

**REARING FRUIT TREE BORERS ON NATURAL HOSTS
AND ARTIFICIAL MEDIUM DIET: 2. *SYNANTHEDON*
MYOPAEFORMIS BORKH. (LEPIDOPTERA : AEGRIIDAE)**

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Abstract

In Egypt, *S. myopaeformis* is a serious pest in apple orchards. Larvae were reared on its natural host and artificial medium diet containing apple saw dust. Number of larvae and pupae completed their development, percentage of pupation, larva and pupa durations, rate of moth emergence, mating, oviposition, longevity, incubation period and percentage hatchability were studied in details on natural host and artificial diet. The approximated life cycle was 97.6 (91 - 102) days on natural host and 56.8 (53 - 61) days on artificial medium diet. Out of 100 eggs reared on their natural host plant (apple) or artificial diet, 22 and 42 % completed their development to adult moths, respectively. Rearing *S. myopaeformis* on artificial diet reduced the total life cycle 1/2 than rearing on their natural host.

INTRODUCTION

Apple trees are liable to be infested with several insect pests, of them *synanthedon myopaeformis* is the most dangerous (El-Sherrif *et al.*, 1999).

Although, Tadros (1977) reared *S. myopaeformis* on its natural host (apple trees) and apple fruits, yet it wasn't reared on artificial diet before.

However, some attempts were carried out abroad to rear some Aegeriid borers on artificial diets such as *S. exitiosa*, *S. pictipes*, *Paranthrene tabaniformis* and *P. dollii* (Russell, 1968; Meyer *et al.*, 1974; Reilly *et al.*, 1987; Moral, 1989 Forschler and Nordin, 1989).

Owing to the great difficulties in rearing these borers on alive tissues to study their behavior and so many other investigations, there was a significant need to devel-

op an artificial diet. Rearing insects on media is advantageous in studying insect pathogens, plant resistant factors, effect of insecticides, the essentiality of certain dietary components in insect nutrition, and study of radiation on fertility and growth.

The present study is an attempt to rear *S. myopaeformis* on an artificial medium diet compared to the natural host.

MATERIAL AND METHODS

1. Stock Culture: During the regular horticultural pruning in winter 1996/1997, infested branches with larvae and pupae of *S. myopaeformis* were collected and transferred to the laboratory at Dokki. Older larvae were left in their tunnels until pupation while pupae were extracted and wrapped in toilet paper and fixed in Petri dishes until emergence. Petri dishes with pupae inside, were kept in an incubator at $25\pm 1^{\circ}\text{C}$ and $55\pm 2\%$ R.H. (Tadros, 1977).

2. Biological Studies: Soon after emergence, as numerous as possible of males and females were released in a large cages (50 x 50 x 100 cm), constructed of wooden frame covered with wire gauze. The cage was placed outdoors under direct sun light. Mating were carefully observed and mated females were transferred to small cylindrical wire gauze cages (10 x 15cm). The eggs laid were collected daily and kept in an incubator until hatching at $25\pm 1^{\circ}\text{C}$ and $55\pm 2\%$ R.H. (Tadros, 1977).

3. Rearing on Natural Host: Upon hatching, the neonate larvae less than one day old were introduced under the bark of apple seedling of 2 years old (about 3 cm thick). Enclosed larvae were shifted into new fresh seedling as needed until completed their development and were about to pupate (in prepupal stage). The larval and pupal durations, adult stage (mating, oviposition, longevity), incubation period and hatching were studied. The total life cycle was also calculated.

4. Rearing on Artificial Medium Diet: The artificial medium diet contained the following components:

Sugar	200 g
Wheat germ bran	100 g

Ascorbic acid	15 g
Dried yeast	158.5 g
Soybean	53 g
Agar	200 g
Weson's salt	11 g
Baby Powder Milk (Nursoy)	316 g
[Contains: Protein (43 g); Fat (87 g); carbohydrate (165 g); Linoleic acid (14 g); Vitamins: B]	
[Contains: Protein (43 g); Fat (87 g); carbohydrate (165 g); Linoleic acid (14 g); Vitamins: B, B, B, B, B, B, B, K, Niacin, Folic acid, Pantothenic acid & Biotin (29745 Mcg); A, D & E (707 IU); C & Inositol (232 mg); Minerals: Ca, P, Mg, Fe, Zn, Na, K, Cl (6247 mg) and Mn, Cu & I (2118 mg)]	
Apple sawdust	1000 g
Methyl parahydroxy benzoate	17.5 g
Formaldehyde 25%	3.6 cc
E-Mox (a semi-synthetic broad spectrum penicillin) (250 mg)	0.4 g
Distilled water	3000 cc

