SCIRPOPHAGA SPP. INCURSION MANAGEMENT PLAN
VERSION 2
by
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MN08004
IF YOU SUSPECT A NEW PEST
IMMEDIATELY NOTIFY:
In Queensland
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In New South Wales
Murray Fletcher, NSW Primary Industries, 02 6391 3800

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

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1.0 BACKGROUND

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 4 million tonnes with a value of $1-2 billion. Over 85% of the sugar is exported. The sugar industry is a major employer and component of the economy of regional coastal areas in northern New South Wales and 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.

During the 1990s, the Standing Committee on Agriculture and Resource Management (now Primary Industries Standing Committee – PISC) developed a general, non-specific, incursion management strategy (SIMS) (Fig. 1) to manage responses to exotic pest incursions. This strategy, which largely remains current, 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 on Exotic Plant Pests (CCEPP) that is convened under the auspices of Plant Health Committee after an incursion occurs. CCEPP is chaired by the Chief Plant Protection Officer (CPPO) in Agriculture, Fisheries and Forestry – Australia and its membership includes the State/Territory Chief Plant Biosecurity Officers. The CCEPP oversights the strategic management of the initial pest response and facilitates decisions on the feasibility of eradication and future direction of the response. It also makes recommendations on strategic response-management issues through Plant Health Committee and Primary Industries Health Committee to PISC, which comprises the chief executive officers of departments of agriculture/primary industries in the Commonwealth and States/Territories. The ultimate decision-making authority regarding pest responses is Primary Industries Ministerial Council, comprising the ministers of agriculture/primary industries in the Commonwealth and States/Territories.

The generic incursion management plan (GIMP) for the plant industries is a refinement of SIMS. 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).
In 2000, Plant Health Australia (PHA) was formed as a private company to coordinate policy development at the national level and facilitate improved biosecurity measurements for Australian plant industries. PHA is the holder of PLANTPLAN, which is the generic emergency response plan for emergency plant pest incursions and is a guide to management of emergency plant pest incursions. The plan provides detailed description of the procedures to follow on local, state and federal levels following a pest incursion.

In the view of the sugar industry, these generalised plans 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 *Scirpophaga* 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). This plan complements those formulated for *Chilo, Sesamia, Diatraea, Eldana* and *Eoreuma* borers (Sallam and Allsopp 2008a-e).
Figure 1: Sequence of steps, officers and organisations in the SCARM incursion management strategy (SIMS)

Critical Path Analysis
- Incursion detected
- Containment
- Eradication

Key
- as the need arises
- direct links

PEST INCURSION → Incursion Detected → Containment → Eradication → MINIMUM IMPACT

Chief Quarantine Officer Plants or equivalent in States

Experts
- taxonomy
- biology
- eradication
- cost/benefit

Compensation → Industry

Affected State

Assistant Director, Plant Quarantine Policy Branch, AQIS

Consultative Committee convened

Funding

Budget

Consultative Committee convened

Interstate Plant Health Regulatory Working Group

Technical Subcommittee

Industry

Plant Industries Committee
Figure 2  Generic incursion management plan (GIMP)
### 2.0 PEST INCURSION MANAGEMENT PLAN

#### 2.1 Summary of Management Plan

<table>
<thead>
<tr>
<th>SUGGESTED TIMELINE</th>
<th>ISSUE</th>
<th>RESPONSIBLE PERSONS</th>
<th>ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 1</td>
<td><strong>INVESTIGATION</strong></td>
<td>BSES, State Department or AQIS Officer, Grower, Member of the Public</td>
<td>Immediately contact BSES or other Entomologist. Hold specimens under secure conditions.</td>
</tr>
<tr>
<td></td>
<td>Notification of suspect pest detection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Day 1-2</td>
<td>Identification of pest</td>
<td>BSES/other Entomologist</td>
<td>Travel to site, inspect suspect plants and specimens</td>
</tr>
<tr>
<td></td>
<td>Not a new pest</td>
<td>BSES/other Entomologist</td>
<td>Suspend operations</td>
</tr>
<tr>
<td></td>
<td>Uncertain identification</td>
<td>BSES/other Entomologist</td>
<td>Collect specimens, return to laboratory and inspect microscopically, also dispatch live specimens (see packaging details in Appendix 1) by express courier to:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>BSES Indooroopilly</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>50 Meiers Road</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Indooroopilly 4068</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Contact: Dr Peter Allsopp</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>☎: 07 3331 3316 or 0408182614</td>
</tr>
<tr>
<td>Day 1</td>
<td><strong>ALERT</strong></td>
<td>BSES/other Entomologist</td>
<td>Place infested premises under quarantine - State departments.</td>
</tr>
<tr>
<td></td>
<td>Positive identification of new pest</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**DO NOT REMOVE PLANTS FROM FIELD**

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.
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<th>ACTION</th>
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</table>
| Day 2-3            | OPERATIONAL Implementation of response action | CEO BSES, State/Territory Chief Quarantine Officer, Plants | Establish:  
  - State/Territory National Management Group (NMG),  
  - Consultative Committee on Exotic Plant Pests (CCEPP),  
  - National Pest Control Head Quarters (NPCHQ),  
  - State Pest Control Centre (SPCC),  
  - Local Pest Control Centre (LPCC).  
  Operations Managers in Pest Control Centres and BSES/other Entomologists | Quarantine alert teams formed and instructed in pest identification, survey/trace-back methods and disinestation 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. |
|                    | 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/LPCC | Collect, compile and interpret survey data. Initiate cost-benefit analysis for eradication or containment. Prepare report for Consultative Committee. |
| Second meeting of Consultative Committee | Consultative Committee, State/Territory National 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. |
<table>
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<th>ISSUE</th>
<th>RESPONSIBLE PERSONS</th>
<th>ACTION</th>
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<tbody>
<tr>
<td>Day 6-9</td>
<td>(a) Eradication</td>
<td>CPPO and affected State/Territory National Management Group, Consultative Committee</td>
<td>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.</td>
</tr>
<tr>
<td>1-36 months</td>
<td>Review</td>
<td>Operations Managers/LPCC State/Territory National Management Group Consultative Committee</td>
<td>Report monthly on ongoing surveys and eradication. Meet bi-monthly or as required to review eradication program.</td>
</tr>
<tr>
<td>Post-eradication</td>
<td>Surveillance</td>
<td>AQIS</td>
<td>Maintain surveillance and off-shore control programs.</td>
</tr>
<tr>
<td>Day 6-9</td>
<td>(b) More information</td>
<td>Operations Manager/LPCC</td>
<td>Surveys and trace-back (ongoing). Report prepared on daily basis.</td>
</tr>
<tr>
<td>SUGGESTED TIMELINE</td>
<td>ISSUE</td>
<td>RESPONSIBLE PERSONS</td>
<td>ACTION</td>
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<tr>
<td>Day 6-20</td>
<td>(c) <strong>Eradication not possible</strong></td>
<td>Consultative Committee, State/Territory National Management Group</td>
<td>Consultative Committee ceases to function and Containment Committee formed. Preparation of containment plan. State/Territory National 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.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Operations Managers/LPCC</td>
<td>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.</td>
</tr>
<tr>
<td>1-12 months</td>
<td></td>
<td>BSES/other Entomologist</td>
<td>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.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BSES/other Entomologist</td>
<td>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.</td>
</tr>
</tbody>
</table>
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 office - contact numbers given on inside of front cover.

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 BSES Indooroopilly and/or to suitable taxonomists 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 (Biosecurity Queensland), 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 National 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 National 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 senior extension officer (from BSES in Queensland). Other members of this local group should represent BSES, local Cane Productivity Service and industry organisations. The Regional Manager, Plant Health from the relevant State/Territory department (from Biosecurity Queensland in Queensland) should also be a member. This group will report to the National 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 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) 6272 3933
   (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 Biosecurity
   Queensland Department of Primary Industries and Fisheries
   80 Ann Street
   BRISBANE QLD 4001
   Facsimile: (07) 3239 6994  Telephone: (07) 3239 3361

D. Chief Quarantine Officer (Plants)
   New South Wales Primary Industries
   161 Kite St
   ORANGE NSW 2800
   Facsimile: (02) 6391 3605  Telephone (02) 6391 3150
E. Chairman
CANEGROWERS
GPO Box 1032
BRISBANE QLD 4001
Facsimile: (07) 3864 6429  Telephone: (07) 3864 6444

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

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

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

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

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

K. Mill Directors and/or Mill Managers, Cane Productivity Service Chairmen, Mill Suppliers Committee, BSES Regional Extension Officer in the district in which the incursion occurs.

