Short communication

ROLE OF SOME ECOLOGICAL FACTORS FOR AN ALTITUDINAL EXPANSION OF SPOTTED STEMBOREER, CHILLO PARTELLUS (SWINHOE) (LEPIDOPTERA: CRAMBIDAE)

Amanuel Tamira 1, Emana Getu 2* and Bekele Jembere 2

1 Ethiopian Institute of Agricultural Research, Melkassa Research Center, POBox 436, Nazareth Ethiopia
2 Department of Biology, Faculty of Science, Addis Ababa University, PO Box 33244
Addis Ababa, Ethiopia. egetudegaga@yahoo.com

ABSTRACT: Survey was carried out during 2004 main cropping season to investigate the abundance and distribution of stemborers, with emphasis on spotted stemborer, Chilo partellus (Swinhoe) in central and eastern Ethiopia. The survey sites were mapped using Arc View GIS software. Three species of stemborers, namely, C. partellus, maize stemborer, Busseola fusca (Fuller) and pink stemborer, Sesamia calamistis (Hampson) were recorded. Chilo partellus was recorded as a dominant and widely distributed species in 96% of the surveyed sites. On the other hand, B. fusca was mainly recorded in highland areas, while S. calamistis was found at all elevations in small number. The current survey revealed the expansion of C. partellus to high-elevated areas as high as 2088 meters above sea level (masl), where it was not recorded earlier in the country. Observations were also made during the survey on the effect of cropping system, wild host and weediness on stemborer infestation, species composition and density. Analysis of variance and independent T test showed higher level of infestation on monocrops and on fields with wild hosts than intercrop and wild host free fields. The results also proved the existence of significant variation in the level of infestation between crop types. Chi square test revealed strong relationship between cropping systems, crop type, presence or absence of wild host and species composition at intermediate and highlands. Borer density was the highest at low altitude as compared to intermediate and high altitude.

Key words/phrases: Altitudinal expansion, Chilo partellus, cropping system, stemborer infestation, wild host

INTRODUCTION

The spotted stemborer, C. partellus (Swinhoe) is one of the most destructive insect pests of maize and sorghum in Ethiopia (Emana Getu et al., 2001) and elsewhere in Africa (Seshu Reddy, 1998). Yield losses due to the pest ranges from 10 to 100% (Assefa Gebre-Amlak, 1985; Emana Getu and Tsedeke Abate, 1999; Kfir, 2001). Since its introduction to Africa in the early 20th century (Tams, 1932), C. partellus has increased its importance spreading to nearly all countries in eastern and southern Africa (Kfir, 1998). In addition to maize and sorghum, pearl millet, finger millet, rice, wheat, sugar cane, foxtail and other wild grasses are hosts of C. partellus at varying preference level (Seshu Reddy, 1998).

Elevation was thought to be a single most important factor determining the distribution of C. partellus (Harris and Nwanze, 1992; Overholt et al., 1997). However, Sithole (1987) challenged the assumption and indicated climatic factors such as temperature, rainfall and humidity influence its distribution, temperature being the most important. Similarly Emana Getu et al. (2002) indicated that the distribution of C. partellus is affected by rainfall and temperature. These generalizations may support each other as temperature and elevation are highly correlated.

Chilo partellus has been known as the most damaging pest at low to mid altitudes commonly occurring below 1500 masl (Seshu Reddy, 1985; Overholt et al., 1997). In Ethiopia, Assefa Gebre-Amlak (1985) reported the pest at elevations below 1600 masl. In more recent survey Emana Getu (2002) recorded C. partellus at an elevation of 1900 masl. Kfir (1997) reported expansion of C. partellus in to the eastern Highveld region of South Africa. This shows that C. partellus has widened its adaptation zone and could be a potential pest at...
higher altitude. Moreover, the pest has proven to be a very efficient colonizer and devastating pest wherever it occurs (Kfir, 1997; Emana Getu et al., 2001).

Despite the increasing importance of *C. partellus* little efforts have been made to understand reasons for its altitudinal expansion and destructive nature. Hence, this study was carried out at selected areas of eastern and central Ethiopia to assess *C. partellus* status at different altitude ranges. Investigation was also made to see the effect of ecotological factors such as altitude, temperature, cropping system, wild host and weediness on infestation, composition and density of stemborers with emphasis on *C. partellus*.

