 4056 1255
Mohamed Sallam, BSES Meringa, 07 4056 1255
BSES Burdekin, 07 4782 5455
Peter Samson, BSES Mackay, 07 4954 5100
Peter Allsopp, BSES Bundaberg, 07 4132 5200
or CEO, BSES Indooroopilly, 07 3331 3333

In New South Wales
Murray Fletcher, NSW Agriculture, 02 6391 3800

In Western Australia
Agriculture WA, 08 9166 4000

DO NOT REMOVE ANY MATERIAL
OR SPECIMENS FROM A SUSPECT AREA,
AS THIS MAY SPREAD THE PEST

1.0 INTRODUCTION

Australia is one of the top three exporters of sugar on the world market, with the total production of sugar in Australia in excess of 5 million tonnes with a value of up to $2 billion. Over 85% of the sugar is exported to 30 international destinations. The sugar industry is a major employer and component of the economy of regional coastal areas in northern New South Wales and Queensland. The industry has expanded at 3-5% per year for the last 7 years, with new sugar mills being built in the Ord River District of Western Australia and the Atherton Tablelands in Queensland.

Australia has remained free of many serious animal and plant pests and diseases due to its isolation and its strict quarantine laws. This pest-free status has allowed Australia to provide agricultural products with lower pesticide usage and to produce these products more efficiently and at a lower cost than some of our competitors. Maintenance of this pest-free status is being threatened by the increasing ease of world travel and the growing demand for importation of agricultural products.

Throughout the world there are many insect pests associated with sugarcane (Box 1953), but there is no one group of pests that could be described as cosmopolitan in world sugarcane (Conlong 1994). Each region appears to have its own group of pest insects that cause the most damage. In Australia there are at least 65 insects associated with sugarcane and the importance of these insects as pests ranges from negligible to high. FitzGibbon *et al.* (1998a) identified 213 species of insects and mites as pests of sugarcane in areas to the immediate north of Australia. 39 of these were considered to pose threats to the Australian sugar industry. Of these, 12 species were stemborers. Commercial plantings of sugarcane in this country do not have stemborers as significant pests.

The Standing Committee on Agriculture and Resource Management (SCARM) has developed a general, non-specific, incursion management strategy (SIMS) (Fig. 1). This strategy outlines the broad areas of an incursion management plan and the appropriate authorities involved. The key feature of the strategy is the operation of a national Consultative Committee that is convened under the auspices of Plant Health Committee after an incursion occurs. Recently, the SCARM Task Force on Incursion Management (STF) has developed a generic incursion management plan (GIMP) for the plant industries. This plan outlines the four steps to incursion management: prevention, preparedness, response and recovery (Fig. 2). These plans were used to develop a generic pest incursion management plan for sugarcane (Allsopp *et al.* 1999). However, this generalised plan will be more useful if developed further to cover each of the important groups of borer species in detail.

The present plan deals with the incursions of *Eldana saccharina* borers into commercial cropping areas and into back-yard plots of sugarcane in non-commercial cropping situations such as the Torres Strait, Cape York Peninsula or urban areas. It outlines appropriate responses, details responsibilities, and provides a more expanded review of the biology, ecology and management of these species than that in the dossiers of FitzGibbon *et al.* (1998b).

Figure 1. Sequence of steps, officers and organisations in the SCARM incursion management strategy (SIMS).

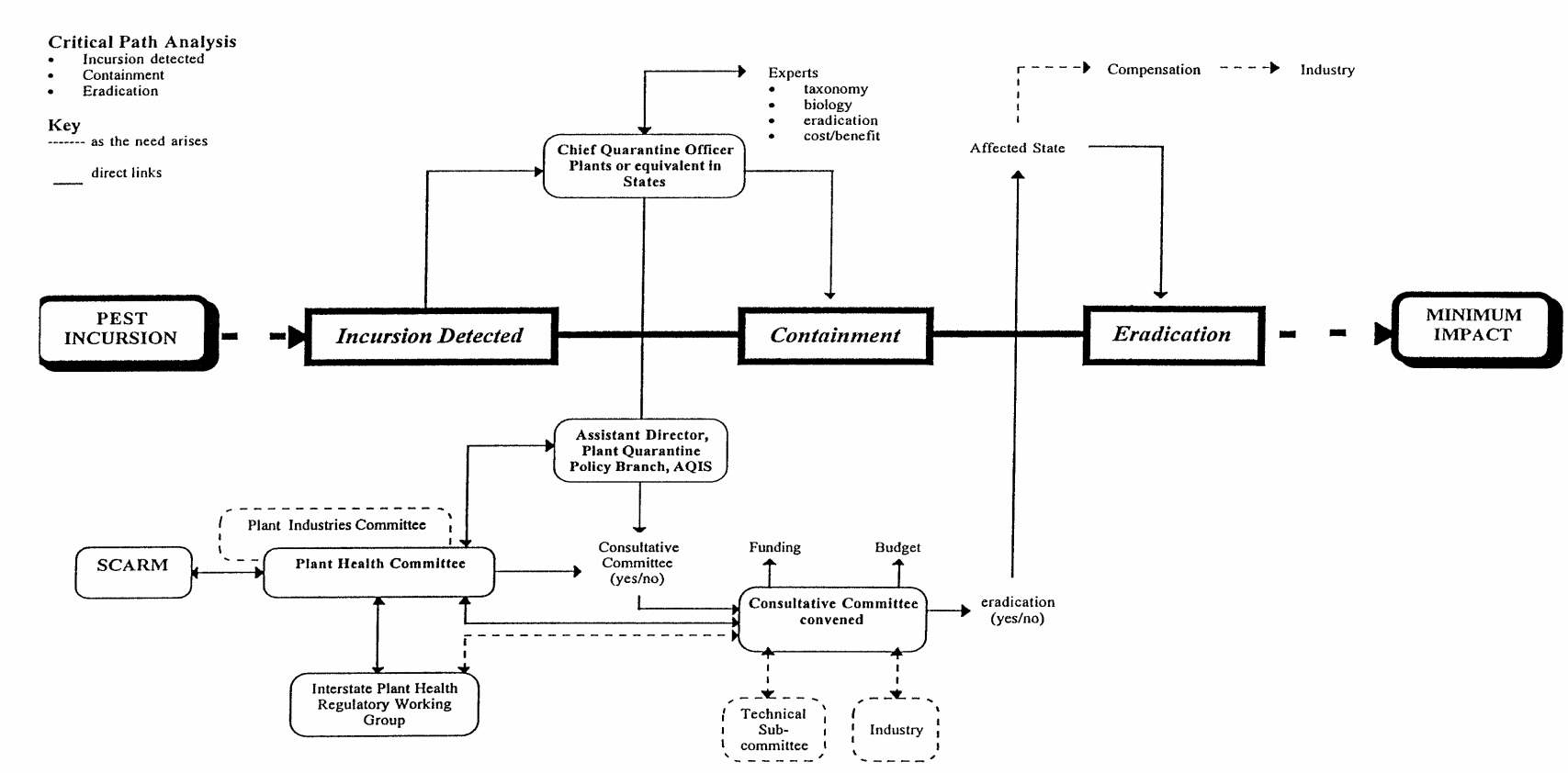
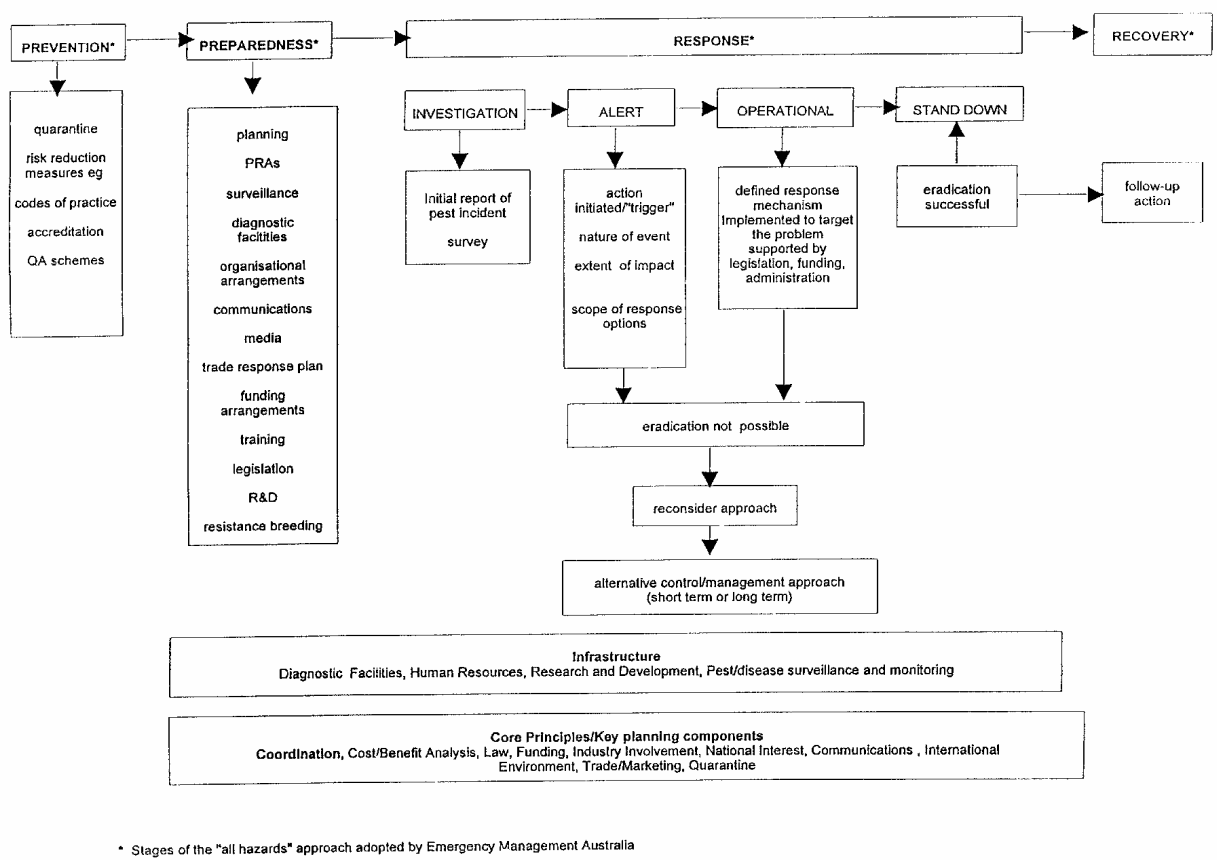


Figure 2. Generic incursion management plan (GIMP).



