

Outbreak, Distribution and Damage Characteristics of Cocoa Stem Borer, *Eulophonotus myrmeleon* Felder 1874 (Lepidoptera: Cossidae) in Major Cocoa Producing States in Nigeria

Emem Basil Kingsley-Umana¹, Uche Evarestus Asogwa², Idongesit Mokwunye²

¹Department of Crop and Soil Science, Faculty of Agriculture, University of Port Harcourt, Rivers State, Nigeria

²Entomology Section, Cocoa Research Institute of Nigeria, Ibadan, Oyo State, Nigeria

Email: ebkingsleyumana@gmail.com, Ucheasogwa1@yahoo.com, idychumok@gmail.com

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Abstract

This study aims to ascertain the extent of the cocoa stem borer *Eulophonotus myrmeleon* distribution, outbreak, and damage to the cocoa plantations in six cocoa growing states in Nigeria. Three local government areas were selected from each of the six major cocoa states and three farms from each local government area. In each farm, 100 cocoa trees were randomly selected and inspected for symptoms and damages of *E. myrmeleon*. The result revealed that *E. myrmeleon* infestation has increased significantly ($p = 0.01$, $df = 1$, $F = 41.77$) in 2019 by 10% from the 2014 inspection. It also showed that the infestation level was significantly different from state to state. Symptoms of infestation include presence of entry/exit holes, woody exudates around the trees, yellowing and browning of the leaves. Damages caused by *E. myrmeleon* infestation are, loses of pod on the affected branch and tree and death of tree. Field observations showed clearly that stem borer is now becoming a serious problem and limiting considerably the production of cocoa in the region. It is time to give more attention to the biology and management of the pest. This is the first report detailing the symptoms and damage done by cocoa stem borers in Nigeria.

Keywords

Cocoa, Stem Borer, Survey, Infestation, Exudates, Damage

1. Introduction

The cocoa crop is afflicted by a wide range of pests, weeds and diseases which can cause very substantial losses, impacting on the livelihoods of farmers and the economies of producing countries [1]. Insect pests have largely contributed to the declining productivity of cocoa in Nigeria. For example, about 25% - 30% loss in yield of cocoa has been attributed to the cocoa mirid, *Sahlbergella singularis* while about 17% is lost through the feeding of the cocoa pod borer *Characoma strictigrapta* [2]. Some cases of major outbreaks could result in total damage (95%) of the plantations. For instance, the pest outbreak in parts of Ondo and Edo states reported in May 2012 caused a complete damage of the plantations [3].

Eulophonotus myrmeleon Felder (Lepidoptera: Cossidae), is a moth in the family Cossidae. The menace of cocoa stem borer, *E. myrmeleon* has earlier been recorded in Cameroon, Côte d'Ivoire, Congo Republic, Ghana, Nigeria, Sierra Leone, Togo and the island of Sao Thomé, Democratic Republic of Congo and South Africa where it attacks members of the Sterculiaceae family [4] [5] [6] [7]. Apart from *Theobroma cacao*, the larvae of *E. myrmeleon* feeds on *Cola acuminata*, *Cola nitida*, *Triplochiton scleroxylon*, *Acalypha* spp, *Populus* spp, *Coffea* spp and *Combretum* spp. [6] [8]. However, they were considered a minor pest of cocoa as their populations occurred in low numbers and the level of attacks was usually very low, with less than 5% of the trees showing damage. Due to the above occurrence of the pest, very little work was conducted to address the problem [9].

Recently, outbreaks of *E. myrmeleon* has been reported to cause damage to cocoa trees in the West and Central African producing countries, including Côte d'Ivoire, Ghana, Cameroon, Nigeria and Togo [10] [11] [12] [13] [14]. However, since 2018, it has been observed that damage caused by cocoa stem borer, *E. myrmeleon* Fldr. (Lepidoptera: Cossidae) in Nigeria is becoming increasingly important.

As a follow up to serious outcry by farmers a survey was carried out in selected cocoa plantations within Nigeria to ascertain the extent of the recent outbreak, their distribution and extent of damage to the cocoa plantations by the stem borer, *E. myrmeleon*.

