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THE LIFE HISTORY OF THE ANGOUMOIS GRAIN MOTH, *Sitotroga cerealella* (OLIVIER) (LEPIDOPTERA: GELECHIIDAE) On Maize (*Zea mays* L.) GRAINS

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By
S.I. El-Sherif, M.Y. Hashem and S.S. Ahmed

Department. of Economic Entomology and Pesticides, Faculty of Agriculture, Cairo University,Giza, Egypt

ABSTRACT

The life-history of *Sitotroga cerealella* on maize grains was studied under optimum constant laboratory conditions of 27 °C and 65±5 % R.H. Eggs were laid on grains singly or in groups of 2- 60 and incubation period ranged 3- 5 days with a mean of 3.9 days. Egg hatchability ranged 85-100% with a mean of 91%. Newly hatched larvae fed on the grain contents until they developed to pre-pupae. Based on the measurements of width of head-capsule and body length, 4 larval instars followed by a pre-pupal period could be approximated. The 1st, 2nd , 3rd and 4th larval instars lasted for 4-6, 5-7, 5-6 and 5-7 days, with means of 4.8, 5.6, 5.6 and 5.8 days, respectively. The duration of the pre-pupa ranged 2-3 days, with a mean of 2.4 days. The pupal stage durated 5-9 days with a mean of 7.0 days. The longevity of adult male moths ranged 6-8 days with a mean of 7.6 days while that of female moths ranged 8-14 days with a mean of 11.4 days. Pre-oviposition period elapsed 2 - 3 days with a mean of 2.6 days, oviposition period lasted for 3-5 days with a mean of 4.1 days and post-oviposition period elapsed 3-6 days with a mean of 4.4 days. The number of eggs/female ranged 164-186 eggs with a mean of 173 eggs. The total life-cycle duration lasted for 33-49 days with a mean of 39 days.

Key words: *angoumois grain moth, life history, maize grains.*

1. INTRODUCTION

The angoumois grain moth, *Sitotroga cerealella* (Olivier) (Lepidoptera: Gelechiidae), has been recognized as a common pest of grains worldwide. According to Agrawal *et al.* (1977), Singh *et al.* (1978) and Howlader & Matin (1989), this pest has a great potential as a pre-harvest and post-harvest threat to grain crops. The larvae of *S. cerealella* feed on the endosperm of the host grains and may cause considerable damage to them (Weston *et al.*, 1993). Sedlacek *et al.* (1998) and Weston & Rattlingourd (2000) reported additional indirect damage to the grains through the attacks of certain secondary insect pests. Both direct and indirect damages lead to quantitative and qualitative economic losses represented in weight loss, decrease of the nutritional value of the grains and reduction of grain germination. As a matter of fact, literature on the life-history of *S. cerealella* to maize grains is apparently scanty. However, reference should be made in that respect to the observations of Mostafa (1977), Consoli & Amaral (1995), Sedlacek *et al*. (2001) and Perez-Mendoza *et al.* (2004). Therefore, the present investigation attempts to fill such a gap in the knowledge on this economically important pest through a brief description of its symptoms of infestation, an approximation of the number and durations of the different larval instars and a determination of the durations of the different developmental stages on maize grains.

2. MATERIALS AND METHODS

The study of the life-history of *S. cerealella* was conducted under the optimum constant conditions of 27 °C and 65±5 % R.H. determined by Sedlacek *et al.* (2001). Grains of the local open pollinated maize cultivar Cairo 1 (with a constant moisture content of 12±1%) were used and

the life cycle started with newly laid eggs obtained from a laboratory reared stock culture of the insect. Adult moths emerged from naturally infested maize grains obtained from a highly infested grain store were introduced into 1 kg. glass jars to lay eggs. Newly laid eggs (< 24 h old) were collected daily by sieving through a 60-mesh sieve. To establish the stock culture, maize grains were sterilized by dipping them into boiling water at a rate of 1/4 liter of water/1kg. of grains then gently heated for approximately an hour to evaporate the rest of water. Such treatment was quite sufficient to keep the grains entirely free of any insect infestation or disease infection. Heating continued until the moisture content of the grains reached 12±1% as measured by a Universal Moisture Tester. Sterilized grains were infested with eggs at a rate of 0.1g of eggs/0.5 Kg. of grains and kept into glass jars incubated under the above-mentioned optimum conditions until adult emergence. Newly laid eggs (elongate in shape and white-creamy in color) were separated daily from the stock culture by sieving as mentioned earlier. The above procedure was repeated again to maintain the stock culture.

