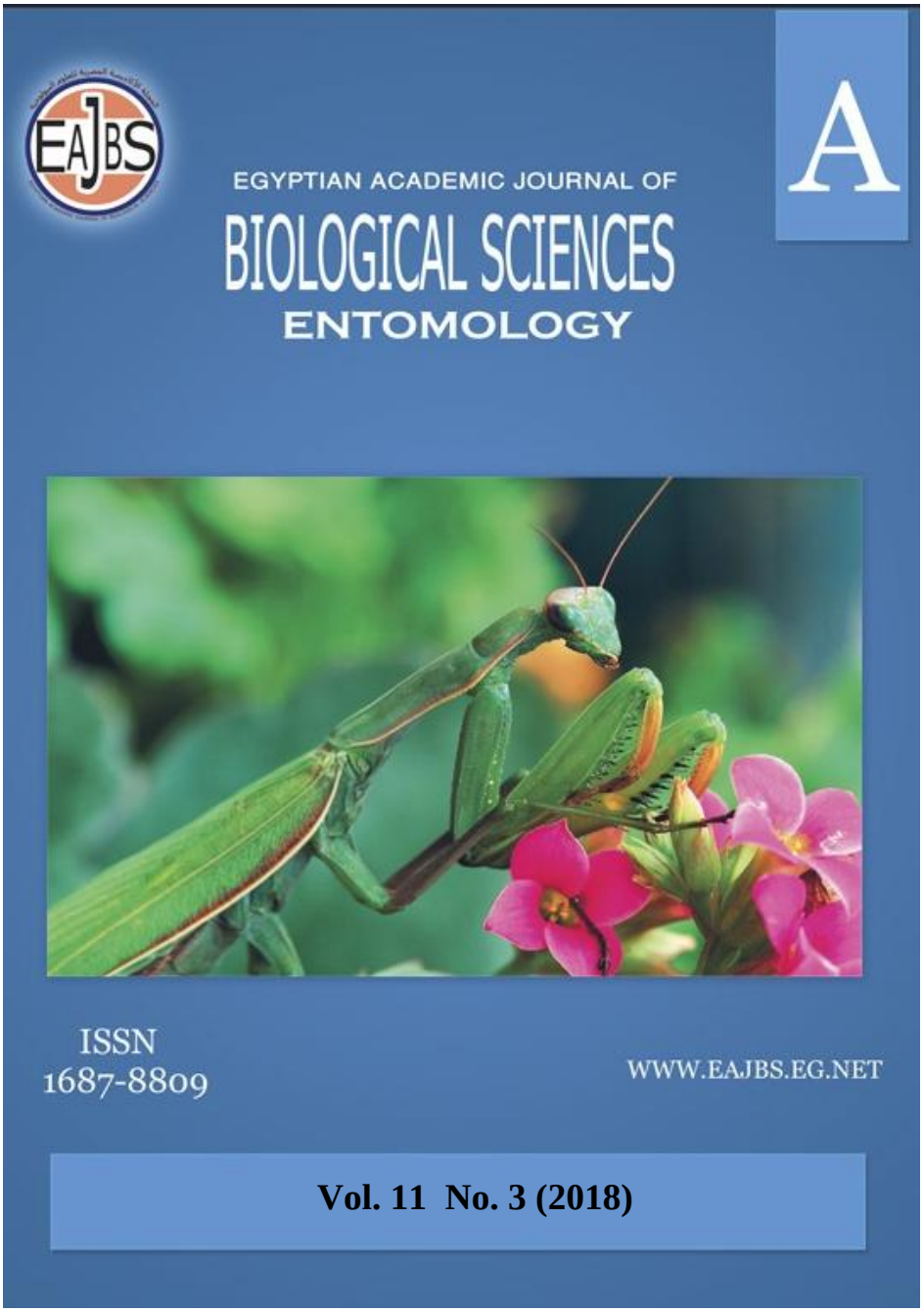

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Breeding of Powder Post Beetle, *Lyctus linearis* Goeze, (Coleoptera: Bostrichidae) on the Artificial Medium Diet.

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ABSTRACT

The powder post beetle, *Lyctus linearis* Goeze, is the member of wood-boring beetles group which belong to family bostrichidae and consider the main cause of the low value and degradation of quality properties of manufactured wood products.

