FIRST RECORDS OF THE STEM BORER COMPLEX (LEPIDOPTERA: NOCTUIDAE; CRAMBIDAE; PYRALIDAE) IN COMMERCIAL SUGARCANE ESTATES OF ETHIOPIA, THEIR HOST PLANTS AND NATURAL ENEMIES

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Abstract

In 2003 and 2004, surveys were completed on sugarcane estates in Ethiopia to determine the lepidopteran stem borer species composition and the impact of natural enemies on the borers in sugarcane and in indigenous host plants. A total of 174 sugarcane plots and four species of indigenous host plants in irrigation canals, wetlands and field margins, were evaluated. Surveys revealed the presence of three lepidopteran stem borer species on sugarcane: *Busseola* sp., *Chilo partellus* and *Sesamia calamistis*. *Eldana saccharina* was recovered from indigenous sedges present in irrigation canals on Metehara and Wonji sugar estates. *Busseola* sp. was the predominant stem borer of sugarcane on Finchawa and Wonji estates. *C. partellus* and *S. calamistis* were recovered in very low numbers at all estates. Three parasitoid species, *Cotesia flavipes*, *Cotesia sesamiae* (both from larvae collected at Wonji Estate), and *Linnaemya* sp. (from Finchawa Estate) emerged from field-collected stem borer life stages. The percentage parasitism by these parasitoids was low, from 2.3 to 4.7%. Two fungal and one bacterial pathogen were isolated from larvae of the borers found. The bacterial pathogen, *Bacillus thuringiensis*, was found to be an important mortality factor of stem borer larvae in young sugarcane at Wonji estate, with an average parasitism of 34.9%.

Keywords: stem borers, Ethiopia, parasitoids, sedges, sugarcane, insect pests

Introduction

Sugarcane for chewing has been grown in Ethiopia for many years. However, the production of refined sugar has only recently commenced (EARO 2000). Commercial cultivation of sugarcane started in the early 1950s at Wonji sugar estate, East Shoa, located in the Rift Valley about 100 km south-east of the capital Addis Ababa (EARO 2000). At present commercial production of the crop in the country is restricted to three Government-owned estates (Wonji, Metehara and Finchawa) that grow sugarcane on 24 000 ha of land. Sugarcane on these estates is irrigated with water supplied from two perennial rivers, the Awash and Finchawa.

Damage by lepidopteran stem borers on Ethiopian sugarcane has long been recognised, but research data on the species composition and natural enemy complex were lacking, being limited to colloquial internal reports on each estate, and confidential consultant reports, not identifying borers found even at the generic level. Stem borer species found on the estates were simply referred to as 'shoot borer', 'top borer' and 'stem borer' based on the crop stage they attack, and the colour and size of the larvae. The two big estates of Wonji and Metehara are located in the upper course of the Awash River, and sugarcane is furrow irrigated. It is not uncommon to see water reservoirs and drainage canals covered with stands of indigenous sedges and grasses that are known to be natural hosts of stem borers (Polaszek and Khan, 1998). However, no survey has yet been done to determine the stem borer complex in these natural host plants.

This paper presents the first published results of surveys conducted to determine stem borer species composition, their host plants and their natural enemy complex in commercial sugarcane estates of Ethiopia.

Materials and Methods

Survey sites

Surveys were conducted on the Ethiopian government owned commercial sugarcane farms of Finchawa (09º52´N; 37º19´E; 1635 m.a.s.l.), Metehara (08º49´N; 39º58´E; 960 m.a.s.l.) and Wonji (08º31´N; 39º12´E; 1500 m.a.s.l.) (Figure 1). These farms are in the middle of the maize and sorghum belts of the country. The area in which the estates are located have mean daily temperatures ranges from 20.8 to 24.48ºC and receive a mean annual rainfall of 545 to 1208 mm. Currently, these farms plant more than 10 different varieties of sugarcane imported from different countries of the world (Tafesse and Haile-Michael, 2001).