* Stages of the "all hazards" approach adopted by Emergency Management Australia

2.0 PEST INCURSION MANAGEMENT PLAN

2.1 Summary of Management Plan

SUGGESTED TIMELINE	ISSUE	RESPONSIBLE PERSONS	ACTION
Day 1	**INVESTIGATION** Notification of suspect pest detection	BSES, State Department or AQIS Officer, Grower, Member of the Public	Immediately contact BSES or other Entomologist. Hold specimens under secure conditions. **DO NOT REMOVE PLANTS FROM FIELD** Keith Chandler (Cairns) 07 4056 1255 Mohamed Sallam (Cairns) 07 4056 1255 Peter Samson (Mackay) 07 4954 5100 Peter Allsopp (Bundaberg) 07 4132 5200 Agriculture WA (Ord) 08 9166 4000 Murray Fletcher (NSW) 02 6391 3800 or CEO BSES 07 3331 3333
			Notify BSES & State/Territory Chief Quarantine Officer, Plants, prepare initial report. State/Territory Chief Quarantine Officer or CEO BSES to notify State/Territory Minister and Chief Plant Protection Officer, AFFA. CPPO to notify Federal Minister, other States and Territories and key industry representatives on a confidential basis.
Day 1-2	Identification of pest	BSES/other Entomologist	Travel to site, inspect suspect plants and specimens
	Not a new pest	BSES/other Entomologist	Suspend operations
	Uncertain identification	BSES/other Entomologist	Collect specimens, return to laboratory and inspect microscopically, also dispatch live specimens (see packaging details in Appendix 1) by express courier to: Glenn Graham Centre for Identification and Diagnostics 155 Goddard Building University of Queensland, Qld 4072 ☎:: 07 3356 1863 Email: g.graham@cpitt.uq.edu.au CSIRO Entomology Australian National Insect Collection (ANIC) Attn: Kim Pullen Clunies Ross Street, Acton, Canberra, 2601 GPO Box 1700, Canberra, ACT, 2601 ☎:: 02 6246 4263 Fax: 02 6246 4364 Email: kimp@ento.csiro.au
	ALERT Positive identification of new pest	BSES/other Entomologist	Place infested premises under quarantine - State departments.

SUGGESTED TIMELINE	ISSUE	RESPONSIBLE PERSONS	ACTION
Day 2-3	**OPERATIONAL** Implementation of response action	CEO BSES, State/Territory Chief Quarantine Officer, Plants	Establish State/Territory Strategic Management Group and Local Operations Centres.
		Operations Managers and BSES/other Entomologists	Quarantine alert teams formed and instructed in pest identification, survey/trace-back methods and disinfestation techniques. Survey and trace-back commenced. Collection and destruction of infested plants on infested premises if appropriate.
Day 2-3	Convene Consultative Committee	CPPO in collaboration with State/Territory Chief Quarantine Officer, Plants	Committee is convened and briefed on incursion and recommends further action. Press Release is prepared and circulated to Government and Industry and BSES Media Officer establishes contacts with media outlets. Chairman of Committee negotiates with Federal and State Ministers on release of Press Release to media and statement by Minister or their nominee. Seek approval from NRA for use of pesticides needed in eradication or containment.
Day 3-5	Review of initial survey data	Operations Managers	Collect and summarise survey data and report prepared for Consultative Committee. Expand surveys and trace-back (ongoing). Destruction of infested plants (ongoing).
		Consultative Committee	Review survey data and recommend Restricted Area (RA) and Control Area (CA) for restriction of movement of plants, plant parts, soil and machinery. Negotiations on quarantine protocols between Consultative Committee and relevant state plant-health agencies. Establish RA and CA by proclamation of necessary legislation. Assess likely success of eradication given available survey data. Prepare and circulate updated Press Release.
Day 6-9	Survey and trace-back	Operations Managers	Collect, compile and interpret survey data. Initiate cost-benefit analysis for eradication or cantainment. Prepare report for Consultative Committee.
	Second meeting of Consultative Committee	Consultative Committee, State/Territory Strategic Management Group	Consultative Committee to meet in district of outbreak (if commercial cane area) and meet with BSES Entomologist and Operations Managers. Review survey data, report on identification from CID-UQ and CSIRO Entomology (ANIC) and cost-benefit analysis and recommend: (a) eradication (b) more information - continue alert (c) eradication not possible, move to active containment.

SUGGESTED TIMELINE	ISSUE	RESPONSIBLE PERSONS	ACTION
Day 6-9	(a) **Eradication**	CPPO and affected State/Territory Strategic Management Group, Consultative Committee	Prepare recommendation for eradication including cost/benefit analysis and a budget. Submit recommendation and budget to SCARM through the Plant Health Committee. Discuss compensation with industry and governments. Prepare State legislation if required to restrict movement of plants and machinery and enforce plough-outs.
	Decision to eradicate made	Operations Managers	Organise destruction of all infested and buffer crops. Re-survey fields surrounding infested crops. Continue wider surveys and trace-back. Organise counselling of affected farmers. Convene Information Meetings for Industry in affected district.
		State/Territory Strategic Management Group, Consultative Committee	Prepare Press Release on decisions of Consultative Committee and SCARM. Inform industry organisations and interstate governments on decisions
Day 10-20	Review	Program and Operations Managers	Reports prepared daily on ongoing survey results. Report on progress of eradication.
		Consultative Committee	Review survey and eradication reports. Re-assess decision to eradicate.
1-36 months		Operations Managers	Report monthly on ongoing surveys and eradication.
		State/Territory Strategic Management Group Consultative Committee	Meet bi-monthly or as required to review eradication program.
3-5 years	Review	State/Territory Strategic Management Group Operations Managers	Final report prepared.
		Consultative Committee	Review final report and success of eradication. Committee to cease function.
Post-eradication	Surveillance	AQIS	Maintain surveillance and off-shore control programs.
Day 6-9	(b) **More information**	Operations Manager	Surveys and trace-back (ongoing). Report prepared on daily basis.

SUGGESTED TIMELINE	ISSUE	RESPONSIBLE PERSONS	ACTION
Day 6-20	(c) **Eradication not possible**	Consultative Committee, State/Territory Strategic Management Group	Consultative Committee ceases to function and Containment Committee formed. Preparation of containment plan. State/Territory Strategic Management Group continues to oversee program until containment plan is fully operational. Prepare State legislation if required to restrict movement of plants and machinery and enforce plough-outs. Report to industry organisations. Discuss industry-wide levy to fund containment with State and Industry bodies.
		Operations Managers	Organise strategic surveys in district outside infested district. Establish road-blocks on major roads out of district to inspect for plants and contaminated machinery. Organise survey teams to monitor pest levels and issue plough-out orders as required to reduce build up. Convene information meetings in affected area.
1-12 months		BSES/other Entomologist/State Plant Improvement Manager	Establish insecticide-screening program. Establish list of potential non-insecticidal controls. Establish propagation areas of resistant varieties initially in affected area but also in other districts. Distribute resistant varieties to affected growers.
		BSES Entomologist/State Plant Improvement Manager	Develop plan for production of pest-free planting material and establish resistance screening for advanced clones in breeding programs if appropriate. Organise visit by overseas Entomologist with expertise in control of particular stemborer.

2.2 Detection of an incursion

2.2.1 Investigation and Alert phases

Anyone finding a plant that they believe may be infested with a new stemborer should **immediately** contact the nearest office of the BSES or relevant State/Territory Department. This office should immediately contact an experienced sugarcane entomologist (BSES) or their nearest State Department of Primary Industries or Agriculture office - contact numbers given on contents page.

Under no circumstances should the suspect infested plants be removed from the infested premises. If there will be some delay before the entomologist can visit the site to inspect the suspect plant, the suspect plants should be covered with paper bags or fertiliser bags tied tightly around the stems.

Any suspect infested plant should be inspected by an entomologist (BSES or State Department) who will confirm that the plant is infested with a new stemborer. The entomologist will take samples and/or specimens for dispatch for DNA analysis at University of Queensland and/or to suitable taxonomists through CSIRO Entomology, Australian National Insect Collection (ANIC) (Appendix 1) for further confirmation, but actions should be initiated immediately the entomologist has confirmed the identification of the stemborer to the best of their ability.

The entomologist must also notify the CEO of BSES or the relevant State/Territory Chief Quarantine Officer (Plants) in the State/Territory Department of Primary Industries/Agriculture, and should also prepare a brief report on the details of the introduction. This notification should be made **urgently**.

The State/Territory Chief Quarantine Officer (Plants) or CEO BSES (in Queensland) will notify the State Minister (through the head of the department) and the Chief Plant Protection Officer in Canberra. The Chief Plant Protection Officer will notify the Federal Minister. A Strategic Management Group should be convened at this stage in the affected State/Territory to coordinate the initial response.

As soon as possible after the entomologist has positively identified a new stemborer the infested premises should be placed under quarantine and no plant material, soil or agricultural machinery should be allowed to leave the premises. After consultation with the Director of BSES and the relevant State/Territory Chief Quarantine Officer (Plants) and CPPO, declaration of a restricted area around the infested premises should be made as soon as possible. The extent of this quarantine area will depend on the type of stemborer, the exact location of the incursion and the geographical and other characteristics of the region.

2.2.2 Operational phase

At this stage, the State/Territory Strategic Management Group is formally established and a Local Operations Centre established in the infested area. The Operations Manager should be a person with good local industry knowledge such as the Regional Manager (from BSES in Queensland). Other members of this local group should represent BSES, local Cane Protection and Productivity Boards and industry organisations. The Regional Manager, Plant Health from the relevant State/Territory department (from Animal and Plant Health Service in Queensland) should also be a member. This group will report to the Strategic Management Group and will ensure that local responses are carried out.

2.2.3 Notification of a quarantine incursion

The following list of authorities should be informed of the details of the incursion by the CEO of BSES or the relevant Director of the State Department of Primary Industries/Agriculture **before** any press releases.

