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Short communication

ROLE OF SOME ECOLOGICAL FACTORS FOR AN ALTITUDINAL EXPANSION OF SPOTTED STEMBORER, *CHILO PARTELLUS* (SWINHOE) (LEPIDOPTERA: CRAMBIDAE)

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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

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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 ecological 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 (Wulenchitii, 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 (X^2). 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. calamistis* 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. calamistis* 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 ($P=0.048$), severity ($P=0.019$) and deadheart count ($P=0.002$) were significantly higher in monocrop than in the intercrop. Farms with wild host have significantly higher percent infestation ($P=0.005$) and severity ($P=0.009$) as compared to wild host free fields. There was no significant difference in percent infestation ($P=0.187$), severity ($P=0.499$) and deadheart count ($P=0.366$) among farms with different levels of weediness. Altitude didn't have influence on percent infestation ($P=0.181$). However, altitude significantly affected *C. partellus* severity ($P= 0.027$) and dead heart ($P=0.001$).

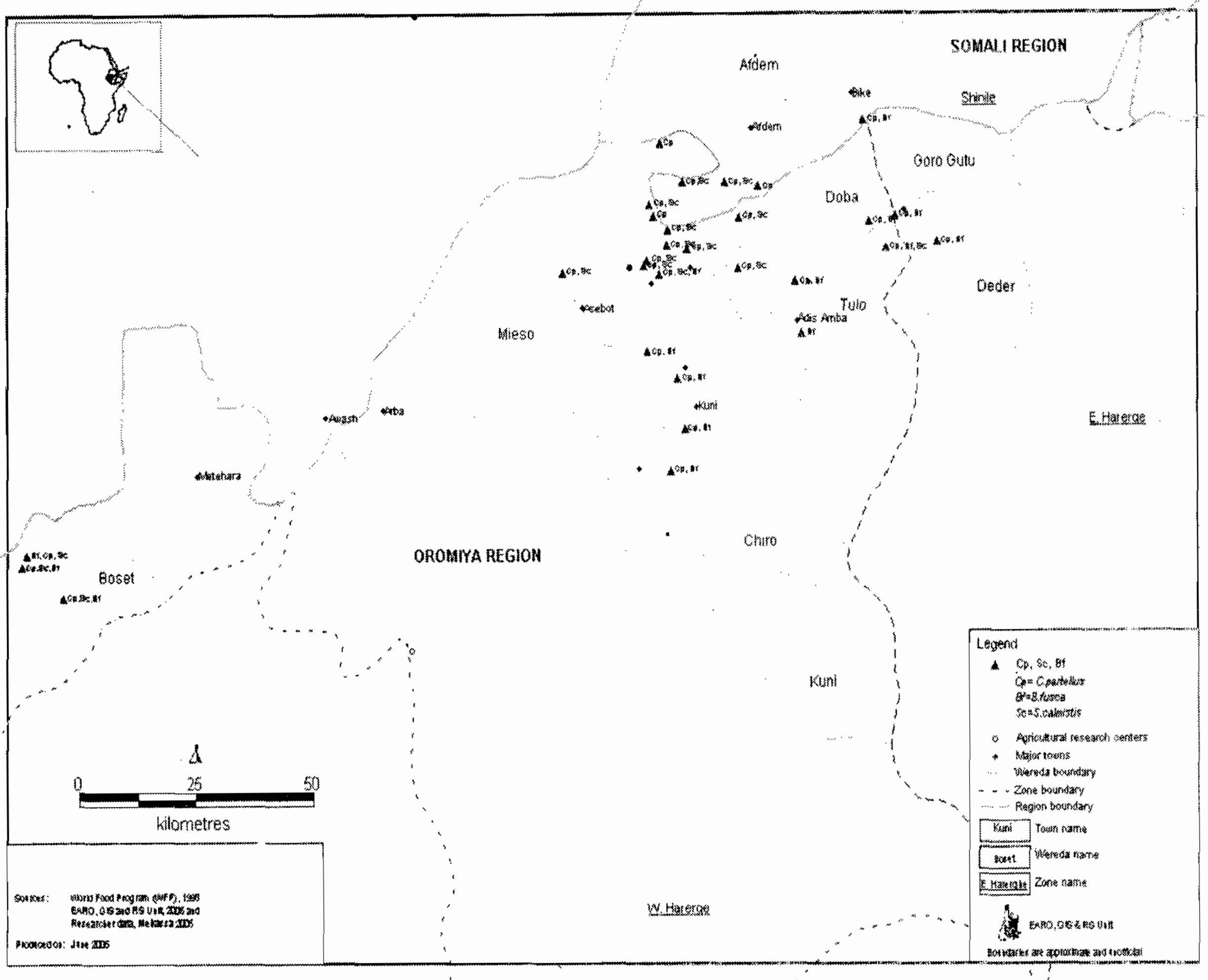

Fig. 1. Species composition and distribution of stemborer at the study sites.

