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Diversity and abundance of lepidopteran stem borer natural enemies in natural and cultivated habitats in Botswana

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ABSTRACT

Lepidopteran stem-borers in Africa are attacked by diverse natural enemies in natural and cultivated environments. Field surveys of stem-borer natural enemies and associated host plants were conducted during the austral summers of 2014/15 and 2015/16 on natural and cultivated habitats across Botswana to determine their diversity and relative abundance. In cultivated habitats, the most common parasitoids of larvae were *Cotesia flavipes* Cameron, *C. sesamiae* (Cameron), and of pupae, *Pediobius furvus* Gahan and *Gambroides nimbipennis* Seyrig. In natural habitats, the larval parasitoids *Chelonus curvimaculatus* Cameron and *Goniozus indicus* Ashmead were recorded, along with the pupal parasitoid, *Dentichasmias busseolae* Heinrich. Furthermore, the predatory ants *Linepithema humile* Mayr, *Crematogaster peringueyi* Emery and *Aenictus* species were recorded in both cultivated and natural habitats. The major cultivated plants hosting stem-borers and related natural enemies were maize, sorghum, sweet sorghum, and the major wild plants were *Echinochloa pyramidalis*, *Typha latifolia, Schoenoplectus corymbosus* and *Cyperus dives*. *Chilo partellus* Swinhoe and *Sesamia* spp. were the major hosts for parasitoids, with *C. partellus* predominating in cultivated habitats and *Sesamia jansei* Tams & Bowden in natural habitats. Larval parasitism ranged from 2.1 to 34.7% and 3.3 to 14.3% in cultivated and natural habitats respectively, whereas pupal parasitism ranged from 6.1 to 10.6% and 6.7 to 9.1%, respectively. Parasitoid percentage abundance ranged from 1.1 to 41.6% and 4.8 to 38.1% in cultivated and natural habitats respectively, with *C. flavipes* dominating in cultivated and *C. curvimaculatus* in natural habitats. Our results show that cultivated and natural environments in Botswana harbor a diverse natural enemy community worthy of conserving for stem-borer biological control.

1. Introduction

Cereal crops such as maize, sorghum and millet are mostly grown by small-scale farmers at subsistence level in sub-Saharan Africa, with the majority of cereal fields usually surrounded by patches of natural habitats harbouring stem borer wild host plants (e.g. grasses and sedges) (Mailafiya et al., 2009). These natural habitats often serve as refugia for stem borers and their parasitoids, sustaining a diversity of stem borer natural enemies within the agroecosystem (Mailafiya et al., 2009; Moolman et al., 2013). Lepidopteran stem borers are among the most destructive insect pests of cereal crops in sub-Saharan Africa, accounting for 5–75% of yield losses (De Groote, 2002; Kfir et al., 2002; Kipkoech et al., 2006; Moolman et al., 2013). In Africa, this represents a significant household food insecurity burden since ~70–80% of the population depend on subsistence agriculture (FAO, 2002). The major lepidopteran cereal stem borer species accounting for damage in Africa include the indigenous pyralid *Eldana saccharina* Walker, the crambid *Chilo orichalcociliellus* (Strand), the noctuids *Busseola fusca* (Fuller) and *Sesamia calamistis* Hampson and the exotic crambid *Chilo partellus* Swinhoe (Kfir et al., 2002; Obonyo et al., 2010; Addo-Bediako and Thanguane, 2012).