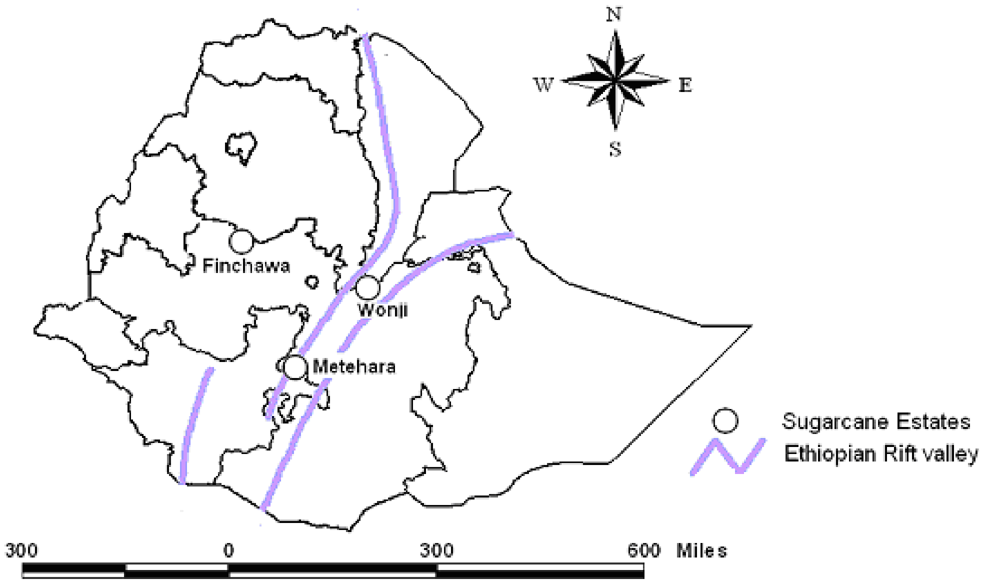

Figure 1. Map of Ethiopia showing location of commercial estates surveyed.

Survey methods

Surveys were conducted twice, during December 2003 to February 2004 and November to December 2004. In these surveys, sugarcane fields and indigenous host plants (large grasses and sedges) growing in wetlands, irrigation canals and on field margins, were examined for possible infestation by stem borers and the presence of any natural enemies.

Surveys in sugarcane fields

Sugarcane plots to be evaluated were randomly identified from production data sheets from each estate, with due consideration given to including all varieties and age groups. Selected sugarcane plots were then inspected for signs of stem borer infestation, such as the presence of dead hearts, larval frass and/or adult exit holes. Levels of infestation were estimated from 100 randomly selected sugarcane stalks from different corners of the selected fields. Thirty of the 100 sample stalks were randomly inspected by walking from the top left corner diagonally to bottom right corner of the field, and the other 30 samples were from the top right corner diagonally to the bottom left corner. The remaining 40 samples were inspected by walking through the centre of the field from top to bottom and side to side. Stalks were examined *in situ* for frass or exit holes, and those with borer holes were recorded as bored plants. Percentage infestation was determined by dividing the number of bored plants by the total number of plants examined per field, and multiplying the resulting value by 100. Regional incidence of stem borers was obtained by dividing the proportion of sugarcane plots infested by the total plots sampled per region and this value was translated into a percentage by multiplying by 100. Relative abundance of each stem borer species was determined as the total number of that species found, expressed as the percentage of the total population of all stem borer species found at each estate.

To determine the existence of any borer and/or natural enemy life stage and extent of damage caused by the borers, 10 infested sugarcane stalks were harvested, dissected and carefully examined for any borer and/or natural enemy life stage present. Any stem borer larva found was collected and placed into a 30 ml plastic vial containing a piece of sugarcane stalk, sedge or artificial diet (Graham and Conlong, 1988). The vial was sealed with a perforated lid. The perforation was covered with very fine mesh stainless steel gauze. Dead or diseased larvae, cocoons of parasitoids and pupae were placed in empty 30 ml plastic vials, and sealed with the perforated lid. The vials were numbered. These numbers corresponded with numbers on a data sheet, where relevant information about the samples collected was recorded. These data included information on host type, part of the plant where the specimen was found, amount of damage, name of the organism (if known), developmental stage, and date and area of collection.