The results indicated that chosen artificial diet has consisted of white corn flour (75%), sawdust (15%), dried yeast (5%), sugar (3.5%) and ascorbic acid (1.5%). This artificial medium revealed clear differences in biological activities and was more suitable from natural host to rearing *Lyctus linearis* beetle for made different investigation studies.

Egg incubation period, larval duration, pupal duration, hardness period and the total period of developmental stages were short-lived in artificial diet, while the number of laid eggs by the female was more in comparison natural host. The statistical analysis showed highly significant negative correlation between the temperature and each the different development stages while; the relative humidity gave positive significant correlation with some different developmental stages.

Five annual generations were obtained from rearing the beetles on the artificial medium diet. The shortest generation recorded 6 weeks (2^{nd} generation), while the longest generation recorded 16 weeks (5^{th} generation).

INTRODUCTION

The powder post beetles play an important role not only in Egypt but also all over the world. Lyctid beetles are considered a serious pest of wooden articles and wood products manufactured, such as, furniture, wooden floors, wood paneling, molding, windows, door frames and plywood….etc; the beetles spend their larval stage slowly boring through the wood. These beetles infest only sapwood of hardwoods, mainly ash, hickory, oak, maple and mahogany (Brammer, 2013).

Lyctus linearis Goeze beetle is the main cause of low value and quality properties of manufactured Robinia wood in Hungary (Molnar and Osztragonacz, 1986).

In China, Shen and Li 1983 stated that the *Lyctus linearis* beetles seriously harms freshly-cut or freshly-processed wood of less than ten-year old trees. The damage is only done in the sapwood, with powder falling off the holes, also, Shi and Ten, 1987 remember that this beetle is one of 8 Lyctid species attack Chinese

hardwood.

Lyctus linearis beetle attacks timber of oak In Germany (Gogola et al, 1999).However, (Gorden et al1999) reported that this beetle preferred to attack the sapwood.

In Israel, Halperin and Gels1999 recorded several species of family Lyctidae at the first time from Sinai; such as (*Lyctus linearis* (Goeze), *Lyctus africanus* (Lesne); *Lyctus brunneus* (Stephens) and *Lyctus parallelocollis* Blackburn). The authors showed that *Lyctus linearis* beetle was the most important of the endemic species of timber destroyers.

Laboratory breeding of wood boring insects on their natural hosts to study essential behavior and other biological, ecological and control investigations is very difficult, owing to their mode of living and feeding hidden inside wood, also the rearing require large amounts from the wood to study of different developmental stages of borers and the other variety studies. Thus the rearing of borers on media is advantageous in simplification of maintenance of insect colonies for various investigations and to be well alternative mean for laboratory studies.

Certain attempts were carried out on rearing of some borers on artificial diet by some researchers, such as, Rosi(1962), Khalsa, et al(1962), Nour and Helal(1971) on *L. africanus,* Helal (1977) on *L. africanus,* Iwate and Nishimoto (1983) on *L. brunneus* , Suzuki(1983) on *L. brunneus* and Titik and Tusyoshi (2013 and 2015) on *L. africanus*

The present investigation was conducted to develop standard methods for rearing the economically important borers in large numbers and short time on artificial diet compared with the natural host to fulfill the requirements of different researches on these borers.

MATERIALS AND METHODS

Laboratory culture of insect:

Infested samples of Poinciana wood with *Lyctus linearis* (Goeze) were collected from Shibin El-Qanater (Qalyubia governorate) and translocated to the laboratory, at Wood Borers Research Department, Plant Protection Research Institute, Dokki, Giza, governorate.

These samples were kept in plastic containers (45cm height and 30cm diameter), covered with muslin cloth, under laboratory conditions (average of 24.8 °c and 51%RH.). Continued observations were made until the beetles emerged.

Preparation of artificial diet:

Three artificial diets were prepared to choose the suitable medium for rearing *L.linearis* beetles. The components of these diets are illustrated in Table (1).