The abundance and distribution of cereal stem borers may be

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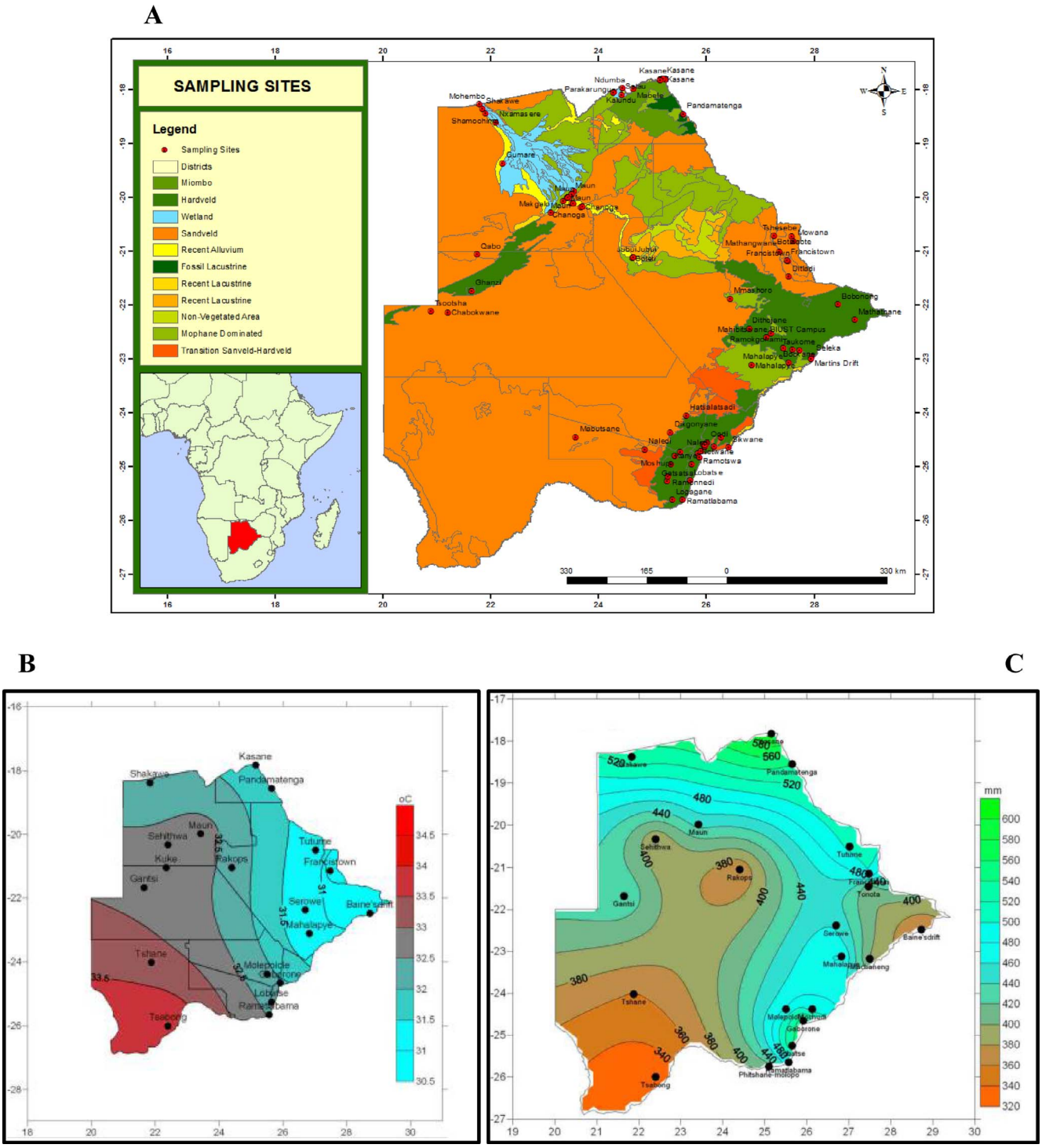

Fig. 1. Botswana maps showing (A) areas surveyed for stem borers in cultivated and natural habitats during 2014/15 and 2015/16 austral summer (B) average annual temperatures and (C) average annual rainfall for the sampled districts.

influenced by abiotic factors such as temperature and precipitation, and biotic factors such as natural enemies and alternative host plants (Mailafiya et al., 2009; Addo-Bediako and Thanguane, 2012). Both parasitoid diversity and parasitism levels have been reported as higher in arable fields intermixed with natural habitats than in arable fields only (Thies et al., 2003), indicating the role of natural habitats in hosting parasitoid diversity. Although natural habitats have been reported to provide refuges for some parasitoid species, low levels of stem borer parasitism (< 8%) have been recorded in East and Austral Africa in wild host plants (Mailafiya et al., 2011; Moolman et al., 2013). Gramineous plants are known to produce secondary metabolites that recruit stem borer parasitoids (Potting et al., 1995; Arab and Bento, 2006). Indeed, this is the case for maize and sorghum plants infested with *B. fusca* and *C. partellus* (Mutyambai et al., 2015). Isolated volatiles from these plants are effective in recruiting the braconid parasitoids *Cotesia sesamiae* Cameron and *Cotesia flavipes* Cameron, and the ichneumonid *Dentichasmias busseolae* Heinrich (Arab and Bento, 2006).

An understanding of the diversity, spatial distribution, abundance and ecological contributions of stem borer natural enemies in both natural and managed ecosystems is required to implement an