The number of internodes of the sample plants were counted and divided into three: the third of the internodes towards the tip of the stalk was referred as ‘upper one-third’; the part in the lower cut with one third of the total internodes was referred as ‘lower one-third’; and the part between these two regions with the remaining one-third of the internodes was referred as ‘middle one-third’. The proportion of borings in each particular part of the stalk were obtained by dividing the total number of bored internodes in that part of the stalk by the total number of internodes bored in a stalk, and these proportions were multiplied by 100 to get the percentage of borings in a particular part of the stalk. Similarly, proportion of internodes bored was calculated by dividing the number of bored internodes by the total internodes in the sample plant, and this value was multiplied by 100 to get the percentage damaged internodes.

Analysis of variance (ANOVA) and means comparison was done using MSTAT-C software (Michigan State University, USA). For comparison of means, the Least Significant Difference Test at Alpha ≤ 0.05 was implemented.

Surveys in indigenous host plants

In surveys of border rows, wetlands and waterways nearby sugarcane fields, attention was given to indigenous host plants belonging to the families of Poaceae, Cyperaceae and Typhaceae. Almost all of the natural hosts of cereal stem borers belong to these three families (Polaszek and Khan, 1998; personal communication[1]). Any indigenous plant belonging to one of these families was considered as a potential host, and was inspected for possible infestation by borers. In the surveys of indigenous host plants, 100 sample plants were collected and inspected for borers and their natural enemies, as described above for sugarcane. In *Cyperus* (Cyperaceae) and *Typha* (Typhaceae) spp. stem borers are known to bore into the umbels and rhizomes (Conlong, 1990). Hence, the umbels and rhizomes not covered with water were inspected. In large indigenous grasses (Poaceae), attention was given to the stalks only. All borers found were treated as described above.

The collected specimens were shipped to the South African Agricultural Research Council's Plant Protection Research Institute (ARC-PPRI) Quarantine Laboratory in Pretoria, where they were reared to borer or parasitoid adult stage. These adults were identified by staff of the Biosystematics Division of the ARC-PPRI in Pretoria, and Dr D Barraclough, School of Biological and Conservation Sciences, University of KwaZulu-Natal, Durban, South Africa. Voucher specimens of species identified are kept at the South African Sugarcane Research Institute (SASRI), Mount Edgecombe, KwaZulu-Natal, South Africa.

Results

Stem borer distribution and abundance in sugarcane

Stem borer species recorded in the surveys and damage intensities observed are shown in Tables 1 and 2. Sugarcane on Ethiopian estates was found infested by three species of lepidopteran stem borers. The species identified were *Busseola* sp. (Lepidoptera: Noctuidae), *Chilo partellus* Swinhoe (Lepidoptera: Crambidae) and *Sesamia calamistis* Hampson (Lepidoptera: Noctuidae) (Table 1). Identification of the *Busseola* sp. on estate farms in Ethiopia to species level was not possible, as all the larval material collected died.

Stem borer species composition and abundance varied between estates (Table 1). On all the estates, sugarcane was infested by two or three species of stem borers. At Wonji estate, sugarcane was infested by a complex of three stem borer species (*S. calamistis*, *C. partellus* and *Busseola* sp.) At Metehara only two of these stem borers, *S. calamistis* and *C. partellus*, were recorded from sugarcane. *Busseola* sp. was found to be the predominant stem borer at Finchawa and Wonji estates, followed by S. calamistis (Table 1). *Chilo partellus* was found at all the estates, but its abundance at Metehara and Finchawa estates was low (Table 1).

Table 1. Species composition of stem borers collected from sugarcane on commercial estates in Ethiopia in 2003 and 2004.

