Journal of Academia and Industrial Research (JAIR)
Volume 2, Issue 8 January 2014

ISSN: 2278-5213

RESEARCH ARTICLE

Life Cycle of *Petiobus setigerus* (Kerrich) (Hymenoptera: Eulophidae): A Parasitoid of the Oil Palm Pest, *Coelaenomenodera elaeidis* (Coleoptera: Chrysomelidae)

T.I. Aneni[1*], C.I. Aisagbonhi[2], B.N. Iloba[3] and V.C. Adaigbe[4]
[1,2,4]Entomology Division, Nigerian Institute for Oil Palm Research, Nigeria
[3]Dept. of Animal and Environmental Biology, University of Benin, Nigeria
tomaneni1@yahoo.com*; +234-80-55514010

Abstract

Oil palm is an important food and cash crop in Nigeria. *Coelaenomenodera elaeidis* is a major pest of the oil palm in Nigeria. A detailed study on the life cycle and ecology of *C. elaeidis* was conducted in the entomology laboratory of the Nigerian Institute for Oil Palm Research. The parasitoid serving as a bio-regulator is highly specialized on the leaf miner larva. Its life cycle is simple with all stages occurring in and around the *C. elaeidis* larva. Ambient air temperature fluctuated between 26°C-34°C and relative humidity from 52%-92%. The findings showed that the incubation period is 14.8 ± 0.45 d. Larval and pupal developmental period were 4.4 ± 1.14 d and 7.4 ± 2.07 d respectively. Total average development period from incubation to adult is 26.4 ± 2.88 d. Adult longevity is 6.3 ± 2.63 d. This study reports a complete life cycle for *Petiobus setigerus*, a *C. elaeidis* parasitoid that holds potential as a biological control agent that can be exploited for leaf miner management in Nigeria.

Keywords: Oil palm, *Coelaenomenodera elaeidis*, parasitoid, *Petiobus setigerus*, biological control.

Introduction

Oil palm is an important food and cash crop which plays a significant socio-economic role in Nigeria. *Coelaenomenodera elaeidis* is one of the most important insect pests of the oil palm in Nigeria. Morin and Mariau (1972) and Hartley (1988) gave accounts of the incidence, life cycle and damage of this pest. The developmental periods are: eggs, 20 d; larvae, 44 d; pupae, 12 d; adult to egg laying, 18 d; total, 94 d (about 3 months). The adult lives on the under-surface of the leaf for 3-4 months after egg laying. There are thus, 3 to 4 generations of this pest in a year. The adults are tiny pale-yellow beetles which scoop and feed in longitudinal grooves on the under-surface of leaflets, the females laying their eggs in pits at the ends of the grooves and covering these with mounds of debris. The larvae that hatch out of the mine or tunnel within the leaflet tissue is between the upper and lower epidermal layers. The larvae attain about 6.8 mm in length, with brownish thorax fused to the head. They mine longitudinally under the upper epidermis of leaflets of mature palms, except those below 3 years old. Their mined galleries attain 15 cm length and 1 cm breadth. Severely attacked palms look scotched from a distance, the young leaves remain green, while the remainders are grey-brown and desiccated. The pupae are mobile and are visible in the center of the galleries, when the dried furrows are teased out. The adults are pale yellow with reddish wing cases. These adults in cases of severe attack can be observed flying within the crown and show preference for migrating to the higher leaves.

The three fundamental kinds of interactions among organisms in ecosystems are those when (a) two organisms may overlap in their resource utilization and the harvesting by one adversely affects the resources available to the other (competition), (b) one organism may use another as its food source (predation, parasitism) and (c) two organisms may cooperate in resource acquisition or in the exchange of resources for services such as pollination or defence (mutualism). Although usually treated separately, these processes are aspects of resource harvesting and many of the same principles apply to all three (Farnworth and Golley, 1973).

One alternative method for management of insect pests is biological control. A variety of biological control agents can be used for insect pest control; which includes pest-specific parasitoids, generalist predators and pathogens (including viruses, bacteria, fungi or nematodes). Biological control is the use of natural enemies to reduce insect pest populations. The reason, biological control is so effective and safe is that a high degree of host-specificity for the targets is sought before a potential control organism can be released into the environment. A parasitoid is “an organism which develops on or in another single ‘host’ organism, extracts nourishment from it and kills it as a direct or indirect result of that development” (Kuris, 1974; Eggleton and Gaston 1990).

