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Research Article

Biology and ecology of *Pleurotroppopsis podagrica* (Waterston) (Hymenoptera: Eulophidae): a potential parasitoid of the oil palm pest, *Coelaenomenodera elaeidis* (Coleoptera: Chrysomelidae)

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ABSTRACT: *Coelaenomenodera elaeidis* (Coleoptera: Chrysomelidae) is endemic in almost all oil palm growing areas of West Africa and regarded as the most devastating insect pest of the oil palm. For the purpose of a detailed knowledge of the rearing, life cycle and ecology of the natural enemy of *C. elaeidis*, field and laboratory studies were conducted in the main station of the Nigerian Institute for Oil Palm Research. 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. Parasitoid larval developmental period averaged 8 d while pupal developmental period had a mean of 7.2 ± 1.48 d. The total developmental period of the parasitoid from larva to adult averaged 23.2 ± 3.56 d. Average longevity of the adult parasitoid was 3.9 ± 3.56 d. Temperature was between 25 – 30ºC and relative humidity ranged between 81–86%. The eulophid wasp, *Pleurotroppopsis podagrica* was found to parasitize *C. elaeidis*. Its larva is predominantly whitish, oval and translucent. The larva is averagely 3mm, oblong at the anterior and posterior sections tapering at both ends. The parasitoid emerged from the posterior region of *C. elaeidis* with the anterior region inside the host. This paper has shown that control of the *C. elaeidis* in its larval stage seems most promising and *P. podagrica* offers potential as bio-control agent for the *C. elaeidis*.

KEY WORDS: Oil palm, insect pest, parasitoid, *Pleurotroppopsis podagrica, Coelaenomenodera elaeidis*

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INTRODUCTION

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; larvae, 44; pupae, 12; adult to egg laying 18; total 94 days (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 6.8mm 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 objective of this work was to study the life cycle of *Pleurotroppopsis podagrica* and evaluate its effectiveness against the *Coelaenomenodera elaeidis*.

METHODOLOGY

Study Site

The study site consisting of 443 mature palms at 9m triangular spacing is 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 ^{0}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 its parasitoids were undertaken by placing parasitoid pupa and third instar leaf miner larva in a plastic cage (11.5cm diameter x 4.5cm 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 camera S760, 7.2 Mega pixels were used. Temperature and relative humidity records were recorded daily with the digital Thermometer W/Hygro IT-202 model.

Leaf miner larval and Parasitoid Rearing

The rearing cages (11.5cm diameter x 4.5cm 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* larvae, when placed in a plastic cage to observe parasitoid attack on it. Adult parasitoids were fed with sugar solution to observe longevity.

Preparation of Sugar solution

One cube of sugar was dissolved in 150ml of distilled water. Solution was stirred evenly until well dissolved solution was obtained. Cotton wool was immersed in the solution for five seconds, removed and then placed in the insect rearing cage.

Results

Incubation period had a mean of 9 d; larval developmental period averaged 8 d while pupal developmental period had a mean of 7.2 ± 1.48 d. The total developmental period of the parasitoid from incubation to adult emergence averaged 23.2 ± 3.56 d (Table 1). Average longevity of the adult *C. podagrica* is 3.9 ± 3.56 d (Table 2). Temperature was between 25 – 30ºC and relative humidity of 81 – 86%.

Host and Parasitoid Action

The host utilized was a live third instar *C. elaeidis* larva collected from a damaged and infested leaflet. The parasitism started 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.

During this period, the eggs were deposited into the leaf miner larva; and the parasitic phase of life started with the larvae showing signs of distress. Because the larvae were only paralyzed and not yet killed, they remained alive and were able to provide continuous fresh food for the growing eggs. Incubation period averaged 9 d (Table 1).

Table 1. Developmental period of *Pleurotroppopsis podagrica* (means in days)

Incubation (days)	Larval duration (days)	Pupal duration (days)	Total days
9	8	7	24
9	8	5	17
9	8	9	26
9	8	7	24
9	8	8	25
Mean: 9	8	7.2 ± 1.48	23.2 ± 3.56

Number of observation (n) = 32

Table 2. Longevity table for *Pleurotroppopsis podagrica*

No. of adult parasitoids (n)	Adult longevity in days
5	3
3	4
1	5
5	3
3	4
10	4
4	3
Mean	3.9 ± 3.56

Number of observation (n) = 31

After the eggs had gone through the incubation stage, they pupated and emerged out of the paralyzed larva after an average longevity of 8 d. The larvae were opaque and ovoid in shape. The larvae were endo-parasitic, developing within the host. The head has an average of six tiny projections apparently used for feeding. It feeds with the head burrowed initially into its host body and later into the artificial diet. The abdominal mid-section has a brownish gelatinous substance. The parasitization and hatching process out of the larvae finally killed them as they emerged out of different parts of the larvae. Plate 1 shows parasitoid emergence from larva.

The parasitoid larvae measuring 2.1mm (length) and 0.5mm (width) had an average longevity of 4.4 ± 1.14 days before pupation. The pupa measured 1.3mm (length) and 0.7mm (width) was black in color and ovoid in shape (plate 2). Adults emerged after an average of 7.4 ± 2.07 days.

Adult Parasitoid

Female adult parasitoids with body length (3.0mm), width (0.9mm) and wings (2.0mm) had an average

Plate 1. Parasitoids emerging from host larva.

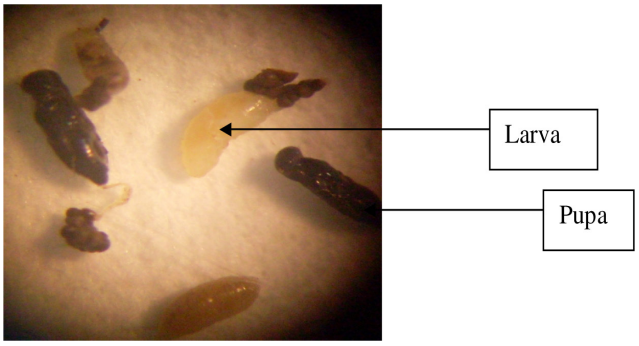

Plate 2. *Pleurotroppopsis podagrica* larvae and pupae.

Plate 3. Adult *Pleurotroppopsis podagrica.*

longevity of 3.9±3.56 d (Table 2). They were completely black (Plate 3).

Discussion and Conclusion

A parasitoid is an insect whose larvae develop by feeding on the body of other arthropods, invariably killing their host and completing their development. Only the female parasitoid seeks hosts (Prakash, 2010). Major characteristics of insect parasitoids include (Hoffman, 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. 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 include pest-specific parasitoids, generalist predators, and pathogens (including viruses, bacteria, fungi or nematodes). Studies of predator-prey and parasitoid-host interactions are fundamental to understanding and effecting bio-control strategies for pest insects (Prakash, 2010). 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).

On emergence of *P. podagrica*, it was observed that the head was usually inside the parasitized larvae. This could be attributed to need for attachment to a source of nourishment. The parasitoid develops within host body and larvae hatch out from host body killing it, thereby acting as its natural enemy. The adults are flying and active insects which seek their host in the natural environment by means of cues. The adult female lays its egg in the host by means of an ovipositor. Emerging adults usually mate based on availability of resources (food) and female adults search for hosts. In this study, artificial diets were important in aiding growth to maturity. This would also enable mass rearing parasitoids all year round for leaf miner control.

This study has revealed that *Pleurotroppopsis podagrica* offers potential as bio-control agent for the *Coelaenomenodera elaeidis*. Bio-control of the *C. elaeidis* in its larval stage seems most promising.

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