**MATERIAL AND METHODS**

**Study sites**

A survey covering three altitude groups, lowland (<1450 masl), intermediate (1450-1800 masl) and highland (>1800 masl), was carried out in the central (Wulenchitti, Boset) and eastern Ethiopia (Asebot, Meiso, Hirna, Badessa). The coordinates of the survey sites were recorded using Global Positioning System (GPS). The study sites were mapped using Arc View GIS soft ware. Annual rainfall and its distribution pattern of the sites were recorded from secondary sources. The current temperature data were also compared with the data collected over the past ten years for study sites with new *C. partellus* record.

**Survey**

Field assessment was conducted on subsistence farmers' maize/sorghum fields during 2004 major cropping season (June-Sept) at vegetative and maturity stages of the crop. Three representative locations were randomly selected at each altitude groups namely, highland, intermediate and lowland. From each location, three maize and/or sorghum fields were randomly selected for the investigation. Percent infestation was determined by dividing the number of infested plants to the total number of plants in a quadrates of 4 x 4 m selected in 'X' fashion at each field. At each field five heavily infested maize/sorghum plants were dissected for determination of species composition. The stemborer density was determined by randomly dissecting 20 maize/sorghum plants per field and counting the number and type of borer per plant. Severity value was determined in 1-9 score (Ampofo, 1986) where 1 represents absence of infestation while 9 refers to very high infestation level and damage. The number of deadheart was determined by counting sorghum/maize plants (stalks) with dead central leaves and growing points due to stemborer attack. The effects of cropping system, weediness and availability of wild host on percent infestation, stemborer species composition, stemborer density, severity and deadheart count were investigated for all altitude groups.

**Data analysis**

Survey data were analyzed using SPSS computer software. The effect of different agronomic practices on percent infestation, species composition and density of stemborers were tested using ANOVA and independent T test whereas the association of the factors were tested using Chi square (X²). Data that lacked normality were transformed using square root and logarithmic transformation techniques. Mean differences were tested using Tukey's Studentized Range (HSD) Test.

**RESULTS**

The study sites, stemborer species and their distribution were illustrated in Fig. 1. Three major species of lepidopteran stemborers: *C. partellus*, *B. fusca*, and *S. calamisits* were recorded at elevations ranging from 1342 to 2088 masl. *Chilo partellus* was the most predominant and widely distributed in 96% of the surveyed sites. Even though *C. partellus* was most abundant in mid and lowlands; it was recorded at an elevation as high as 2088 masl. *B. fusca* was mainly recorded at highland, while *S. calamisits* was recorded at all elevations, but in small number.

Comparison of current temperature data with the previous decade mean data showed an increase in temperature for sites with new *C. partellus* record (Fig. 2). This might have contributed to the expansion of *C. partellus*, which usually prefers warmer environment as compared to *B. fusca*.

Percent infestation (F=0.048), severity (F=0.019) and deadheart count (F=0.002) were significantly higher in monocrop than in the intercrop. Farms with wild host have significantly higher percent infestation (F=0.005) and severity (F=0.009) as compared to wild host free fields. There was no significant difference in percent infestation (F=0.187), severity (F=0.499) and deadheart count (F=0.366) among farms with different levels of weediness. Altitude didn't have influence on percent infestation (F=0.181). However, altitude significantly affected *C. partellus* severity (F= 0.027) and dead heart (F=0.001).
Chi square test revealed significant association among cropping system, weediness, wild host with species composition. Table 1. There was strong association between crop types and species composition of stemborer at intermediate and high altitudes (Table 2). *Chilo partellus* was widely distributed and take the lion share among the stemborer species available in most cases.
Table 1. Effect of cropping system, weediness, wild host and crop type on species composition.

<table>
<thead>
<tr>
<th>Species Composition</th>
<th>Cropping system</th>
<th>Weediness</th>
<th>Wild host</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Monocrop</td>
<td>Intercrop</td>
<td>Some</td>
</tr>
<tr>
<td>C. partellus</td>
<td>68.2 (88)</td>
<td>23.3 (27)</td>
<td>37.7 (67)</td>
</tr>
<tr>
<td>B. fusca</td>
<td>31.8 (41)</td>
<td>76.8 (89)</td>
<td>62.3 (94)</td>
</tr>
<tr>
<td>S. calamisitis</td>
<td>0.0 (0)</td>
<td>0.0 (0)</td>
<td>0.0 (0)</td>
</tr>
<tr>
<td>P value</td>
<td>0.0001</td>
<td>0.0001</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

Table 2. Effect of different crops and crop association on percent species composition at different elevations.