Dry ingredients of each medium (flour & oak sawdust) were mixed together, the sugar, ascorbic acid and dry yeast dissolved in distilled hot water then adds to mixed and impaste together. The pastiness was divided into small pieces measured (8x4x2cm) and dried for 3 days at 60°C in electric oven**.**

Table (1): Artificial diet components used for rearing *L.linearis* beetles

No.	Artificial diet (A)	Artificial diet (B)	Artificial diet (c)
		Components (Rate %)	
1	Wheat flour (75)	White corn flour (75)	Yellow cornmeal flour (75)
2	Sawdust (15)	Sawdust (15)	Sawdust (15)
3	Dried yeast (5.0)	Dried yeast (5.0)	Dried yeast (5.0)
4	Sugar (3.5)	Sugar (3.5)	Sugar (3.5)
5	Ascorbic acid (1.5)	Ascorbic acid (1.5)	Ascorbic acid (1.5)

Laboratory rearing:

Laboratory rearing on artificial diets was conducted to determine the suitable artificial diet; ten pieces of each previous diet were placed in 10 plastic boxes (12cm long, and 6cm wide and 5cm height), each provided with 5 couples of beetles and covered with muslin cloth. The boxes left under laboratory conditions until the new generation emerged. The more suitable artificial diet for breading was chosen according to a large number of emerged beetles from different three diets.

To study biological activities of different development stages of *L.linearis* beetle: ovipositional periods, incubation period, larval duration, pupal duration, hardness period, number of eggs per female and generation period; fifty plastic boxes (12cm long, and 6cm wide and 5cm height), each contain one piece of chosen artificial diet, and provided with one couple of newly emerged beetles resulting from laboratory culture and covered with muslin cloth. Continued observation was carried out, daily inspection was made until beetles emerged of new generation. Some pieces were splinted on various periods to study the different internal developmental stages. The emerged beetles from each generation were reared again for determining the annual number of generations on artificial diet. The statistical analysis for obtained data carried out by SAS program (2001)

RESULTS AND DISCUSSION

1. Preference artificial diet for rearing *L.linearis* beetles:

The more suitable artificial diet of breading *L.linearis* beetle was chosen from one of the tested three diets, (Table 1).

The results indicated that the artificial diet (B) was preferential diet of beetles which resulted in the highest number of emerged beetles, Table (2). This medium was consist of white corn flour (75%), sawdust (15%), dried yeast (5%), sugar (3.5%) and ascorbic acid (1.5%).

Table (2): Number of emerged beetles resulting from rearing of *L.linearis* beetles on different artificial diets after one generation.

Medium diet	Number of emerged beetles	
	Mean ± SD	Range
Artificial diet (A)	187.33 ± 25.77	148 -211
Artificial diet (B)	242.00 ± 50.11	192 - 281
Artificial diet (c)	201.66 ± 13.71	187- 220

2. Some biological activities for *L.linearis* beetles reared on artificial diet:

Data on some biological aspects of *L.linearis* beetles reared on artificial diet (B) are illustrated in Table (3) and showed the following results:

2.1. Incubation period:

The incubation period of laid eggs by *L.linearis* female was ranged 4-12 days in various generations. The highest incubation period was ranged 8-12, days with a mean 9.6 ±1.53 days, at average 16.9 °C and 54.6% RH., in the 5th generation, while the lowest incubation period was ranged 4 -7 days, with a mean 6.2 ±1.03 days, at average 32.2 °C and 44.6%RH., in the 2nd generation.(Table 3). Mohamed (2013) found that incubation period of *L.linearis* beetle ranged 4-13 days during the different generations on royal Poinciana wood.

2.2. Larval duration:

The results appeared that the longest larval duration, from egg hatching to pupation, lasted 74-79 days, with a mean 84.7 ± 6.35 days in the 5th generation, at

average 17.3°C and 57.7%RH., while the shortest duration of larva was ranged 17-21 days, with a mean 19.1 ± 1.18 days, at average 31.4 °C and 45.9%RH., in the 2nd generation.(Table 3). Mohamed (2013) found that the larval duration of *L.linearis* reared on royal Poinciana wood ranged 28-108 days, while Helal (1981c) showed that the larval duration of *L.africanus* beetles ranged 18 -96 days, during different generations.

