

EVOLUTIONARY CYCLE OF *CYDALIMA PERSPECTALIS* WALK. UNDER THE INFLUENCE OF CLIMATE CONDITIONS IN CRAIOVA AREA

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Abstract

*The aim of the paper is to highlight the link between climatic conditions and the developmental stages of the species *Cydalima perspectalis*. If the temperature is low the evolution in days of the development stages increase and vice versa. For the population studied in 2020, the first flight of adults took place on May 18, and the last on October 14. It is clear that it completed 2 generations and the amount of effective temperature for the first generation is 646.7°C and for the second generation it was 628.3°C. The amount of effective temperature (degrees-days) in the period 2019-2020 for the egg stage varies between 62.8°C in 2020 and 48.6°C in 2019, for the larval stage is between 444.8°C (2020) and 403.4°C (2019) and for the pupae stage the values are between 139.1°C (2020) and 74.1°C (2019). Under the natural influence of climatic factors, the number of generations of the species *Cydalima perspectalis* in the Craiova area varies from one year to another, this suggests that this species is directly dependent on temperature.*

Key words: life cycle, temperatures, *Cydalima perspectalis*

INTRODUCTION

Cydalima perspectalis Walk. belongs to the order Lepidoptera, family Crambidae, native from the Asian Continent [14]. In Europe it managed to colonize most of the countries: Germany [5], the Netherlands [19], France [9], Switzerland [16], Austria [28], Romania [13], Belgium [8], Italy [4], Hungary [34], Turkey [12], Czech Republic [33] and Slovenia [30].

The most recent reports are from Malta [1], Northern Macedonia [21], Gibraltar [26], Lithuania [25], Kosovo [10] and Belarus [31], in 2018 it was reported in the USA in Ontario [23]. In the European countries this pest completes two generation [11], [15], [20], to three generations per year [16],[29], [22], [3], [2]. In years with a warmer climate, species *Cydalima perspectalis* can develop a fourth generation [16], [6], [7].

In Galicia, the number of annual generations has been found to fluctuate depending on climatic conditions, completing two generations in 2014 and 2015, three generations in 2016 and up to five generations in 2017 [27].

In Romania a different number of generations are reported depending on the area, in Cluj this species completes two generations/year [24], and in Craiova three generations/year [32]. Research on the ecology of the box tree moth has been conducted worldwide by the following authors: [18], [35], [17], [36], [20]. Studies conducted in Japan [18] on laboratory populations reported a different duration of development of *Cydalima* eggs at different temperatures, so it was shown that with increasing temperature, the development (in days) decreases, thus at a temperature of 15°C egg development period lasts fifteen days, at 20°C lasts seven days, at 25°C lasts four days, at 30°C lasts three days.

In the areas of origin, full development for the second and third generations of the same year takes place in 25 days at a temperature of 25°C [18], and in northern China the second and third generations of the same year completed their development within 25 days at a temperature of 27°C [35].

The developmental period for the pupae stage of the *Cydalima* species is 38 days at a constant temperature of 15°C, 17 days at 20°C, 10 days at 25°C and 7 days at 30°C

[18], and for the preoviposition period were 5.5 days at 15°C and 3.2 days at 20°C, 2.3 days at 25°C and 2.2 days at 30°C [18].

The lifespan of females is 8.02 ± 0.18 days and 8.69 ± 0.12 days for males [36].

For the population of the species *Cydalima perspectalis* studied in Switzerland, the minimum temperature for the development of the stages was: 10.91°C and 48-54°C the amount of effective temperature for the egg stage, 8.38°C and 322.58°C the amount for the stage of larva and 11.5°C and 133.33°C the amount of effective temperature for the pupae stage, and for the first generation the effective temperature is 518°C, and for the second generation is 430°C [20].

In the Garrotxa area, *Cydalima perspectalis* develops 3 generations, so they calculated the amount of effective temperature (degree-days) for each stage of development according to generation.

The amount of effective temperature for the preoviposition period is 36.3°C, for the egg stage it is 59.5°C, the larval stage is 449.0°C, and the pupae stage is 148.4°C, these values correspond to the first generation. For the second generation for each stage of development we have the following values, 42.2°C for the preoviposition period, 58.6°C for the egg stage, for the larval stage was 404.7°C and for the pupae stage was 145.1°C. The amount of effective temperature for the preoviposition period of the third generation was 41.1°C, for the egg stage it was 54.2°C, for the larval stage was 401.3°C, and for the pupae stage was 95.7°C.

The amount of effective temperature for the first generation is 693.2°C, for the second generation 650.6°C, and for the third generation the value of the actual amount of temperature is 592.3°C [2].

MATERIALS AND METHODS

The purpose of the research is to show how climatic conditions influences the development of *Cydalima perspectalis*, by following the evolutionary cycle and development period (in days), each stage was staggered in correlation with the average temperature. The researches were carried out

in field conditions, in the Al. Buia Botanical Garden from Craiova in 2020. For the monitoring of each stage of development, we took samples from field and counting of the larvae was made weekly. Accurate identification of the flight period of adults of the species *Cydalima perspectalis* was performed using pheromone traps (Photo 1).