Dry ingredients were mixed together, then added to the agar solution in distilled hot water. The liquid ingredients, except ascorbic acid, were then added. The mixture was stirred by the electric stirrer until it became homogenous. The ascorbic acid was added afterwards then stirring was resumed. The medium then was stored under refrigeration until used. The filter paper on which eggs were deposited were cut into convenient pieces for distributing on the artificial diet surface. Newly hatched larvae were introduced into Petri dishes loaded with 25 gms of the diet at the rate of 10 larvae per each. Grown larvae were distributed singly in Petri dishes afterwards. Newly hatched larvae penetrated inside the diet to have shelter and feed. Petri dishes containing the diet and larvae were kept under room conditions at an average of 31.9°C and 71±1% R.H. until pupation. Larval, pupal duration and moth emergence were observed and recorded. The resulted adults were reared in cages as previously mentioned and mating, egg laying, fecundity and adult life span as well as incubation period and hatching were studied carefully. The total life cycle was also studied.

RESULTS AND DISCUSSION

A. Rearing *S. myopaeformis* on its Natural Host Plant

During the period from April, 1997 until July, 1997, *S. myopaeformis* was reared on its unique natural host plant (apple seedling) under mean laboratory conditions of 28.7 ± 1 °C and $59 \pm 1\%$ R.H.

1. Larval and pupal stages: Table 1 emphasized that out of 100 newly hatched larvae exposed to apple seedling 57 larvae succeeded to penetrate the apple bark. After one month, 40 larvae proceeded their development. Then the larvae completed their development were 27, showed only 27% pupation. Larval infestation was concentrated in the lower parts of the stem and larger branches near the soil surface. This is because of the thick layer of cambium region. These areas are rich in sap provided the larvae with the essential requirements for development. Under laboratory conditions, larvae were reared on apple seedlings to provide an almost similar natural rearing conditions. The larval duration ranged 72 – 84 days with an average 79.30 ± 1.34 days at 28.1 ± 1 °C and $56 \pm 2\%$ R.H. (Table, 1). Full mature larvae bore just under the bark, gnawing an incomplete circular exit hole in the bark, then pupated by enclosed in an oval elongated cocoon built of numerous white mate – like strands adhering to particles of gnawed bark and the dark brown larval feces. Data in Table 1 concluded that the pupal duration lasted 11.5 ± 0.37 days (range, 11 – 13 days) under mean laboratory conditions of 29.4 ± 1 °C and $60 \pm 1\%$ R.H.

2. Adult stages: Out of 27 pupae reared on apple seedlings, 24 pupae succeeded to complete their development and emerged. The percentage of moth emergence ranged from 66.7% to 100%, showing a mean of 80.84% moth emergence, Table, 1.

S. myopaeformis moths are active only during the daytime. Copulation occurred at the same or the next day of adult emergence. Out of 10 pairs were under observation, 4 pairs copulated on the same day of emergence while rest 6 pairs copulated on the next day. Copulation process lasted for 53 to 97 minutes with an average of 81.30 minutes. Under laboratory conditions, eggs were deposited singly or in small chains (2 – 3 eggs) or egg mass (5 – 8 eggs) on the mesh wire of the breeding cages, on corrugated filter paper or artificially wounded apple cuttings laid in the cages to collect the oviposited eggs. Deposition of eggs started on the same day of mating or the next day.