2. Methodology

The study on the distribution of cocoa stem borer was in six cocoa growing states in Nigeria A three-stage purposeful sampling technique was used to identify subjects for the survey. The first stage involved the purposive selection of the six highest cocoa growing state (Oyo, Osun, Ogun, Ondo, Cross River and Ekiti states) (Figure 1) were accessed in 2014 and 2019. The second stage involves the selection of three Local Government Area in each state, where cocoa is grown in commercial quantity. The last stage involved the selection of three large commercial cocoa farms in each Local Government Area making it a total of 9 Farms

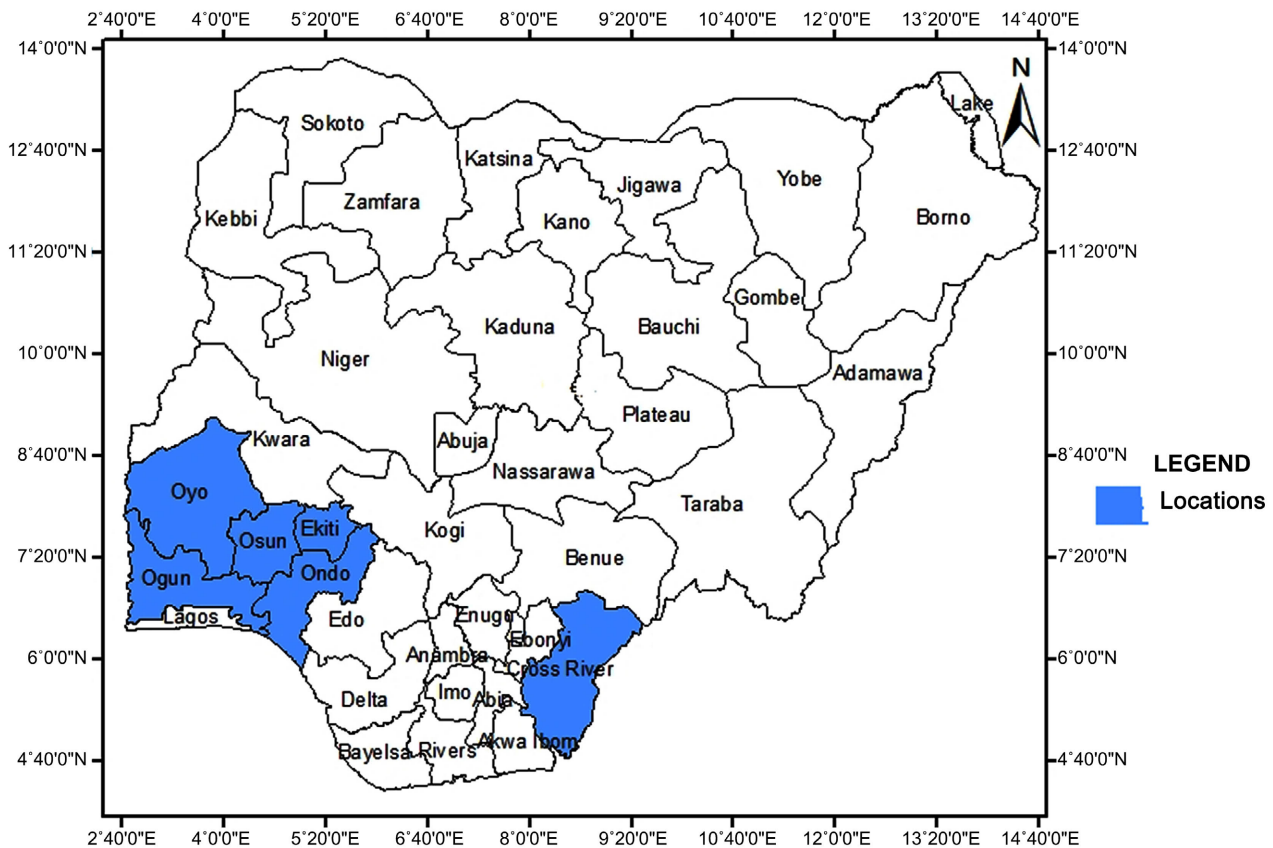


Figure 1. Map showing the study location.

per state. Cross River State (5.8702°N, 8.5988°E) Oyo (8.1574°N, 3.6147°E) Osun (7.5629°N, 4.5200°E) Ogun (6.9980°N, 3.4737°E) Ondo (6.9149°N, 5.1478°E), and Ekiti (7.7190°N, 5.3110°E).