L. 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 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 (will be referred to here as SCCC to avoid confusion with State Pest Control Centre - 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, QCanes or State Department Manager of appropriate department (Program Manager)
- BSES senior extension officer for the 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 National Management Group (NMG) should be formed to oversee the implementation of the Emergency Response campaign (ER). ER operations will be carried out by a Local Pest Control Center (LPCC), which will be established in the area of incursion as soon as the pest is identified as exotic. The centre will operate under a State Pest Control Centre (SPCC) on the state level and a National Pest Control Head Quarters on the national level (NPCHQ). Those two groups coordinate communication between LPCC and CCEPP and provide strategic input into managing the ER. Composition of these centres and the Head Quarters 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 National 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 (preferably 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.

A Local Pest Control Centre (LPCC) will be formed, and this may include staff of the State Department, BSES, Cane Productivity Service or the equivalent, 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 Productivity Service 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.

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

AQIS - NAQS  
PO Box 96  
Airport Administration Centre  
Cairns International Airport  
Cairns, Queensland 4870  
Tel (07) 4030 7800  
Fax (07) 4035 9578  

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.

The survey team, operating through LPCC and initially consisting of sugar industry personnel, should initiate surveys 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 SPCC 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 CCEPP 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 a Sugarcane Pest Consultative Committee (will be referred to here as SCCC to avoid confusion with State Pest Control Centre - SPCC). SCCC will form a central part of the main CCEPP and will be in close contact with local groups such as Cane Productivity Services or their equivalents.

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

The 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 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 a *Scirpophaga* stemborer species 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, and on 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, e.g. 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 in Queensland and New South Wales, Cane Productivity Services (and equivalents) 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 (especially 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 plough out of infested fields. If there are many infested fields, it may be necessary to set a level of infestation that would require plough out (eg 10% 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 (e.g. hats and overalls) should be worn. All other clothing worn in an infested field, including hats, should be washed in hot water (>60°C). 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 that 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 Australian Pesticides and Veterinary Medicines Authority (APVMA), PO Box 6182, Kingston, ACT 2604; telephone 02 6210 4700, fax 02 6210 4813.

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 parasitoids 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.

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 (e.g. 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 Primary Industries and Fisheries 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 a *Scirpophaga* stemborer species 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.
4.0 ACKNOWLEDGEMENTS

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

5.0 REFERENCES


APPENDIX 1 - CONTACTS FOR IDENTIFICATION OF INSECTS

Confirmation of the identity of insects should be made through:

**DNA analysis**
BSES Indooroopilly

**Morphological identification**
CSIRO Entomology
Australian National Insect Collection (ANIC)
Clunies Ross Street, Acton, Canberra, ACT
GPO Box 1700
Canberra, ACT, 2601
☎: 02 6246 4040
Fax: 02 6246 4177
Email: enquiries@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 database and a summary report prepared and forwarded to the operations manager.
Sugarcane Stemborer Survey

Commercial Crops

<table>
<thead>
<tr>
<th>Farm Name:</th>
<th>Farm No:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mill Area:</td>
<td>Locality:</td>
</tr>
<tr>
<td>Block No:</td>
<td>Variety:</td>
</tr>
<tr>
<td>Crop Class:</td>
<td>Plant Source:</td>
</tr>
</tbody>
</table>

Movement of plants and machinery off property:  

Date of Inspection:  
Inspection method:  

<table>
<thead>
<tr>
<th>No. of infested plants located:</th>
<th>Sketch of field and location of infested plants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distribution in block:</td>
<td></td>
</tr>
<tr>
<td>GPS Co-ordinates of block and infested plants:</td>
<td></td>
</tr>
</tbody>
</table>

Sample number for insect specimens

Comments:..............................................................................................................................................................
..............................................................................................................................................................................
..............................................................................................................................................................................

Team Leader: .......................  Signature: .......................  Date:.......................
## Sugarcane Stemborer Survey
### Dwellings/Abandoned Cane

<table>
<thead>
<tr>
<th>Dwelling Location: (Street No./Local Authority No./GPS Co-ordinates):</th>
</tr>
</thead>
<tbody>
<tr>
<td>...........................................................................................................</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Owner/Occupier:</th>
</tr>
</thead>
<tbody>
<tr>
<td>...........................................................................................................</td>
</tr>
</tbody>
</table>

| Sugarcane no. stools: ..................................... | No. of infested plants: ..................................... |
|---------------------------------------------------------------|

### Type of sugarcane -

<table>
<thead>
<tr>
<th>Noble: .....................................</th>
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</thead>
<tbody>
<tr>
<td>Edule: .....................................</td>
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<tr>
<td>Commercial: .....................................</td>
</tr>
<tr>
<td>Spontaneum: .....................................</td>
</tr>
</tbody>
</table>

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

**Sample number for insect specimens**

<table>
<thead>
<tr>
<th>Comments: ....................................................................................................................</th>
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</table>

<table>
<thead>
<tr>
<th>Team Leader: .....................................</th>
<th>Signature: .....................................</th>
<th>Date: .....................</th>
</tr>
</thead>
</table>
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 and Fisheries.

From the office of

NEWS RELEASE

.......................................................... MP

Minister for Primary Industries and Fisheries

Date

Program to Eradicate NAME OF PEST

The Queensland Primary Industries and Fisheries Minister, ........................................... said today that SCIRPOPHAGA STEMBOORDER had been detected on a sugarcane farm in the NAME OF AREA with the property immediately being quarantined.

Mr ........................................ said BSES Limited 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 …………………………………….. are available.

SCIRPOPHAGA STEMBOORDER is a serious pest of sugarcane that can reduce yields.

“This is the first suspected case of SCIRPOPHAGA STEMBOORDER in Australia and a control plan developed by BSES with assistance from State and Federal Governments has been activated,” Mr. ......................................... said.

“Under the plan, an Industry-Government 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, the Federal Government and the QDPI&F 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 SCIRPOPHAGA STEMBORER
Location map of outbreak
### APPENDIX 4 - ABBREVIATIONS USED IN THIS REPORT

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFFA</td>
<td>Department of Agriculture, Fisheries and Forestry - Australia</td>
</tr>
<tr>
<td>ANIC</td>
<td>CSIRO Entomology, Australian National Insect Collection</td>
</tr>
<tr>
<td>APVMA</td>
<td>Australian Pesticides and Veterinary Medicines Authority</td>
</tr>
<tr>
<td>AQIS</td>
<td>Australian Quarantine and Inspection Service</td>
</tr>
<tr>
<td>BSES</td>
<td>BSES Limited</td>
</tr>
<tr>
<td>CA</td>
<td>Control Area</td>
</tr>
<tr>
<td>CCEPP</td>
<td>Consultative Committee on Exotic Plant Pests</td>
</tr>
<tr>
<td>CEO</td>
<td>Chief Executive Officer</td>
</tr>
<tr>
<td>CPPO</td>
<td>Chief Plant Protection Officer</td>
</tr>
<tr>
<td>CSIRO</td>
<td>Commonwealth Scientific and Industrial Research Organisation</td>
</tr>
<tr>
<td>DCP</td>
<td>Dangerous Contact Premises</td>
</tr>
<tr>
<td>GIMP</td>
<td>Generic Incursion Management Plan</td>
</tr>
<tr>
<td>IP</td>
<td>Infested Premises</td>
</tr>
<tr>
<td>LPCC</td>
<td>Local Pest Control Centre</td>
</tr>
<tr>
<td>MRL</td>
<td>Maximum Residue Limit</td>
</tr>
<tr>
<td>NAQS</td>
<td>Northern Australia Quarantine Strategy</td>
</tr>
<tr>
<td>NMG</td>
<td>National Management Group</td>
</tr>
<tr>
<td>NPCHQ</td>
<td>National Pest Control Head Quarters</td>
</tr>
<tr>
<td>PHC</td>
<td>Plant Health Committee</td>
</tr>
<tr>
<td>PISC</td>
<td>Primary Industries Standing Committee</td>
</tr>
<tr>
<td>QDPI&amp;F</td>
<td>Queensland Department of Primary Industries and Fisheries</td>
</tr>
<tr>
<td>RA</td>
<td>Restricted Area</td>
</tr>
<tr>
<td>SCARM</td>
<td>Standing Committee on Agricultural Resource Management</td>
</tr>
<tr>
<td>SIMS</td>
<td>SCARM Incursion Management Strategy</td>
</tr>
<tr>
<td>SP</td>
<td>Suspect Premises</td>
</tr>
<tr>
<td>SCCC</td>
<td>Sugar Cane Consultative Committee</td>
</tr>
<tr>
<td>SPCC</td>
<td>State Pest Control Centre</td>
</tr>
<tr>
<td>STF</td>
<td>SCARM Task Force on Incursion Management</td>
</tr>
</tbody>
</table>
APPENDIX 5 - DOSSIER ON SCIRPOPHAGA SPP. AS PESTS OF SUGARCANE

Genus Scirpophaga Treitschke 1832

The genus Scirpophaga Treitschke belongs to the family Pyralidae, subfamily Schoenobiinae. Members of this genus are mainly stem borers of graminaceous crops. The genus is distributed in the Palaearctic, Ethiopian, Oriental and Australian regions. It is especially important in the Indian subregion, where species are pests of rice and sugarcane (Arora 2000).