Out of 10 fertilized females, 6 pairs started to deposit on the same day and the rest 4 pairs laid eggs on the next day. Oviposition period continued for 3 – 6 days with an average of 4.5 days. Out of 10 pairs, 1, 4, 4 and 1 females continued to oviposit for 3, 4, 5 and 6 days, respectively. Female died on the last day of oviposition. Fertile females reared on apple seedlings laid 11 – 106 eggs with an average 71.1 ± 30.6 eggs. The average number of eggs remained in the female ovaries was 155.5 ± 44.3 ranging from 92 to 235 eggs. Thus, the approximated fecundity reaches 179 – 346 eggs with an average of 236.6 ± 71.7 eggs, Table 2. Females reared on apple seedlings under laboratory conditions lived 3 – 7 days with an average of 4.9 days. Males lived shorter as their life span was only 2 – 4 days with an average of 3.1 days.

3. Egg stage: Data in Table 2 indicated that under mean laboratory conditions of 29.4 ± 1 °C and 60 ± 1 % R.H. the incubation period ranged 5 – 7 days with an average of 6.4 ± 0.66 days. The percentage hatchability reached 94%, ranging from 80 to 100%.

4. Approximated life cycle: As show in Table 3 the total life cycle of *S. myopaeformis* reared in its natural host (apple seedlings) under mean laboratory conditions of 28.7 ± 1 °C and 59 ± 2 R.H. approximated 91 to 102 days, with an average of 97.6 days. The current results of rearing *S. myopaeformis* on its natural host (apple seedlings) are approximated with Tadros (1977) who found that the larval duration on apple branches lasted 70 – 82 days. He also recorded that the incubation period, pupal duration lasted 5 and 11 – 13 days, respectively. Mated females laid 5 – 193 eggs with pre-oviposition, oviposition and post-oviposition periods were from 0 – 1, 3 – 6 and 0 – 0 days, respectively.

B. Rearing *S. myopaeformis* on Artificial Diet: During the period from April, 1997 until June, 1997; *S. myopaeformis* was reared on artificial medium diet containing apple sawdust under mean laboratory conditions of 25.9 ± 1 °C and 55 ± 2 % R.H.

1. Larval and pupal stages: Upon hatching larvae crawled on the diet surface, secreted silken threads around themselves for protection and started boring their tunnels just under the diet surface. Table 1 emphasized that out of 100 newly hatched larvae placed on the diet, 78 larvae succeeded to penetrate the diet. After two weeks 61 larvae proceeded their development. Only 49 larvae completed their development, showing only 49% pupation.

Table 1. Larval, pupal duration and percent moth emergence of *S. myopaeformis* reared on apple seedlings and artificial diet under laboratory conditions.

Host/Diet	No. of hatched larvae	No. of larvae succeeded to penetrate apple bark	No. of larvae completed their development and pupate	% pupation	Larval duration (in days)		Pupal duration (in days)		No. of pupae completed their development and pupate	% moth emergence	Recovery
					Average	Range	Average	Range			
Natural Host	100	57	27	27	79.30 ± 1.43	(72-84)	11.5 ± 0.37	11 - 13	22	81.48 (66.7 - 100)	22 %
Artificial Diet	100	78	49	49	38.1 ± 0.70	35-41	11.5 ± 0.56	10 - 13	42	85.7 (66.7 - 100)	42 %

The larval tunnels are irregular inside the medium diet. The larval frass are ejected behind the larvae in its tunnel.

Under mean laboratory conditions ($25.3 \pm 1^\circ\text{C}$ and $53 \pm 2\%$ R.H.) the larval duration ranged 35 – 41 days with an average of 38.1 ± 0.7 days, Table 1.

Full grown larvae constructed pupal cocoon made of medium particles and larval frass with the silken threads secreted by larvae. The pupal duration, Table 1, ranged from 10 – 13 days, with an average of 11.5 ± 0.56 days under mean laboratory conditions of $27.1 \pm 1^\circ\text{C}$ and $58 \pm 2\%$ R.H.

2. Adult stages: Out of 49 pupae reared on artificial medium diet, 42 pupae succeeded to complete their development and emerged. The percentage of moth emergence ranged from 66.7 % to 100% (mean of 85.7%) moth emergence, Table 1.