A. Chief Plant Protection Officer (CPPO)
Department of Agriculture, Fisheries and Forests - Australia
GPO Box 858
CANBERRA ACT 2601
Facsimile: (02) 6272 5835 Telephone: (02) 6271 6534
(02) 6271 6471 for general reporting

B. The Minister
Department of Agriculture, Fisheries and Forests - Australia
GPO Box 858
CANBERRA ACT 2601
Facsimile: (02) 6273 4120 Telephone: (02) 6277 7520

C. General Manager, Plant Health
[Chief Quarantine Officer (Plants)]
Mr Ken Priestly
Queensland Department of Primary Industries
80 Ann Street
BRISBANE QLD 4001
Facsimile: (07) 3239 6994 Telephone: (07) 3239 3361

D. Chief Quarantine Officer (Plants)
Mr Rowland Gwynne
Agriculture Western Australia
3 Baron-Hay Court
SOUTH PERTH WA 6151
Facsimile: (08) 9367 6248 Telephone (08) 9368 3315

E. Program Manager, Horticultural Products and Plant Protection
[Chief Quarantine Officer (Plants)]
Mr Doug Hocking
New South Wales Agriculture
161 Kite St
ORANGE NSW 2800
Facsimile: (02) 6391 3605 Telephone (02) 6391 3150

F. Chairman
CANEGROWERS
GPO Box 1032
BRISBANE QLD 4001
Facsimile: (07) 3864 6429 Telephone: (07) 3864 6444

G. Chairman
Australian Cane Farmers Association Ltd
GPO Box 608
BRISBANE QLD 4001
Facsimile: (07) 3303 2024 Telephone: (07) 3303 2020

H. Chairman
New South Wales Cane Growers Association
PO Box 27
WARDELL NSW 2477
Facsimile: (02) 6683 4503 Telephone: (02) 6683 4205

I. Chairman
Ord River District Canegrowers Association
KUNUNURRA WA 6743
Facsimile: (08) 9169 1489 Telephone: (08) 9169 1488

J. Chairman
Ord Sugar Industry Board
278 Indooroopilly Rd
INDOOROOPILLY QLD 4068
Facsimilie: (07) 3870 8597 Telephone: (07) 3870 8597

K. Chairman
Queensland Sugar Corporation
GPO Box 891
BRISBANE QLD 4001
Facsimile: (07) 3221 2906 Telephone: (07) 3231 0199

L. Chairman
Sugar Research and Development Corporation
PO Box 12050
BRISBANE ELIZABETH STREET QLD 4002
Facsimile: (07) 3210 0506 Telephone: (07) 3210 0495

M. Chief Executive Officer
BSES
PO Box 86
INDOOROOPILLY QLD 4068
Facsimile: (07) 3871 0383 Telephone: (07) 3331 3333

N. Mill Directors and/or Mill Managers, Cane Protection & Productivity Board Chairman, Mill Suppliers Committee, BSES Regional Extension Officer in the district in which the incursion occurs.

O. Chairman
Australian Sugar Milling Council Pty Ltd
GPO Box 945
BRISBANE QLD 4001
Facsimile: (07) 3221 1310 Telephone: (07) 3221 5633

A communication strategy should be developed and implemented at the first meeting of the Consultative Committee.

The involvement of offices of the ministers of the federal and relevant state departments of Primary Industries/Agriculture must be assumed in any quarantine incursion. The Federal and State/Territory Minister's press secretaries should be contacted and be appraised of the details of the incursion and discussions held on the release of the initial and future significant press releases. All press releases should be sent to the Federal and State/Territory Ministers' press secretaries **before** they are released to the media. This will allow the ministers to reply to any media enquires. This action may not be appropriate in all situations and should be negotiated with the CPPO.

An example of a possible press release is given in Appendix 3. A fact sheet giving details of the pest should be forwarded to all organisations with the initial press release.

On the initial press release the CEO of BSES or the relevant state department or CPPO will nominate a media spokesperson(s) whose name will be shown on the press release. **Other staff should contact this person before releasing or making any comments on the incursion to the media**.

2.2.4 Formation of Sugarcane Pest Consultative and Containment Committees

A Sugarcane Pest Consultative Committee (SPCC) should be formed to assess the initial survey results, make recommendations on eradication to SCARM through the Plant Health Committee (PHC) and to direct eradication if feasible. The Committee will be chaired by the Chief Plant Protection Officer. The PHC will determine the format of the committee and would be expected draw on expertise from sources such as:

BSES Manager, Research and Development or State Department Manager of appropriate department (Program Manager)
BSES Regional Manager for region where incursion has occurred (Operations Manager)
CEO of BSES
State Chief Quarantine Officers (Plants)
BSES or State Department Entomologist
AQIS Representative
Media Liaison Officer
Industry Representatives
Representatives of other industries if a multi-host species

This committee should meet as soon as possible after the incursion has been confirmed and then after the initial survey which should be completed within 1 week. In view of the strategic nature of the Consultative Committee and the decisions it makes, the location of these meetings is not important. However, once the initial emergency phase is over, there would almost certainly be a Consultative Committee meeting in the outbreak area so that members gain the necessary geographical and other contextual understanding necessary to facilitate strategic decision-making.

In each affected State/Territory, a Strategic Management Group should be formed to oversee operations in eradication. This group reports to the Consultative Committee and provides strategic input into managing the operations of the Local Operations Centres. Composition of this group should be negotiated between the relevant State/Territory department, industry, and, if in Queensland, BSES.

If eradication is considered not to be feasible, the national Consultative Committee may be disbanded and a State/Territory Containment Committee formed; the AQIS representative would not normally be a member of this Committee. At the same time, Regional Managers, Plant Health, may cease membership of the Local Operations Centres and composition of the Strategic Management Group may change.

2.3 Management of an incursion

If the SPCC considers eradication is not possible (**and before that decision is made)**, actions should be taken to contain the incursion to the region where the incursion has occurred.

2.3.1 Surveillance

An urgent requirement will be to determine the extent of the incursion. This action should be initiated immediately. Samples of insects (preferrably placed in 95+% ethanol or sent live in sealed containers to allow DNA analysis) should be collected to confirm identification.

There is a need to establish a list of host plants to allow establishment of quarantine protocols and aid in defining areas for surveys. This should be done by BSES Entomologists and/or state department officers - much of those data are in Appendix 5.

2.3.1.1 Commercial-crop areas

It will be essential to initiate surveys urgently if an incursion is found in a commercial sugarcane crop area. This will be required to define the area of spread, to limit any further spread and to allow appropriate responses to be initiated.

Inspection teams should be formed. These may include staff of the State Department, BSES, Cane Protection & Productivity Board, sugar mill and AQIS (only trace-back activities).

The owner and manager of the property should be interviewed to determine the source of planting material brought on to the property in the last 2 years and whether planting material or alternative hosts from the property have been moved to other properties. Movement of soil and machinery should also be determined and the other farms in the same harvesting group identified. Inspection teams should inspect all properties identified by the interview.

The approach to the inspection in commercial sugarcane crops will depend on the growth stage of the crop and the pest involved. In crops less than 2 m high, it should be possible to walk the crops. If the crop is lodged, inspections will be difficult. Inspections in lodged crops could be conducted from the headland and then row for row as the cane is harvested. Inspection of alternative host crops will depend on the type of crop involved. Crops will have to have stems sliced to detect borers.

During the inspection of these fields any infested plants located should be collected in paper bags or fertiliser bags for destruction. This same procedure should be followed for the farms with links to the infested farm as identified by interviews with the owners/managers and local mill and Cane Protection and Productivity Board staff.

After this initial survey, a meeting should be held of the Sugarcane Pest Consultative Committee to assess the findings of the survey. This committee will determine whether eradication is feasible or whether containment of spread to non-infested areas should be the objective of future actions. If eradication is considered to be feasible, the Consultative Committee will make a recommendation to the Plant Health Committee. While the Plant Health Committee and SCARM consider the recommendation, at least containment should proceed.

If incidence is low in the initial survey the inspection teams should then proceed to inspect 10% of sugarcane fields on a stratified random pattern throughout the rest of the mill area. If a known highly susceptible variety is grown in the mill area, a high percentage of fields of this variety should be included in the survey.

All other canegrowing districts, particularly those adjoining the infested area, should conduct random surveys of sugarcane and alternative host fields to determine the status of the pest in these districts. The number of fields to be surveyed depends on the type of pest involved.

All canefarmers should be sent a leaflet describing the pest and be asked to report any suspect plants to their nearest BSES or State Department Office.

2.3.1.2 Non-commercial-crop and non-sugarcane crop areas

If the incursion is in a non-commercial-crop area other than the far northern areas of Australia, such as Brisbane or Townsville, the local State Department office should be informed immediately and in consultation with BSES and CPPO a management plan developed. A survey team should be formed including staff of BSES and/or State Departments and, where appropriate, AQIS staff (normally only for trace-back activities). These teams should interview the owner of the infested premises to obtain information about movement of cane plants and alternative hosts, soil and machinery onto and off the infested premises in the previous 2 years.

A survey should be conducted tracing the source of the plants involved and any plants moved off the infested premises. When the tracing has been completed, the survey team should inspect all properties in a wider area. Initially this should be set at a 1 km radius in a city or 10 km radius in the country. The survey should then be extended to cover a wider area depending on the situation. Crops and plants other than sugarcane should be inspected if the borer has more than sugarcane as a host.

2.3.1.3 Northern Australia

If the incursion occurs in a sparsely isolated area of Northern Australia, the NAQS Co-ordinator should be advised and requested for assistance:

AQIS - NAQS
PO Box 96
Airport Administration Centre
Cairns International Airport
Cairns
Queensland 4870
Tel (07) 4030 7854
Fax (07) 4035 9578

John Curran
Agriculture Western Australia
PO Box 350
Broome
Western Australia 6725
Tel (08) 9192 1579
Fax (08) 9193 5236
email - jcurran@agric.wa.gov.au

The team leader should interview the owner of the premises to try and trace back the source of the infestation. If cane plants, soil or machinery have been brought from or taken to another site in the last 2 years the team should immediately inspect these sites or arrange for another team to inspect the site(s).

If there are no obvious links to other sites, the survey team should conduct a survey of all sugarcane and alternative hosts, radiating out from the original source. This survey would be the next priority after following any possible links. Sugarcane is mainly grown in backyard or garden situations and, therefore, surveys should concentrate on current or abandoned dwellings. Commercial or non-commercial plantings of alternative hosts should also be examined.

Concurrent with the survey, all infested plants should be collected and destroyed to reduce the risk of further spread of the pest.

Survey teams, initially consisting of sugar industry personnel, should be initiated in all commercial sugarcane areas concentrating on the closest areas to the incursion. Other personnel should join survey teams following appropriate training. Team members should be prepared to change clothes after inspecting infested premises. Sugarcane and alternative hosts must be inspected.

The survey team should be instructed by the relevant State Department on correct methods of approaching members of the public during the survey and their legal rights and limits of entry to property.

2.3.2 Other containment actions

All movement of sugarcane and alternative host planting material, plant parts, soil and sugarcane machinery will be restricted. Planting material will require a period in an approved quarantine facility with suitable disinfestation treatments (See Section 3.2.7) before release to another region. All machinery must be thoroughly cleaned of all dirt and organic matter and steam cleaned before moving out of the infested area. A certificate stating the equipment has been inspected and is suitable for transport must be issued by a State official.

Definition of a quarantine area should happen early and will need Interstate Plant Health Regulation Working Group input. Road-blocks may be established on all main roads out

of the infested region to ensure that no sugarcane, alternative hosts or contaminated machinery are carried out of the region.

The SPCC should develop a policy for the plough-out of infested crops within the infestation area in an attempt to reduce pest pressure. A well-developed crop may have to be burnt and harvested before plough-out; harvested material may be sent to the mill. A suggested limit of infested plants should be established, based on the type and potential severity of the stemborer. This will require a large inspection team to monitor the level of pests in crops. This team will be managed by the SPCC in cooperation with local groups such as Cane Protection & Productivity Boards.