2.3. pupal duration:

The longest pupal duration recorded 9-14 days, with a mean 11.7± 1.52days, at average 22.5 °C and 59.1%RH, in the 5th generation, while the shortest one was ranged 5 -8 days, with a mean 6.6 ± 1.11 days, recorded during the 2nd generation, at average 34.6 °C and 50.6%RH., for formed pupae inside artificial diet until transformation to adult beetle (Table 3). Mohamed (2013) mentioned that pupal duration of *L.linearis* ranged 6-15 days during the different generations when reared on royal Poinciana wood, while Haggag and Batt (2000) found that the pupal stage of *L.impressus* beetle was ranged from 5 to 18days.

2.4. Hardness period:

When pupa transforms to adult, it requires period to become its body hard, this period recorded 3.4, 2.1, 2.6, 2.8 and 4.4 days during the 1st, 2nd, 3rd, 4th, and 5th generation (Table3). Mohamed (2013) found that the hardness period of *L.linearis* beetle reared on royal Poinciana wood was ranged 1-5 days during different generations.

2.5. Ovipositional periods:

2.5.1. Pre- oviposition period:

As shown in Table (4**),** the obtained data indicated that the highest pre-oviposition period ranged 1-4days, with a mean 2.7 ± 0.84 days during the 5th generation, while the lowest period ranged 1-2days with a mean 1.2 ± 0.40 days, during the 2nd generation. Mohamed (2013) mentioned that pre-oviposition period of *L.linearis* ranged 0-4 days when reared on royal Poinciana wood, while Helal (1981b) stated that this period of *L.africanus* beetle *was* between 2 to 3.1days.

2.5.2. oviposition period:

The duration of oviposition showed that the highest duration ranged 5-12 days, with a mean 7.9 ± 0.42 days during the 5th generation, while the lowest period ranged 3-7 days, with a mean 5.5± 0.30 days, during the 2nd generation, (Table4). Mohamed (2013) stated that oviposition period of *L.linearis* in 1st, 2nd, 3rd and 4th generation was ranged (4-10), (3-8), (5-9) and (5-10) days, respectively when reared on royal Poinciana wood.

2.5.3. Post-oviposition period:

The post-oviposition period ranged 10-15days, with a mean 12.9 ± 0.40 days, during the 5th generation, while it recorded 9-13 days, with a mean 10.2± 0.28 days, during the 2nd generation. (Table4). Mohamed (2013) reported that the Post-oviposition period of *L.linearis* was ranged (9-13),(9-13), (9-14) and (9-14) days, during in 1st, 2nd, 3rd and 4th generation, respectively when reared on royal Poinciana wood.

2.6. Number of laid eggs / female:

The number of deposited eggs by female varied according to generation time. The highest number of laid eggs per female was ranged 32-59 eggs with a mean 44.9 ± 7.56 eggs in the 2nd generation, while the lowest number of eggs was ranged 16-35 eggs, with a mean 27.7±6.57 eggs in the 5th generation (Table4). Mohammed (2013) found the number of deposited eggs by the female of *L.linearis* reared on natural host varied from 18-59 eggs recorded during the different generation, while Helal (1981a) found average number of laid eggs per female of *L.africanus* was 32 eggs.

Table (3): Duration different stages of *L.linearis* Goeze beetle reared on artificial diet under laboratory condition.

stages	Duration (in days)					
	Item	1st generation	2nd generation	3rd generation	4th generation	5th generation
Egg	Mean ± SD	8.1 ± 1.37	6.2 ± 1.03	7.0 ± 0.95	7.7 ± 1.27	9.6 ±1.53
	Range	4 – 9	4 - 7	5 - 8	6-10	8-12
	Temp. °C	27.4	32.2	30.7	29.6	16.9
	RH%	40.3	44.6	47.8	49.1	54.6
Larval	Mean ± SD	24.8 ± 2.91	19. 1 ± 1.18	21.4±1.36	22.2 ±1.78	84.7 ± 6.35
	Range	22 -31	17-21	19-23	20 -25	74-97
	Temp. °C	27.1	31.4	30.1	29.7	17.3
	RH%	42.7	45.9	49.4	55.6	57.7
Pupal	Mean ± SD	8.4 ±1.66	6.6 ± 1.11	6.9 ± 0.77	7.5± 1.20	11.7 ± 1.52
	Range	6-11	5-8	6-8	6 -9	9-14
	Temp. °C	30.3	34.6	33.9	31.2	22.5
	RH%	45.6	50.6	52.3	51.2	59.1
Hardness	Mean ± SD	3.4 ±0.97	2.1 ±0.77	2.6 ± 1.07	2.8 ± 0.81	4.4 ±0.97
	Range	2-5	1 - 3	1 - 4	2 - 4	2-6
	Temp. °C	28.1	33.8	31.6	29.8	22.9
	RH%	45.4	47.6	49.9	53.2	55.6