Some species have a restricted host range, such as the rice borer Scirpophaga incertulas (Walker), whilst others have a wide host range, such as S. nivella (Fabricius) and S. excerptalis (Walker). Lewvanich (1981), who provided a thorough revision of this previously confused genus, lists 35 species of Scirpophaga, two of which are “recorded” from sugarcane. These are S. excerptalis and S. innotata (Walker). The latter species is known to be strictly a pest of rice, and there are no documented references of this species attacking cane anywhere the pest exists; therefore, that record is highly doubtful. Another species, S. magnella de Joannis, which is morphologically very similar to S. excerptalis, is listed by Lewvanich (1981) as feeding on Saccharum sp. in Bangladesh, and on Saccharum bengalense in Pakistan.

One important finding of Lewvanich (1981) was that Scirpophaga nivella is not a pest of sugarcane, and all the references to this species in cane are referable to S. excerptalis, since S. nivella is mainly a pest of rice.

In the current document, information is provided on S. excerptalis and S. magnella. Information on S. nivella is also presented here, based on a large number of references which refer to this species as a pest of sugarcane. Many references from India and Indonesia still refer to the ‘sugarcane top borer’ as S. nivella. It is important, therefore, to confirm the identity of Scirpophaga borers in India and Indonesia before any control strategies are to be put in place.

The followings are the main characteristic features of the Schoenobiinae based on Lewvanich (1981) and Arora (2000): Head with the frons rounded; ocelli present; labial palpi generally porrect, sometimes upturned or turned downwards distally, size variable; maxillary palpi present, generally porrect and not exceeding half the length of labial palpi, probosces absent; antennae filiform, finely ciliated, or weakly serrate in male; ciliation confined to ventral surface, the dorsal surface smoothly scaled. Chaetosema present. Hindwings with frenulum spine single in male and held by a well-developed retinaculum process or bar from subcostal vein of forewing underside; in female, the spine is single or more but held by a cluster of bristles from cubital vein of forewing underside; mid and hind tibiae with unequal pair of spurs, the outer ones being the shorter. Abdomen slender; tympanal organs present and located near the base of abdomen; praecinctorium present, simple, with the tympanic bullae medially fused; a large flattened scale-tuft generally presenting male, extending from the posterior median of seventh sternite to the eighth sternite; this membranous area possesses another tuft of flattened and shorter scales; female devoid of any such tufts, but with anal tufts at the posterior tip mainly to cover eggs during oviposition. The tufts in female variously coloured, which help in identifying various species. Venation. Forewing: Vein R1 free, or confluence with Sc; Rs, R3, R5 free, or stalked with R3+4; Cu2 (Cuu) generally developed only near the margin. Hindwing: Vein Sc stalked with Rs for a short distance beyond angle, after latter's origin; Rs-M1 short stalked, from angle of cell; Cu2 only developed near margin.

The following is a key to Asian species of economic importance in the genus Scirpophaga based on Arora (2000):

1. Forewing with the vein R1 anastomosed with Sc .......................................................................................... 2
   - Forewing with the vein R1 free from Sc ................................................................................................... 5
2. Forewings upperside ochreous in both sexes; hindwing with the frenulum spine single in male, double fused in female. Labial palpi twice the diameter of eye. Anal tufts in female ochreous white . ................................................................. Scirpophaga whalleyi Lewvanich
   - Forewings upperside ochreous only in male, or white in both sexes; hindwings with the frenulum spines single in both sexes .................................................................................................................. 3
3. Forewings upperside ochreous white to yellowish in male, white in female; underside fuscous in male, white in female. Labial palpi about 2.5 times the diameter of eye. Anal tufts in female yellowish .......................................................................................................................... Scirpophaga xanthogastrella (Walker)
   - Forewings upper and underside white in both sexes. Labial palpi 1.5 times the diameter of eye ...... 4
4. Anal tufts orange red in female ................................. *Scirpophaga excerptalis* (Walker)
   - Anal tufts yellowish in female ................................. *Scirpophaga magnella* de Joannis

5. Forewings upperside ochreous yellow in male, with, or without spots on submedian area and lower angle; with an oblique series of spots from apex in male, ochreous yellow or whitish in female, with or without spot at lower angle .......................................................... 6
   - Forewing upperside pale ochreous or white in both sexes, without any markings ....................... 8

6. Labial palpi much longer, about 3-4 times the diameter of eye, and porrect. Forewings with the vein R₁ curved, running close to Sc, sometimes touching it; upperside ochreous in both sexes; hindwing with the frenulum spine double in female; anal tufts pale ochreous in female ...................................................... 6
   - Labial palpi shorter, not more than twice the diameter of eye. Forewings with the vein R₁ running close to Sc, without touching it; upperside whitish in female; hindwing with the frenulum spine single or double in female ............................................................................................................................................. 7

7. Labial palpi 1.3 times the diameter of eye. Hindwings with the frenulum spine double in female.
   - Labial palpi 1.5 times the diameter of eye. Hindwings with the frenulum spine single in female.

8. Labial palpi about twice the diameter of eye. Hindwings with the frenulum spine double in female.
   - Labial palpi equal to diameter of eye. Hindwings with the frenulum spine single in both sexes. Anal tufts whitish to pale ochreous in female ............................................................................................................................................. 9

9. Specimens larger ........................................................................ *Scirpophaga fusciflua* Hampson
   - Specimens smaller ........................................................................ *Scirpophaga virginia* Schultze

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**Genitalia of *S. incertulas***

**Genitalia of *S. innotata***
Although some Asian members of the genus *Scirpophaga* are major pests of rice and, to a lesser degree, sugarcane, African species do not seem to be of any significance to gramineous crops and are not extensively studied (Maes 1998).
**Scirpophaga excerptalis** (Walker)

*Chilo excerptalis* Walker 1863  
*Scirpophaga monostigma* Zeller 1863  
*Scirpophaga butyrota* Meyrick 1889  
*Scirpophaga intacta* Snellen 1890  
*Scirpophaga excerptalis* (Walker): Hampson 1895  
*Scirpophaga chrysorrhoa* Zeller sensu Hampson 1895 (misidentification)  
*Scirpophaga auriflua* Zeller: sensu Hampson 1895 (misidentification)  
*Topeutis* (*sic*) *rhodoproctalis* Hampson 1919  
*Scirpophaga xanthogastrella* (Walker): sensu Fletcher and Gosh 1920 (misidentification).  
*Scirpophaga nivella* (F.): sensu Shibuya 1928 (misidentification).  
*Tryporyza butyrota* (Meyrick): Common 1960  

This species has also been referred to as *Tryporyza nivella intacta* Snellen in some references (Pu et al. 1988; Alba 1990; 1991), see also Samoedi (1988a).

**IMPORTANT**

This species has been incorrectly referred to as *Scirpophaga nivella* in several publications. It is now confirmed that *S. excerptalis* and *S. nivella* are two different species, with *S. nivella* being strictly a pest of rice and not occurring in cane (Lewvanich 1981). However, several recent publications still refer to *S. excerptalis* as *S. nivella*. Only references using the name *S. excerptalis* are cited in this chapter.

### Common names
Top borer, sugar cane top borer, top shoot borer.

### Distribution
Bangladesh, Bhutan, China, India, Indonesia, Japan, Malaysia, Nepal, Pakistan, Philippines, Papua New Guinea, Singapore, Sri Lanka, Taiwan, Thailand, Vietnam (Arora 2000).

### Host plants
*Scirpophaga excerptalis* is mainly a pest of sugarcane. Other hosts include *Chloris barbata*, *Echinochloa colona*, *Erianthus arundinaceum*, *E. munja*, *E. ravennae*, *Naranga prophyrocoma*, *Panicum* sp., *Pennisetum purpureum*, *Saccharum spontaneum*, *Sclerostachya fuscct*, *Sorghum bicolor* and *Sorghum halepense* (Arora 2000).

### Symptoms
Common symptoms of infestation are the appearance of parallel rows of ‘shot holes’ on leaves, a red streak caused by mining inside the midrib, deadhearts and a bunchy top appearance of shoots (Arora 2000).