Estate	No. of borers recovered	Species composition (%)			
		C. partellus	*Busseola* sp.	*S. calamistis*	*E. saccharina*
Wonji	43	25	57	18	0
Metehara	3	33	0	67	0
Finchawa	16	6	69	25	0

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Based on the data obtained from the two surveys, 41.3 to 63.5% of the fields evaluated in the three sugarcane estates showed symptoms of borer damage in their sugarcane (Table 2). Within the affected fields, the mean percent stalks bored ranged from 7% at Metehara to 17% at Wonji (Table 2). Mean internode damage of between 7.4 and 10% was recorded (Table 2). Although borings were found along the whole length of sugarcane stalks sampled, significantly higher proportion of these($P \leq 0.01$) were concentrated in the lower and middle thirds of the stalks (Table 2).

Table 2. Mean percentage incidence and species composition of stem borers collected from sugarcane on commercial sugarcane estates in Ethiopia in 2003 and 2004.

Estate	No. of fields	Fields infested (%)	% inf. stalks	Mean age (Months)	No. of nodes/ stalk	Nodes dam. (%)	Part of stalk bored (%)		
							Upper	Middle	Lower
Wonji	74	63.5	17	±12	16	10.1	9e	33bcde	58ab
Metehara	46	41.3	7	±12	17	7.9	6.5e	25.8cde	67.7a
Finchawa	56	53.6	12	±11	17	7.4	15de	36.7bcd	48.3abc

Values followed by different letters differ significantly from each other at $p \leq 0.05$

Stem borers in indigenous wild host plants

In surveys of indigenous host plants, Cyperus dives C.B.Cl. (Cyperaceae) growing in irrigation canals at Wonji and Metehara estates was found infested with *Eldana saccharina* Walker (Lepidoptera: Pyralidae). Old and new borings were found in 20-25% of the *C. dives* samples inspected (Table 3). *Typha latifolius* L (Typhaceae) and *Sorghum arundinaceum* (Desv.) Stapf. (Poaceae) were found to be free of infestation by stem borers (Table 3).

Table 3. Indigenous host plants searched and status of stem borers in the natural hosts in 2003 and 2004.

Estate	Host plant	No. of plants dissected	No. of borers recovered	Inf (%)	Species composition (%)			
					C. partellus	*Busseola* sp.	*S. calamistis*	*E. saccharina*
Wonji	*C. dives*	200	11	20	0	0	0	100
	T. latifolius	100	0	0	0	0	0	0
Metehara	*C. dives*	700	3	25	0	0	0	100
Finchawa	*S. arundinaceum*	100	0	0	0	0	0	0

Natural enemies

Natural enemies collected from the stem borers are shown in Table 4. Two larval parasitoids, the native *Cotesia sesamiae* Cameron (Hymenoptera: Braconidae) and the exotic *C. flavipes* Cameron (Hymenoptera: Braconidae), and a pupal parasitoid, *Linnaemya* sp. (Diptera: Tachnidae), were reared from stem borers collected. The level of parasitism by these indigenous and exotic natural enemies was very low, ranging from 2.3 to 6.3% (Table 4).

Table 4: Natural enemies of stem borers recorded during surveys of sugarcane and indigenous sedges on the estate farms in Ethiopia in 2003 and 2004.

Estate	Natural enemy found		Host insect	Life stage attacked	Host plant	% parasit.
	Species	No.				
Wonji	*C. flavipes*	1	*S. calamistis*	Larvae	Sugarcane	2.3
	C. sesamiae	2	*Busseola* sp.	Larvae	Sugarcane	4.7
	B. thuringiensis	15	*C. partellus*, *S. calamistis*,[1] *Busseola* sp.	Larvae	Sugarcane	34.9
	Entomophthora sp.	1	*Busseola* sp.	Larvae	Sugarcane	2.3
Finchawa	*Linnaemya* sp.	1	*Busseola* sp.	Pupae	Sugarcane	6.3
	B. bassiana	1	*Busseola* sp.	Larvae	Sugarcane	6.3