In each local government area, there was a general interaction with small farmers groups to first ascertain their knowledge perception of the pest, after which three farmer with good knowledge volunteered and took us to their infested farms. In each farm, a total of 100 randomly selected cocoa tree stands were sampled by systematically traversing the farms at both diagonals and longitudinal ends. Each selected cocoa stand in each location was closely observed for the presence or absence of the *E. myrmeleon* symptoms on their various parts (trunks, stems, pods, cherelles, twigs, leaves), which was appropriately recorded.

The activities of cocoa stem borer were randomly observed in its natural habitat on all the selected cocoa plots. Each infested cocoa stand was closely observed for symptoms on the various parts (trunks, stems, pods, cherelles, twigs, leaves) of the cocoa trees. They were further cut open to show the tunneling patterns of the borer. Field pictures were taken with a digital camera and detailed descriptions of the tunneling pattern of the borers were made.

Random destructive sampling of infested cocoa stands was carried out by cutting off some stems and trunks with sharp cutlass. They were further cut open to expose the various developmental stages of the borer. Field pictures were taken with a digital camera and detailed descriptions of the various stages of the borers

observed were made.

All data generated from this study were analyzed using simple descriptive statistics of their various means and multiple factors analysis of variance (ANOVA) in Minitab with subsequent mean separation done using Tukey's test.

3. Results

3.1. Survey of Cocoa Stem Borer and Pest Incidence Mapping

There is an outstanding level of devastation of the cocoa farms by cocoa stem borer in all states surveyed. The highest infestation rate of 30.1% was recorded for Cross River State in 2019/2020 against 4% in 2014/2015 (**Figure 2**). This was closely followed by Oyo (18.7%). The percentage of damaged trees as a result of the feeding activities of the stem borer in Osun state was 12.6%. This was followed by Ondo state 7.4%, Ogun state 7.0% and Ekiti state with the least damage infestation of 4.5%. There is a significant difference in the percentage of *E. myrmeleon* in the cocoa growing farms in different states of Nigeria ($n = 9$, $p = 0.01$, $df = 5$, $F = 9.03$) in the 2019/20 season and the 2014/2015 growing season ($n = 9$, $p = 0.02$, $df = 5$, $F = 4.35$). The mean percentage infestation grew by over 10% from 2.09% in 2014/2015 to 13.39% in 2019/2020 and was significantly different ($n = 54$, $p = 0.01$, $df = 1$, $F = 41.77$) (**Figure 3**).

3.2. Damage Characteristics of Cocoa Stem Borer

The cocoa stem borer *E. myrmeleon* is a serious insect pest of *Theobroma cacao*, which sometimes kills the tree completely within a few months of infestation. The initiation of attack could be recognized by the presence of small holes on the cocoa tree trunk/branches followed by gummosis, extrusion of chewed up fibers and excreta at the base of trunks as the grub expels them out. These holes increase as infestation progresses (**Figures 4(a)-(c)**).

The larva of *E. myrmeleon* bores and tunnels into the trunks and stem branches of cocoa, enlarging the gallery as it grows. The larvae spend their entire immature life inside the cocoa trunks and stem branches. The damage caused by the cocoa stem borer *E. myrmeleon* is characterized by the presence of wood shavings and frass deposits at the entrance of the hole in the trunk/branch (**Figure 5(a)**) and at the base of the cocoa tree (**Figure 5(b)**). In addition, emissions of gummy mucilage exudates were noticed flowing off from the entrance hole down the trunk of the tree (**Figure 5(c)**).