### Economic impact
*Scirpophaga excerptalis* is considered to be a major pest of sugarcane in many parts of India. Reductions in yield and sugar contents of up to 51% and 2.0 units, respectively, were recorded in Indian cane fields (Pandey et al. 1997a; Madan et al. 1999). In a study in Karnal, India, during the 1997-98 and 1998-99 seasons, sugarcane infestation by *S. excerptalis* resulted in 30.08% weight loss and decreased cane length by 24.39% (Madan & Singh 2001). In Uttar Pradesh, India, a study by Singh & Singh (1997) recorded reductions in cane stalk length by up to 68.0%, the number of internodes by up to 67%, cane weight by up to 86%, and CCS by up to 25.90% due to borer infestation.

### Morphology
Arora (2000) gives the following description of this species:
Head with the frons smooth; labial palpi porrect, about 1.5 times the diameter of compound eye, sometimes slightly longer but never more than twice the diameter of eye; ocelli present, small; antennae simple in both sexes, profusely ciliated in male, sparsely in female, about half the length of forewing-costa in male and two-fifths the length in female (shorter in female). Hindwing with frenulum single in both sexes.
Above: *Scirpophaga excerptalis* larva in growing point.

Above: Male (left) and female (right) *Scirpophaga excerptalis*.

Above: Formation of dead heart caused by *Scirpophaga excerptalis* larva.

Above: Dead top due to *Scirpophaga excerptalis*. 
**Male**

Head with the frons white; labial palpi white, sometimes suffused with fuscous; antennae generally dark. Thorax upperside white, underside pale ochreous, suffused with fuscous; legs generally white on insideside, fuscous on outside generally throughout up to claws, particularly in forelegs, fuscous suffusion sometimes reduced in tibia of mid- and hind legs. Abdomen white on upperside, pale ochreous on underside. Wings slightly shining white on upperside, pale ochreous on underside, sometimes suffused with fuscous, without or with a dark prominent spot at lower angle of cell in forewing.

**Female genitalia**

**Female**

As in male except that legs are more shining white, with less of fuscous suffusion on underside. Anal tufts brilliant orange-red.

**Female genitalia**

**Forewing**

Vein R₁ anastomosed fully with Sc, arising almost in line with Cu₁b below; R₂ a little before upper angle of cell; R₁+R₂ stalked, the stalk generally shorter than R₃ which is longer than R₃; R₃ from below the upper angle of cell; M₁ below R₃; M₂-M₃ very close to each other but not connate; Cu₁₅ slightly before lower cell-angle, close to M₃ and in line with the origin of R₂ above; Cu₁₉ from before the cell angle and Cu₁₁₅.

**Hindwing**

Sc free till about cell angle, beyond which it is anastomosed with Rs for halfway toward margin; M₁ from cell angle; M₂-M₃, Cu₁₆, Cu₁₉ as in forewing.

It is very important to realize that this species has for a long time been erroneously referred to as *Scirpophaga nivella*. Lewvanich (1981) states clearly that *S. nivella* does not occur in cane, which poses a question mark regarding the status of *S. nivella* as a cane pest. In addition, Arora (2000) refers to this confusion of identity and states that a large number of specimens identified as *S. nivella* has been re-
examined in India and found to be *S. excerptalis*. However, he states that about 35 male and female specimens present in the Indian Institute of Sugarcane Research (IISR), Lucknow, were true *S. nivella* that were collected from sugarcane fields. It is also important to realise that no further records of *S. nivella* in cane have been made at the IISR in Lucknow since 1972. Hence, a survey of pyralids in cane fields of Lucknow (where the insects were collected) is envisaged by Indian taxonomists to establish whether *S. nivella* is associated with sugarcane. The confusion in the identity of *S. excerptalis* and *S. nivella* was resolved by Lewvanich (1981) who differentiated the two species based on the following set of characters:

<table>
<thead>
<tr>
<th>Character</th>
<th><em>S. excerptalis</em></th>
<th><em>S. nivella</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Labial palpi</td>
<td>1.5-2 times the diameter of eye</td>
<td>1.3 times the diameter of eye</td>
</tr>
<tr>
<td>Vein R₁</td>
<td>Anastomosed with Sc in forewing</td>
<td>Free</td>
</tr>
<tr>
<td>Frenulum spine in female</td>
<td>Single</td>
<td>Double</td>
</tr>
<tr>
<td>Anal tufts in female</td>
<td>Orange-red</td>
<td>Ochreous</td>
</tr>
<tr>
<td>Male forewing</td>
<td>White</td>
<td>Ochreous, with oblique band of spots from apex</td>
</tr>
</tbody>
</table>

**Detection methods**

*Scirpophaga excerptalis* adult moths are characterised by both wings being shining white in both sexes on both upper and underside. Females have characteristic orange-red anal tufts not found in any other *Scirpophaga* species. R₁ vein is anastomosed with Sc in forewings and frenulum spine is single in females (Arora 2000).

Trials in sugarcane plantations in Zhanjiang, Guangdong Province, China, showed that the greatest number of *S. excerptalis* males were attracted to traps baited with a 7:3 ratio of (E)-11-hexadecenal to (Z)-11-hexadecenal (Liu *et al.* 1992).

**Biology and Ecology**

Adult females of *Scirpophaga excerptalis* lay their eggs in masses on the lower surface of the leaves. Singh *et al.* (1999) showed that the distribution of egg masses on sugarcane leaves followed a positive binomial distribution. On the other hand, a study conducted in a cane farm at Ishurdi, Bangladesh Sugarcane Research Institute, showed that the dispersion pattern of the egg masses follows a Poisson distribution, in contrast with that of the larvae, which showed an aggregated pattern (Kundu *et al.* 1996). Studies in India suggested that collecting of egg masses mechanically during the first and second broods is an economic method to reduce the damage caused by the third generation significantly (Madan *et al.* 1999).

Studies in India showed that *S. excerptalis* has five broods (generations) during the cane-growing season. Reports from the states of Punjab and Haryana reveal that the third brood in particular is the most damaging (Duhra & Sharma 1993; Chaudhary & Yadav 1995; Pandey *et al.* 1997a). Gangwat *et al.* (2003) stated that the third brood of *S. excerptalis* was responsible for the greatest losses in cane weight (74.36%) and juice (81.43%) in Lucknow, Uttar Pradesh, India.

In Haryana, India, Mukunthan (1985) recorded four larval instars in both the second and third generations as determined from head capsule widths. In the laboratory, first-instar larvae tended to enter the midrib of the first leaf of growing plants via the lower epidermis, which is the only part of the leaf exposed at this stage. Larvae tunnel in the same midrib for 24-48 h and emerge through the upper epidermis. Two or three first- or second-instar larvae, or more rarely third instars, can be found in the spindle of stems, and, due to competition for food, only one larva ultimately survives in the region near the growing point of the stem.

In a study in Haryana, India, Sardana & Das (2001) showed that high temperature coupled with intermittently high rainfall and humidity favoured *S. excerptalis* infestation. In Karnal, India, the highest incidences of the borer infestation (41.48 and 36.51%) were recorded in October, while the lowest (13.27 and 12.06%) were recorded in May (Madan & Singh 2001). Similarly in the Punjab, Shenhmar & Brar (1996) recorded *S. excerptalis* as being active from March to October, with most of the damage inflicted during July-August. The borer starts appearing in cane fields in the northern Indian states of Punjab and Haryana in mid March to mid May, and the population is generally very low (first brood). During the second brood (mid May to end June), temperature is usually high and this keeps the population under check. The third brood (July-August) coincides with the onset of monsoons, when climatic conditions favour the multiplication of the pest. Hence, this generation is the most destructive to shoots and causes reduced
tilling. Populations start declining during the fourth generation (August-September) and reach a minimum during the overwintering fifth generation (October-March) (Madan et al. 1999).

Larvae feed on the growing points of cane plants causing deadhearts and reducing tilling. In India, Saikia et al. (1994) recorded an increase in the incidence of *S. excerptalis* as levels of nitrogen fertilizers increased, with the lowest borer incidence (5.56%) recorded at 0 kg N/ha.

In a study on the key mortality factors of *S. excerptalis* in Haryana, India, results showed that parasitization of various stages and failure of neonate larvae to enter the midribs were the key mortality factors common on all the host plants, with *Telenomus* sp. causing the highest mortality of the egg stage. The first three larval instars were not attacked by parasitoids, but the final instar was attacked by *Rhaconotus scirpophagae* (Hymenoptera: Braconidae) and *Isotima javensis* (Hymenoptera: Ichneumonidae), and the pupae by the *Stenobracon deesae* (Hymenoptera: Braconidae) and *Xanthopimpla predator* (Hymenoptera: Ichneumonidae) (Mukunthan 1989).