Table 1. Developmental period of *Petiobus setigerus* (means in d).

Incubation (d)	Larval duration (d)	Pupal duration (d)	Total days
14	3	7	24
15	4	6	25
15	4	5	24
15	5	9	29
15	6	10	30
Mean: 14.8 ± 0.45	4.4 ± 1.14	7.4 ± 2.07	26.4 ± 2.88

Number of observation (n) = 22; Means are values of 5 replicates.

Parasitoids, which mainly include taxa belonging to the Hymenoptera, play an important role in the maintenance of other arthropod populations, acting as regulators of host densities. Studies of predator-prey and parasitoid-host interactions are fundamental to understanding and effecting bio-control strategies for pest insects (Prakash, 2010). The objective of this work is to study the life cycle of *P. setigerus* and evaluate its effectiveness against *C. elaeidis*.

Materials and methods

Study site: The study site consisting of 443 mature palms at 9 m triangular spacing located at the main station of the Nigerian Institute for Oil Palm Research (NIFOR) near Benin, Edo State, Nigeria. The palms were planted in the year 2000. There are two seasons; wet and dry seasons. Average mean temperature is 26.6°C.

Field and laboratory studies: Pruned, damaged and infested fronds from the field were cut open and studied for presence of different life stages of *C. elaeidis* and their potential parasitoids. Observations on the relationship between the life cycle of *C. elaeidis* and *P. setigerus* (Kerrich) by placing parasitoid pupa and third instar leaf miner larva in a plastic cage (11.5 cm diameter x 4.5 cm tall) with a net cover for aeration. This provides the environment for emerged adult parasitoids to attack the larva. Five replicates were observed. A Wild Heerbrugg M 3B Binocular Microscope and a Samsung S760, 7.2 Mega pixels were used. Temperature and relative humidity were recorded daily with the digital Thermometer W/Hygro IT-202 model.

Leaf miner larval and parasitoid rearing: The rearing cages (11.5 cm diameter x 4.5 cm tall) were kept in the laboratory. The cages were placed in trays containing water to prevent ants from entry. Cotton wool soaked with sugar solution was provided for feeding of *C. elaeidis* larva, when placed in a plastic cage to observe parasitoid attack on it. Adult *P. setigerus* were fed with sugar solution to observe longevity.

Preparation of sugar solution: One cube of sugar was dissolved in 150 mL of distilled water. Solution was stirred evenly until well dissolved solution was obtained. Cotton wool was immersed in the solution for 5 sec, removed and then placed in the insect rearing cage.

Table 2. Longevity for *Petiobus setigerus*.

No. of adult parasitoids (n)	Adult longevity (d)
3	5
6	6
4	4
4	10
Mean	6.3 ± 2.63

Number of observation (n) = 22; Means are values of 5 replicates.

Results and discussion

Incubation period had a mean of 14.8 d ± 0.45 d; larval developmental period averaged 4.4 ± 1.14 d while pupal developmental period had a mean of 7.4 ± 2.07 d. The total developmental period of the parasitoid from incubation to adult emergence averaged about 26.4 ± 2.88 d (Table 1). Average longevity of the adult parasitoid is 6.3 ± 2.63 d (Table 2). Temperature was between 25-30°C and relative humidity was 81-86%.

The host: The host utilized is a live third instar *C. elaeidis* larva collected from a damaged and infested leaflet.

Parasitoid action on host: The parasitism starts immediately after parasitoid adult emergence, locating and finding the larva a suitable host. Only the female parasitoid seeks hosts (Prakash, 2010). They aggressively insert their ovipositor into the larva and paralyze it. Also using a piercing ovipositor as a sting, the parasitoid directly injects its eggs into the paralyzed larva.

Incubation: During this period, the eggs have been deposited into the leaf miner larva and the parasitic phase of life begins with the larva showing signs of distress. Because the larva was only paralyzed and not yet killed, the larva remained alive and was able to provide continuous fresh food for the growing eggs. Incubation period averaged 14.8 ± 0.45 d (Table 1).