Their feeding activities damage the vascular tissues, arrest the sap flow, and weaken the stem thereby resulting in yellowing, browning and shedding of leaves, drying of twigs, which sometimes results in the death of the tree. If a branch is affected, you could see the leaves on that branch drying up while the rest of the leaves are still fresh. As the infestation progresses, it can spread to all parts of the tree, killing it. Even at the peak of the rainy season, the infested cocoa plantations from a distance will appear like it has been ravaged by fire (**Figure 6**).

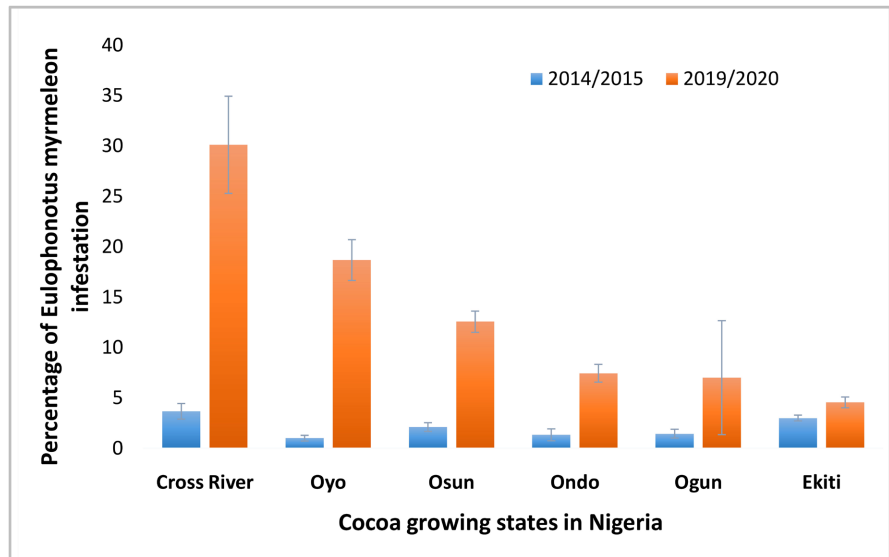


Figure 2. Infestation of *Eulophonotus myrmeleon* in the different cocoa growing state in Nigeria in the 2014/2015 and 2019/2020.

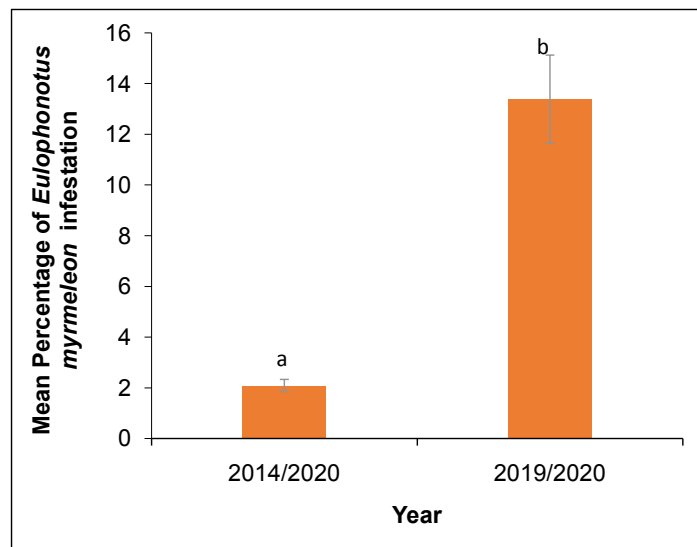


Figure 3. *Eulophonotus myrmeleon* infestation level in cocoa growing farms in Nigeria.