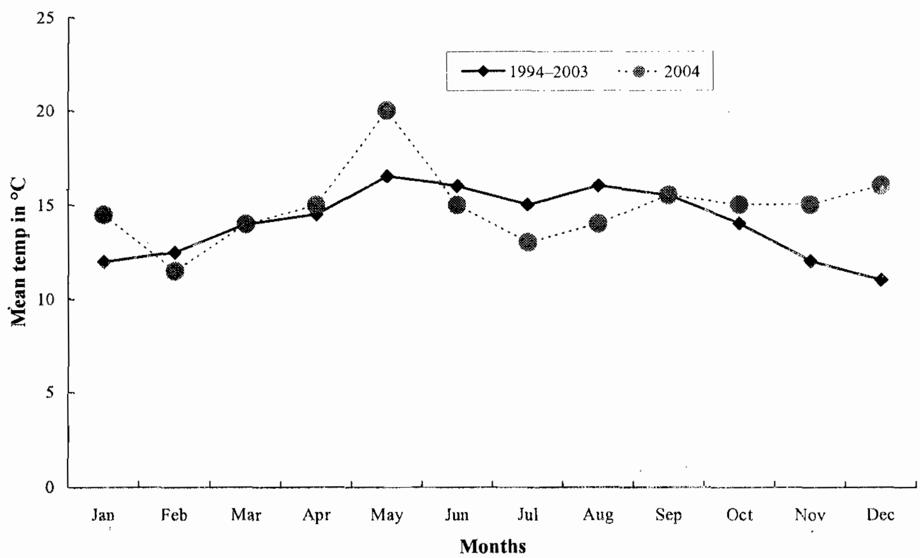

Fig. 2. Mean temperature at Chiro (Asebe Teferi) for the year 1994–2003 and 2004.

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.

Species Composition	Cropping system		Weediness		Wild host	
	Monocrop	Intercrop	Some	Lots	Present	Absent
C. partellus	68.2 (88)	23.3 (27)	37.7 (57)	61.7 (58)	57.7 (101)	20.0 (14)
B. fusca	31.8 (41)	76.7 (89)	62.3 (94)	38.3 (36)	42.3 (74)	80.0 (56)
S. calamistis	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
P value	0.0001		0.0001		0.0001	

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

Crop	Intermediate			Highland		
	Cp	*Bf*	*Sc*	*Cp*	*Bf*	*Sc*
Maize	83.3 (25)	10.0 (3)	6.7 (2)	-	-	-
Maize + beans	75.0 (12)	25.0 (4)	0.0 (0)	-	-	-
Maize + sorghum	98.5 (134)	1.5 (2)	0.0 (0)	-	-	-
Sorghum	88.1 (259)	5.8 (17)	6.1 (18)	70.7 (41)	27.6 (16)	1.7 (1)
Sorghum + beans	-	-	-	27.0 (20)	73.0 (54)	0.0 (0)
Sorghum + Maize + beans	-	-	-	41.5 (17)	58.5 (24)	0.0 (0)
P value		0.0001			0.0001	

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

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. calamists* were recorded in central (Wulenchitii, Boset) and eastern Ethiopia (Asebot, Meiso, Hirna, Badessa) during a survey in the 2004 main cropping season. Similar records were made in Ethiopia previously (Assefa Gebre-Amlak, 1985; Emana Getu, 1997; Kassahun 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. calamistis* 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-Amlak, 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 contributed for the incidence of the pest at higher altitudes.

In the current study, it was observed that species composition varied with cropping system, weediness, wild host and crop type at mid and higher altitudes. *C. partellus* was abundant in monocrop than intercrop. In most cases, higher proportion of *C. partellus* was recorded from fields with wild hosts as compared to those with out wild hosts. There was high *C. partellus* proportion in sorghum than maize sole cropping. Intercropping each of them with beans reduced density per plant of *C. partellus*. Emana Getu (2002) also reported similar facts on effect of cropping system, crop type and presence/absence of wild host on species composition. Analysis of these factors is believed to be essential for implementing appropriate pest management options (Emana Getu, 2002).

Additionally, cropping system and presence or absence of wild host had significant effect on percent infestation, severity and deadheart count. Higher stemborer percent infestation, severity and deadheart count were observed in monocrop than intercrop. The result agrees with previous reports, which indicated that intercropping lowers infestation of pest (Skovagard and Pats, 1996; Emana Getu, 2006). Roots (1973) explained the increased pest population in monoculture is due to higher concentration of the host plants in time and space, while Risch *et al.* (1983) and Andow (1991) suggested that the reduction in pest number in multiple cropping arise from herbivore impediments in colonization and movement. In the study, presence of wild host is observed to increase the infestation of maize/sorghum crop by stemborers and severity of damage. This could be due to the role of wild hosts in supporting carrying over population to the next season and as the result influencing status of stemborers in subsequent crops.

CONCLUSION

From this work, it can be concluded that *C. partellus*, *B. fusca* and *S. calamistis* 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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