

SOME MORPHOLOGICAL CHARACTER AND BEHAVIOR OF RED FLOUR BEETLE TRIBOLIUM CASTANEUM (COLEOPTERA: TENEBRIONIDAE)

Iman Abbas Khudhair



Department of Biology, College of Science, University of Anbar, Iraq

E-mail: emanabbaskh59@gmail.com

Abstract

The study of the flour beetle or dark beetle was targeted for its economic importance because of the damage it causes to dry grain crops. The study dealt with determining the length and width of the adult insects, the larva, and the pupae, so the adult was the widest (0,62) mm and the larva was the longest (2,673) mm. Also, the length of the antenna was determined and it reached (0.253) mm as well an expansion was observed in the last three segments of the antenna. The study proved that the fore and hind legs have two claws and four tarsus segments, and one claw for the middle legs with five tarsus segments. their distribution was determined in a volume of (12,5) cm³ of flour, so the adult was the most prevalent compared to pupae and larvae. Also, the adult colors were observed and recorded, as it was dark brown, while the larvae was pale yellow, and the pupae was pale white. The type of larvae was also determined, it was protopoda, while the pupal type was obtect pupa. The adult beetle is flightless and has an affinity for light.

Keywords: *Tribolium*, *floure insects*, *dark beetel*, *Tenebrionidae*.

I. Introduction

The red flour beetle (*Tribolium castaneum*) is a species of beetle in the family Tenebrionidae,

Order: Coleoptera,

Class: Hexapoda (Insecta),

Phylum: Arthropoda. (Grünwa *et al.* 2013).

The red beetle infects stored food grains, dry pastries, legumes, dry pastries, and what pets eat from dry and dry foods, as well as nuts, dried plants, seeds, and dried models in the museum (Via 1999; Weston and Rattlingourd, 2000). This insect has an allergic effect, although it is unable to sting because it does not have a stinger, as its mouth parts are of the biting type specialized for breaking dry food (Alanko *et al.* 2000). This insect did not registered as transmission and cause spread of diseases, as it is not intrusive and does not live on eating buildings or furniture, but it is considered one of the most dangerous pests of cereals and legumes stored in warehouses, bios or shops, as it causes damage and stinky smell (Walter VE 1990).

These small insects live in temperate regions, either for cold regions or in winter they live in special places where heat and central heating are available, where these places are protected. The origin of this beetle is Indo-Australian (Tripathi *et al.*



2001). Despite the small size of this insect, it can live for three years or more and for longer periods of time (Walter VE 1990; Good, 1936). The reddish-brown color is the color that distinguishes this insect. As for the antenna, they end up having it end in a three-segmented club (Bousquet, 1990). Three-segmented antennal club and the sides of the thorax are slightly curved of the adult red flour beetle. The head of a beetle has no beak at the top and there are slightly curved sides of the thorax (Baldwin & Fasulo, 2005). The front, middle and hind legs of the red flour beetle, show the 5-5-4 tarsal formula (Baldwin & Fasulo, 2003). The slit eye is the eye feature on the head of this insect (Baldwin & Fasulo, 2003).

The color of the eggs of these insects is white and their size is not visible to the naked eye because the flour atoms cover them. As for the adult, the possibility of its flight is weak, but it may be able to do so sometimes under emergency circumstances (Ryan et al, 1970). The eggs hatch within 3-5 days at a temperature of 32-35°C. Pupae are naked and unprotected. Their development varies heterogeneously from egg to adult depending on the different oceanic aetiologies, however, the average is 26 days at 32-35 °C. can live these beetles in grains with a moisture level of up to 8%. The ovulation rate is 400-500 eggs per female (Ryan et al, 1970; Wirth & Ratanaworabhan, 1972).

The larvae are long, slender, yellow to light brown in color, and about 6 mm long (George & Palli, 2020). These larvae can cause damage and burrow into the grain, but they do not benefit from them in their food, so they resort to another food that is more suitable (Okosun et al, 2021). The difference in the lifespan of the larvae is caused by the environment, food, temperature, humidity, or the condition of the insect. But it is always active, hiding away from the light (Shahina & Salma, 2011) . The color of the pupae and larva is translucent white or light yellow (Arakane et al, 2010). These beetles breed in all seasons of the year, the number of days in their life cycle is approximately 90 days, and their life span may reach three years. All individuals of its life cycle are found at the same time and place (Lee et al, 2013).