The bacterial pathogen, *Bacillus thuringiensis* Berliner (Eubacteriales: Bacilliaceae), was found to be an important mortality factor of larvae of all stem borer species in young sugarcane at Wonji estate. Up to 50% of the larvae in young sugarcane (1-3 months old) were attacked by this bacterium, with a mean percentage mortality of 34.9% of the larvae recovered on this estate. Fungal pathogens, *Entomophthora* sp. (Entomophthorales: Entomophthoraceae) and *Beauveria bassiana* Balls. (Deuteromycotina: Hyphomycetes), were also recorded; however, the mortality of borers caused by these natural enemies was minimal (Table 4).

Discussion

Stem borers in sugarcane

Sugarcane insect pests such as lepidopteran stem borers and soil insects are believed to be local insects that have adopted sugarcane as a host consequent to its cultivation (Pemberton and Williams, 1969; Conlong, 1994). The geographic distribution of most of these insect pests is very narrow, although few are cosmopolitan (Pemberton and Williams, 1969). The stem borer complex recorded on Ethiopian sugarcane estates is quite different from that reported from other areas of Africa (Leslie, 1994; Conlong, 1994; Conlong, 2000). Of the four stem borers recorded in these surveys, two of the species, *Busseola* sp and *C. partellus*, have never been considered important pests of sugarcane (Polaszek and Khan, 1998; Charpentier and Mathes, 1969; Way and Kfir, 1997). The *Busseola* species on Ethiopian estates was not identified to a species level, as all the larvae collected died and there was no adult specimen for morphological identification. However, the DNA-based method of identification indicated that the *Busseola* species in Ethiopian sugarcane belonged to *Busseola fusca* Fuller (Lepidoptera: Noctuidae) and *Busseola phaia* Bowden (Lepidoptera: Noctuidae). *Busseola fusca* is indigenous to Africa and is a serious pest of cereal grains (Harris, 1962; van Rensburg et al, 1987). It is the major pest of maize and sorghum in all African countries south of the Sahara (Harris, 1989; Abate *et al*, 2000). It feeds on several wild grasses and crops (Ingram, 1958; van Rensburg and van den Berg, 1990; Haile and Hofsvang, 2002; Charles *et al*, 2003). It has been recorded from sugarcane fields, but never at pest levels (Polaszek and Khan, 1998; Conlong, 2000). In contrast to *B. fusca*, *B. phaia* has never been recorded as a pest in crop fields. In the results of an extensive survey reported by Nye (1960), *B. phaia* was common in wild host plants and was rarely found in maize fields adjacent to infested wild host plants. Recent surveys in Kenya, however, evidenced that *B. phaia* is becoming common in maize fields, showing the potential of this insect to become a serious pest (personal communication[1]). This insect has never been recorded from sugarcane and its presence in Ethiopia was not known. There is thus an urgent need for proper morphological identification of the species, using adult specimens to accurately identify the *Busseola* species on Ethiopian estates, and the source of infestation.

In contrast to *C. partellus* and *Busseola* sp., the most important African sugarcane borers, *S. calamistis* and *E. saccharina* (Leslie, 1994), are of minor or no importance on Ethiopian estates. *E. saccharina* is confined only to the indigenous wild host plants and *S. calamistis* is of minor importance on all three estates.

B. fusca, *S. calamistis* and *C. partellus* were previously reported to be the predominant stem borers of sorghum and maize in highland, mid-altitude and lowland areas of the country, respectively (Gebre-Amlak, 1985; Getu *et al*, 2001). However, more recent surveys on peasant sugarcane farms in Ethiopia have shown that these borers are also predominant in sugarcane (Assefa *et al*, 2006). The expansion in the range of host plants attacked by these stem borers can be associated with the cropping practices followed (Assefa *et al*, 2006). As all the commercial estate farms visited are located in the middle of the major maize and sorghum growing regions of the country, sorghum and maize fields nearby might have been the source of the founding populations of stem borers recorded in sugarcane at the estates.