Potential useful insecticides should be identified from the literature (some listed in Appendix 5) and application made for emergency use permits to NRA within 3 days of detection. These insecticides should be field tested to determine relative efficacies and establish MRLs as soon as possible.

The CEO of BSES or relevant State/Territory departments should limit further planting of known highly susceptible cultivars of sugarcane in the infested region. Suitable resistant cultivars should be multiplied as quickly as possible for distribution to growers with particular attention to known infested farms.

2.3.3 Eradication

Bags of all infested plants collected in the initial survey should be incinerated on site (with due regard to fire safety). If incineration is not feasible, bags should be placed into black ‘garbage’ bags that are then sealed and placed in the sun for 1 week to heat up and kill pests.

If the SPCC considers eradication a feasible option all infested fields and buffer areas should be destroyed (See Section 3.2.4).

Methods for eradication will depend on the extent of the incursion and the biology of the stemborer. These need to be considered by the SPCC on a case-by-case basis.

2.4 Information meetings

Meetings of all sugar industry personnel, both milling and grower sectors, should be convened in the infested mill area by the SPCC as soon as possible to explain the current status of the incursion and the proposed control program. This meeting will be essential to keep the industry fully informed and to enlist their assistance in the control programs. Similar meetings should be conducted in other regions as time permits.

2.5 Overseas expert

An overseas expert on control of stemborers in sugarcane, presumably from South Africa, should be contacted as soon as possible after the pest is detected and asked for information on detection and control.

The expert should be invited to review the eradication or containment program. The best time for the visit of the expert will be decided by the SPCC, but it is likely to be between 3-12 months after the incursion when the extent of the incursion has been determined and urgent actions have been undertaken.

3.0 PRINCIPLES OF CONTROL AND ERADICATION

3.1 Introduction

If *Eldana saccharina* stemborer is detected in Australia, the response will depend on whether the infested plants are found in commercial crops or as isolated plants in non-crop areas, andon the range of alternative hosts.

3.1.1 Infested plants in commercial crops

If the incursion is restricted to a small number of fields it may be possible to eradicate the stemborer. The immediate response should assume eradication is possible until surveys determine the distribution of the pest.

If infested plants are found in commercial crops it will be essential to determine as soon as possible the extent of infestation. If infestation is widespread and pests have been present for some time, eradication is unlikely to be successful and containment is likely to be the only viable option.

Containment will involve strict quarantine on movement of all sugarcane plant parts, alternative host-plants, soil and contaminated machinery. Reduction of sources of the pest by plough-out and fallowing of infested fields, removal and destruction of infested plants, eradication of abandoned sugarcane, planting pest-free material and planting of resistant varieties could all be important in containing the spread of the pest.

3.1.2 Isolated plants in non-crop areas

Sugarcane and its relative, *Saccharum edule,* are widely grown throughout the Torres Strait and in home gardens in northern Australia and as far south as Sydney. In some areas, the wild sugarcane relative *Saccharum spontaneum* has established as a weed, eg on the banks of the Mulgrave River near Cairns. Alternative hosts may also be grown over wide areas. If a new stemborer is found in isolated plants in a non-crop area, it may be feasible to eradicate the outbreak, depending on the biology and host range of the pest. Eradication will involve:-

- Immediate isolation and destruction or treatment with appropriate insecticides of all *Saccharum* species and alternative hosts within 10 km of the outbreak and follow-up destruction of any regrowth.

- Intensive surveys within 150 km of the incursion to determine any spread of the pest. These surveys would concentrate on current and abandoned dwellings where sugarcane and alternative hosts may have been planted.

- Public awareness campaign to alert all BSES, State Departments of Primary Industries/Agriculture in Queensland, New South Wales and Western Australia,

Cane Protection & Productivity Board staff, cane farmers and the general public to report any symptoms resembling those associated with the pest.

3.2 Methods to eradicate and prevent spread

Eradication of stemborers from isolated incursions in non-commercial crop areas will have a high probability of success if the infestation is detected early. Monitoring of the distribution of the pest in neighbouring countries may be important to warn of the approach of the pest. In non-commercial crop situations, such as wild *Saccharum* species and garden *Saccharum* species, it may be difficult to detect the pest. Regular surveys of qualified inspectors and good public awareness are the best approaches. Regular contact with sugar industries in neighbouring countries should be maintained to monitor the pest status of their crops. Surveillance should be high in the Torres Strait, Cape York Peninsula, Ord River and Northern Territory, and near the Cairns, Brisbane and Darwin airports.

3.2.1 Quarantine and movement controls

Quarantine and movement control must be imposed at several levels (dependant on what legislative controls are available):

Infested Premises (IP): A premises on which the pest is confirmed or presumed to exist. Total movement control is imposed.

Dangerous Contact Premises (DCP): A premises containing susceptible host plants, which are known to have been in direct or indirect contact with an IP or infested plants. Total movement control is imposed.

Suspect Premises (SP): A premises containing plants which may have been exposed to the pest and which will be subjected to quarantine and intense surveillance. Provided there is no evidence of infestation, the premises then reverts to normal status.

Restricted Area (RA): A restricted area will be drawn around all IPs and DCPs and include as many SPs as practical. The distance in any one direction is determined by factors such as terrain, the distribution, harvesting and management practices, the weather (particularly rainfall, temperature and prevailing winds), the distribution of other host plants in home gardens, and the biology of the stemborer.

The RA is not determined by drawing a circle of a certain diameter around the IP. The boundaries must be modified as new information comes to hand. A high level of movement control and surveillance will apply.

Control Area (CA): A CA will be imposed around the RA and include all remaining SPs. The purpose of the CA is to control movement of susceptible plant species for as long as is necessary to complete trace-back and epidemiological

studies. Less stringent movement control and surveillance will apply. Once the limits of the pest have been confidently defined, the CA boundaries and movement restrictions should be relaxed or removed.

Movement controls should be maintained to contain the pest to within infested areas.

3.2.2 Trace-back

It is important in any incursion to try and identify the source of the outbreak. If the infestation has resulted from the illegal entry of an infested cutting or alternative host plant, the period in which the infested plant has been present and the subsequent movement of infested cuttings or plants from the original infested site will be important factors in determining the likely success of eradication, the extent of the restricted area, and the actions required.

If it appears likely that the incursion is through movement of contaminated machinery, then the movements of the machine should be traced.

Aerial incursions may require a much wider survey to determine whether spot incursions have occurred in other locations. Movements of plants and machinery from the infested premises should be thoroughly investigated.

3.2.3 Surveillance surveys

Eradication or restricting spread of the stemborer will depend on the initial distribution and the range of alternative host plants, and surveys should be initiated as soon as possible after the first record of the pest. The scope of these surveys will obviously vary with these parameters, but those detailed below should be taken as the first approximation.

3.2.3.1 In commercial-crop areas

If a new stemborer is found in a commercial sugarcane crop, the entire field in which the pest was found should be walked row for row and the intensity of infestation determined. All fields within a 2-km radius of the initial infestation should be walked row for row, followed by inspections of 10% of fields at random throughout the remaining mill area or adjoining mill areas. All fields on farms belonging to the same farmer/company and the same harvester group as the infested farm should be inspected. Any farm on which machinery (including vehicles) or planting material from the infested farm has been shifted to in the previous 2 years should be inspected. If a highly susceptible variety is present in the region inspections should include a high percentage of fields of this variety. Extreme care should be taken to decontaminate all clothing and machinery before moving from a known infested site if the pest is a planthopper, aphid, scale, mealybug or whitefly.

Surveys in alternative hosts should be similar to these, but may vary due to the nature of the crop.

Random inspections should be made throughout all other mill areas concentrating on any known susceptible sugarcane cultivars and alternative hosts.

Careful records of the number of infested plants per field, the distribution of infested plants within a field (infested plants in runs down a row suggest infested planting material, individual plants scattered throughout the field suggest aerial transmission) and the location of infested fields (mark on mill maps).

The intensity and number of positive findings in the initial 2-km-radius survey and the survey of farms with a link to the original farm should be reviewed before proceeding with the wider survey. If the pest is widespread on these farms, it is likely that the pest has been present for some time and eradication is less likely to be possible. Future action should concentrate on preventing movement from this region/mill area to surrounding regions/mill areas. If only a few infested plants or fields are found close to the original infestation, there may be some possibility of eradication and strict quarantine should be enforced around the infested farms. Detailed surveys should continue within the infested mill areas.

3.2.3.2 In non-commercial-crop areas

All *Saccharum* species and alternative host plants within a 1-km radius in a city or a 10-km radius in rural areas of the initial finding should be inspected and then inspections should be made radiating out from this initial area. The surveys would concentrate on current and abandoned dwellings where sugarcane and alternative hosts may have been planted.

A careful record should be kept of the location of cane plants and alternative hosts for follow-up inspections. Follow-up inspections should be carried out at 3, 6 and 12 months after the first finding. No plants should be removed from any location.

3.2.4 Destruction of infested plants

No insects, plants or soil should be removed from the infested premises, except for scientific purposes by an authorised person. Great care should be taken to limit the dispersal of any pest.

The actual methods of destroying infested plants will depend on the number of plants involved and the growth stage of the crop. If there are less than 50 infested plants, they should be dug out and should be destroyed fully by burning in an incinerator or in a pit. The cane in the infested fields should then be destroyed by rotary hoeing the field. The crop may be slashed or knocked down with a tractor first to assist in the hoeing. The field should be rotary hoed, disced or ploughed 3-4 and 6-8 weeks after the initial hoeing to destroy all volunteers. After these cultivations any further volunteers should be sprayed with glyphosate. If weather makes it impossible to plough the field it should be sprayed with glyphosate at 10 L/ha, left for at least 2-3 weeks and ploughed as soon as possible

after this time. The field should be left fallow with no sugarcane volunteers or grass weeds for 12 months. All machinery must be decontaminated immediately after use.

If there are a large number of infested plants in the field, the field should be rotary hoed and/or sprayed with glyphosate.

If the survey shows that only a small number of fields are infested (1-5), an area of 300-500 m around the extremities of the infested fields should be rotary hoed and left fallow for at least 6 months to starve out pests. If no rain falls within the first 2 months, and irrigation is available, the field should be irrigated to field capacity on at least two occasions to promote plant growth and hatching of eggs or activity of larvae.

The actual extent of the initial infestation will determine whether it is necessary to continue ploughout of infested fields. If there are many infested fields, it may be necessary to set a level of infestation that would require ploughout (eg 5% of stools) to help reduce the population for further spread outside the initial infested region.

3.2.5 Decontamination of clothing and machinery

3.2.5.1 Clothing

Where possible, disposable clothing (eg hats and overalls) should be worn. All other clothing worn in an infested field, including hats, should be washed in hot water (>60ºC). The clothing should be sealed in a plastic bag for transport to the laundry. Shoes or boots should also be washed thoroughly.