This insect does not infect clean, healthy grains, although it is present in damaged, infected grains (Walter VE, 1990). The adults will go towards cover when disturbed. And this beetle can be found not only inside infested grain products but in crevices where grain may have poured with high humidity, it causes an unpleasant odor, and as a result, mold grows in the grain (Phillips et al 1993; Pugazhvendan et al, 2009). They secrete chemicals called quinines that can cause the contaminated feed to turn pink and have a strong, putrid odor (Li et al, 2013). MATERIALS AND METHODS

Insects used in this study were gained from laboratory colonies elevated on wheat flour at the Entomology laboratory in biology department, collage of science, Anbar University ,Iraq at a constant temperature of 27 ± 2 and 70 ± 5 R.H. They were collected during the period from 2021 to 2022 in different seasons of the years.

The length and width of adults, larvae, pupae, and antennae were measured using a compound microscope and a dissecting microscope (Fabres *et al* 2014). An eyepiece was inserted on a 4x magnification power and a drawing scale (0.025), The average length and width were calculated for ten randomly selected insects present in a size (12.5) cm³ of wheat flour. The prevalence and presence of adults, larvae, and pupae of the same size were also calculated. The average was taken for ten sizes of wheat flour that were chosen randomly. Also, the same microscopes were used to examine and diagnose the shape of the antenna, the claws of the legs, and the number of segments of the tarsus. Also, the type and shape of the larvae and pupae were determined by microscopes. Through inspection, it was confirmed the ability of these insects to fly and attraction to light.

RESULTS AND DISCUSSION .II

The results showed that the average length of adult insects was about (2.089) mm, and their width was (0.62) mm (Good, 1936). while the pupae length was (1.846) mm and its width was (0.5) mm, and the length of the larva was (2.673) mm, while its width was (0.359) mm. It also showed that the average length of the antenna was (0.253) mm (Walter VE, 1990).

It was also found that the prevalence and presence of insects in size (12.5) cm³ in wheat flour for adult insects was approximately four adults, two larvae, and three pupae in the same size of the random sample studied as in (Walter VE, 1990).

The results revealed that the shape of the antenna has a gradual expansion in relation to the last three segments (Fabres et al, 2014). Through inspection, the color of the adult insect was determined to be dark brown (Good, 1936). As for the larva, it was obtect pupa type with pale yellow color while the pupae type was protopoda medium in size surrounded by small hairs all over the body with pale white color (Ryan et al, 1970).

Microscopic examination showed that the fore and hind legs had two claws, and the mid legs had only one claw. As for the tarsus segments in the fore and hind legs, there are four segments and five segments for the mid legs this is consistent with what the study proved to the researcher (Baldwin & Fasulo, 2003).

It has been confirmed that the insect is completely attracted to light (Duehl et al, 2011). and it was unable to fly some studies have proven that the wings of adult insects are complete, but it is rare for them to fly, and even if they do fly, their flight will be very weak, and that is when crowded and in dire straits (Clark-Hachtel et al, 2013).

III. CONCLUSIONS

Some morphological and behavioral characteristics of the red flour beetle were deduced, as the larva is the longest, while the adult is the widest, as well as the length and shape of the antenna and the shape of the legs in terms of claws and tarsus. Its spread was determined in a certain volume of flour, where the adult is the most widespread in the dark brown color, while the colors of the larva and pupae are light color. Determining the type of larva and pupal, it was concluded that this insect is unable to fly and is attracted to light.