Table (4): Ovipositional periods and number of laid eggs of *L.linearis* Goeze reared on artificial diet under laboratory condition**.**

stages	**Duration (in days)**					
	Item	**1st generation**	**2nd generation**	**3rd generation**	**4th generation**	**5th generation**
	Lab. Cond.	Temp.26.9°C & 41.4RH.	Temp.32.6°C & 45.3RH.	Temp.30.1 °C & 47.1RH.	Temp.28.9°C & 48.7RH.	Temp.16.3 °C & 53.9 RH.
Pre-oviposition	Mean ± SD	1.9± 0.30	1.2 ± 0.40	1.4± 0.49	1.6± 0.49	2.7± 0.84
	Range	1 - 2	1 - 2	1 - 2	1 - 2	1 - 4
oviposition	Mean ± SD	7.2 ± 0.35	5.5 ±0.30	6.2 ± 0.35	6.8 ± 0.45	7.9 ± 0.42
	Range	5-10	3-7	4-8	4-9	5-12
Post-oviposition	Mean ± SD	11.9 ± 0.30	10.2 ± 0.28	10.8 ± 0.35	11.4 ± 0.36	12.9 ± 0.40
	Range	10-14	9-13	9-14	9-14	10 - 15
Number of eggs /female	Mean ± SD	35.1 ± 6.50	44.9 ± 7.56	40.9 ± 9.13	37.6 ± 7.36	27.7± 6.57
	Range	21- 44	32 - 59	25- 52	22- 48	16 - 35

3. Effect of temperature and relative humidity on different developmental stages of *L.linearis* beetle.

The influence of mean laboratory temperature and relative humidity during rearing period of *L.linearis* beetle on the artificial diet, estimated by simple correlation (r) and simple regression (b), Table (5), detected highly significant negative correlation between the temperature and duration of each ovipositional periods, incubation period, larval period, pupal period and hardness period ("r" of these periods = -0.990 to -0.995), whereas, the effect showed highly significant positive correlation between the temperature and number of deposited eggs (r = 0.962).

The relative humidity showed positive significant correlation with pre-oviposition period, incubation period, larval period, pupal period and hardness duration(r =0.585, 0.545, 643, 0.649 and 0.513,respectively), while the correlation was insignificant with oviposition and post oviposition periods (r=-0.450 & 0.496), whereas the correlation was significant and negative between relative humidity and number of deposited eggs (r = -0.551), Table(5).

Table (5): Effect of temperature and relative humidity on different developmental stages of *L.linearis* beetles reared on artificial diet under laboratory conditions, estimated by simple correlation (r) and simple regression (b).

Factors / Stage	Temperature °C		RH%	
	simple correlation (r)	Simple regression (b)	Simple correlation (r)	Simple regression (b)
Pre-oviposition	-0.990	-0.092	0.585	0.074
oviposition	-0.903	-0.132	0.450	0.09
Post oviposition	-0.944	-0.155	0.496	0.111
Incubation	-0.946	-0.198	0.545	0.131
Larval	-.0979	-.4.831	0.643	2.858
Pupal	-0.994	-0.428	0.649	0.278
Hardness	-0.995	-0.213	0.513	0.109
Number of eggs/female	0.962	0. 998	-0.551	-0.775

4. Number of annual generations and occurrence periods

Data illustrated in Table (6) show the number of annual generations and emergence periods of *L.linearis* beetles rearing on artificial diet during the period extended from the 1st week of April 2017 until 2nd week of April 2018.