**Management**

**Chemical control**

Phosphamidon, a systemic organophosphorus insecticide, reduced top borer incidence and increased cane yield over control by 53.25 and 34.12% at Saraiya sugar factory in Uttar Pradesh, India, respectively (Pandey and Solanki 2007).

In Assam, India, malathion 10% dust at 2.0 kg ai/ha reducing the infestation of *S. excerptalis* along with *Chilo tumidicostalis* from 57.59 and 66.42% in untreated controls to 15.71 and 16.25%, respectively (Deka et al. 1999b). While in Gujarat, three treatments of phorate 10 G at 1 kg a.i./ha reduced incidence of top borer to only 1.82%, and also minimized damage by other cane borers (Pandya 1997). In Orissa, Aldrin 30 EC was shown to reduce borer infestation by up to 78.63% (Jena et al. 1994), while in Haryana, two applications of carbofuran granules at 1.0 kg a.i./ha effectively reduced the borer's 3rd and 4th brood attack in ratoons, with application at the end of July being better than at the end of June (Mrig & Chaudhary 1992).

In the state of Bihar, India, nitrogen fertilizers mixed with gamma HCH (lindane), urea mixed with lindane, compost soaked urea with lindane, neem cake blended with urea and lindane, and a combination of the latter two treatments applied at planting reduced the incidence of the third and fourth borer generations. Compost soaked urea in combination with lindane gave the maximum increase in cane height and leaf area (Yazdani et al. 1993). In Lucknow, Uttar Pradesh, basal application of Furadan at 1.0 kg/ha in the last week of June proved effective (Tanwar et al. 2003), while the application of carbofuran at 1 kg a.i./ha combined with the collection and destruction of egg masses was recorded to be highly effective (Gangwar et al. 2003).

In Navsari, India, a “maximum protection” approach comprised of: sett treatment with 0.1% dimethoate; 1 kg carbofuran/ha at 30 days after planting (DAP) and 1 kg phorate/ha at 60 DAP; 0.075% endosulfan at 120 DAP; 1 kg carbofuran/ha at 150 DAP; release of *Trichogramma chilonis* 7 times at 40000 parasites per hectare at 15 days interval beginning from 135 DAP and the detrashing of lower leaves at 6, 7 and 8 months after planting (Pandya & Patel 2007).

In Padrauna, India, plant extracts of *Eucalyptus rostrata* reduced bore infestation to only 3% following application (Pandey & Singh 1998).

Treatment with 2.0% Multineem (a neem oil based product) resulted in the lowest top borer incidence (3.93%) when applied against third brood in field trials in India (Tewari 2001). While treatment with Nimbicidine (a neem-based insecticide) at 2.5 L/ha in March, April and August was effective in suppressing top borer populations in Bangladesh (Abdullah et al. 2006).

**Biological control**

The following is a list of natural enemies recorded to attack the different stages of *S. excerptalis*:

**Apanteles (Cotesia) flavipes Cam. (Hymenoptera: Braconidae):** Larval parasitoid, recorded in the Philippines and Thailand (Alba 1990; Suasa-ard & Charensom 1995).

**Elasmus zehntneri Ferr. (Hymenoptera: Elasmodidae):** Gregarious larval ectoparasitoid. Recorded to attack *S. excerptalis* in Uttar Pradesh and in North Bihar, India (Gupta et al. 1994; Pandey et al. 1997a; Tanwar & Varma 1997; Singh et al. 2002). Egg and larval periods combined were 7.12 ± 0.83 days, and the pupal period was 11.30 ± 2.12 days. Male and female adults lived for 13.75 ± 2.59 and 17.0 ± 2.13 days, respectively (Tanwar 1990).

**Glyptomorpha (=Stenobracon) nicevillei Bingham (Hymenoptera: Braconidae):** Larval parasitoid, recorded in cane fields of Uttar Pradesh, India (Tanwar & Varma 1997).
**Heterorhabditis indicus** Poinar (Nematoda: Heterorhabditidae): A species of nematodes described from populations recovered from *S. excerptalis* in Coimbatore, India (Poinar et al. 1992).

**Isotima javensis** Row. (Hymenoptera: Ichneumonidae): A solitary larval ectoparasitoid that attacks late instar larvae and the prepupal stage of *S. excerptalis* in North Bihar and Uttar Pradesh, India (Easwaramoorthy et al. 1992; Tanwar & Varma 1997); also recorded from the pupal stage (Gupta et al. 1994; Pandey et al. 1997a). In the Punjab, India, Shenhar & Brar (1996) conducted field releases of this parasitoid and recorded parasitism levels of up to 52%. Damage by *S. excerptalis* where the parasitoid was released was reduced to 10% compared to 22% in the control.

**Melcha ornatipennis** Cameron (Goryphus ornatipennis) (Hymenoptera: Ichneumonidae): Pupal parasitoid. Low parasitism levels were recorded in Uttar Pradesh, India (Singh et al. 2002).

**Pseudoshirakia sp.** (Hymenoptera: Braconidae): Larval parasitoid, recorded in Eastern Uttar Pradesh cane fields, India, parasitizing *S. excerptalis* in low levels (Tanwar & Varma 1997).

**Rhaconotus sp.** (Hymenoptera: Braconidae): Larval parasitoid, recorded in India (Pandey et al. 1997a).

**Rhaconotus scirpophagae** Wlk. (Hymenoptera: Braconidae): Larval parasitoid, recorded attacking *S. excerptalis* in Indian cane fields. Maximum parasitization (33.42%) was recorded in August in the state of North Bihar (Gupta et al. 1994), also recorded to be abundant in Uttar Pradesh (Tanwar & Varma 1997; Singh et al. 2002).

**Rhoptromeris sp.** (Hymenoptera: Eucoilidae): Larval parasitoid, recorded in Eastern Uttar Pradesh cane fields, India (Pandey et al. 1997a).

**Spathius sp.** (Hymenoptera: Braconidae): Larval parasitoid. Recorded in Eastern Uttar Pradesh cane fields, India, parasitizing *S. excerptalis* in low levels (Tanwar & Varma 1997).

**Stenobracon deesae** Cam. (Hymenoptera: Braconidae): Solitary larval ectoparasitoid, recorded by Gupta et al. (1994) to be the most prevalent parasitoid of *S. excerptalis* in all cane crops in North Bihar, India. Peak parasitization (54.80%) was recorded in June - August. Also recorded in Uttar Pradesh (Singh et al. 2002).

**Stenobracon sp.** (Hymenoptera: Braconidae): Recorded in Papua New Guinea to be a key parasitoid of this species in *Saccharum spontaneum* (wild cane), but rarely found in commercial crops (Kuniata & Korowi 2005).

**Telenomus beneficiens** (Zehntner) (Ceraphron) (Hymenoptera: Scelionidae): Egg parasitoid. Parasitism levels of up to 43.8% were recorded in Andhra Pradesh, India (Rajak & Varma 2001).

**Telenomus dignus** Gahan (Hymenoptera: Scelionidae): Egg parasitoid. Recorded to cause parasitism of up to 47.1% of the egg masses in cane fields of Eastern Uttar Pradesh, India (Pandey et al. 1997a; Tanwar & Varma 1997). In Orissa, India, field records attribute 14.63% percentage parasitism to this species in sugarcane (Jena & Patnaik 1997).


**Tetrastichus howardi** (Olliff) (Hymenoptera: Eulophidae): A gregarious pupal endoparasitoid. Recorded attacking pupae of *S. excerptalis* in Uttar Pradesh, India (Baitha 2007). However, *T. howardi* is a polyphagous facultative hyperparasitoid which attacks a wide range of hosts including other parasitoids, hence, the option for its use in introduction biological control should be reconsidered.


**Trichogramma chilonis** Ishii (Hymenoptera: Trichogrammatidae): Egg parasitoid. Recorded to attack eggs of *S. excerptalis* in Uttar Pradesh cane fields in India (Tanwar & Varma 1997). This species was also used in inundative releases in cane fields of Eastern Uttar Pradesh at the rate of 20,000 wasps/acre/week, which resulted in percentage parasitism of only 10 - 15% (Pandey et al. 1997a). More recent results from Uttar Pradesh showed that 12 sequential releases of 50000 adults/ha at 10 days intervals proved effective in reducing top borer infestation (Singh 2006).


Pheromone trapping
Trials in sugarcane plantations in Zhanjiang, Guangdong Province, China, showed that the greatest number of *S. excerptalis* males were attracted to traps baited with a 7:3 ratio of (E)-11-hexadecenal to (Z)-11-hexadecenal (Liu *et al.* 1992).