To study the life history of *S. cerealella*, 50 newly-laid healthy eggs were carefully transferred to glass vials (4 × 10 cm.) with the aid of a tiny camel's hair brush. Ten vials (replicates) were used. Vials were covered with muslin fitted in place with rubber band and checked daily to record egg hatching.

The follow-up of the larval instars of insects living inside grains is quite difficult due to failure in detecting the moulting integuments. Therefore, a more or less approximate procedure was developed and utilized to overcome such difficulty and determine -as far as possible- the number and durations of the different larval instars of *S. cerealella* inside maize grains. For this purpose, three glass jars of one pound capacity each were provided with sterilized maize grains at a rate of ½ Kg. / jar. Each jar was infested with newly laid eggs obtained from the stock culture at a rate of 0.1 g. (about 3500 eggs) then incubated under the above mentioned optimum conditions. A random sample of 50 grains was taken daily from each jar and carefully dissected under a stereoscopic microscope to collect larvae, pre-pupae and / or pupae from them. Grain dissection continued daily until all larvae transformed into pupae. Collected larvae, pre-pupae and pupae were preserved in 70% ethyl alcohol and glycerol (1:1 by volume). Preserved specimens were separately mounted on slides using Hoyer's medium and examined under a stereoscopic microscope provided with a micrometric linear eye-piece. Measurements of width of the head-capsule and body-length were taken and arbitrarily classified, as far as possible, into more or less five uniformed groups each representing a particular instar. To test the accuracy of such arbitrarily grouping pattern, the groups representing the different larval instars were compared statistically. Based on the statistical differences between the groups, four larval instars and a prepupal stage could be approximated as shown in Table (1) and Fig. (1).

Table (1). Width of head-capsule and body-length of the different larval instars of *S. cerealella* under optimum laboratory conditions (27 ºC and 65±5% R.H.)

Instar	Width of head- capsule (mm)	Body-length (mm)
1st	0.157-0.196 (0.177 ± 0.003)[a]	1-1.4 (1.2±0.05)[a]
2nd	0.323-0.392 (0.360 ± 0.009)[b]	2.1- 2.8 (2.4±0.08)[b]
3rd	0.588-0.686 (0.623 ± 0.009)[c]	2.9-3.2 (3.02±0.04)[c]
4th	0.764-1.000 (0.856 ± 0.013)[d]	5.5-6 (5.8 ±0.08)[d]
Pre-pupa	0.882-1.147 (0.984 ± 0.019)[e]	7-8 (7.4 ± 0.12)[e]
F value	808.561**	1012.33**

Means followed by different letters are significantly different from each other at *P<0.05* (Duncan test).

Two hundred newly-formed pupae were carefully removed from the dissected grains with the aid of a tiny camel's hair brush and transferred separately into glass vials (4 ×10 cm) covered with muslin fitted in place with rubber band. Vials were then incubated under the optimum conditions and checked daily to record pupal duration and % adult emergence.

Ten pairs (one female and one male each)

of the newly-emerged moths were individually transferred into glass vials (4 × 10 cm) each provided with 2-4 black paper strips of suitable size to serve as oviposition sites and tightly covered with muslin fitted in place with rubber band. Vials were examined daily to remove the paper strips with the eggs sticking to them and replace the strips with new ones until the female moths died. Eggs deposited on the paper strips were kept into Petri-dishes incubated under the optimum conditions and the quantitative data of the pre-oviposition, oviposition and post- oviposition periods, adult longevity and number of laid eggs / female were recorded.

