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Prevalence of *Apate monarchus (fab.)* on *Terminalia ivorensis (a. Chev.)* from Olabisi Onabanjo University's Main Campus, Southwestern Nigeria

Sulaimon Adebisi Aina[1*], Ismail Babatunde Onajobi[2], Titilola Fausat Salisu[1], Oyindamola John Samson[2], Folarin Ojo Owagboriaye[1], Rasheed Yemi Oladunjoye[1], Ajoke Saudat Sanusi[3], Olubukanla Olubukunola Oyesiku[3], Hafsat Adebisi Akinyemi[1], Adeoye Ayoola Toheeb[1]

[1]Department of Zoology & Environmental Biology, Olabisi Onabanjo University, Ago-Iwoye, Ogun-State, Nigeria.
[2]Department of Microbiology, Olabisi Onabanjo University, Ago-Iwoye, Ogun-State, Nigeria.
[3]Department of Plant Science, Olabisi Onabanjo University, Ago-Iwoye, Ogun-State, Nigeria.

*Corresponding author: aina.sulaimon@oouagoiwoye.edu.ng

Abstract
Insects and plants developed many different kinds of interactions during the course of their long-term cohabitation. This investigation aim was to determine the presence of *Apate monarchus* on *Terminalia ivorensis* from Olabisi Onabanjo University's main campus in Ago-iwoye, Ogun State. Samples were obtained from the underside of each tree, and statistics on the prevalence (%) of insect pests and the level of infestation were noted. The frequency and incidence of the pests were evaluated. Insects on Road 1 had a TPP rate of 73.91%, compared to a TIP rate of 52.17%, indicating that Road 1 had a higher TPP rate. The TPP rate is greater than the TIP rate for insects there, as seen by the TPP rate for insects on the right side of Road 1 (78.57%) and the TIP rate (42.85%). The insects on the left side of Road 1 have a TPP rating of (33.33%) and a TIP rating of (66.66%), which is lower than their TIP rating. Although the incidence rate was below 25%, the results showed that there were beetles on trees at a prevalence rate of above 70%. This may be a result of these trees' placement and spacing.
Keywords: Black borers, *Apate monarchus*, Insects, Plants, *Terminalia ivorensis,* Incidence,

Introduction

The emergence of many types of interactions between insects and plants was a result of long-term cohabitation (Witzany, 2006). There are several ways that insects can harm plants, including by eating them or spreading dangerous plant infections (David and Ramamurthy, 2012; Braack *et al.,* 2018; Aina *et al.,* 2021). Plants have developed several defense systems to decrease insect assault. By identifying the compounds found in insect saliva and oviposition fluids, as well as their eating habits, plants may distinguish between physical damage and insect damage (Doss *et al.,* 2000; Methöfer *et al.,* 2005; Aina *et al.,* 2023).

Several signaling mechanisms are used to transmit the information after identification of an insect pest infestation (Maffei *et al.,* 2007). In response, insects have also developed a variety of methods to circumvent plant defense systems, including detoxifying poisonous plant compounds or storing them away and using them for self-defense (Peng *et al.,* 2007). Since insects pollinate the majority of blooming plants, plants have also formed mutualistic connections with insects. Plants give pollinators sustenance in the form of nectar and pollen in exchange for the transport of pollen (Hägg *et al.,* 2013). Because the soil in which they are grown is lacking in nutrients, carnivorous plants have developed the ability to catch the insects to meet their nutrient demand (Wackers *et al.,* 2001).

The Bostrichid beetle known as the black borer (BB), *Apate monachus* (Figure 1) is destructive to ornamental and fruit trees as well as other woody plants. The species has a long history of attacking citrus plants, as well as grapevines, peach, apple, pear, avocado, ornamental and fruit trees (Wysoki *et al.,* 2002; Tzanakakis, 2003; Liu *et al.,* 2008; Di Franco and Benfatto, 2008). Large portions of Southern tropical regions are affected by *Apate monachus*, which is also known to be detrimental to palm trees in Tunisia (Walker, 2008). *A. monachus* is a pest of coffee plantations in Tanzania and causes issues with forest management and wood-processing enterprises in West Africa (Waller *et al.,* 2007).

Young carob (*Ceratonia siliqua* L., Fam. Fabaceae) and pomegranate (*Punica granatum* L., Fam. Punicaceae) plants were discovered to be infested with adult *A. monachus* at a plant nursery in June 2010. This observation supports the spread of *A. monachus* throughout the Mediterranean region and the number of plant species on which it is a pest (Ozturk and Ulusoy, 2006). The development of the larval stadium can vary in length from 32 months to 36 months in *A. monachus*, however under more favorable circumstances; it can be shortened to 55-114 days (Oztop et al., 2010).