Host resistance
Resistance in sugarcane to *S. excerptalis* infestation has been investigated in India. Chaudhary & Yadav (1998a) examined 30 sugarcane genotypes of known susceptibility to *S. excerptalis* and showed a positive correlation between incidence of top borer and moisture present in leaf blades, mid ribs and growing points. On the other hand, there was a negative correlation between dry matter content of these plant parts and borer incidence. In another study, Chaudhary & Yadav (1998b) showed that the presence of lignin in midribs of genotypes had a significant negative correlation with borer incidence, but not in growing points or leaf blades. A negative correlation was found between total chlorophyll content in the mid ribs, growing points and leaf blades of different sugarcane genotypes and infestation by *S. excerptalis*, while the presence of nitrogen in the mid ribs, growing points and leaf blades showed a positive correlation with borer incidence (Chaudhary & Yadav 1995; 1996).

In a study in Haryana, India, Mukunthan & Mohanasundaram (1996) recorded that the larval period of borer, larval and pupal weight and borer fecundity did not differ in resistant and susceptible sugarcane hybrids. This suggested that no antibiosis mechanism operates in resistant varieties once the larvae are established in the spindle. In a tolerant host, the larval period was shortened and the larval and pupal weights were reduced. This was attributed to shortage of food supply due to the short spindle and thin stalk diameter. Mukunthan & Mohanasundaram (1998) observed two types of failures of attack by *S. excerptalis* in relation to sugarcane resistance to deadheart formation in Karnal (Haryana State) and Chakia (Bihar State) of India. Attacks were unsuccessful either because of failure of neonate larvae in the mid rib to reach the spindle or failure of older larvae in the spindle to reach the meristem (Type 2). Type 1 failure was frequent (19.2 to 26.7%) while Type 2 was rare (2.9 to 5.1%) among the genotypes they studied.

In the Indian Punjab, 14 varieties of sugarcane were screened for resistance to *S. excerptalis* and termites (*Odontotermes* spp.). Varieties with longer leaf spindles suffered less damage from the pyralid, while fast germinating varieties were less damaged by termites (Singla *et al.* 1988).

Intercropping
In Sangrur, Indian Punjab, autumn planted cane intercropped with radishes and turnips had the lowest incidence of the first brood of *S. excerptalis*. Similar results were obtained in sugarcane intercropped with sunflower and gobhi sarson (*Brassica campestris* var. *sarson*) (Singla *et al.* 1994). Intercropping cane with coriander (*Coriandrum sativum*), ajowan (*Carum copticum*), onions, garlic, fenugreek, fennel and black cumin (*Nigella sativa*) reduced incidence of the top borer, with ajowan as an intercrop giving the lowest incidence (4.8%), compared with control (sugarcane only) where borer incidence reached 14.65% (Varun *et al.* 1990). In Shahjahanpur, Uttar Pradesh, intercropping sugarcane with spices such as coriander (*Coriandrum sativum*), onion, methi (*Trigonella foenum-graecum*), garlic, souff, ajavan and mangrail (*Nigella sativa*) reduced the incidence of *S. excerptalis* and increased sugarcane yield. Intercropping with ‘ajavaan’ recorded the lowest incidence of the first brood (2.12%), second brood (1.88%) and third brood (2.88%) *S. excerptalis* (Singh *et al.* 2003).

Farming practices
In the Indian Punjab, an irrigation interval of 12-14 days or above in the spring, a higher plant density (24000 three-budded setts), and irrigation at a rate equivalent to the soil water content during the monsoon season resulted in a lower incidence of *S. excerptalis* (Singla & Duhra 1990).

In Uttar Pradesh, India, incidence of *S. excerptalis* and *Chilo auricilius* were markedly higher in the autumn and spring planted crops than the late spring-planted crop that had a negligible incidence. Early maturing cultivars were more susceptible to borer infestation than late-maturing cultivars (Singh *et al.* 1997).

In Sangrur, Indian Punjab, shoot damage by *S. excerptalis* was higher in east-west planted sugarcane, whereas this trend was reversed for *C. infuscatellus* (Singla & Duhra 1992).

Collection and destruction of pest egg masses, adults and infested shoots in April and May (first and second broods) was found to be a cheaper method of control than insecticide use (Madan & Singh 2000). Collecting egg masses is a common control method in India. In a big initiative in Bihar, over 11 million egg masses were collected in the 1987-88 cane season. Collected eggs were exposed in field cages so that
Trichogramma egg parasitoids could be conserved (Singh et al. 1989). In Haryana, the timely mechanical removal of top borer infested shoots or egg masses reduced the incidence of third brood by more than 50 % in all the cultivars studied (Jaipal 2000).

**Integrated Pest Management**
During 1993-95, an Integrated Pest Management approach for the control of *Scirpophaga excerptalis* was trialled on sugarcane at Seorahi, Uttar Pradesh, India. Control methods included egg-mass collection during oviposition by the first and second generations during March and May, treatment with carbofuran at 30 kg a.i./ha, and release of *Trichogramma chilonis* and *T. japonicum* at 50,000 adults/ha per week during the third generation. This management approach was reported to increase cane yield by 18.07% (Pandey et al. 1997b).

**Means of movement**
The most likely means of entry of *Scirpophaga excerptalis* into Australia would be by the introduction of infested planting material. 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:** High - close to commercial Australian areas and 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 present (see Match Indexes for climates at selected locations and principal Australian areas below).
Scirpophaga magnella (de Joannis)

Scirpophaga magnella de Joannis, 1929
Scirpophaga monostigma Zeller: sensu Hampson, 1895 (misidentification)
Scirpophaga auriflua Zeller: sensu Leech, 1901 (misidentification)

This species is morphologically almost identical to *S. excerptalis*; they can be separated using the following characters (Lewvanich 1981):

<table>
<thead>
<tr>
<th>Character</th>
<th><em>S. excerptalis</em></th>
<th><em>S. magnella</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Subteguminal process of the male genitalia</td>
<td>Takes the shape of a slender, long spine</td>
<td>Takes the shape of a stout, short spine</td>
</tr>
<tr>
<td>Colour of the anal tuft in female</td>
<td>Orange-red</td>
<td>Ochreous-yellow</td>
</tr>
<tr>
<td>Ostium bursae</td>
<td>Strongly wrinkled</td>
<td>Less wrinkled</td>
</tr>
</tbody>
</table>

Distribution
Afghanistan, Bangladesh, Burma, China, Hong Kong, India, Iran, Nepal, Pakistan, Thailand, Vietnam.

Host plants
*Scirpophaga magnella* is reported to feed on *Saccharum* sp. in India, Pakistan, Taiwan and the Philippines; *Saccharum bengalense* in Pakistan; *Erianthus munja* in India and found at rest on *Oryza sativa* in India (Lewvanich 1981).

Morphology

**Male genitalia**

**Female genitalia**

No further information is available on this species; it has probably been confused with *S. excerptalis* and studied under the name *S. nivella* (Lewvanich 1981).
**Scirpophaga nivella (F.)**

*Tinea nivella* Fabricius 1794  
*Crambus niveus* (Fabricius) Fabricius 1798  
*Scirpophaga chrysorrhoa* Zeller 1863  
*Scirpophaga auriflua* Zeller 1863  
*Scirpophaga brunnescens* Moore 1888  
*Scirpophaga butyrota* Meyrick: sensu Meyrick 1889 (misidentification)  
*Schoenobius celidias* Meyrick 1894  
*Schoenobius brunnescens* (Moore): Hampson 1895  
*Crambus nivella* (Fabricius) 1898  
*Apurima nivella* (Fabricius): Aurivillius 1898  
*Scirpophaga euclastalis* Strand 1918  
*Scirpophaga nivella* (Fabricius): Shibuya 1928

**Common names**  
Rice stem borer, white top moth borer.

**Distribution**  
Bangladesh, Borneo, Hong Kong, India, Indonesia, Malaysia, Pakistan, Philippines, Singapore, Sri Lanka, Taiwan, Thailand, Vietnam (Cheng 1999; Arora 2000).

**Status in Australia**  
The Checklist of the Lepidoptera of Australia (Nielsen et al. 1996) uses the name *chrysorrhoa* as an alternative species name for *Scirpophaga nivella*. Under that name, Common (1960) indicates that it is found in Northern Australia, extending southwards along the eastern coast to northern NSW. Specimens examined by Common (1960) from Australia were collected from the following regions: Queensland: Ayr, Bowen, Brisbane, Cairns, Cape York, Dunk Island, Halifax, Mackay, Stewart River, Silver Plains (Cape York Peninsula), Townsville; New South Wales: Brunswick Heads, Burringbar; Western Australia: Ivanhoe; Northern Territory: Bathurst Island, Darwin, Groote Eylandt, Humpty Doo, Marraki, Mary River, Melville Island, Stapleton.