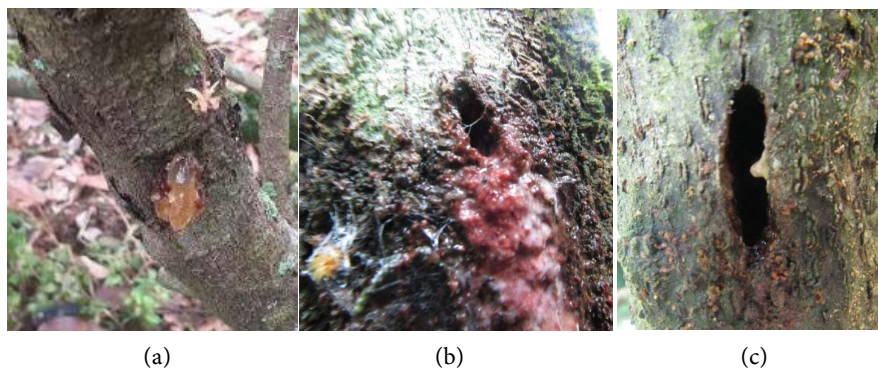


Figure 4. (a) Initial stage of infestation (b) Initiation of the hole (c) Widening of the hole.

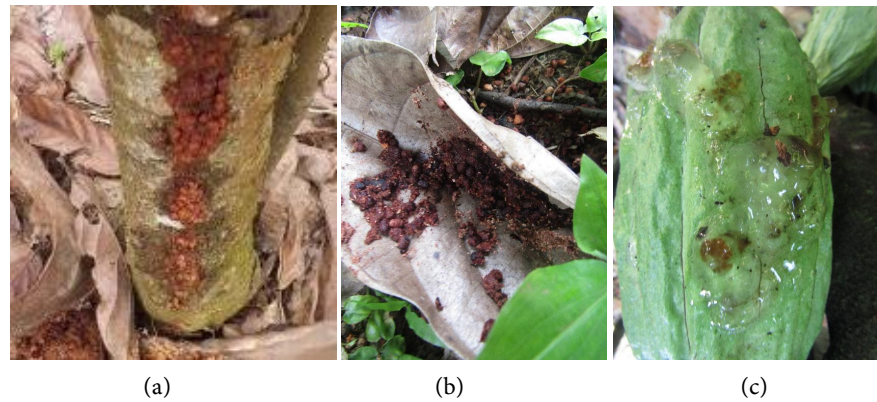


Figure 5. (a) Cocoa trunk with extrusion of chewed up fibres at the base (b) Frass and wood exudate at the surrounding of the cocoa stem. (c) Gummy mucilage exudates from an infected branch.

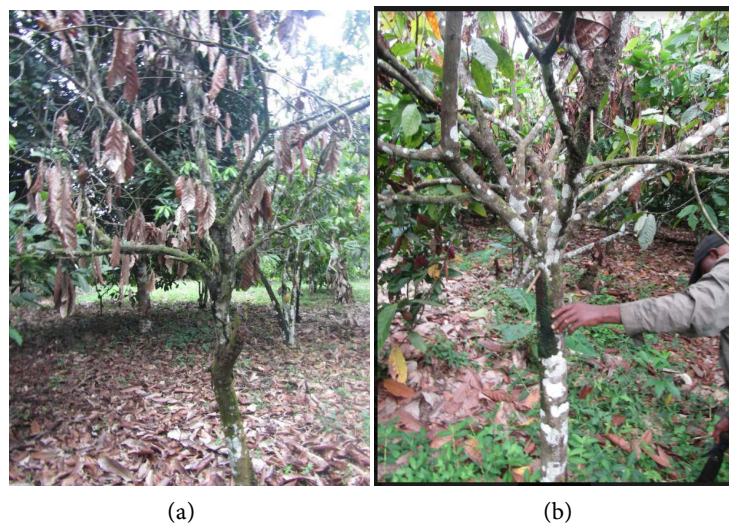


Figure 6. Cocoa trees with dried up leaf canopy.

The damage of the cocoa stem borer is further characterized by the shedding of mature flowers and drying up of the flower cushions, a drop in fruit production and sudden deterioration of all the mature and immature pods already on the infested cocoa tree (Figure 6). Majority of the tunneling was upward towards the branches however, sometimes, their tunneling is downwards towards the underground roots (Figure 7). It was also observed that young cocoa trees less than one year old were not attacked.