Survey teams should change their clothes after inspecting an infested site, before moving to another field.

3.2.5.2 Vehicles and Machinery

All vehicles and machinery should be thoroughly washed and steam cleaned to remove all dirt and plant residues before leaving an infested property; this includes private vehicles which have entered the property. The vehicle or machine must be inspected by an authorised person before it is allowed to move. Survey teams and other visitors to infested sites should avoid driving vehicles close to the infested field.

3.2.6 Control with insecticides

Potentially useful insecticides should be identified from the literature and the dossiers in Appendix 5 as a matter of urgency. Those insecticides with established MRLs (Maximum Residue Levels) in Australian sugarcane should be used. Permission for use must be obtained from the National Registration Authority, PO Box E240, Kingston, ACT 2604; telephone 02 6272 5158, fax 02 6272 4753.

Screening to determine efficacy should commence as soon as possible (within 3 days of detection), especially if it is clear that there is no chance of short-term eradication.

3.2.7 Non-insecticidal control

The known infested fields and those close by should be planted with resistant varieties after the prescribed fallow period.

Varieties with high levels of resistance to stem borers, have been bred in many overseas sugar industries. Some of these varieties are held in variety collections at BSES Experiment Stations. Some Australian varieties may also be resistant to the pest. In the case of an incursion, a selection of any resistant varieties should be multiplied for use on infested farms and for possible introduction into the area if eradication is unsuccessful or is not possible.

Other controls, such as the introduction of parasites and predators, use of traps, and management options, may be useful in controlling introduced pests. Information should be taken from the literature, the dossier in Appendix 5 and from consultation with overseas experts, particularly South African.

3.2.8 Approved-seed plots

Distribution of approved seed should be discontinued until the extent of the incursion is determined. It may be necessary to hot-water treat all cane being distributed from an approved seed plot. The approved seed plot should be inspected for the pest row-for-row before any cane is distributed.

3.2.9 Abandoned sugarcane and alternative hosts

All abandoned sugarcane within 10 km of the incursion should be destroyed, as this could act as a source of re-infestation of the pest. Spraying with glyphosate may be the most effective and efficient method of destruction, but follow-up sprays may be necessary.

In some areas the wild sugarcane relative, *Saccharum spontaneum*, has established as a weed (eg banks of the Mulgrave River near Cairns) and sugarcane and its relative *Saccharum edule* are grown in home gardens in the Torres Strait and across northern Australia as far south as Sydney. Attempts should be made to destroy these plants if they are found to be infested with the pest. This would need to be discussed with the Queensland Department of Natural Resources and Mines to determine the environmental impacts of any control program.

Sugarcane grown in backyards should be inspected in the area near any incursion and any infested plants should be destroyed.

3.3 Feasibility of control in Australia

If *Eldana* stemborer is found on isolated plants outside a commercial canegrowing area, it would be feasible to eradicate the pest from Australia. If an initial incursion occurred in a commercial crop, it is unlikely that eradication will be possible, but the response to the incursion should assume that eradication is possible until the extent of the incursion is known. Experience with stemborers in other canegrowing areas shows that spread within a country with distinct breaks between canegrowing areas can be delayed significantly through careful internal quarantine. This delay in spread would allow the screening of insecticides, resistant varieties and other controls before the arrival of the pest. Ultimately, if eradication is not achieved, the pest may be controlled, but this will involve potentially serious yield losses and the loss of valuable commercial varieties.

A decision to eradicate or contain must be based on an appropriate cost-benefit study. Factors to be considered include: resistance levels in current commercial cultivars; area in which the incursion occurred; cost of insecticides; costs associated with parasite rearing. Dr Neville Tudroszen (NJT Consulting - telephone 07 5576 7270) and Dr Ross McLeod (Esys Development - telephone 02 9233 8183) have experience in sugarcane and in cost-benefit analyses.

4.0 ACKNOWLEDGEMENTS

We thank colleagues in BSES, AFFA and QDPI for their input to this plan. We acknowledge the work of overseas colleagues that forms the basis of the dossiers.

5.0 REFERENCES

Allsopp, P G, FitzGibbon, F, and De Barro, P J (1999) Pest incursion management plan. Bureau of Sugar Experiment Stations Publication Project Report PR98006.

Box, H E (1953). List of Sugar-cane Insects. A Synonymic Catalogue of the Sugar-cane Insects and Mites of the World, and of their Insect Parasites and Predators, arranged Systematically. CIE, London, 101 pp.

Conlong, D (1994). Report on the Second ISSCT Entomology Workshop. Proceedings of the Second Sugar Cane Entomology Workshop, Mount Edgecombe, South Africa, May 30-June 3, 1994.

FitzGibbon, F, Allsopp, P G and De Barro, P J (1998a). Pest Risk Analysis of Sugarcane for the Northern Australia Quarantine Strategy - Quarantine Insects. Bureau of Sugar Experiment Stations Consultancy Report CO98003: Brisbane.

FitzGibbon, F, Allsopp, P G and De Barro, P J (1998b) Sugarcane exotic pests - pest risk analysis database. BSES Publication Compact Disc CD98001.

APPENDIX 1

CONTACTS FOR IDENTIFICATION OF INSECTS

Confirmation of the identity of insects should be made through:

DNA analysis
Glenn Graham
Centre for Identification and Diagnostics
155 Goddard
University of Queensland QLD 4072
☎: 07 3365 1863
Mobile: 0401719315
Email: g.graham@cpitt.uq.edu.au

Morphological identification
Kim Pullen
CSIRO Entomology
Australian National Insect Collection (ANIC)
Clunies Ross Street, Acton, Canberra, ACT
GPO Box 1700
Canberra, ACT, 2601
☎: 02 6246 4263
Fax: 02 6246 4364
Email: kimp@ento.csiro.au

Specimens should be placed live in individual, sealed, non-breakable containers with a piece of sugarcane stem for food and a piece of paper towelling to absorb excess moisture, or placed in 95+% ethanol. Upon arrival, live specimens must be killed by freezing to ensure that they do not escape.

APPENDIX 2 - SURVEY FOR SUGARCANE STEMBORERS

Method

1. Teams of 2-4 people will be trained in recognition of the pest, survey methods, disinfection, and protocols for surveys on private and public lands.

2. Equipment:-

- disposable hats, overalls and gloves
- washable boots
- illustrated guide to established pests likely to be confused with the target stemborer and to the introduced species
- mill or local authority maps, hand-held GPS device (one per team)
- paper bags or fertiliser bags to collect infested material
- slicing knives
- 70% methylated spirits in hand held spray bottles to disinfect equipment
- portable cleaning kit for boots
- survey report sheets
- identification tags and leaflets explaining reason for survey
- mobile phone
- small bottles of 100% ethanol (where DNA samples need to be analysed) or methylated spirits for collecting insect specimens

3. Owners of private properties will, where possible, be advised in advance of the survey, by letter drop, radio, and/or TV.

4. Team to dress in protective clothing before entering property and display identification tags.

5. Vehicles to be left on farm roads.

6. Team leader to identify group to property owner/manager if available, explain survey and provide them with a leaflet on the pest.

7. All cane plants are inspected or the pre-determined number of blocks and rows walked in commercial crops.

8. When an infested plant is located, it should be carefully covered in a paper or fertiliser bag, the stalk cut and the bag sealed. If large numbers infested plants are present (eg >100), the team should leave the field without removing plants; these fields should then be destroyed by burning and/or ploughing.

9. Infested plants should be incinerated. Treated material should be buried on the infested property. Disposable clothing should be placed in bags of water-soluble plastic and washed in a hot cycle or autoclaved. Vehicles and boots should be treated with contact insecticide or steam-cleaned.

10. Complete survey form.

11. Advise property owner/manager of survey results.

12. If the pest is located on the property, report results immediately to the operation control centre.

13. At the end of each day, the survey sheets will be entered onto the data base and a summary report prepared and forwarded to the operations manager.

Sugarcane Stemborer Survey

Commercial Crops

Farm Name: …… **Farm No**: ……

Mill Area: …… **Locality**: ……

Block No: …… **Variety**: ……

Crop Class: …… **Plant Source**: ……

Movement of plants and machinery off property: ……

Date of Inspection: …… **Inspection method**: ……

No. of infested plants located: ……

Distribution in block: ……

GPS Co-ordinates of block and infested plants: ……

Sketch of field and location of infested plants ↑ **N**

Sample number for insect specimens

Comments:……..…

……..…..…

……...

Team Leader: …….. **Signature**: …….. **Date**:..……

Sugarcane Stemborer Survey

Dwellings/Abandoned Cane

Dwelling Location: (Street No./Local Authority No./GPS Co-ordinates):

……...

Owner/Occupier:

……...

Sugarcane no. stools: **……..** **No. of infested plants:** **…….**

Type of sugarcane -

Noble: **……..**

Edule: **……..**

Commercial: **……..**

Spontaneum: **……..**

Trace-back - source of plants: **……..** **Movement plants to other properties:** **…….**

Sample number for insect specimens

Comments: **……**

……..

……..

Team Leader: **……..** **Signature:** **……..** **Date:..……**

APPENDIX 3 - DRAFT PRESS RELEASE

This may be made in the name of the federal or state minister responsible for plant health; the example given is for the Queensland Minister for Primary Industries.

	From the office of
NEWS RELEASE	**..... MLA**
	Minister for Primary Industries

Date

Program to Eradicate NAME OF PEST

The Queensland Primary Industries Minister, ..., said today that ELDANA STEMBORER had been detected on a sugarcane farm in the **NAME OF AREA** with the property immediately being quarantined.

Mr ..... said Bureau of Sugar Experiment Stations (BSES) senior entomologist ..... had inspected the infested plants and confirmed that the pest was present. Further confirmation will be available when results from samples that were sent to the Centre for Identification and Diagnostics at the University of Queensland and CSIRO Entomology (Australian National Insect Collection).

ELDANA STEMBORER is a serious pest of sugarcane that can reduce yields.

"This is the first suspected case of **ELDANA STEMBORER** in Australia and a control plan developed by BSES with assistance from AQIS has been activated," Mr. ..... said.

"Under the plan, a BSES task force has begun tracing all movements of cane and machinery from the suspect property and has commenced a survey of neighbouring farms. This includes a total ban on movement of cane and machinery from the suspect property.

BSES, AQIS and the QDPI are working closely with the sugar industry to ensure the outbreak is eradicated or contained as quickly as possible," Mr. ..... said.

The source of this outbreak is unknown at this stage.

Media contact: Mr ..... (Ministerial Adviser)
Phone: .....
Fax: .....