L.linearis beetles reared on artificial diet detected 5 annual generations which occupied the period from 1st week of April 2017 until 1st week of Mar.2018. The shortest duration of generation (6weeks) recorded during the 2nd generation (4th week of May to 2nd week of July) and also appeared the shortest duration of beetles emergence (3 week) during the period from 2nd week of July to the 4th week of July. The longest period of generation was 16 weeks (1st week of November 2017 to 1st week of March 2018), this generation detected the longest period (6 weeks) of beetles emergence from 1st week of March to 2nd week of April 2018. Mohamed (2013) found the *L.linearis* beetle reared on Poinciana wood has four annual successive generations, the duration of these generations ranged 8 -18 weeks. Nour and Helal (1971) mentioned that *L. africanus* has 2 generations when reared on oak wood, while Helal (1981c) stated that *L. africanus* has five generations on the royal Poinciana wood, whereas Haggag and Batt(2000) found that *L.impressus* reared on citrus wood has three generations, their durations 18,13 and 21 weeks respectively.

Table (6): Annual generations and occurrence periods of powder post beetle *L.linearis* Goeze reared on artificial diet under laboratory conditions

G.	Generation period		Duration in weeks	Occurrence period		Duration in weeks	Lab. Cond.	
	from	to		from	to		Temp °C	RH %
1st	1st week of Apr. (2017)	4th week of May	8	4th week of May (2017)	3rd week of Jun.	4	24.8	43.5
2nd	4th week of May	2nd week of Jul.	6	2nd week of Jul.	4th week of Jul.	3	32.7	48.7
3rd	2nd week of Jul.	1st week of Sep.	7	1st week of Sep.	4th week of Sep.	4	29.6	46.3
4th	1st week of Sep.	1st week of Nov.	8	1st week of Nov.	1st week of Dec.	5	27.4	53.5
5th	1st week of Nov.	1st week of Mar.(2018)	16	1st week of Mar.	2nd week of Apr.(2018)	6	17.8	54.6
Total	----------		45	----------		22		

G. = Generation Lab. Cond. = laboratory conditions

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ARABIC SUMMERY

تربية خنفساء الليكتس الساحقة ***Lyctus linearis* Goeze** على بيئة غذائية

محمد عبد الغنى بط – معوض حسين رمضان

معهد بحوث وقاية النباتات- مركز البحوث الزراعية- الدقى – الجيزة- مصر

تعتبر خنفساء *Lyctus linearis* واحدة من أعضاء فصيلة بوستريكدى المسبب الرئيسى لخفض قيمة وجودة المنتجات الخشبية المصنعة وتهدف هذا الدراسة لعمل بيئة غذائية مناسبة للتربية الكمية لهذة الخنافس لاجراء الدراسات البحثية المختلفة.

وتشير النتائج أن البيئة الغذائية المختارة لتربية الخنافس عليها هى التى أنتجت العدد الأكبر من الخنافس الخارجة وهذه البيئة تتكون من دقيق الذرة البيضاء (75%) ونشارة الخشب (15%) والخميرة الجافة (5%) والسكر (3.5%) وحامض الأسكوربيك (1.5%).

وقد وجدت أختلافات واضحة فى النشاطات البيولوجية المختلفة وكانت البيئة الغذائية أكثر مناسبة من العائل الطبيعى لتربية الخنافس عليها لتسهيل عمل الدراسات البحثية المختلفة ، وكانت فترة حضانة البيض والمدة اليرقية وفترة العذراء والفترة الكلية للنمو أقصر عمرا فى البيئة الغذائية وكان عدد البيض الموضوع بواسطة الأنثى أكثر فى البيئة الغذائية.

وقد أظهر التحليل الأحصائى وجود ارتباط سالب عالى المعنوية بين الحرارة ومراحل النمو المختلفة بينما كان للرطوبة النسبية ارتباطات معنوية موجبة مع كل فترات ماقبل وضع البيض والحضانة والفترة اليرقية وفترة العذراء و تصلب الحشرة وكانت غير معنوية مع فترات وضع البيض وما بعد وضع البيض.

وقد أنتجت هذه البيئة 5أجيال سنوية أقصرها الجيل الثانى (6أسبوع) بينما أطولها كان الجيل الخامس (16أسبوع).