**Host plants**

<table>
<thead>
<tr>
<th>IMPORTANT</th>
</tr>
</thead>
</table>
This species is mainly a pest of rice. Its status in sugarcane as a pest is now doubtful, since Lewvanich (1981) stated that *S. nivella* does not occur on sugarcane, and most records of this species in cane are referable to *Scirpophaga excerptalis* (see section on *S. excerptalis*). However, several recent references are available on this species as a pest of cane. What is presented here is based on these references, but it is important to realize that the status of the species in cane has to be revised. In addition, the suggestion that *Scirpophaga chrysorrhoa* in Australia is the same species as *S. nivella* in Asia requires further examination.

**Symptoms**  
Dead shoots appear as a result of tunnelling in the growing points. Early infestation results in thinning and stunting of cane, while later infestation leads to side shooting from the top buds (Samoedi 1995).

**Economic impact**  
Few references are available on the economic impact of *S. nivella* in cane. In a variety trial in West Java, Indonesia, yield losses caused in sugarcane due to top borer ranged between 8.51% and 9.28%, with early infestation of young canes contributing most to yield losses (Samoedi 1988b). Similarly, Samoedi (1995) recorded a reduction of sugar yield due to borer infestation in Java by an average of 9%.

**Morphology**  
Arora (2000) gives the following description of adult *Scirpophaga nivella*:  
Head with the frons smooth; labial palpi porrect, short and about 1.3 times the diameter of eye; antennae minutely serrate and profusely ciliated in male and simple and sparsely ciliated in female, about half the
length of forewing costa in male and one third in female. Outer tibial spurs half the length of inner ones. Frenulum spine single in male and held by a retinaculum bar; spines two in female, held by a cluster of bristles.

**Male**
Head, thorax and abdomen pale ochreous. Forewing ochreous to dark-greyish ochreous; with three fuscous spots on submedian fold, the fourth spot at lower angle of cell; an oblique series of fuscous spots from costa, near apex, to near third spot; a series of very small fuscous neural dots along termen, sometimes quite reduced. Underside: labial palpi dark. Legs dark, particularly the basal joints; forewings fuscous; hind wing semi-hyaline white, paler in basal half.

**Female**
Head, thorax, abdomen, wings and legs whitish on upper as well as underside. Wings unmarked on both sides. Anal tufts ochreous yellow.
Vein R₁ free, running straight to costa; R₂ free, from a little before the upper angle of cell; R₃+₄ on a long stalk; R₅, M₁ from below the upper angle of cell, nearly equidistant to R₃+₄; M₂, M₃ close to each other from lower angle; Cu₁a from before the angle, about twice as far from M₁ as the latter from M₂; Cu₁b also about twice as far from Cu₁a as the latter from M₃, and arising in line with R₁ above.

**Hindwing**
Vein Sc anastomosing with Rs, after the latter's origin from cell angle, for about basal one third; M₁ from cell angle and connate with Rs; M₂, M₃ close to each other at lower angle and, along with Cu₁a, placed as in forewing. Other features as given for the genus.

**Detection methods**
Check growing points for damage or presence of larvae. Pheromone can be used to attract adult moths.

**Biology and Ecology**
Kamani & Vyas (1985) studied the biology of *Scirpophaga nivella* in Gujarat, India, in the laboratory. Results showed that the average incubation period was 7.97 days, and durations of the first, second, third, fourth and fifth larval instars were 2.13, 4.63, 5.23, 5.85 and 6.42 days, respectively. The prepupal and pupal periods lasted 1.45 and 11.80 days, respectively. The lifespan of male adults averaged 3.63 days and that of the female 3.44 days. The mean number of egg masses deposited by each female was 4.22, and fecundity averaged 94.15 eggs/female. Recorded sex ratio (males to females) was 1:1.109.

Samoedi et al. (1995) conducted field studies in Ngadirejo, Indonesia, and showed that the borer distribution was contagious both in irrigated and unirrigated fields, and the economic threshold was determined at the infestation level of 4%.

In a survey carried out in sugarcane fields in Taiwan in 1974-84, *S. nivella* represented only 11.3% of the pest population complex, whilst *Argyropluschista ceana* (*Tetramoera schistacea*) and *Proceras venosatus* (*Chilo sacchariphagus sacchariphagus*) represented 67.9% and 9.9% of the total pest population, respectively (Cheng et al. 1987).

In sugarcane fields of the Punjab, India, Goel et al. (1983) studied mortality factors influencing population levels of the top borer, which included relative humidities below 40% in the second and third weeks of May, temperatures above 40°C in May-June, egg, larval and pupal parasites, failure of first-instar larvae to enter the mid ribs and leaf whorls and quick growth of the cane plants. Parasitism by *Telenomus* sp. was higher in the second generation studied than the first. Parasitism of late-instar larvae by *Isotima javensis* (Rohw.), *Rhaconotus scirphagae* Wlkn. and *Stenobracon nicevillei* (Bingham) was important in the third generation.

In rice fields, nightly light trap catches of *S. nivella* in West Bengal, India, showed two discrete peaks of abundance in each trap corresponding to conducive weather conditions and abundance of rice plants. Summer catches were significantly correlated with maximum temperature and minimum relative humidity during the day, and minimum temperature and wind speed at night, whereas autumn catches were significantly associated with maximum temperature and minimum relative humidity at night. Autumn crops had higher infestations, and sustained greater larval density than summer ones. Catches of immature and mature females were greatest at full moon and new moon, respectively (Banerjee et al. 1986).

**Management**
In India, soaking cane setts in monocrotophos 36 EC and phosphamidon 85 EC at 1.0% gave effective results against top borer as well as plassey borer (*Chilo tumidicostalis*). Insecticide soaking gave protection up to August, after which pest numbers increased, though crop yield did increase compared to untreated plots (Deka et al. 1999a).

In Pakistan, application of Furadan 3G (carbofuran) at germination and at earthing up gave the best control of *S. nivella*, *Chilo infuscetellus* and *Emmalocera depressella* (*Polyvoca depressella*) (Halimie et al. 1989). Other methods used in Pakistan include trash mulching at the time of sowing, removal of dead hearts, hand collection of egg masses and cutting of infested shoots at 15 days interval (Khaliq et al. 2005).
Resistant varieties
In Pakistan, work by Khaliq et al. (2005) showed that infestation was positively correlated with nitrogen, potassium, calcium, magnesium and ferrous plant contents. Phosphorous, carbohydrates, fats and zinc were correlated with lower infestation levels at tillering stage, with variety BF-162 and SPSG-26 being the most resistant.

Pheromone trapping
In Indonesia, studies showed that gland extracts of females contain the complex pheromones of hexadecenal (3%), (E)-11-hexadecenal (77%) and (Z)-11-hexadecenal (20%) (Permana et al. 1995).

Biological control
A large number of natural enemies are recorded on this pest, however, and according to Lewvanich (1981), they should be referred to S. exerptalis, since mostly all were recorded in cane. The following are only the main parasitoids recorded on this species; many other ambiguous records were discarded.

**Anastectus sp.** (Hymenoptera: Eulophidae): Larval parasitoid, recorded from India (Butani 1958).

**Apanteles flavipes** Cameron (Hymenoptera: Braconidae): Larval parasitoid, recorded from India (Butani 1958; Butani 1972).

**Apanteles scirpophagae** Ashmead (Hymenoptera: Braconidae): Larval parasitoid, recorded from India (Box 1953; Butani 1972).

**Aprostocetus sp.** (Hymenoptera: Eulophidae): Pupal parasitoid, recorded from India (Butani 1972).

**Bracon chinensis** Szepligeti (Hymenoptera: Braconidae): Larval parasitoid, recorded from India (Butani 1972).

**Bracon famulus** Bingham (Hymenoptera: Braconidae): Larval parasitoid, recorded from India (Butani 1972).

**Campyloneurus mutator** Fabricius (Hymenoptera: Braconidae): Larval parasitoid, recorded from India (Butani 1972).

**Elasmus sp.** (Hymenoptera: Elasmidae): Larval ectoparasitoid. Reported to attack mature *S. nivella* larvae in Indonesia (Samoedi 1993).

**Elasmus zehntneri** Ferriere (Hymenoptera: Elasmidae): Larval ectoparasitoid. Reported to attack fully grown larvae and prepupae of *S. nivella* in Indonesia. Parasitism rates were increased due to inundative releases from only 0.8% to almost 30%. One host larva produced up to 60 adult parasitoids both in the field and laboratory (Ubandi et al. 1988).

**Goniozus indicus** Ashmead (Hymenoptera: Bethylidae): Larval ectoparasitoid, recorded from India (Box 1953; Butani 1958, 1972).