IV. References:

- Alanko K, Tuomi T, Vanhanen M, Pajari-Backas M, Kanerva L, Havu K, Saarinen K, Bruynzeel DP. 2000. Occupational IgE-mediated allergy to *Tribolium confusum* (confused flour beetle) *Allergy* 55: 879-882. <https://doi.org/10.1034/j.1398-9995.2000.00572.x>
- Arakane, Y., Dittmer, N. T., Tomoyasu, Y., Kramer, K. J., Muthukrishnan, S., Beeman, R. W., & Kanost, M. R. (2010). Identification, mRNA expression and functional analysis of several yellow family genes in *Tribolium castaneum*. *Insect biochemistry and molecular biology*, 40(3), 259-266. <https://doi.org/10.1016/j.ibmb.2010.01.012>
- Arakane, Y., Specht, C. A., Kramer, K. J., Muthukrishnan, S., & Beeman, R. W. (2008). Chitin synthases are required for survival, fecundity and egg hatch in the red flour beetle, *Tribolium castaneum*. *Insect biochemistry and molecular biology*, 38(10), 959-962. <https://doi.org/10.1016/j.ibmb.2008.07.006>
- Baldwin, R., & Fasulo, T. R. (2003). Confused Flour Beetle, *Tribolium confusum* Jacquelin du Val (Insecta: Coleoptera: Tenebrionidae) and Red Flour Beetle, *Tribolium castaneum* (Herbst)(Insecta: Coleoptera: Tenebrionidae). *UF/IFAS Extension: Gainesville*. <https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=1f006c02d8d2b846c16344bc25b50e3c4c275bfe>
- Baldwin, R., & Fasulo, T. R. (2005). Confused Flour Beetle, *Tribolium confusum* Jacquelin du Val and Red Flour Beetle, *Tribolium castaneum* (Herbst)(Insecta: Coleoptera: Tenebrionidae): EENY-289/IN566, rev. 1/2004. EDIS, 2005(1). <file:///C:/Users/hp/Downloads/tracydz,+IN566.pdf>



Bosly, H. A., & Kawanna, M. A. (2014). Fungi species and red flour beetle in stored wheat flour under Jazan region conditions. *Toxicology and Industrial Health*, 30(4), 304-310. <https://doi.org/10.1177/0748233712457449>

Bosquet, Y. (1990). Beetles associated with stored products in Canada: an identification guide. *Publication-Agriculture Canada (English ed.)*, (1837). <https://www.cabdirect.org/cabdirect/abstract/19901143621>

Clark-Hachtel, C. M., Linz, D. M., & Tomoyasu, Y. (2013). Insights into insect wing origin provided by functional analysis of vestigial in the red flour beetle, *Tribolium castaneum*. *Proceedings of the National Academy of Sciences*, <https://doi.org/10.1073/pnas.1304332110> 110(42), 16951-16956.

Duehl, A. J., Cohnstaedt, L. W., Arbogast, R. T., & Teal, P. E. A. (2011). Evaluating light attraction to increase trap efficiency for *Tribolium castaneum* (Coleoptera: Tenebrionidae). *Journal of Economic Entomology*, 104(4), 1430-1435. <https://doi.org/10.1603/EC10458>

Fabres, A., de Campos Macedo da Silva, J., Fernandes, K. V., Xavier-Filho, J., Rezende, G. L., & Oliveira, A. E. A. (2014). Comparative performance of the red flour beetle *Tribolium castaneum* (Coleoptera: Tenebrionidae) on different plant diets. *Journal of pest science*, 87, 495-506. <https://link.springer.com/article/10.1007/s10340-014-0569-3>

George, S., & Palli, S. R. (2020). Histone deacetylase 11 knockdown blocks larval development and metamorphosis in the red flour beetle, *Tribolium castaneum*. *Frontiers in genetics*, 11, 683. <https://doi.org/10.3389/fgene.2020.00683>

Good, Newell E. (1936). "The flour beetles of the genus *Tribolium*" (PDF). *USDA Report*. 498: 1-58. [file:///C:/Users/hp/Downloads/tb498%20\(2\).pdf](file:///C:/Users/hp/Downloads/tb498%20(2).pdf)

Grünwald, S., Adam, I. V., Gurmai, A. M., Bauer, L., Boll, M., & Wenzel, U. (2013). The red flour beetle *Tribolium castaneum* as a model to monitor food safety and functionality. *Yellow Biotechnology I: Insect Biotechnologie in Drug Discovery and Preclinical Research*, 111-122. https://link.springer.com/chapter/10.1007/10_2013_212

Lee, A. K., Sze, C. C., Kim, E. R., & Suzuki, Y. (2013). Developmental coupling of larval and adult stages in a complex life cycle: insights from limb regeneration in the flour beetle, *Tribolium castaneum*. *Evodevo*, 4(1), 1-17. <https://evodevojournal.biomedcentral.com/articles/10.1186/2041-9139-4-20>

Li, J., Lehmann, S., Weissbecker, B., Ojeda Naharro, I., Schütz, S., Joop, G., & Wimmer, E. A. (2013). Odoriferous defensive stink gland transcriptome to identify novel genes necessary for quinone synthesis in the red flour beetle, *Tribolium castaneum*. *PLoS genetics*, 9(7), e1003596. <https://doi.org/10.1371/journal.pgen.1003596>