A huge deciduous tree often found in Western Africa called *Terminalia ivorensis* (Fig. 2), also known as Black Afara, Ivory Coast Almond, Idigbo, Framire, and Emire, is in danger of losing its habitat because to inadequate regeneration and wood exploitation (Ozturk and Ulusoy, 2006). It may grow up to 46 meters tall and have a trunk diameter of 4.75 meters. Its bole has modest buttresses at the base and is very straight. The crown has a horizontal spread and a flat top. No portion of the plant is edible; however, it is highly prized for its therapeutic properties and for its superior wood. For a variety of ailments such wounds, sores, hemorrhoids, rheumatism, ulcers, blennorrhea, and kidney issues, various plant components are employed as treatments (Aina *et al.,* 2021). As a result of associated benefits including the ecologically benign character of wood, its complete capacity for renewal, and its cheap handling costs, the usage of wooden buildings in the construction sector has recently expanded (Hassani *et al.,* 2014). This aim of this study is to assess the prevalence of *Apate monarchus* on *Terminalia ivorensis* on Olabisi Onabanjo University's Main-Campus in Ago-Iwoye, Ogun state due to the observed destructive behavior of the pest.

Figure 1: *Apate monarchus* (Crowe, 2004)

Figure 2: *Terminalia ivorensis* (Hawtborne, 1998).

Materials and Methods

Study Area

Olabisi Onabanjo University, Ago-Iwoye (Figure 3) is a State (owned and operated) University situated in Ago-Iwoye, Ogun State, Nigeria. The University was founded July 7, 1982 as Ogun State University (OSU) and was renamed Olabisi Onabanjo University on May 29, 2001 in honour of Chief (Dr.) Olabisi Onabanjo, whose efforts as the then civilian Governor of Ogun State gave birth to the University. Meanwhile, many students still refer to the institution as OSU, an acronym for the former name (Onajobi *et al.*, 2020).

Figure 3: Olabisi Onabanjo University, Mini-Campus, Ago-Iwoye. Ogun-State Map

Survey and Sampling Method

The survey area (Road 1) was chosen specifically for this survey due to the distribution and population of *T. ivorensis* along it. The total number of *T. ivorensis* surveyed was 23. Moreover, observation and sampling were made on 85 trees that were on active vegetative growth and amount of holes as well as location of holes, were noted. Samples were collected on individual tree bases and data on incidence (%) of insect pest, severity (score 1- 5; 1 as least severe and 5 as very severe) were taken according to Braack *et al.* (2018). Insect pest prevalence (occurrence) and incidence were assessed using the equations 1 and 2.

$$\textbf{Percentage of Occurence (prevalence)} = \frac{\textbf{No.of iinsects/}\textit{holes observed}}{\textbf{Total No.of Trees assesed}} \textbf{ X 100} \qquad \text{Equation 1}$$

$$\textbf{Insect pest incidence (I)} = \frac{\textbf{No.of infected Trees}}{\textbf{Total No.of Trees assesed}} \textbf{X 100} \qquad \text{Equation 2}$$

Pest identification

To ascertain the predominant insect pests, samples were characterized both on the field and in the lab using pest identification guidebooks and specimens were preserved accordingly in 70% ethanol and then presented in insect boxes for future reference (Aina *et al.,* 2016).

Statistical Analysis

Data collected were analysed using descriptive methods like line graphs and comparison tools with the aid of SPSS version 21 (Aina *et al.,* 2021).

Results

Distribution and Severity of *Apate monarchus*

The distributions and severity of *A. monarchus* on *T. ivorences* are presented in Table 1. The result obtained shows the incidence of *A. monarchus* on the right side of the road is more than that of the left side. It also indicated the amount and position of the holes made by *A. monarchus* on the trees, and the observable presence of fresh saps on the trees as a plant response mechanism (Figure 4 and 5).

Figure 4: Hole bored upwardly in the trunk

Figure 5: Sap produced as plant response to tissue damage

Prevalence and Incidence of *A. monarchus* on *T. ivorensis*

The percentages of prevalence and incidence of *A. monachus* (Figure 6) on *T. ivoriensis* was estimated for; Road I, Right side of Road I and Left side of the Road I is presented in Table 2 as a total prevalence percentage (TPP) of 73.91% for insects on Road I, 78.57% for insect prevalence on the Right side of Road I, and 33.33% for insects on the Left side of Road I. The incidence rate revealed that the total incidence percentage (TIP) of insects on Road 1 was 52.17%, which of insects on Road I (Right and Left sides) was 42.85% and 66.66% respectively as showed in Table 3.