3. RESULTS AND DISCUSSION

3.1. The egg stage

The eggs of *S. cerealella* are usually laid on maize grains, particularly in the cracks and crevices on the grain surface. They are laid singly or in groups of 2- 60 eggs, with a mean of 23.9 eggs / group. The egg is elongate, oval in shape and measures 0.50-0.70 mm with a mean of 0.60 mm. in length and 0.29-0.33 mm with a mean of 0.30 mm in width (Fig. 1 A). Newly-laid eggs are whitish-creamy in colour but with the progress of embryonic development they change to pale-red then tend to darken gradually to shiny-red shortly before hatching. The head-capsule and body of the developing larva are easily seen through the egg-chorion (Fig. 1B). The newly hatched larva takes its way out of the egg-shell through a longitudinal lateral cleft. Incubation period ranged 3- 5 days, with an average of 3.9±0.25 days and the % hatchability ranged 85 - 100%, with a mean of 91%.

3.2. The larval stage

As mentioned earlier, the larval, pre-pupal and pupal stages of *S. cerealella* are spent inside the infested grains. The larva (Fig. 1 C, D, E &F) has four instars. The different larval instars are nearly similar in body characters. However, with the progress of larval development, the colour of the head-capsule darkness gradually from light-brown into dark-brown. Larval body is whitish-creamy with pale-brown lateral spiracles. Thoracic and abdominal segments carry latero-dorsal setae. Thoracic legs are short and dark-brown while abdominal pro-legs are vestigial. Under constant laboratory conditions of 27 °C and 65±5 % R.H. the 1^{st}, 2^{nd}, 3^{rd} and active 4^{th} larval instars lasted for 4-6, 5-7, 5-6 and 5-7 days, with means of 4.8, 5.6, 5.6 and 5.8 days, respectively. Before changing into pre-pupa, the full-grown active larva excavates the whole grain endosperm forming a pupal cell leaving only a delicate small circular lid (the window, Fig.1 C&D). The pre-pupa (Fig. 1 G) lasted 2-3 days, with a mean of 2.4 days. The total duration of the 4^{th} larval instar (both active larva and inactive pre-pupal periods) ranged 7-10 days, with a mean of 8.2 days. The total duration of the larval stage ranged 21-29 days, with a mean of 24.2 days.

3.3. The pupal stage

The pupa (Fig. 1H) is obtect, broadly rounded at the head, wide at the thorax and its abdominal segments taper gradually towards the caudal end. It measured 5.0 - 5.5 mm in length, with a mean of 5.25 mm and 0.78- 0.88 mm in width (at its widest part) with a mean of 0.84 mm. The newly-formed pupa is whitish-creamy in colour but with the progress of body sclerotization it renders light-brown then reddish-brown before moth emergence. The dorsal aspect of the pupal body is relatively darker in colour than its ventral aspect. The pupal stage lasted for 5-9 days, with a mean of 7.0 days.

3.4. The adult stage

Female moths (Fig. 1 I) are relatively larger in size than males. The body length of the adult moth measured 4.5-5.0 mm, with a mean of 4.7mm in males and 5.0-6.0 mm, with a mean of 5.4 mm in females. The means of adult wing-expanse were approximately 14.0 and 15.5 mm in males and females, respectively. The head of the adult moth is covered with dense yellow-brown scales. Antennae are filiform in shape, long, slender, and brown in colour. Labial palps are long and sharply curved upwards. The thorax is also covered with dense yellow-brown scales but the pro-thorax takes a relatively dark-brown hue. Forewings are pale grayish-brown in colour and their margins heavily fringed with fine hairs. A central small black spot is located