Technical information contact: **Designated person- phone number**
CEO, BSES 07 3331 3333

Attached: Fact Sheet on **ELDANA STEMBORER**
Location map of outbreak

APPENDIX 4 - ABBREVIATIONS USED IN THIS REPORT

AFFA	Department of Agriculture, Fisheries and Forests - Australia
ANIC	CSIRO Entomology, Australian National Insect Collection
AQIS	Australian Quarantine and Inspection Service
BSES	Bureau of Sugar Experiment Stations
CA	Control Area
CEO	Chief Executive Officer
CPPO	Chief Plant Protection Officer
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DCP	Dangerous Contact Premises
GIMP	Generic Incursion Management Plan
IP	Infested Premises
MRL	Maximum Residue Limit
NAQS	Northern Australia Quarantine Strategy
NRA	National Registration Authority for Agricultural and Veterinary Chemicals
PHC	Plant Health Committee
QDPI	Queensland Department of Primary Industries
RA	Restricted Area
SCARM	Standing Committee on Agricultural Resource Management
SIMS	SCARM Incursion Management Strategy
SP	Suspect Premises
SPCC	Sugarcane Pest Consultative/Containment Committee
STF	SCARM Task Force on Incursion Management

APPENDIX 5 - DOSSIER ON *ELDANA SACCHARINA* AS A PEST OF SUGARCANE

***Eldana saccharina* (Walker)**

Common names
African sugar-cane borer, Eldana borer.

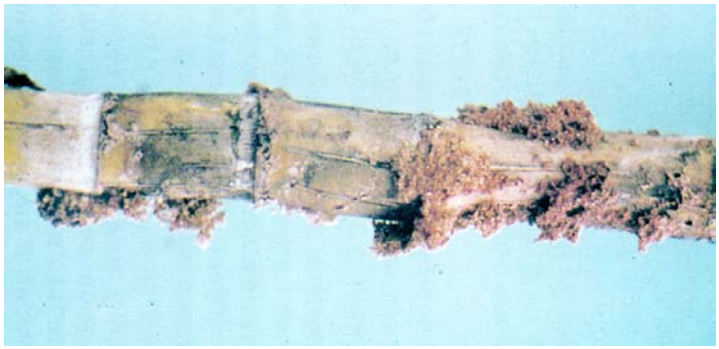
Distribution
Eldana saccharina is indigenous to Africa.

Angola, Benin, Burundi, Botswana, Cameroon, Chad, Congo, Ghana, Ivory Coast, Kenya, Mozambique, Nigeria, Rwanda, Sierra Leone, Somalia, South Africa, Swaziland, Tanzania, Uganda, Zambia, Zimbabwe.

Eldana saccharina was first described by Walker (1865) from Sierra Leone, West Africa (See also Appert 1970). Conlong (1997a) suggested that differences in boring behaviour by *Eldana saccharina* in sugarcane recorded from different parts of Africa were due to the existence of different biotypes of this species in the continent (see also Sampson & Kumar 1985). This was analysed further by King *et al.* (2002) who showed that populations from South Africa were genetically distinct from those from Uganda, Cameroon and Benin.

Host plants
Sugarcane is the main hostplant. Other hosts include *Amaranthus dubius* Mart. (pigweed), *Cladium mariscus*, *Cyperus distans*, *C. esculentus*, *C. fastigiatus*, *C. immensis*, *C. latifolius*, *C. maculatus*, *C. natalensis*, *C. papyrus* (papyrus), *C. prolifer*, *C. rotundus*, *C. sexangularis* and *C. textiles* (sedges), *Eleusine coracana* (millet), *Fuirena umbellate*, *Kyllinga elatior*, maize, *Manihot utilissima* pohl. (Cassava), *Mariscus riparius*, *Pennisetum glaucum* (*P. typhoides*) pearl millet, *Pennisetum purpureum* (Napier fodder, elephant grass), *Panicum maximum*, *Phragmites* sp. (reed), *Pycerus polystachyus*, rice, *Rottboellia cochinchinensis* (*R. exaltata*), *Sorghum arundinaceum*, *Sorghum versicolor* and *Sorghum vulgare* var. *sudanense* (Atkinson 1979; Bosque-Perez & Schulthess 1998; Meijerman & Ulenberg 1998; Polaszek & Khan 1998).

Symptoms
Eldana saccharina mainly infests mature cane and maize plants. Infestation causes lodging of the plants due to tunnelling and provides access to fungal diseases into stems and maize cobs. Adult exit holes can be seen in stems and they are usually covered with frass.



Frass on stalk (from SASEX)

Economic impact
Records from South Africa showed that loss in recoverable sucrose in Swaziland cane is about 1% for every 1% of damaged internode. Losses mainly result from adverse effects on cane quality (reduced brix, pol and purity and increased fibre). Reductions in cane mass are also apparent but only significant in cane harvested towards the end of the season (King 1989). Other records by Smaill & Carnegie (1979) estimate yield losses of 0.1% with every 1% of stalks damaged. In Tanzania, Waiyaki (1974) estimates a decrease in brix of 0.332% for each 1% increase in joints bored, while in Ivory Coast, Cochereau (1982) estimates a 0.5%

loss in sugar mass for each 1% node bored. Infestation also increases the levels of red rot (*Glomerella tucumanensis*) infection in cane (Trenor & Bailey 1989).

In maize, though infestation occurs relatively late, damage can be severe as a result of tunnelling. Damage of up to 20% was recorded in maize fields in West Africa, and infestation in maize was found to affect grain filling (Bosque-Perez & Mareck 1991). In Benin, studies showed that nitrogen had a positive effect on plant growth as well as the development and survival of the stemborer complex in maize (mainly *E. saccharina* and *Sesamia calamistis*), and thereby increased the incidence of dead hearts and stem tunnelling (Setamou *et al*. 1995).

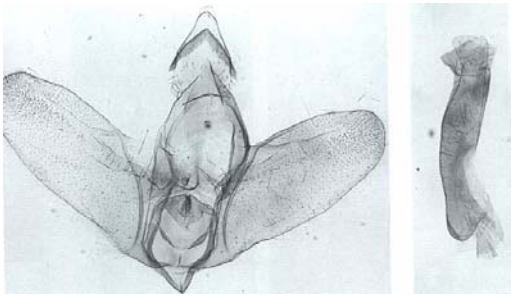
Morphology

Adults

Maes (1998) gives the following description of *E. saccharina*: Fore wings are elongate, almost elliptical, with a rounded distal edge, which is typical of many Galleriinae. The longitudinal veins are brown against a lighter background and there are two distinct dark spots in the anterior half of the fore wings. At rest, the wings are folded over the abdomen and over the lighter coloured hind wings. Specimens from different localities in Africa seem to have considerable variation in size and colour.

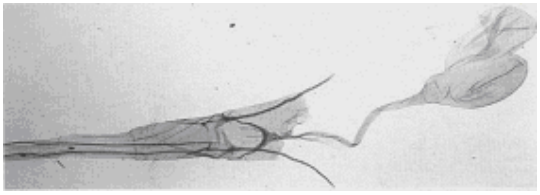
Eldana saccharina Adult moth (Polaszek 1998).

Male genitalia: Valva rounded near the apex, protrusions are lacking. The juxta is oval and the triangular uncus bears a row of spines. The aedeagus is slightly bent near the middle (Maes 1998).



Eldana saccharina male genitalia (Polaszek 1998).

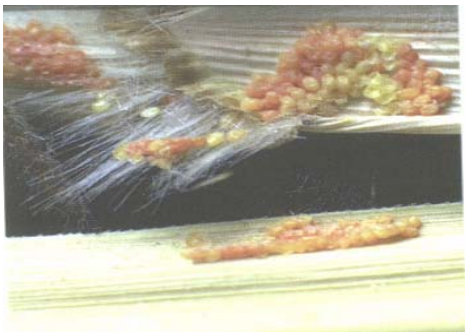
Female genitalia: Strongly elongate. The apophyses posteriores are very long. The ostium is V-shaped and the ductus bursae are narrow, with the ductus seminalis just beneath the antrum. The corpus bursae has a large appendix bursae (Maes 1998).



Eldana saccharina female genitalia (Polaszek 1998).

Maes (1998) found no major differences in genitalia in specimens from different localities in Africa.

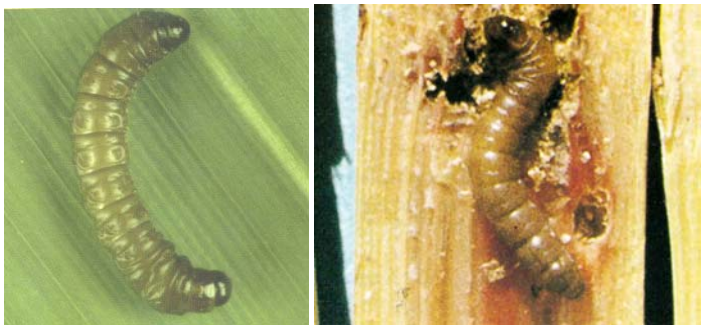
Eggs



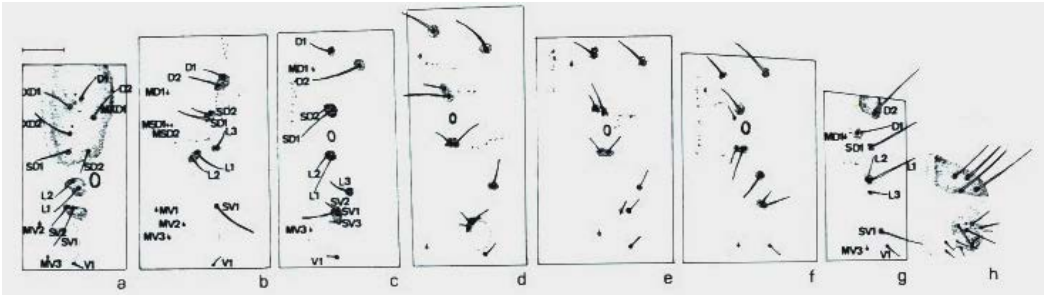
Eldana saccharina eggs (Polaszek 1998)

Larvae

Light brown- to dark grey-coloured larvae with brown pinacula. Covered with very small dark-coloured spots. Head capsule reddish brown to dark brown. Prothoracic shield and suranal plate brown. Spiracles black and oval-shaped. First to eighth abdominal segments each with two macroscopical subdorsal setae. Ninth abdominal segment with three lateral setae. Crochets on ventral prolegs arranged in ovals, triordinal (Meijerman & Ulenberg 1998).



Eldana saccharina larva (Polaszek 1998 and from SASEX).



Eldana saccharina setal map (Polaszek 1998).

Detection methods

Light trapping can be used to detect adults. Checking leaves for egg masses, especially on those near the base of the plant, as well as debris and dead leaf matter can give a good indication on the presence of the pest. Stalk splitting to look for larvae and pupae and detection of larval frass and emergence holes can also be used for monitoring. Lodging of cane and evidence of tunnelling are more advanced signs of infestation.