S. myopaeformis moths copulated sometimes the same or mostly the next day of adult emergence. Coitus occurred while flying in the sunny days. Out of 10 pairs kept under observation, 2 pairs copulated the same day of emergence while the rest 8 pairs copulated the next day. Copulation process lasted for 38 to 62 minutes with an average of 51.2 ± 8.1 minutes. Eggs were laid singly or in small chains (2 – 5 eggs) or egg masses (6 – 13 eggs). Eggs were deposited on the mesh wire of the breeding cages, on corrugated or toilet paper lined in the oviposition cages. Deposition of eggs started the same days of mating or the next day at most. Out of 10 fertilized females, 4 started to deposit eggs on the same day and the rest 6 laid eggs the next day. Oviposition period continued for 2 – 5 days with an average of 2.89 ± 1.14 days. Out of 10 pairs, 1, 5, 2 and 2 female continued oviposition for 2, 3, 4 and 5 days. Fertile females reared on artificial diet laid 27 – 62 eggs with an average of 46.9 ± 9.02 eggs. The average number of eggs remained in the females ovaries was 186.6 ± 14.31 ranging from 163 – 211 eggs. Thus the approximated fecundity reached 207 – 257 eggs with an average of 233.5 ± 16.43 eggs, Table 2. Females reared on artificial diet under mean laboratory conditions ($27.1 \pm 1^\circ\text{C}$ and $58 \pm 1\%$ R.H.) lived 3 – 5 days with an average 4.01 ± 0.70 days. Males lived shorter as their life span was only 2 – 4 days with an average of 3.2 ± 0.75 days.

3. Egg stage: Data in Table 2 indicated that under mean laboratory conditions of $27.1 \pm 1^\circ\text{C}$ and $58 \pm 1\%$ R.H., the incubation period ranged 6 – 8 days with an average

Table 2. Oviposition periods and number of eggs laid per female of *S. myopaeformis* reared on apple seedlings and artificial diet under laboratory conditions (29.4 ± 1 °C and $60 \pm 1\%$ R.H.).

Days after emergence	Number of eggs laid					
	Natural host		Artificial diet			
	Average	Range	Average	Range	Average	Range
2	13.40 ± 7.50	3 - 28	2.0 ± 0.82	0 - 3		
3	24.00 ± 10.01	3 - 37	8.8 ± 2.96	5 - 13		
4	22.22 ± 10.93	1 - 43	22.90 ± 5.85	13 - 34		
5	12.86 ± 3.52	8 - 19	15.38 ± 5.54	6 - 225		
6	8.0 ± 2.00	6 - 10	7.33 ± 2.87	4 - 11		
7	2	-	-	-		
Total no. of eggs/female	71.1 ± 30.6	11 - 106	46.90 ± 9.02	27 - 62		
No. of eggs found in the ovaries after death	155.5 ± 44.30	92 - 235	186.60 ± 14.31	163 - 211		
Fecundity	236.60 ± 71.70	179 - 346	233.50 ± 16.43	207 - 257		

Table 3. Approximated life cycle of *S. myopaeformis* reared on apple seedlings and artificial diet under laboratory conditions (28.7 ± 1 °C and $59 \pm 2\%$ R.H).

Host diet	Natural diet		Artificial diet	
	Range (in days)	Average (in days)	Range (in days)	Average (in days)
Pre- oviposition period	0 - 1	0.4	0 - 1	0.6
Oviposition period	3 - 6	4.5 ± 1.35	2 - 5	2.89 ± 1.14
Post-oviposition period	0 - 0	0 - 0	0 - 0	0 - 0
Egg	5 - 7	6.4 ± 0.66	6 - 8	6.6 ± 0.66
Larva	72 - 84	79.3 ± 1.34	35 - 41	38.1 ± 0.70
Pupa	11 - 13	11.5 ± 0.37	10 - 13	11.5 ± 0.56
Days of life cycle	91 - 102	97.6	53 - 61	56.8

of 6.6 ± 0.66 days. Under the same laboratory conditions, the percentage of hatchability reached 85% ranging from 70 to 90%.

4. Approximated life cycle: As shown in Table 3, the total life-cycle of *S. myopaeformis* reared on artificial diet under mean laboratory conditions 25.9 ± 1 °C and 55 ± 2 %R.H. approximated from 53 to 61 days with an average of 56.8 days. The results of Tadros (1977) who reared *S. myopaeformis* on apple fruits were almost in agreement with the present results as the larval duration was 37 – 42 days, the pupal duration was 11 – 13 days and the incubation period was 5 days.