3.3. Description of the Various Stages of the Cocoa Stem Borer

The eggs of the cocoa stem borer were conspicuously absent at the time of this field assessment as they may have all hatched and progressed to other life stages (larvae, pupae, and adults). The larva (grub) of *E. myrmeleon* has a curled light brownish body with wrinkled skin and dark head capsule (Figure 8). The larvae are usually large, measuring approximately 1 cm thick and 5 cm long on the average.



Figure 7. Tunneling downwards towards the underground roots.



Figure 8. The grub of *Eulophonotus myrmeleon*.

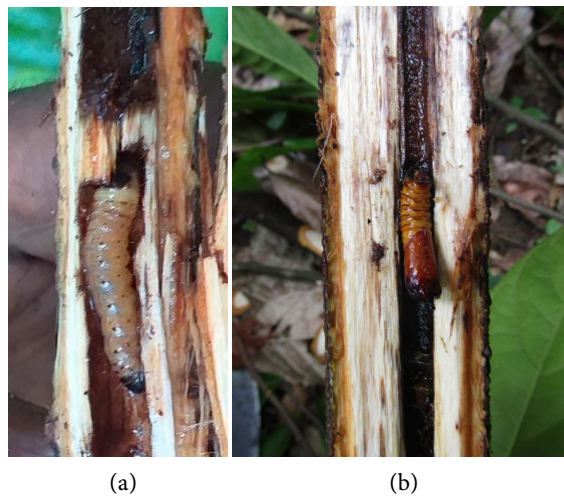


Figure 9. (a) Stem borer larva developing inside the cocoa stem branches (b) Pupating of the larvae.

The adult borer was totally evasive throughout the period of this field survey. The difficulty encountered in rearing the larvae of the cocoa stem borer and thereby getting the adult insect for proper identification and description had remained a big challenge for us in Nigeria. The larvae remain in the stem of the cocoa and pupate (Figure 9) and then emerge as adults.

4. Discussion

The cocoa stem borer, *Eulophonotus myrmeleon*, which hitherto before now was regarded as a minor pest with minimal damages inflicted on cocoa trees [7] [14], is fast assuming a major pest status across all the cocoa growing states in Nigeria especially in Cross River State. The *E. myrmeleon* Felder has now become a serious cocoa insect pest in Nigeria with serious economic consequences. The result of this study shows that the level of attack of *E. myrmeleon* increased astronomically from 2015 to 2020, indicating that this insect has become a serious problem for the farmers in the states sampled. The current pest incidence in 2019/2020 was generally high across cocoa agro ecologies of the six (6) cocoa producing states covered by the survey. This damage proportion is considered economical for tree crops like cocoa especially because of the nature of damage inflicted on the plant, recovery of the stem is rarely possible. This corroborates the report by [15] who reported that *E. myrmeleon* which was not considered a serious pest of cocoa in Cote d'Ivoire is now a serious menace with above 25% infestation. [16] reported a rise in rainfall and lower temperature to play an important role in the rise of the population of *E. myrmeleon* in Cote d'Ivoire.

The emerging larvae desert galleries in drying cocoa trunk and stem branches wood, to make excavation of new galleries in fresh wood beneath the protection of a tent of wood particles bound together with silk. This usually results in a single cocoa tree being riddled with 5 to 30 fresh bores or more at the same time. The borer is a slow spreading pest as it has a long-life cycle. They were found to aggregate in clusters of cocoa trees. The pest appears to gradually spread to neighboring trees, which results in farms having areas with stem borer attack, while other areas appear untouched [17].