Biology and Ecology

Eldana saccharina occurs in sub-Saharan Africa from approximately latitude 15°N to 30°S. Adult females live 6-15 days depending on temperature, and lay egg batches of 50-100 eggs on either dry leaves at the

bases of plants, debris on the soil or the hairy margins of maize leaf sheath. In sugarcane, dead leaf matter, base of plant and litter receive high eggs numbers. Laboratory results showed that adult females lay 380-620 eggs depending on temperature. Fecundity is positively correlated with temperature but females are short lived at higher temperatures (30°C). Incubation period is 5-6 days and young larvae feed first on the leaf sheaths before entering the stem. Leslie (1993) studied the dispersal of neonate larvae on cane stalks and in litter, and did not find a clear effect of variety on neonate larval behaviour. After dispersal, larvae find concealed positions on the stalk, and those found boring were associated with buds, root bands or cracks. Dispersal was found to be more rapid in litter and larvae could cover distances of up to 800 mm. Larvae tunnel actively in stalks, and, in maize, can also move into the ears and feed on the grain. In a study in Kenya on larval dispersal in maize and sorghum, it was found that neonate larvae first settled in the leaf sheath and remained there until the third instar before entering the stalks. In naturally infested maize, more larvae settled in the basal section of the plants between the second and fifth node/internode, and in sorghum they settled between the fourth and seventh node/internode. In sorghum, entry to stalks was limited by the wall toughness and presence of waxes. The extent of stalk tunnelling indicated that larval feeding was higher in the internodes in case of maize and in the peduncles in case of sorghum (Kantiki & Ampofo 1989).

Eldana saccharina is capable of developing through out the year provided that suitable plants are available. Development of immature stages highly depends on temperature and can range from 33 to 173 days under temperatures between 30° and 15°C. Under controlled laboratory conditions, thermal constant estimates for the egg, larval and pupal stages were determined at 119, 618.6 and 160.3 day degrees C above average thresholds of 5.3, 10.2 and 10.7°C, respectively. Thermal constants for the seven larval instars were determined at 80, 70, 69, 74, 86, 129 and 116 day degrees C, respectively. Larval duration increased when nitrogen was reduced in the larval diet (Way 1995). In the field, pupation occurs inside the stem or maize cobs, and the pupa is covered by a cocoon made of silk and plant debris. Larvae make an exit hole that is usually covered with frass. Pupation period takes about 7-14 days. Up to six generations may develop per year, and insects tend to infest mature plants. This information is summarized in a population-dynamics model (Horton *et al.* 2000) that simulates population growth and damage indexes.

Sampson & Kumar (1985) studied the life history and behaviour of *Eldana* on sugarcane in Southern Ghana; their study recorded that mated females laid an average of 327 eggs in a period of 4 days. Eggs were mainly deposited on the inner side of leaf sheaths fitting tightly onto the stem. The duration of the egg stage averaged 5.64 days in the laboratory and 5.82 days in the field. The larval, prepupal and pupal periods averaged 31, 2.05 and 9.76 days, respectively, and the life cycle was completed in 36-62 days. The preoviposition period was 2 days, and the female reproductive life lasted 4 days. Adults lived for 6-13 days. Newly hatched larvae spread out in the first 3 days after hatching. Pupae frequently occurred very close to the exit hole (less than 5 cm). They also found that adults reared from field-collected larvae had a sex ratio of males to females of 42:51, which differed from the ratio of 1:1 in the laboratory.

Studies in South Africa showed that *E. saccharina* is restricted to a narrow coastal belt coinciding with the 16°C isotherm for the winter month of July (see Girling 1978; Atkinson 1980, Betbeder-Matibet 1985; Leslie 1993; Shanower *et al.* 1993 & Maes 1998).

Eldana infestations in South Africa are heavier in intensively grown rather than peasant-grown sugarcane, and are more severe in water-stressed plants. Studies showed that increased infestations are associated with increased stalk total nitrogen. Infestations in older cane are usually higher than in younger cane, which maybe due to the presence of phenolic compounds in younger cane or in cane tops. Levels of nitrogen are much higher in the feeding sites of the insect in natural host plants than in cane stalks, and adult fecundity from natural hosts appears to be higher than that of moths from sugarcane (Atkinson & Nuss 1989).

Management

Studies in tropical Africa showed that control of *Eldana* can be achieved using a pest management plan that takes in consideration the use of healthy sugarcane stock in plantations, using cropping cycles that do not exceed 12 months when possible and the use of resistant or tolerant varieties. Chemical control in maize can also be achieved by spraying or granular application of insecticides such as carbofuran, chlorpyrifos or fenitrothion (Anon. 1985).

In the early 1980s, the establishment of a sugarcane plantation and sugarmill at Lotakila, Congo (formerly Zaire), was delayed because of the occurrence of heavy *Eldana* infestation. Management methods were implemented such as the destruction of reservoirs of the pest, burning of heavily infested cane, exclusive use of resistant varieties, soaking of planting pieces in river water for 30 h before planting to drown the larvae and pupae, elimination of the borer's wild food plants by means of herbicides, application of carbofuran (Furadan) to canes 3-4 and 6 months old, burning of cane before harvest, and cane cutting at ground level to leave no stump in which the borer can survive. These measures have reduced the infestation to less than 1% (Wang *et al.* 1983).

Chemical control

In South Africa, air application of alpha cypermethrin reduced *Eldana* damage in cane fields after three monthly applications. Sett dipping in the pyrethroids lambda cyhalothrin and cypermethrin gave best results. Fumigation with methyl bromide was effective with high larval mortality and insignificant effect on germination (Leslie 2000).

In Ivory Coast, West Africa, deltamethrin (as an emulsifiable concentrate at 15 g a.i./ha) and carbofuran (as granules at 200 g a.i./ha) gave economical control of *Eldana saccharina*, *Busseola fusca* and *Sesamia calamistis* on maize. Applications 20 and 40 days after emergence gave economically viable yield increases were obtained in a moderately intensified cropping system (Moyal 1989).

Plant resistance

Linear models based on data acquired by near infrared (NIR) spectrophotometry showed that components of nodal bud scale extract contribute towards resistance to *E. saccharina* in cane (Rutherford *et al.* 1997).

A gene bank of *Bacillus thuringiensis* isolate number 234, which is a natural isolate and also highly toxic to *Eldana saccharina*, was made in the positive selection cloning vector pEcoR252. The library was probed for the delta endotoxin protein of *B. thuringiensis* HDI, and 11 clones carrying *B. thuringiensis* delta endotoxin gene DNA sequences were detected. In addition, a cryIA(c) (crystal protein) gene was cloned from *Bacillus thuringiensis*. The gene was introduced into an isolate of *Pseudomonas fluorescens* capable of colonizing sugarcane, on two broad host range plasmids, pDER405 and pKT240, carrying 13 and 28 copies respectively. Glasshouse trials showed that sugarcane treated with *P. fluorescens* 14:Omegon Km cry were more resistant to *Eldana* than untreated sugarcane (Herrera & Thomson 1989; Herrera *et al.* 1997).

Keeping & Meyer (2000) recorded that the application of 5000 kg calcium silicate/ha significantly reduced borer damage by 24%. The interaction between variety and silicon treatment was not significant, however, the ameliorating effect of silicon on resistance was greater for susceptible than for resistant varieties

Pheromones

Using electroantennography, male and female antennae reacted equally strongly to the following compounds: (Z)-3,7-dimethylocta-2,6-dienoic acid, 6,10,14-trimethyl-2-pentadecanol, 4-hydroxy-3-methoxybenzyl alcohol, 1-octadecane thiol, 16-hexadecanolide, and 18-octadecanolide in the wing gland and abdominal hair pencil secretions of males, and (Z)-9-hexadecenal and cis-3,7-dimethyl-6-octen-4-olide (cis-eldanolide). Results were also confirmed using coupled gas chromatography electroantennography, and it was found that male as well as female antennae responded to eldanolide. Vanillin, substituted phenols related to vanillin, and some oxygenated monoterpenes elicited weak responses in male and female antennae (Burger *et al.* 1993).

Earlier work by Kunesch *et al.* (1984) suggests that *Eldana* males produce sex pheromones of two types. The first is produced by wing glands and acts as a long-range attractant, inciting females to climb to the top of their canes. The second pheromone is secreted by hair pencils on the coremata when the female approaches and makes her receptive to copulation. The wing gland pheromone has been identified as trans-3-methyl-4-dimethylallyl-gamma-lactone (trans-dihydro-4-methyl-5-(3-methyl-2-butenyl)-2(3H)-furanone).

Antifeedants

Isopongaflavone is an antifeedant that was isolated and identified from methanol extracts of seeds of *Tephrosia elata* collected in Kenya. The product was found to be very active against *Eldana*. Another antifeedant (Rotenone) was also found to be effective (Bentley *et al.* 1987).

Crude extracts of root bark of *Harrisonia abyssinica*, which is an East African shrub widely used in local medicine, was shown to have insect antifeedant, antimicrobial, cytotoxic and plant growth inhibitory activities. Pedonin was isolated from the methanolic extracts of the root and it showed potent antifeedant activity against *Eldana* (Hassanali *et al.* 1987).

Biological control

Since 1981, the South African Sugar Association Experiment Station (SASEX) has placed large emphasis on the biological control of *Eldana* due to the cryptic nature of the pest and the difficulties facing chemical control options. SASEX followed two biological control approaches, the first is the importation and release of parasitoids of closely related pest species from other parts of the world, an approach that has so far proved unsuccessful in the control of *Eldana* in South Africa (for a list of the exotic (non-African) parasitoids tested against *Eldana* in South Africa, see Conlong 1994). The second approach is to import indigenous parasitoids that are recorded to attack *Eldana* in other African countries (Conlong 2000), or still in South Africa but in its indigenous host plants, which are wetland sedges, an approach that showed little success in the control of *Eldana*. Modern sugarcane cultivars may lack semiochemicals that attract the parasites to the plant (Conlong & Kasl 2001).

The following are indigenous parasitoids recovered from *Eldana* in Africa:

***Actia* sp. (Tachinidae: Diptera):** A larval parasitoid. Conlong & Mugalula (2001) recorded this parasitoid attacking *Eldana* larvae in *Cyperus papyrus* umbles in Uganda. Parasitism rates were up to 23.8%.

***Bassus sublevis* (Granger) (*Agathis* sp.) (Hymenoptera: Braconidae):** Larval parasitoid. Attacks small *Eldana* larvae in *Cyperus papyrus*, *C. dives* and *C. fastigiatus* as well as in sugarcane in South Africa (Conlong 1997b).

***Campoplex* sp. (Hymenoptera: Ichneumonidae):** Larval parasitoid. Recorded from Uganda by (Conlong & Mugalula 2001) attacking *Eldana* larvae in *Cyperus papyrus* umbles.