The previous results concluded that the percentage recovery of *S. myopaeformis* from egg to adults reached 22% when reared on its natural host and 42% when reared on its artificial diet. Rearing larvae on artificial diet was 1.6 times more successful than those reared on the natural host. The larval duration was almost 1/2 reduced when reared on artificial diet (38.1 days) than those reared on its natural host (79.3 days). However pupal duration was equal in both rearing host or diet. Coitus lasted longer in adults reared on the natural host (81.3 min.) than those reared on artificial diet (51.2 min.). Pre-oviposition period was shorter (0.4 day) in females reared on natural host than those reared on artificial diet (0.6 day). Oviposition period, however, was longer in females reared on natural host (4.5days) than those reared on artificial diet (2.9 days) Fertile females laid more eggs (71.1 eggs) when reared on natural host than those reared on artificial diet (46.9 eggs). Females in both cases died the last day of oviposition. Rearing on natural host ,the resulted females and males lived 4.9 and 3.1 days, while those reared on artificial diet lived 4.0 and 3.2 days, respectively. Incubation period was almost equal in both rearing host and diet (6.4 and 6.6 days), while the percentage hatchability was more than (94%) in adults resulted from rearing on natural host than those on artificial diet (85%). The total life cycle was longer in case of rearing larvae on its natural host (97.6 days) than those reared on artificial diet (56.8 days). However rearing *S. myopaeformis* on artificial diet is easier and shorter than in rearing on its natural host (apple), thus it is of great importance in applying advanced studies on the pest.

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تربية حفارات أشجار الفاكهة علي عوائلها الطبيعية
وعلي البيئات الغذائية المصنعة: ٢- حفار ساق الحلويات رائق الأجنحة
Synanthedon myopaeformis
(رتبة حرشفية الأجنحة : عائلة اجيريدي)

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يعتبر حفار ساق الحلويات *S.myopaeformis* من عائلة أجيريدي ورتبة حرشفيات الأجنحة من الآفات شديدة الخطورة في حدائق التفاح في مصر. تمت تربية الحفار على عائلة الطبيعي (شتلات التفاح) وعلى بيئة صناعية تحتوي على نشارة خشب من التفاح. تمت دراسة عدد اليرقات والعذارى التي أكملت دورة حياتها، ونسبة التعذر، ودورات اليرقات والعذارى، ومعدل خروج الفراشات، والتلقيح، ووضع البيض، وعمر الحشرات الكاملة، وفترة حضانة البيض، ونسبة فقس البيض في حالة التربية على العائل الطبيعي والبيئة الصناعية. بلغ عدد اليرقات التي نجحت في استكمال نموها وتعذرت ٢٧، ٤٩٪ في حالة العائل الطبيعي والبيئة الصناعية المصنعة، علي التوالي. أظهرت النتائج أن متوسط فترة النمو اليرقي وفترة حياة العذراء، ونسبة خروج الفراشات، وفترة حياة الطور الكامل، ومدة حضانة وضع البيض، ونسبة فقس البيض ٧٩،٣، و ١١،٥، ٨٠، ٨٤٪، و ٤، و ٦،٤، و ٩٤٪ يوم علي العائل الطبيعي بينما كانت ٢٨،١، و ١١،٥، و ٨٥،٧٪، و ٣،٨، و ٦،٦، و ٨٥٪ يوم علي البيئة الغذائية المصنعة، علي الترتيب. دلت النتائج على أن الحشرة أكملت دورة حياتها في ٩٧،٦ يوم (٩١ - ١٠٢)، ٥٦،٨ (٥٣ - ٦١) يوم عند التربية على العائل الطبيعي والبيئة الصناعية، علي الترتيب. بلغت النسبة المئوية للفراشات التي أكملت دورة حياتها من ١٠٠ بيضة تم تربيتها علي عائلها الطبيعي (التفاح) والبيئة المصنعة ٢٢، ٤٢٪ علي الترتيب. كما نتج عند تربية حفار ساق الحلويات رائق الجنحة علي بيئة مصنعة تقليل إجمالي فترة دورة الحياة بمقدار النصف تقريبا بالمقارنة بالتربية على عائلها الطبيعي.