Figure 6: Preserved samples of *A. monachus*

Comparison between the total prevalence percentage (TPP) and total incidence percentage (TIP) was presented in Table 4. Insect on Road I have a TPP rate of 73.91% and the TIP rate is 52.17% indicating that TPP rate is greater than the TIP rate in Road 1. Insect on Right side of Road I have a TPP rate of 78.57% and the TIP rate is 42.85% indicating that TPP rate is greater than the TIP rate on insect at the Right side of Road I. While insect on Left side of Road I have a TPP rate of 33.33% and the TIP rate is 66.66% indicating that TPP rate is less than the TIP rate on insect at the Left side of Road I as shown in (Figure 7).

Table 1: Distribution and population of *A. monarchus* on *T. ivorensis*

Tree position	No. of Insect	No. of Holes	Position of Holes	Presence of Sap
Right Side of the Road	2	21	Top and Middle	Yes
	2	14	Top and Middle	Yes
	1	11	Top and Middle	Yes
	1	8	Top and Middle	Yes
	0	5	Top	Yes
	0	6	Top	Yes
	0	8	Top	Yes
	0	7	Top	Yes
	0	0	Nil	Yes
	1	12	Top and Middle	Yes
	1	7	Top and Middle	Yes
	0	0	Nil	No
	0	0	Nil	No
	0	8	Top	Yes
Left Side of the Road	1	19	Top and Middle	Yes
	1	7	Top and Middle	Yes
	1	5	Top and Middle	Yes
	0	0	Nil	No
	0	0	Nil	No
	0	0	Nil	No
	1	8	Top and Middle	No
	1	7	Top and Middle	No
	1	9	Top and Middle	Yes

Table 2: Prevalence rates of *A. monarchy* on *T. ivorensis* in (%)

Study Area	Total Number of Tree Infected (TPNTI)	Total Number of assessed Trees (TNAT) %	Total Prevalence Percentage (TPP) %
Insect on Road I	17	4.35	73.91%
Insect on Right side of Road I	11	7.14	78.57%
Insect on Left side of Road I	3	11.11	33.33%

Table 3: Incidence rates of *A. monarchy* on *T. ivorensis* in (%)

Study Area	Total Number of Tree Infected (TPNTI)	Total Number of assessed Trees (TNAT) %	Total Incidence Percentage (TIP) %
Insect on road 1	12	4.35	52.17%
Insect on right side of road 1	6	7.14	42.85%
Insect on left side of road 1	6	11.11	66.66%

Table 4: Comparison of the prevalence and incidence rate of *A. monarchy* on *T. ivorensis* in (%)

Study Area	Prevalence (%)	Incident (%)
Road I	73.91	52.17
Right Side	78.57	42.85
Left Side	33.33	66.66

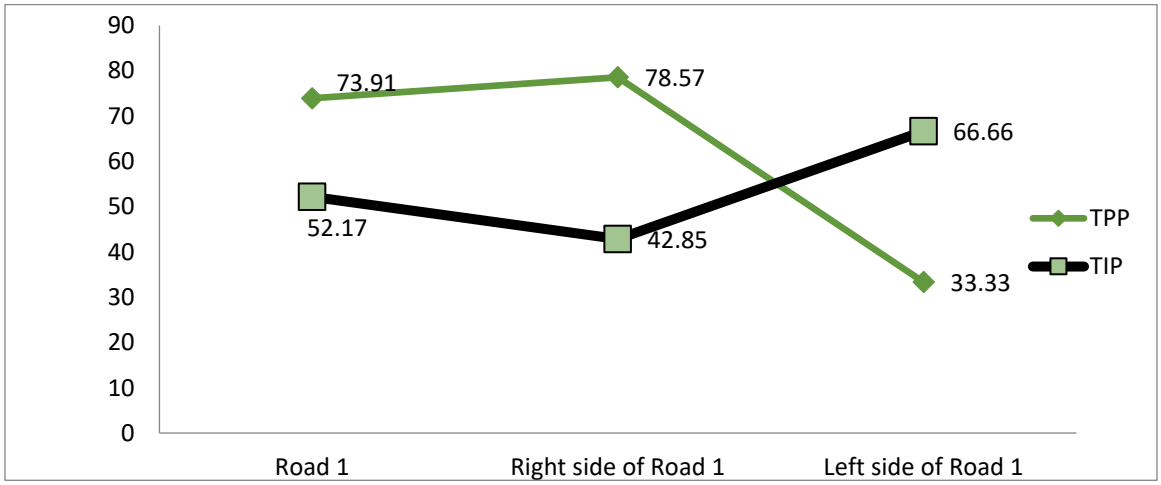

Figure 7: Comparison of the prevalence and incidence rate of *A. monarchy* on *T. ivorensis*