Okosun, O. O., Allen, K. C., Glover, J. P., & Reddy, G. V. (2021). Biology, ecology, and management of key sorghum insect pests. *Journal of Integrated Pest Management*, 12(1), 4. <https://doi.org/10.1093/jipm/pmaa027>

Phillips, T. W., Jiang, X. L., Burkholder, W. E., Phillips, J. K., & Tran, H. Q. (1993). Behavioral responses to food volatiles by two species of stored-product Coleoptera, *Sitophilus oryzae* (Curculionidae) and *Tribolium castaneum* (Tenebrionidae). *Journal of Chemical Ecology*, 19, 723-734. <https://link.springer.com/article/10.1007/bf00985004>

Pugazhvendan, S. R., Elumalai, K., Ross, P. R., & Soundarajan, M. (2009). Repellent activity of chosen plant species against *Tribolium castaneum*. *World Journal of Zoology*, 4(3), 188-190. https://www.researchgate.net/profile/Kuppusamy-Elumalai/publication/238738088_Repellent_Activity_of_Chosen_Plant_Species_Against_Tribolium_castaneum/links/004635289a301834d4000000/Repellent-Activity-of-Chosen-Plant-Species-Against-Tribolium-castaneum.pdf

Ryan, M. F., Park, T., & Mertz, D. B. (1970). Flour beetles: responses to extracts of their own pupae. *Science*, 170(3954), 178-180. DOI: [10.1126/science.170.3954.178](https://doi.org/10.1126/science.170.3954.178)



Shahina, F., & Salma, J. (2011). Pakistani strains of entomopathogenic nematode as a biological control agent against <https://www.researchgate.net/profile/Shahina>-stored grain pest, *Tribolium castaneum*. *Pak. J. Nematol*, 29(1), 25-34. [Fayyaz/publication/265980181_PAKISTANI_STRAINS_OF_ENTOMOPATHOGENIC_NEMATODE_AS_A_BIOLOGICAL_CONTROL_AGENT_AGAINST_STORED_GRAIN_PEST_TRIBOLIUM_CASTANEUM/links/5524eae40cf22e181e73b221/PAKISTANI-OF-ENTOMOPATHOGENIC-NEMATODE-AS-A-BIOLOGICAL-CONTROL-AGENT-AGAINST-STORED-GRAIN-P](https://www.researchgate.net/profile/Shahina/publication/265980181_PAKISTANI_STRAINS_OF_ENTOMOPATHOGENIC_NEMATODE_AS_A_BIOLOGICAL_CONTROL_AGENT_AGAINST_STORED_GRAIN_PEST_TRIBOLIUM_CASTANEUM/links/5524eae40cf22e181e73b221/PAKISTANI-OF-ENTOMOPATHOGENIC-NEMATODE-AS-A-BIOLOGICAL-CONTROL-AGENT-AGAINST-STORED-GRAIN-P)

Tripathi AK, Prajapati V, Aggarwal KK, Kumar S. 2001. Toxicity, feeding deterrence, and effect of activity of 1,8,-Cineole from *Artemisia annua* on progeny production of *Tribolium castaneum* (Coleoptera: Tenebrionidae). *Journal of Economic Entomology* 94: 979-983. <https://doi.org/10.1603/0022-0493-94.4.979>

Via, S. (1999). Cannibalism facilitates the use of a novel environment in the flour beetle, *Tribolium castaneum*. *Heredity*, <https://www.nature.com/articles/6884820>82(3), 267-275.

Walter VE. 1990. Stored product pests. In Handbook of Pest Control Story K, Moreland D. (editors). Franzak & Foster Co., Cleveland, OH. pp. 526-529. <https://archive.lib.msu.edu/tic/wetrt/page/1964jul21-30.pdf>

Weston PA, Rattlingourd PL. 2000. Progeny production by *Tribolium castaneum* (Coleoptera: Tenebrionidae) and *Oryzaephilus surinamensis* (Coleoptera: Silvanidae) on maize previously infested by *Sitotroga cerealella* (Lepidoptera: Gelechiidae) *Journal of Economic Entomology* 93: 533-536. <https://doi.org/10.1603/0022-0493-93.2.533>

Wirth, W. W., & Ratanaworabhan, N. C. (1972). A revision of the tribe Stenoxenini (Diptera: Ceratopogonidae). *Annals of the Entomological Society of America*, 65(6), 1368-1388. <https://doi.org/10.1093/aesa/65.6.1368>