At all the estates visited, sugarcane was found infested by a complex of stem borers. The impact of these mixed species of stem borers on yield loss needs to be quantified. Mixed species of stem borers were reported to be more damaging and causing greater yield loss than a single population of one species at similar infestation levels in maize (van den Berg *et al*, 1991). These authors related the increased yield loss in mixed species to the difference in niche occupied by the different stem borer species that minimised the effect of density-dependent factors on individual populations in the mixture.

Stem borers in indigenous host plants

Cyperus dives is the only host plant of *E. saccharina* recorded on Ethiopian sugarcane estates. *C. dives* sedge was recorded as the predominant host of this pest in other parts of Africa (Girling, 1972; Atkinson, 1979; Atkinson, 1980; Mazodze and Conlong, 2003). In contrast, *Typha latifolius* and *Sorghum arundinaceum* (Desv.) Stapf. (Poaceae), both previously reported to host *E. saccharina* (Girling, 1972; Betbeder-Matibet, 1981; Maes, 1998; Polaszek and Khan, 1998; Mazodze and Conlong, 2003), were free from the pest in Ethiopia. The presence of *E. saccharina* in indigenous wild host plants growing in irrigation canals on the estates is a potential danger for commercial sugarcane production in the country. In Zimbabwe, where the borer was first observed in sedges close to sugarcane in 1987, a severe outbreak of *E. saccharina* was reported from two sugarcane fields in 1999 (during a severe drought), and the borer has since then spread throughout their industry (Mazodze *et al*, 1999; Mazodze and Conlong, 2003). The same may happen in Ethiopia should current biotic and/or abiotic factors change to favour the incursion of *E. saccharina* into sugarcane. Climate and sugarcane expansion and related agronomic factors should continually be monitored in order to predict the relevant changes, and to take corrective action before serious infestation occurs.

The biggest sugarcane estates, Metehara and Wonji, are established on the banks of the Awash River, which is their sole source of water for irrigation. These swamps, channels and riverbanks are natural habitats of sedges from which *E. saccharina* was collected. Should encroachment of the crop into indigenous host plant habitats of the insect take place, there is a real danger of the insect moving into the crop, as hypothesised by Conlong (1997).

This move can be further exacerbated by having over-aged cane left standing in the field. In southern Africa and Uganda it has been clearly demonstrated that *E. saccharina* prefers older sugarcane (Nuss *et al*, 1986; Conlong and Mugalula, 2001). On the Ethiopian estates, sugarcane is left in the field before harvest for up to 22 months. This practice makes sugarcane vulnerable to *E. saccharina* attack. The sugar estates in Ethiopia should be mindful of this fact, and manage their harvesting accordingly to minimise the chance of *E. saccharina* colonisation and population build-up.

One of the reasons that *E. saccharina* prefers older sugarcane is because, in these older plants, nutrients are no longer used for plant growth, especially nitrogen (Nuss *et al*, 1986), which then becomes available for insect use. It has also been shown that *E. saccharina* infestations increase as nitrogen fertiliser application rates increase (Carnegie, 1981). Reduction of nitrogen fertiliser to 30 kg per hectare is recommended to reduce *E. saccharina* problems in sugarcane (Anon, 1994). Ethiopian sugar estates, however, practise the blanket application of high amounts of fertiliser, 200 to 700 kg/ha of Ammonium Sulphate Nitrate (ASN), which contains 26% nitrogen (Kedru, 1993). This additional nitrogen, which the sugarcane plant cannot use, will certainly increase the chance of colonisation, survival and growth of E. saccharina in this sugarcane. Careful monitoring and application of high nitrogen fertilisers should be practised, so that only the amount needed by the plant is applied, leaving no available nitrogen in the plant that can be exploited by the insect.