There was an earlier belief that the cocoa stem borer spreads fast as a pest in areas with heavy pesticide abuse on trees, which kills off their natural predators [8]. This may be a possible explanation to the spread of the pest in cocoa farms. Cocoa farmers rely heavily on the use of pesticides for the management of capsid pest of cocoa [18] [19], which may have led to the destruction of natural enemies, development of resistance by *E. myrmeleon* and/or pest resurgence. This observation is in tandem with the results of this study, which has shown the infestation levels of the borer to be on the increase in Nigeria. It also corroborates earlier reports of very high infestation rates in Côte d'Ivoire and Ghana [11] [13] [15] [20]. Usually, the populations of *E. myrmeleon* are seldom large enough for their activities to be severe in cocoa plantations in Nigeria. However, the recent climatic changes and severe dry seasons, which caused considerable die-back in

cocoa, may have created conditions favoring larval migration of the borer and thus increasing the injurious effects of *E. myrmeleon*. Climate change is known to affect the population dynamics, survival rate and geographical distribution of insect pests [21]. Since *E. myrmeleon* is relatively a new serious pest of cocoa, there are no known effective methods for the management of the pest. The use of pesticides for the management of *E. myrmeleon* in cocoa field is challenging as most of the life stage of the pest is spent hidden in the stem or branches of the tree therefore pesticides used in managing other pest like the capsids are ineffective against *E. myrmeleon* [14]. Management strategy for *E. myrmeleon* need to be studied and developed urgently to reduce the spread and the limit the damages caused by *E. myrmeleon* to cocoa production.

5. Conclusion

Very high damage symptoms of this Lepidopterous insect pest were observed in farmers farms. Indeed, the cocoa stem borer, which had been reported in Nigeria, before now as a minor insect pest, is fast becoming a major pest of cocoa and urgency must be given to its study to fully understand its biology and develop a sound management measure for this pest. Meanwhile, the farmers are advised to adhere strictly to the guidelines of Good Agricultural Practices in their cocoa farm to stem down the current high incidence of the pest. The biology of the *Eulophonotus myrmeleon* should be studied in detail and methods for the control of this pest are researched. Movement of plant material should be done carefully to avoid the movement of this pest from areas of high densities to areas of low densities.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

- [1] End, M.J., Daymond, A.J. and Hadley, P. (2021) Technical Guidelines for the Safe Movement of Cacao Germplasm. Revised from the FAO/IPGRI Technical Guidelines No. 20 (Third Update, 2021). Bioversity International, Rome.
- [2] Ntougam, E.N., Kamgang, J.C., Kamla, V.C., Mualla, Y., Tchappi, I.H., Galland, S. and Wono, Y.E. (2020) Agent-Based Model of Cocoa Mirids at the Scale of a Cocoa Farm. *Procedia Computer Science*, **170**, 1180-1185. <https://doi.org/10.1016/j.procs.2020.03.032>
- [3] Asogwa, E.U., Mokwunye, I.U. and Oyedokun, A.V. (2012) Cocoa Insect Pest Outbreak in Some Parts of Ondo, Oyo, Osun and Edo States of Nigeria. Technical Re-