**Harmoniae sp.** (Hymenoptera: Chalcididae): Larval parasitoid, recorded from India (Butani 1972).

**Iphiaulax famulus** Bingham (Hymenoptera: Braconidae): Larval parasitoid, recorded from India (Butani 1972).

**Iphiaulax sikkimenis** Cameron (Hymenoptera: Braconidae): Larval parasitoid, recorded from India (Butani 1972).

**Ischnojoppa luteator** F. (Hymenoptera: Ichneumonidae): Pupal parasitoid, recorded from India (Butani 1972).

**Isotima dammermani** Rohwer (Hymenoptera: Ichneumonidae): Pupal parasitoid, recorded from India (Butani 1972).

**Isotima javensis** (Rohw.) (Hymenoptera: Ichneumonidae): A solitary ectoparasitoid. Reported to attack mature larvae and prepupae of *S. nivella* in Indonesia (Samoedi 1993). In India, a native strain is responsible for good control of the top borer, especially in the south (Goel et al. 1983; Pawar 1987). Also recorded from Indonesia (Kalshoven 1981).

**Listrognathus** (*Mesostenoideus*) **calvinervis** Cameron (Hymenoptera: Ichneumonidae): Larval parasitoid, recorded from India (Butani 1958).

**Macrocentrus jacobsoni** Szépl. (Hymenoptera: Braconidae): Larval parasitoid, recorded from Taiwan (Box 1953).

**Melcha ornatipennis** Cameron (Hymenoptera: Ichneumonidae): Pupal parasitoid, recorded from India (Box 1953; Butani 1958) and Burma (Box 1953).

**Pharanus sp.** (Telenomus sp.) (Hymenoptera: Scelionidae): Egg parasitoid. Reported to attack mature *S. nivella* larvae in Indonesia (Samoedi 1993).

**Pimpla predator** Fabricius (Hymenoptera: Ichneumonidae): Pupal parasitoid, recorded from India (Box 1953).

**Rhaconotus roslinensis** Lal (Hymenoptera: Braconidae): Larval parasitoid, recorded from India (Butani 1972).

**Rhaconotus scirpophagae** Wilkinson (Hymenoptera: Braconidae): Larval parasitoid, recorded from Pakistan (Carl 1962) and India (Butani 1972; Box 1953).
*Rhaconotus signipennis* Walker (*Hymenoptera: Braconidae*): Larval parasitoid, recorded from India (Butani 1972).

*Shirakia yokohamensis* Cam. (*Hymenoptera: Braconidae*): Larval parasitoid, recorded from Taiwan (Box 1953).

*Stenobracon deesae* Cameron (*Hymenoptera: Braconidae*): Larval parasitoid, recorded from India (Box 1953; Butani 1958) and Pakistan (Carl 1962).

*Stenobracon karnalensis* Lal (*Hymenoptera: Braconidae*): Larval parasitoid, recorded from India (Butani 1972).


*Stenobracon nicevillei* Bingham (*Hymenoptera: Braconidae*): Larval parasitoid, recorded from India (Butani 1958; Goel et al. 1983).

*Stenobracon trifasciatus* Szépl. (*Hymenoptera: Braconidae*): Larval parasitoid, recorded from Taiwan, Indonesia and the Philippines (Box 1953; Kalshoven 1981).

*Sturmiosps inferens* Townsend (*Hymenoptera: Tachinidae*): Larval parasitoid, recorded from India (Butani 1972).

*Syzectus* sp. (*Hymenoptera: Ichneumonidae*): Larval parasitoid, recorded from India (Butani 1972).

*Telenomus beneficiens* (Zehntner) (Ceraphron) (*Hymenoptera: Scelionidae*): Egg parasitoid, recorded from India, Indonesia and the Philippines (Box 1953; Kalshoven 1981).

*Telenomus beneficiens* var. *elongatus* (*Hymenoptera: Scelionidae*): Egg parasitoid. Seasonal occurrence of this parasitoid was studied in Taiwan and parasitism rates as high as 68.4% were reached in the field. The parasitoid began emerging in March and reached a peak of 54.5 adults/312 m² in May then numbers declined gradually and none were found later than December (Cheng & Chen 1999).

*Telenomus dignus* Gahan (*Hymenoptera: Scelionidae*): Egg parasitoid, recorded from India (Butani 1972).

*Telenomus dignoides* Nixon (*Hymenoptera: Scelionidae*): Egg parasitoid, recorded from Indonesia (Mohyuddin 1987), Pakistan (Carl 1962) and India (Butani 1972).

*Telenomus rowani* Gahan (*Hymenoptera: Scelionidae*): Egg parasitoid, recorded from India (Butani 1972).

*Telenomus saccharicola* Mani (*Hymenoptera: Scelionidae*): Egg parasitoid, recorded from India (Butani 1972).

*Temelucha* sp. (*Hymenoptera: Ichneumonidae*): Larval parasitoid, recorded from India (Butani 1972).

*Tetrastichus ayyari* Rohwer (*Hymenoptera: Eulophidae*): Pupal parasitoid, recorded from India (Butani 1972).

*Tetrastichus schoenobii* (*Hymenoptera: Eulophidae*): Egg parasitoid, recorded from Indonesia (Mohyuddin 1987).

*Tetrastichus scirpophaga* Mani (*Hymenoptera: Eulophidae*): Egg parasitoid, recorded from Indonesia (Mohyuddin 1987).

*Trichogramma australicum* Girault (*Hymenoptera: Trichogrammatidae*): Egg parasitoid, recorded from India (Butani 1972).

*Trichogramma chilonis* (Ishii) (*Hymenoptera: Trichogrammatidae*): Egg parasitoid, recorded from China (Liu et al. 1996), Taiwan (Cheng et al. 1987) Inundative releases of this parasitoid in Al Noor Sugar Mills area of Pakistan reduced borer infestation significantly (Ashraf & Fatima 1996).

*Trichogramma evanescens minutum* Riley (*Hymenoptera: Trichogrammatidae*): Egg parasitoid, recorded from India (Butani 1958).

*Trichogramma japonicum* Ashmead (*Hymenoptera: Trichogrammatidae*): Egg parasitoid, recorded from Taiwan (Cheng and Chen 1999).

*Trichogramma nanum* Zhnt. (*Hymenoptera: Trichogrammatidae*): Egg parasitoid, recorded from Indonesia (Box 1953).

*Vipio deesae* (Cameron) (*Hymenoptera: Braconidae*): Larval parasitoid, recorded from India (Butani 1972).

*Xanthopimpla stemmator* Thunberg (*Hymenoptera: Ichneumonidae*): Pupal parasitoid, recorded from Taiwan (Box 1953) and India (Butani 1972).

**Predators**

*Brumus suturalis* F. (*Coleoptera: Coccinellidae*): Recorded feeding on eggs of *Scirpophaga nivella* (Fabr.) in India (Butani 1958).

*Brumus* (*Coccinella*) *suturalis* Fabricius (*Coleoptera: Coccinellidae*): Recorded feeding on eggs of *Scirpophaga nivella* (F.) in India (Butani 1972).
Other species of *Scirpophaga*

The followings are the remaining *Scirpophaga* spp as listed by Lewvanich (1981), they are not recorded from sugarcane thus unlikely to be of any pest status in this crop.

*Scirpophaga praelata* (Scopoli)
*Scirpophaga xanthopygata* (Schawerda)
*Scirpophaga parvalis* (Wileman)
*Scirpophaga phaedima* Common
*Scirpophaga gilviberbis* Zeller
*Scirpophaga perca* Common
*Scirpophaga imparella* (Meyrick)
*Scirpophaga xantharrenes* Common
*Scirpophaga melanoclista* Meyrick
*Scirpophaga xanthogastrella* (Walker)
*Scirpophaga brunnealis* (Hampson)
*Scirpophaga ochritinctalis* (Hampson)
*Scirpophaga bradleyi* Lewvanich
*Scirpophaga khasis* Lewvanich
*Scirpophaga flaviodorsalis* (Hampson)
*Scirpophaga melanostigma* (Turner)
*Scirpophaga tongyaii* Lewvanich
*Scirpophaga occidentella* (Walker)
*Scirpophaga fusciflua* Hampson
*Scirpophaga ochroleuca* Meyrick
*Scirpophaga virginia* Schultze
*Scirpophaga subumbrosa* Meyrick
*Scirpophaga marginepunctella* (de Joannis)
*Scirpophaga serena* (Meyrick)
*Scirpophaga goliath* Marion & Viette
*Scirpophaga lineata* (Butler)
*Scirpophaga aurivena* (Hampson)
*Scirpophaga auristorigella* (Hampson)
*Scirpophaga gotoi* Lewvanich
*Scirpophaga whalleyi* Lewvanich
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