Birth: After the eggs had gone through the incubation stage, they pupated and emerged out of the paralyzed larva after an average longevity of 14.8 ± 0.45 d. The larva is opaque and ovoid in shape. The larva is endo-parasitic, developing within the host. The parasitization and hatching process out of the larva finally killed it as they emerged out of different parts of the larva.

Plate 1. *Petiobus setigerus* emerging from host larva (X 100).

Plate 2. *Petiobus setigerus* larvae and pupae (X 100).

Plate 3. Adult *Petiobus setigerus.*

Plate 1 shows parasitoid emergence from larva. The parasitoid larvae measuring 2.1 mm (length) and 0.5 mm (width) had an average longevity of 4.4 ± 1.14 d before pupation. The pupa measuring 1.3 mm (length) and 0.7 mm (width) is black in colour and also ovoid in shape (Plate 2). Adults emerged after an average of 7.4 ± 2.07 d.

Adulthood: Female adult parasitoids with body length (3.0 mm), width (0.9 mm) and wings 2.0 mm had an average longevity of 6.3 ± 2.63 d (Table 2). They are completely black (Plate 3). Adult parasitoids are usually free living and highly mobile, being proficient at searching for hosts (Hoedjes *et al*., 2011).

Hymenopteran parasitoids nearly always have well-developed ovipositors that they use to access and assess hosts, lay eggs and inject various secretions on or into them. These venom secretions may cause temporary or permanent paralysis or modify the host's immune system and/or its metabolic functions (Godfray 1994; Quicke 1997). *Petiobus setigerus* had an average total developmental period of 26 d. There are thus, 13 to 14 generations of this natural enemy in a year. Major characteristics of insect parasitoids include (Hoffman and Frodsham, 1993): They are specialized in their choice of host; they are smaller than host; only the female searches for host; different parasitoid species can attack different life stages of host; eggs or larvae are usually laid in, on, or near host; immature remain on or in host; adults are free-living, mobile and may be predaceous; and immature almost always kill host. Parasitoids are unique in that during their life cycle, their habits vary from characteristically predator like (Oviposition) to characteristically parasitic (Incubation). Natural enemies could be conserved by less regular mowing of field edges to maintain habitat and alternate food sources for their populations, especially during the dry season.

Conclusion

This study has revealed that *Petiobus setigerus* offer potential as bio-control agent for *C. elaeidis*. Bio-control of *C. elaeidis* in its larval stage seems most promising.

Acknowledgements

I thank Prof. D.A. Enobakhare for his help in identifying the parasitoid. I also appreciate the technical assistance of Mr. Job Amusan.

References

1. Eggleton, P. and Gaston, K.J. 1990. "Parasitoid" species and assemblages: convenient definitions or misleading compromises? *Oikos.* 59: 417-421.
2. Farnworth, E.G. and Golley, F.B. 1973. Fragile Ecosystems. Springer-Verlag, New York. p.258.
3. Godfray, H.C.J. 1994. Parasitoids: Behavioral and evolutionary ecology. Princeton, NJ: Princeton Univ. Press.
4. Hartley, C.W.S. 1988. The Oil palm. Third Edition. Longman London. p.761.
5. Hoedjes, K.M., Kruidhof, H.M., Huigens, M.E., Dicke, M., Vet, L.E. and Smid, H.M. 2011. Natural variation in learning rate and memory dynamics in parasitoid wasps: Opportunities for converging ecology and neuroscience. *Proc. of the Royal Soc. B: Biol. Sci.* 278: 889-897.
6. Hoffman, M.P. and Frodsham, A.C. 1993. Natural enemies of vegetable insect pests. Cooperative Extension, Cornell University, Ithaca, NY. p.63.
7. Kuris, A.M. 1974. Trophic interactions: Similarity of parasitic castrators to parasitoids. *Quarterly Rev. Biol.* 49: 129-148.
8. Morin, J.P. and Mariau, D. 1972. Sur la biologie Coelanomenodera elaeidis. IV. Ladynamique des populations du ravageur et ed ses parasites. *Oleagineux.* 27(10): 469-472.
9. Prakash, M. 2010. Understanding entomology. Sachin Printers. p.294.
10. Quicke, D.L.J. 1997. *Parasitic Wasps*. Chapman and Hall, London.