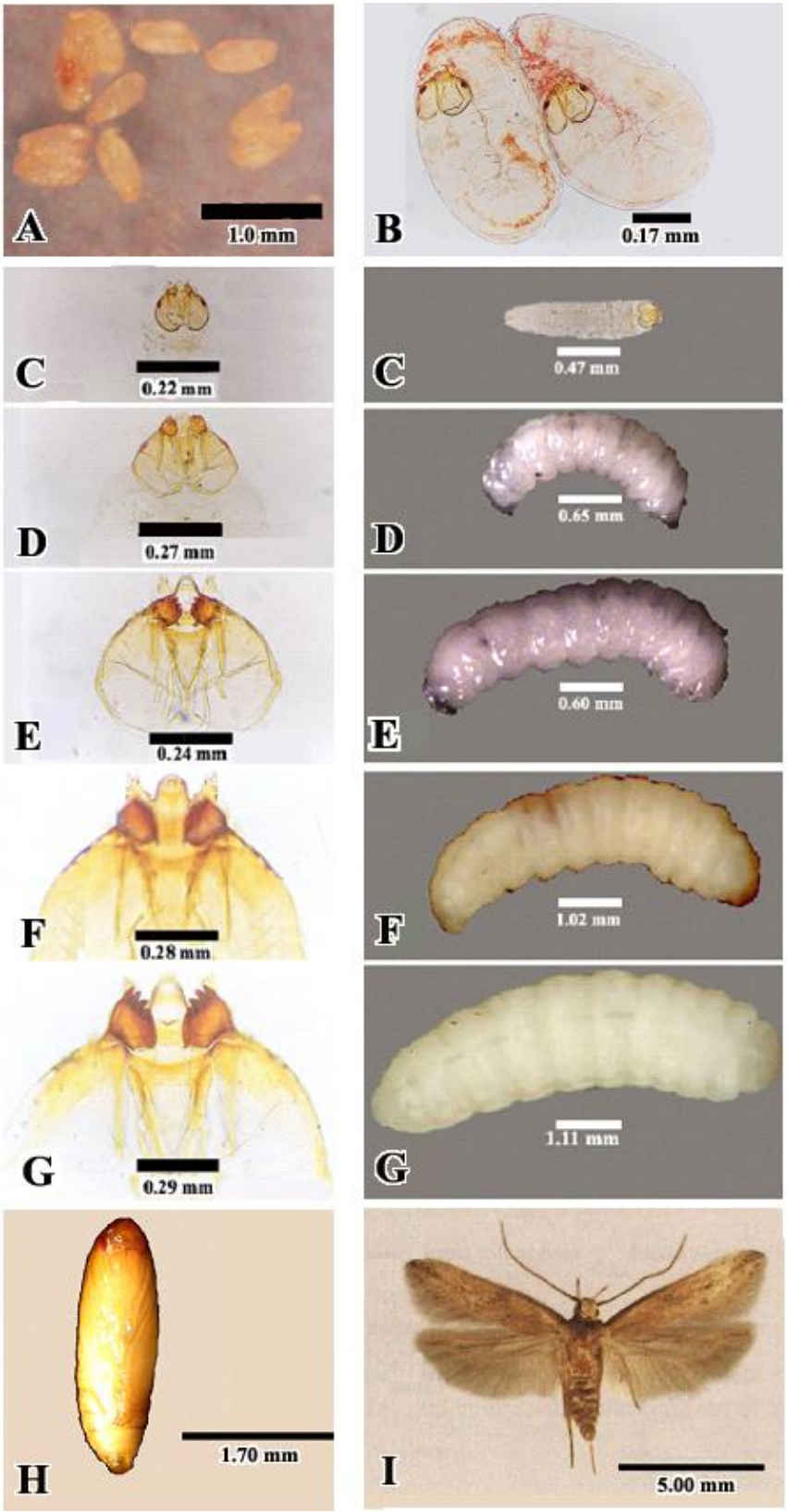

Fig.(1). The developmental stages of *S. cerealella*: A: Singly laid eggs. B: Larva seen through the egg-shell prior to hatching. C-G: Head-capsules and bodies of the different larval instars and the pre-pupa (C: 1st instar larva D: 2nd instar larva E: 3rd instar larva. F: 4th instar larva G: Pre-pupa.). H: The pupa. I: The adult.