Discussion

The results obtained from the study shows that on the 23 trees surveyed, there were 14 *A. monarchy* collected and though no insect was found on some of the trees, holes had been bored into those trees by these insects, this was in line with Bonsignore (2012) who recorded that the adult beetles produce circular holes and large sinuous tunnels on young trees that can involve the trunk and branches.

The holes were bored slightly below half the length of the trees but most were bored at the top of the trees. This suggests that these insects might dwell at the upper part of the trees which would make it difficult to control. The study results indicate that for insects observed along route 1, there is a notable difference in their Thermal Preference Performance (TPP) and Thermal Indifference Performance (TIP) rates. Specifically, the TPP rate was found to be 73.91%, while the TIP rate stood at 52.17%, indicating a higher TPP rate compared to the TIP rate.

Furthermore, when focusing on the insects located on the right side of road 1, the results showed that they exhibited a TPP rate of 78.57% and a TIP rate of 42.85%. This disparity signifies that the TPP rate among these insects was notably higher than their TIP rate. In contrast, when examining the insects situated on the left side of road 1, their TPP rate was measured at 33.33%, while their TIP rate was 66.66%. This finding suggests that these insects had a lower TPP rate compared to their TIP rate.

For a visual representation of these findings, please refer to Figure 4, which provides an illustrative depiction of the variation in TPP and TIP rates among insects along different sides of road 1. The result above indicated that *A. monarchy* had a very high colonization on *Terminalia ivorensis* which is in line the study of Braack *et al.* (2018) who recorded over 70% prevalence rate of beetles on trees, though the incidence rate fell below 25%. This might be due to the location and spacing of these trees. The amount of holes found on the trees greatly outnumber the amount of insects found on them, this might be because of the season and time of survey.

Some of the trees showed no presence of the insect as there were no holes or sap on them even at the top and their barks were smooth. *A. monarchus* has been recorded to cause severe damage to growing plants especially coffee as reported by Bonsignore (2012), the survey also revealed that no serious effect was done by these insects on the trees which is also in line with the work of David and Ramamurthy (2012).

Conclusion

The predominance of *Apate monarchus* on *Terminalia ivorensis* from Olabisi Onabanjo University, Ago Iwoye, is confirmed by this study. The study involved collecting samples from the underside of these trees and recording statistics related to insect pests' prevalence (%) and the extent of infestation. These results imply that insects on the left side of Road 1 had a lower preference for the thermal conditions compared to their indifference towards them, signifying a thermal preference for cooler environments. It is worth noting that although the incidence rate of insect pests on the trees was below 25%, there was a substantial prevalence of beetles, with a prevalence rate exceeding 70%. This observation suggests that the specific placement and spacing of these trees may have contributed to the higher prevalence of beetles in the area. The study provides valuable insights into the thermal preferences of insects in this environment and highlights the potential impact of tree placement on insect infestations, particularly with regards to beetles. Further research may be needed to explore the ecological implications of these findings and their relevance to pest management strategies.

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References

Aina, S.A., Onajobi, I.B., Salisu, T.F., Owagboriaye, F.O., Olasupo, A.O., Sanusi, A.S., Samson, O.J. & Adeoye, A.T. (2023). Comparative lethal effects of three *Ocimum* plants species against *Culex quinquefasciatus* mosquito larvae. *Munis Entomology & Zoology*, 18(1): 481-488.

Aina, S.A., Onajobi, I.B., Sanusi, A.S. & Kolejo, O.S. (2021). Larvicidal potentials of three indigenous plants against malaria vector, *Anopheles gambiae* L. *Jordan Journal of Biological Sciences*, 14(4): 847– 852.

Aina, S.A., Owagboriaye, F.O. & Ojobaro, O.E. (2016). Incidence and diversity of insects on *Moringa oleifera* (Lam.) and *Jatropha curcas* (Linn.) in South-West Nigeria. *African Journal of Science and Nature*, 3: 62:65.

Bonsignore, C.P. (2012). *Apate monachus* (Fabricius, 1775), a bostrichid pest of pomegranate and carob trees in nurseries – short communication. *Plant Protectection Science,* 48: 94-97.