<table>
<thead>
<tr>
<th>Crop</th>
<th>Intermediate</th>
<th>Highland</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cp</td>
<td>Bf</td>
</tr>
<tr>
<td>Maize</td>
<td>83.3 (25)</td>
<td>10.0 (3)</td>
</tr>
<tr>
<td>Maize + beans</td>
<td>75.0 (12)</td>
<td>25.0 (4)</td>
</tr>
<tr>
<td>Maize + sorghum</td>
<td>98.3 (134)</td>
<td>1.5 (2)</td>
</tr>
<tr>
<td>Sorghum</td>
<td>88.1 (259)</td>
<td>5.8 (17)</td>
</tr>
<tr>
<td>Sorghum + beans</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Sorghum + Maize + beans</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>P value</td>
<td>0.0001</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

Note: Numbers in parenthesis in both tables indicate the stemborer count. 
Cp = Chilo partellus  Bf = Busseola fusca  Sc = Sesamia calamisitis

There was no significant variation in borer density per plant due to cropping system (p=0.91) and wild host (p=0.99). At maturity stage there was significant difference (p=0.028) in borer density among the different elevations. Borer density was highest at low altitude as compared to mid and high altitudes. There was no significant difference among crops and crop association in stemborer density per plant (p=0.39).

**DISCUSSION**

Three species of stemborers, C. partellus, B. fusca, and S. calamisitis were recorded in central (Wulenchitti, Boset) and eastern Ethiopia (Asebot, Meiso, Hirna, Badesa) during a survey in the 2004 main cropping season. Similar records were made in Ethiopia previously (Assefa Gebre-Amalk, 1985; Emana Getu, 1997; Kassaahun Yitaferu and Walker, 1997; Emana Getu and Tsedeke Abate, 1999; Mulugetta Negeri, 2001). C. partellus was recorded at all elevations, though it was particularly abundant at lowland and intermediate altitudes. B. fusca was mainly dominant in highlands and cooler areas while S. calamisitis was recorded at all elevations.

C partellus was said to be lowland pest commonly occurring below 1500 m in Eastern and southern Africa countries (Warui and Kuria, 1983; Overholt et al., 1997; Haile and Hofsvang, 2001). In Ethiopia, C. partellus was reported to exist at elevations below 1600 masl (Assefa Gebre-Amalk, 1985), but Emana Getu (2002) recorded the pest at an elevation of 1900 masl. In the current study, C. partellus was recorded at an elevation of 2088 masl suggesting gradual expansion of the pest to new ecological niches. This may be attributed to the changes in cropping pattern and behavior of the pest. The result concurs with Bate et al. (1991), who reported the expansion of C. partellus to higher elevations of the western Highveld region of South Africa. The current finding is in contrary with Seshu Reddy (1983) and Harris and Nwanze (1992) who reported C. partellus as a low elevation stemborer species.

Moreover, the current survey revealed that C. partellus was the predominant species with wide distribution. In some locations, C. partellus accounted for about 94% of the borer population. This may contradict with the countrywide survey by Emana Getu (2002) who reported B. fusca as the most important and widely distributed stemborer species in Ethiopia. The shift in abundance of the two stemborer species give the impression that the exotic C. partellus is overtaking the position of the indigenous B. fusca. An increase in temperature noted at high elevation might also have
CONCLUSION

From this work, it can be concluded that *C. partellus*, *B. fusca* and *S. calamistris* were the major stemborer species recorded in central and eastern Ethiopia. Yet, *C. partellus* was the dominant species with wide distribution in the region. *Chilo partellus* has been known as lowland pest occurring at elevation below 1500 m; nevertheless, in the current survey the pest was recorded at an elevation as high as 2088 masl. This indicates that the pest is expanding its ecological niches to higher altitudes. An increasing importance of the *pest* in abundance and distribution suggest that *C. partellus* may be displacing the indigenous stemborer, *B. fusca* and/or competing with it.

*Chilo partellus* was highly abundant in monocrop than inter crop. Higher percentage of *C. partellus* was recorded from fields with wild hosts in and around than wild host free fields. Sorghum fields had higher *C. partellus* infestation than maize under monocropping. Percent infestation and severity of the pest was high in fields with wild hosts and monoculture. Comparison results also revealed an increase in temperature in highland areas where *C. partellus* was currently recorded which might have contributed to the occurrence of the pest. These facts suggest that one or a combination of ecological factors may influence species composition and *C. partellus* abundance.

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REFERENCES