at a nearly equal distance from both the anterior and lateral apices of the wing. Hindwings are relatively shorter and narrower than forewings. Hindwings carry dense long fringes on their posterior edges and taper to apex. Legs are dark-brown. The abdomen consists of ten segments and is covered with dense yellow-brown scales. It is pear-shaped in females and rather slender ending with evident genitalia in males. The Longevity of the adult male moths ranged 6-8 days, with a mean of 7.6 days while that of female moths ranged 8-14 days, with a mean of 11.4 days. The pre-oviposition period of mated females lasted for 2 - 3 days, with a mean of 2.6 days, oviposition period took 3-5 days, with a mean of 4.1 ± 0.28 days and post-oviposition period elapsed 3-6 days, with a mean of 4.4 ± 0.26 days. The number of eggs laid/female ranged 164-186 eggs, with a mean of 173 ± 2.4 eggs.

3.5. Total life-cycle duration

The total life-cycle duration (from egg to egg) on maize grains elapsed 33-49 days, with a mean of 39 ± 7.0 days. Under the same conditions the life-span (from egg to death of adult moth) ranged 37-54 days, with a mean of 42.7 days in males and 39-58 days, with a mean of 45.0 days in females.

Few authors contributed to the knowledge on the life-history of *S. cerealella* on maize grains. Said (1966) mentioned that the incubation period of eggs, % hatchability and adult longevity were 4 days, 91.4 %, 12.38 for males and 13.61 days for females, respectively and added that the pre-ovipostion period and average number of eggs/ female was < 24 hours and 4.3- 71.8 eggs, respectively. These findings seem to agree with the findings of the current study for both incubation period and hatchability, but they are comparatively shorter for adult longevity, longer for pre-ovipostion period and smaller for the number of eggs/ female. However, Shenouda (1966) mentioned a relatively less number of eggs/ female (135.2) and longer incubation period, larval-pupal, pupal and whole life-cycle durations (6.1, 29.1, 11.1, and 44.5 days, respectively). Consoli and Amaral (1995) reported mean percentages of 86.8-95.3% for hatchability, ranged 85.5-164.82 eggs/ female for egg-laying capacity with durations of 37.5- 43.5 days for the developmental period from egg to adult. Perez-Mendoza *et al.* (2004) referred that the incubation period of the egg stage was 4.1 days and the mean for the larval-pupal period was 19.8 days. Such results agree with the findings of the current investigation regarding incubation period but are relatively longer for the larval-pupal period.

4. REFERENCES

Agrawal, R. K.; Bhardwaj, A. K.; Sirvastava, P. K. and Singh, K. N. (1977). Pre-harvest infestation of wheat by grain moth and rice weevils. Indian J. Entomol. Vol.39: 357-360.

Consoli, F. L. and Amaral, F. B. F. (1995). Biology of *Sitotroga cerealella* (Olivier) (Lepidoptera: Gelechiidae) reared on five corn (maize) genotypes. J. Stored Prod. Res. Vol. 31 (2): 139-143.

Howlader, A. J. and Matin, A. S. M. A. (1989). Observations on the pre-harvest infestation of paddy by stored grain pests in Bangladesh. J. Stored Prod. Res. Vol. 24 (4): 229-231.

Mostafa, T. S. (1977). Biological and ecological studies on the angoumois grain moth, *Sitotroga cerealella* (Olivier)(Gelechiidae: Lepidoptera). Ph.D. Thesis, Fac. Agric., Cairo Univ., Egypt, 196 pp.

Perez-Mendoza, J.; Weaver, D. K. and Throne, J. E. (2004). Development and survivorship of immature angoumois grain moth (Lepidoptera: Gelechiidae) on stored corn. Environ. Entomol. Vol. 33(4): 807-814.

Said, M. (1966). *Sitotroga cerealella*, biological studies and chemical control. M.Sc. Thesis, Fac. Agric., Cairo Univ., Egypt, 74 pp.

Sedlacek, J. D.; Weston, P. A.; Price, B. D. and Rattlingourd, P. L. (1998). Survey of insect pests in shelled corn stored on-farm in Kentucky. J.