Braack, L., Almeida, A.P.G., Cornel, A.J., Swanepoel, R. & Jager, C. (2018). Mosquito-borne arboviruses of African origin: review of key viruses and vectors. Parasites & Vectors, 11: 29. doi: 10.1186/s13071-017-2559-9.

Crowe, T.J., (2004). Coffee pests in Africa. In: Coffee growing, processing and sustainable production. A guidebook for growers, processors, traders and researchers [ed. by Wintgens, J. N.]. Weinheim, Germany: Wiley-VCH, 1022 pp.

David, B.V. & Ramamurthy, V.V. (2012). Elements of Economic Entomology, Namrutha Publications, Chennai, pp 83-87.

Di Franco, F. & Benfatto, D. (2008). Nuove infestazioni di *Apate monachus* Fabr. (Coleoptera Bostrychidae) nei limoneti siciliani. *Terra e Vita*, 50: 26–27.

Doss, P.R., Oliver, J.E., Proebsting, W.M., Potter, S.W., Kuy, S.R., Clement, S.L., Williamson, R.T., Carney J.R. & DeVilbiss E.D. (2000). Plants make galls to accommodate foreigners: some are friends, most are foes. *Proceedings of the National Academy of Sciences, USA*, 97: 6218-23.

Hägg, J.F., Zagrobelny, M. & Bak S. (2013). Plant Defense against Insect Herbivores. *International Journal of Molecular Sciences*, 14: 10242-97.

Hassani, M.M., Falk, K.W., Stefan, H. & Hans, J.H. (2014) ''Rheological Model for Wood'', Computational Physics for Engineering Materials, Zurich, pp.1-37.

Hawthorne, W, (1998). *Terminalia ivorensis*. In: IUCN. 2007 IUCN Red list of threatened species. [Internet] http://www.iucnredlist.org. Accessed October 2023.

Liu, L.Y., Schönitzerand, K. & Yang, J.T. (2008). A review of the literature on the life history of Bostrichidae (Coleoptera). *Mitteilungen der Münchner Entomologischen Gesellschaft*, 98: 91–97.

Maffei, M.E., Mithöfer, A. & Boland W. (2007). General Mechanisms of Plant Defense and Plant Toxins. *Trends in Plant Sciences*, 12: 310-6.

Methöfer, A., Wanner, G. & Boland W. (2005) *Plant Physiology*, 137: 1160-68.

Onajobi, I.B., Idowu, E.O., Adeyemi, J.O., Samson, O.J. Ogunyinka, P.I. and Fagade, O.E. (2020). In vitro antibacterial activities and molecular characterization of bacterial species isolated from farmlands against selected pathogens. *Biotechnology Reports* (Elsevier), 27 e00513. www.elsevier.com/locate/btre.

Öztop, A., Keçec, M. & Kivradim M. (2010). Investigation on pomegranate pests in Antalya province: stem and branch pests. *Batı Akdeniz Tarımsal Araştırma Enstitüsü Derim Dergisi*, 27: 12–17. (in Turkeish).

Özturk, N. & Ulusoy M.R. (2006). Pests and natural enemies determined in pomegranate orchards in Turkey. In: International Symposium Pomegranate and Minor Mediterranean Fruits (1st ISHS). ISHS *Acta Horticulturae*, No. 818.

Peng, J., Li, Z. & Huang, Y. (2007). *Journal of Plant Interaction*, 2: 93-99.

Tzanakakis, M.E. (2003). Seasonal development and dormancy of insects and mites feeding on olive: a review. *Netherlands Journal of Zoology*, 52: 87–224.

Wackers, F.L., Zuber D., Wunderlin R. & Keller K. (2001). *Annals of Botany*, 87: 365-70.

Walker, K. (2008). Black borer (*Apate monachus*) Pest and Diseases Image Library. Available at http://www.padil.gov.au.

Waller, J.M., Bigger, M. & Hillocks, R. J. (2007). *Ascotis selenaria reciprocaria* Walk in Tanzania. *East African Agricultural and Forestry Journal*, 35: 49–51.

Wizany, G. (2006). Plant Communication from Biosemiotic Perspective. *Plant Signaling and Behavior*, 1(4): 169–178. doi:10.4161/psb.1.4.3163.

Wysoki, M., Berg, M. van den, Ish-Am, G., Gazit, S., Pena, J.E. & Waite G.K. (2002). Pests and pollinators of avocado. In: Pena J.E., Sharp J.L., Wysoki M. (eds): Tropical Fruit Pests and Pollinators: Biology, Economic Importance, Natural Enemies and Control. CABI Publishing, Wallingford: 223–293.