In South Africa, sugarcane varieties show different levels of resistance to *E. saccharina*. (Nuss *et al*, 1986). The number of internodes bored, larval mass and *E. saccharina* population was found to vary between varieties (Nuss *et al*, 1986; Rutherford *et al*, 1993; Bond, 1988; Keeping, 1999). Thus, it is recommendable to regularly monitor sugarcane fields adjacent to the water bodies for infestation by *E. saccharina* and to avoid planting varieties showing E. saccharina susceptibility in fields bordering indigenous host plant stands, to minimise the chance of colonisation by the borer.

Natural enemies

Previous studies in sorghum and maize fields of Ethiopia (Getu *et al,* 2001; Yitaferu and Walker, 1997; Gebre-Amlak, 1985) reported a large number of parasitoids to be associated with stem borers. However, only few of these were recorded in this study. The braconid, *C. flavipes*, was the only exotic parasitoid of stem borers recorded in this study. It is a gregarious endoparasitoid of lepidopterous stem borers of gramineous plants and is indigenous to South-East Asia (Mohyuddin, 1971). This larval parasitoid was introduced from Pakistan into Kenya (Overholt *et al*, 1994) from where it was released to other African countries (Overholt, 1998). The parasitoid has never been released in Ethiopia, but it was recently found established on *C. partellus*, *S. calamistis* and *B. fusca* in maize and sorghum (Getu *et al*, 2001). The recovery of this parasitoid in a sugarcane field at Wonji estate may indicate its permanent establishment in the country and its potential as a polyphagous biocontrol agent in stem borer management. The other parasitoids recorded in this survey are the indigenous braconid larval parasitoid, *C. sesamiae* and the tachinid pupal parasitoid *Linnaemya* sp. The former was reported to be a common parasitoid of stem borers in cereal grains (Getu *et al*, 2001), whereas the latter is reported in Ethiopia only from sugarcane (Assefa *et al*, 2006).

The bacterial pathogen, *B. thuringiensis*, was found to be an important mortality factor for stem borers in young sugarcane fields at Wonji. Some *B. thuringiensis* isolates are reported to be highly toxic to stem borer larvae (Jacobs, 1989). Therefore, it is important to test the efficacy of *B. thuringiensis* from Ethiopian sugarcane on its major stem borers for possible use in stem borer management.

The fungal conidiophores that emerged from larva killed by the entomopathogenic *Entomophthorales* fungus evidenced that this pathogen is part of the natural enemy complex of stem borers in Ethiopian sugarcane. Several species of *Entomophthorales* fungi are known to attack insects belonging to different orders (Hatting, 2002). In recent surveys in Ethiopia, these entomopathogenic fungi were recorded from *E. saccharina* in sedges and from *Busseola* spp. in sugarcane (Assefa *et al*, 2006). *B. bassiana*, which was reported from *E. saccharina* in South and West Africa (Conlong, 1990; 2001) was also recorded in this study. This indicates the potential of fungal pathogens to adapt to different habitats and attack diverse species of stem borers. The *Entomophthorales* fungi need to be identified to species level and investigation on the potential of these fungal pathogens as biocontrol agents is recommended.

There is a need to conduct a study on the population dynamics of these pests and their natural enemies to have a clear understanding of the natural enemy complex and its impact on commercial sugarcane farms. The low number of parasitoid species recorded can be ascribed to the low number of stem borer life stages recovered, but it is important to determine whether this is the case throughout the sugarcane growing seasons.

Conclusions

Results of the surveys show that a complex of stem borers has colonised sugarcane on commercial estates in Ethiopia, and there is a threat that *E. saccharina* could invade sugarcane plots, already being present in its indigenous hosts on the estates. Intense supervision is required to control the level of infestation by borers and prevent colonisation of sugarcane by *E. saccharina*. The natural enemy complex and the level of parasitism recorded were low at the time of the surveys, and more monitoring and research is needed to determine whether these impact on stem borer populations. Studies on the population dynamics of the borers and the parasitoids are important to identify key control factors and possible impact through augmentation. The strain of the bacterial pathogen, *B. thuringiensis*, at Wonji estate needs to be identified and tested against all stem borers for its future potential in stem borers management in sugarcane.

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