- port, CRIN, Ibadan, 17 p.
- [4] Entwistle, P.F. (1963) A Note on *Eulophonotus myrmeleon* Fldr. (Lepidoptera, Cossidae), a Stem Borer of Cocoa in West Africa. *Bulletin of Entomological Research*, **54**, 1-3. <https://doi.org/10.1017/S0007485300048549>
 - [5] Entwistle, P.F. (1972) Pest of Cocoa. Longman Group Ltd., London, 778 p.
 - [6] Yakovlev, R.V. (2011) Catalogue of the Family Cossidae of the Old World (Lepidoptera). *Neue Entomologische Nachrichten*, **66**, 1-130.
 - [7] Adu-Acheampong, R., Padi, B. and Sarfo, J.E. (2004) The Life Cycle of the Cocoa Stem Borer *Eulophonotus myrmeleon* in Ghana. *Tropical Science*, **44**, 28-30. <https://doi.org/10.1002/ts.127>
 - [8] Hill, D.S. (2008) Pests of Crops in Warmer Climates and Their Control. Springer, Dordrecht.
 - [9] Hill, D.S. and Waller, J.M. (1982) Pests and Diseases of Tropical Crops Volume 2: Handbook of Pests and Diseases. John Wiley & Sons, Hoboken.
 - [10] Caplong, P., Paulin, D, Alauzet, C. and Decazy, B. (1993) Le foreur du tronc du cacaoyer, *Eulophonotus myrmeleon* Felder (Lepidoptera: Cossidae), un ravageur potentiellement dangereux en cacaoculture. *Proceedings of the 11th International Cocoa Research Conference*, Yamoussoukro, 18-24 July 1993, 215-221.
 - [11] Wegbe, K., Gnakpenou, D., Djekpor, E.K. and Homa, S. (1995) Résultats préliminaires sur l'étude d' *Eulophonotus myrmeleon* Felder (Lepidoptera: Cossidae), foreur du tronc du cacao: Description des dégâts, dispersion, évolution des populations dans le Kloto, sud du Togo. *Proceedings of INCOPEP 1st International Seminar*, Accra, 6-10 November 1995, 15-22.
 - [12] Gnakpenou, D., Wegbe, K. and Djekpor, E.K. (1996) Études préliminaires sur le foreur du tronc du cacaoyer, *Eulophonotus myrmeleon* Felder (Lepidoptera: Cossidae) au Togo: Repartition et bio-écologie. *Proceedings of the 12th International Cocoa Research Conference*, Salvador, 17-23 November 1996, 45-49.
 - [13] Padi, B. and Adu-Acheampong, R. (2000) Preliminary Measure for the Control of the Cocoa Stem Borer *Eulophonotus myrmeleon* Felder (Lepidoptera: Cossidae). *Proceedings of the 13th International Cocoa Research Conference*, Kota Kinabalu, 9-14 October 2000, 649-657.
 - [14] Anikwe, J.C. (2010) The Seasonal Occurrence and Control of the Cocoa Stem Borer, *Eulophonotus Myrmeleon* Fldr. (Lepidoptera: Cossidae) on Cocoa in Ibadan, Nigeria. *Libyan Agriculture Research Center Journal International*, **1**, 142-146.
 - [15] N'Guessan, A.H., N'Guessan, K.F., Kouamé, N.N., Kouassi, K.P. and N'Guessan, W.P. (2016) Distribution géographique et importance des dégâts de foreurs des tiges dans le verger de cacaoyers de Côte d'Ivoire. *Journal of Animal & Plant Sciences*, **27**, 4282-4292.
 - [16] N'Guessan, K.F., Kébé, I.B. and Adiko, A. (2010) Seasonal Variations of the Population of *Eulophonotus myrmeleon* Felder (Lepidoptera: Cossidae) in the Sud-Bandama Region of Côte d'Ivoire. *Journal of Applied Biosciences*, **35**, 2251-2259.
 - [17] David, S. (2005) Learning about Sustainable Cocoa Production: A Guide for Participatory Farmer Training. 1. Integrated Crop and Pest Management. Sustainable Tree Crops Program, International Institute of Tropical Agriculture, Yaoundé, 188 p.
 - [18] Idris, A., Rasaki, K., Folake, T. and Hakeem, B. (2013) Analysis of Pesticide Use in Cocoa Production in Obafemi Owode Local Government Area of Ogun State, Nigeria. *Journal of Biology, Agriculture and Healthcare*, **3**, 1-9.
 - [19] Aminu, F., Ayinde, I., Sanusi, R. and Olaiya, A. (2019) Determinants of Pesticide

Use in Cocoa Production in Nigeria. *Canadian Journal of Agriculture and Crops*, **4**, 101-110. <https://doi.org/10.20448/803.4.2.101.110>

- [20] N'Guessan, K.F. (2006) The Cocoa Stem Borer, *Eulophonotus myrmeleon* Felder (Lepidoptera: Cossidae) and Others New Potentially Dangerous Lepidopteran Pests of Cocoa. *Actes de la 15^{ème} Conférence Internationale sur la Recherche Cacaoyère*, San José, Costa Rica, 9-14 October 2006, 1079-1086.
- [21] Skendžić, S., Zovko, M., Živković, I.P., Lešić, V. and Lemić, D. (2021) The Impact of Climate Change on Agricultural Insect Pests. *Insects*, **12**, Article No. 440. <https://doi.org/10.3390/insects12050440>