***Descampsina sesamiae* Mesnil (Diptera: Tachinidae):** Larval parasitoid that attacks both *Sesamia calamistis* and *Eldana saccharina* in maize and cane in West Africa. Introduced into South Africa from Ghana and Nigeria in 1975-1984, but failed to attack *Eldana* in South Africa (Conlong 1994). It was discovered later that the parasitoid maggots were encapsulated by *Eldana* larvae, and that it is mainly a parasitoid on *Sesamia calamistis* and rarely attacks *Eldana* in West Africa, which confirms data by Sampson & Kumar (1986) who recorded a very low parasitism rate (0.42%) by this parasitoid on *Eldana* in sugarcane estates at Asutsuare, Ghana, while parasitism of *Sesamia botanephaga*, *S. penniseti* and *S. calamistis* ranged from 47.7% to 93.6%.

***Goniozus natalensis* Gordh (*Goniozus indicus* Ashmead) (Hymenoptera: Bethylidae):** Larval parasitoid. Naturally attacks *Eldana* in *Cyperus papyrus* and *C. dives* in South Africa. It was also introduced into South Africa from Malawi and Botswana in 1981, and shows some promise in the control of *Eldana* as it can also exploit *Chilo partellus* in *Sorghum arundinaceum* in the same wetland habitat of South Africa (Conlong 1994; Conlong 1997b).

***Iphiaulax* sp. (Hymenoptera: Ichneumonidae):** Larval parasitoid. Attacks small *Eldana* larvae in *Cyperus papyrus*, *C. dives* and in sugarcane in South Africa (Conlong 1997b).

***Orgilus bifasciatus* Turner (Braconidae: Hymenoptera):** Larval parasitoid. Naturally attacks *Eldana* in *Cyperus papyrus* and *C. dives* and sugarcane in South Africa (Conlong 1994).

***Schembria eldana* Barraclough (Diptera: Tachinidae):** Larval parasitoid. Naturally attacks *Eldana* in *Cyperus papyrus* in South Africa and Kenya (Conlong 1997b).

***Sturmiopsis parasitica* (Curran) (Diptera: Tachinidae):** Larval parasitoid. This species is the most widespread and commonly recorded tachinid stemborer parasitoid in Africa. Recorded to attack *Eldana* in West Africa (Harris 1998) and established in South Africa (Martin *et al*. 2001).

***Syzeuctus eldanae* (S. *tonganus*) Kriechbaumer (Hymenoptera: Ichneumonidae):** A solitary larval endoparasitoid. Conlong & Mugalula (2001) recorded this parasitoid attacking *Eldana* larvae in *Cyperus papyrus* umbles in Uganda. Other unidentified species of *Syzeuctus* were also recorded from *Eldana* in Ivory Coast and Chana (Conlong 2001).

***Telenomus applanatus* Bin & Johnson (Hymenoptera: Scelionidae):** Egg parasitoid, restricted to *E. saccharina*, and has not been recorded outside West Africa (Bin & Johnson 1982). Introduced to South Africa from Ivory Coast in 1980-1982 but doesn't seem to have been successful (Conlong 1994, 1997b).

***Trichogrammatoidea eldanae* (Viggiani) (Hymenoptera: Trichogrammatidae):** Egg parasitoid, attacks *Eldana* in maize fields of Ivory Coast. Introduced to South Africa from 1980 - 1984 with no apparent success (Conlong 1997b).

***Venturia* sp (*Chriodes* sp.) (Hymenoptera: Ichneumonidae):** Larval parasitoid. Attacks small *Eldana* larvae in *Cyperus papyrus*, *C. dives* and in sugarcane in South Africa (Conlong 1997b).

Currently the SASEX programme is investigating the role of *Xanthopimpla stemmator* Thunb. (Hymenoptera: Ichneumonidae), a pupal parasitoid of *Chilo sacchariphagus* that was imported into South Africa in 1984-1988 from Mauritius (Conlong 1997b). Release of another imported pupal parasitoid, *Tetrastichus howardi* (Oliff) (Hymenoptera: Eulophidae), was stopped because it was found to attack *Cotesia sesamiae*, which is an important parasitoid of *Chilo* spp in Africa, as a hyperparasitoid (Conlong 1997b).

Pathogens

***Beauveria bassiana*:** Entomopathogenic fungus, a strain was isolated from of *E. saccharina* larvae in South Africa. The strain is susceptible to desiccation (Jacobs 1989).

Monitoring

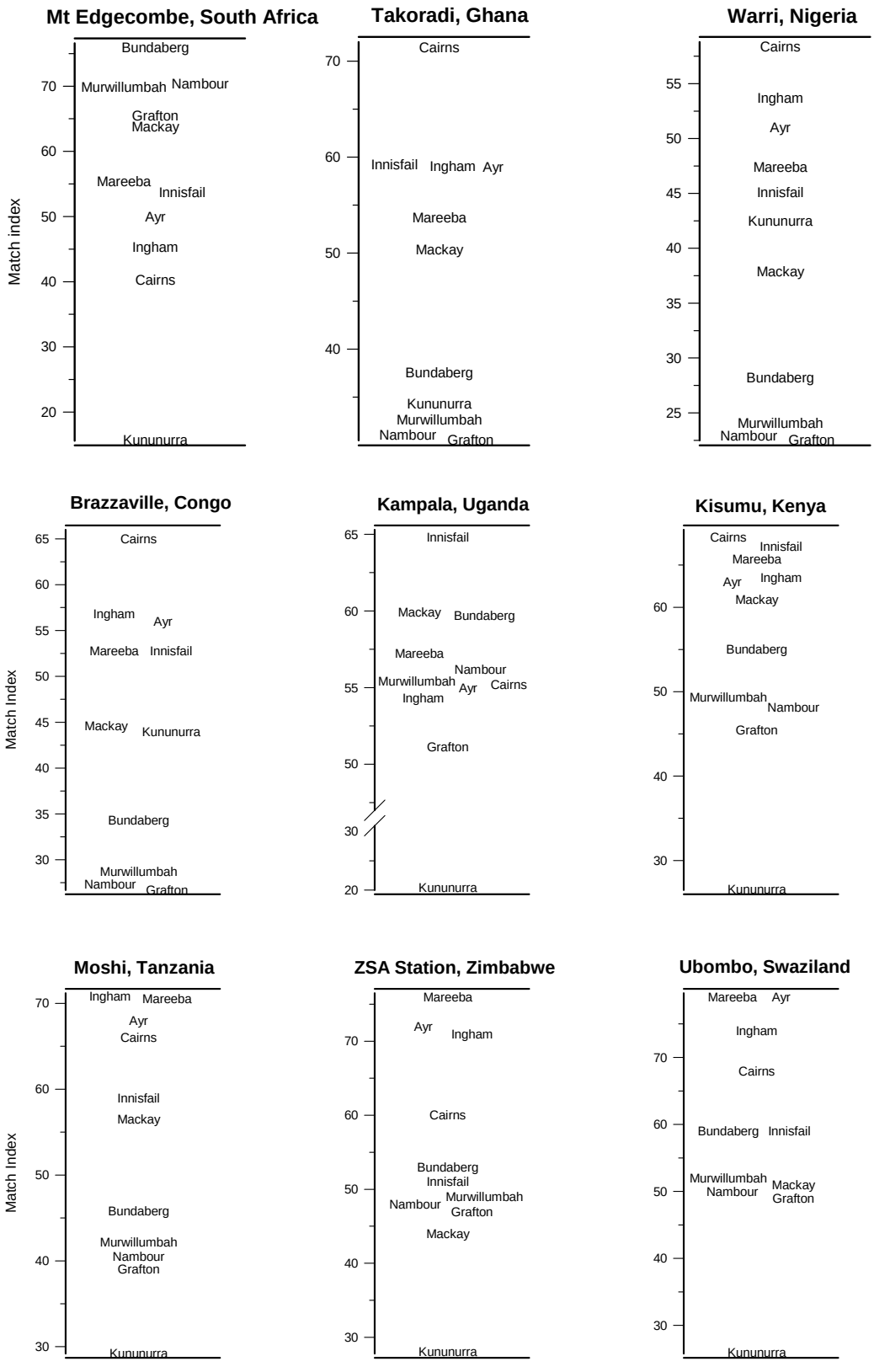
Between 1987-1990, Leslie (1990) recorded an outbreak of *Eldana* on the Oribi Flats, South Africa, and compared data on larval density (larvae per 100 sugarcane stems) with rainfall trends and temperature. It was concluded that the outbreak was due to stress induced by lower than normal rainfall, and further exacerbated by the shallow sandstone soils. In addition, minimum temperatures for the 1998-1990 season were above the activity/development threshold for pest larvae. Leslie (1990) emphasizes the importance of monthly estimates of larval density (especially in susceptible fields) and monitoring adult populations by light traps.

Means of Movement

The most likely means of entry of this species into Australia would be by the introduction of infested planting material from South Africa. The chance of the introduction of moths or eggs on aircraft, in luggage, or on people is much smaller, though still significant.

Phytosanitary Risk

Entry potential: Medium - isolated from Australia, but readily transmitted on infected planting material.
Colonisation potential: High in all sugarcane-growing areas.
Spread potential: High, unless strict controls imposed over movement of infested material.
Establishment potential: Depends on biotype introduced (see Match Indexes for climates at selected locations and principal Australian areas below).


Mt Edgecombe, South Africa
Match index
Bundaberg
Murwillumbah
Nambour
Grafton
Mackay
Mareeba
Innisfail
Ayr
Ingham
Cairns
Kununurra
Takoradi, Ghana
Cairns
Innisfail
Ingham
Ayr
Mareeba
Mackay
Bundaberg
Kununurra
Murwillumbah
Nambour
Grafton
Warri, Nigeria
Cairns
Ingham
Ayr
Mareeba
Innisfail
Kununurra
Mackay
Bundaberg
Murwillumbah
Nambour
Grafton
Brazzaville, Congo
Match Index
Cairns
Ingham
Ayr
Mareeba
Innisfail
Mackay
Kununurra
Bundaberg
Murwillumbah
Nambour
Grafton
Kampala, Uganda
Innisfail
Mackay
Bundaberg
Mareeba
Nambour
Murwillumbah
Ayr
Cairns
Ingham
Grafton
Kununurra
Kisumu, Kenya
Cairns
Innisfail
Mareeba
Ayr
Ingham
Mackay
Bundaberg
Murwillumbah
Nambour
Grafton
Kununurra
Moshi, Tanzania
Match Index
Ingham
Mareeba
Ayr
Cairns
Innisfail
Mackay
Bundaberg
Murwillumbah
Nambour
Grafton
Kununurra
ZSA Station, Zimbabwe
Mareeba
Ayr
Ingham
Cairns
Bundaberg
Innisfail
Nambour
Murwillumbah
Grafton
Mackay
Kununurra
Ubombo, Swaziland
Mareeba
Ayr
Ingham
Cairns
Bundaberg
Innisfail
Murwillumbah
Nambour
Mackay
Grafton
Kununurra

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