Entomol. Sci. Vol.33 (2): 171-179

Sedlacek, J.D.; Komaravalli, S.R.; Hanley, A.M.; Price, B.D.and Davis, P.M. (2001). Life history attributes of Indian meal moth (Lepidoptera: Pyralidae) and angoumois grain moth *Sitotroga cerealella* (Olivier) (Lepidoptera: Gelechiidae) reared on transgenic corn kernels. J. Econ. Entomol. Vol. 94 (2): 586-592.

Shenouda, M. G. (1966). Morphological and biological studies on *Sitotroga cerealella*. M. Sc. Fac. Agric., Alex. Univ.

Singh, K. N.; Agrawal, R. K. and Sirvastava, P. K. (1978). Infestation of grain moth *Sitotroga cerealella* (Olivier) and maize weevil *Sitophilus zeamais* Mots. on standing crops in the field. Bull. Grain. Technol. Vol. 16: 125-127.

Weston, P. A.; Barney, R. J. and Sedlacek, J. D. (1993). Planting date influences preharvest infestation of dent corn by angoumois grain moth *Sitotroga cerealella* (Olivier) (Lepidoptera: Gelechiidae). J. Econ. Entomol. Vol.86 (1): 174-180.

Weston, P. A. and Rattlingourd, P. L. (2000). Progeny production by *Tribolium castaneum* (Coleoptera: Tenebrionidae) and *Oryzaephilus surinamensis* (Coleoptera: Silvanidae) on maize previously infested by *Sitotroga cerealella* (Lepidoptera: Gelechiidae). J. Econ. Entomol. Vol. 93 (2): 533-536.

تاريخ حياة فراشة الحبوب على حبوب الذرة الشامية
Sitotroga cerealella (Olivier) (Lepidoptera: Gelechiidae)

سمير الشريف ابراهيم – محمد يسرى هاشم – سيدة سيد أحمد

قسم الحشرات الاقتصادية والمبيدات – كلية الزراعة – جامعة القاهرة- الجيزة -مصر

ملخص

درس تاريخ حياة فراشة الحبوب *Sitotroga cerealella* (Olivier) التابعة لعائلة Gelechiidae على حبوب الذرة الشامية تحت الظروف المثلى لمعيشتها وهى 27 ° م , و65± 5 % رطوبة نسبية. وضع البيض فرديا أو في مجموعات من 2 الى 60 بيضة على السطح الخارجي للحبوب، وبلغت فترة الحضانة 3-5 أيام، بمتوسط 3.9 يوماً, والنسبة المئوية للفقس 85 – 100 % ، بمتوسط 91 %. واعتمادا على قياسات عرض محفظة رأس اليرقة وطول جسمها خلال المراحل المختلفة لنمو وتطور اليرقة وحتى بلوغها طورما قبل العذراء أمكن بشكل تقريبى تمييز اربعة أعمار يرقية يليها فترة ما قبل العذراء. واستغرقت الاعمار اليرقية الأول و الثانى و الثالث و الرابع 4- 6 و 5 – 7 و 5 – 6 و 5 – 7 أيام، بمتوسط 4.8 و 5.6 و 5.6 و 5.8 يوماً، على التوالى. أما فترة ما قبل العذراء فقد استغرقت 2 -3 أيام، بمتوسط 2.4 يوماً. وبلغت مدة طور العذراء 5 – 9 أيام، بمتوسط 7 أيام. وكانت فترة حياة الحشرة الكاملة للذكور6 – 8 أيام، بمتوسط 7.6 يوماً، و للاناث 8 – 14 يوماً بمتوسط 11.4 يوماً. وبلغت فترات ماقبل وضع البيض، ووضع البيض، و ما بعد وضع البيض 2 – 3 أيام بمتوسط 2.6 يوماً ، و 3 – 5 أيام بمتوسط 4.1 يوماً ، و 3 – 6 أيام بمتوسط 4.4 يوماً، على التوالى. و بلغ عدد البيض لكل أنثى 164 – 186 بيضة بمتوسط 173 بيضة. وأستغرقت دورة الحياة الكاملة 33- 49 يوماً، بمتوسط 39 يوماً.

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