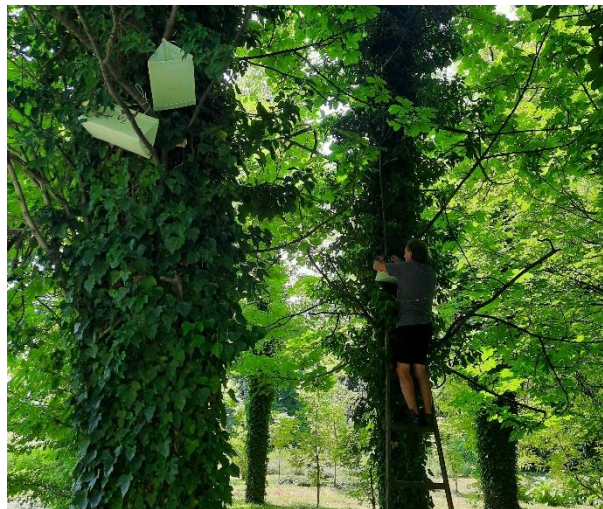


Photo 1. Mounting pheromone traps
Source: Own experiment. Original.

RESULTS AND DISCUSSIONS

The data obtained with the help of pheromone traps, made it possible to determine the flight period of the species *Cydalima perspectalis* in Craiova, the first adults being caught on May 18, and the last adults were on October 14.

The flight of the adults of the hibernating generation, was staggered between May 18th and June 25th, the peak of the flight period was on June 10th.

After a period of inactivity of about 3 and a half weeks, a second flight period begins on July 20, corresponding to the first generation and lasts until August 24. The maximum of the flight period was between July 29 and August 12.

The third flight period starts on September 7 and lasts until October 14, the maximum flight curve being between September 15 and 23.

The flight curve of adults of the species *Cydalima perspectalis* during 2020 shows three peaks of activity, specific to the hibernating generation (May 18-June 25), the first generation (July 20-August 25) and the

second generation (September 7 and October 14) (Fig.1).

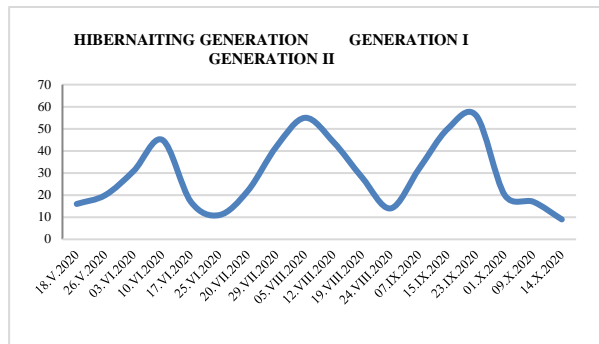


Fig. 1. Flight phenology of *Cydalima perspectalis* in 2020

Source: Own results.

Most of the larvae came out of diapause in the second decade of March, being at the 4th age of larval development and evolved over a period of 50 days until the appearance of the first pupae in the field (Photo. 2).



Photo 2. The beginning of hibernating larvae activity
 Source: Original.

The pupae stage of the hibernating generation lasted 17 days until the appearance of the first adults, at a temperature of 16.9°C.

The eggs of the first generation were observed in the third decade of May and their development lasted 15 days at an average temperature of 15.1°C. The larvae were observed on June 6 and their development lasted over a period of 31 days at an average temperature of 22.3°C, the first pupae were observed on July 7 and developed over a period of 13 days at an average temperature of 22.2°C, and the first adults appeared on July 20.

The second generation appeared on July 24, the eggs of this generation developed for 5 days at an average temperature of 22.2°C, after this period appeared the first larvae that developed for 27 days at an average temperature of 24.6°C. For the pupae stage the average temperature was 22.7°C, and the evolution of this stage was 12 days. The adults of the second generation appeared on September 7.

For the third generation, the eggs developed over a period of 4 days at an average temperature of 24°C, and from September 15 the larvae evolved.

The data mentioned above represent the minimum duration from which each stage of each generation of species *Cydalima perspectalis* evolved. During the research it was observed that the larvae of the winter generation are affected by the constant temperature changes from May to April, some of them were found dead in the last decade of March (5.9°C) and the first decade of April (8.8°C), then the lowest values of the development period of the hibernating larvae were registered.

During 2020, the species *Cydalima perspectalis* developed two complete generations, and the third is partial. In 2019 in the same area it has developed 3 generation and the fourth was partial, in this case temperature was the main cause of the differences of generation from a year to another.

However, third-generation larvae, even if they completed their cycle, would not survive as a pupae stage due to the low temperature recorded after the third decade of October (11.6°C) and November (5.5°C).

So for the two generations completed in 2020 by the box tree moth, the amount of effective temperature for the egg stages of the first generation was 62.8°C, for larva stage was 444.8°C and for the pupae stage was 139.1°C is 646.7°C, and for the second generation the amount of effective temperature is 628.3°C, the data are presented in Table 1 and for the data already published for the year 2019, the amount of effective temperature is presented in Table 2.

Table 1. The amount of effective temperature (degree-days) in 2020 for the development stages of *Cydalima perspectalis*

DEVELOPMENT STAGES	AMOUNT OF EFFECTIVE TEMPERATURE 2020	1ST GENERATION	2ND GENERATION
EGG		62.8°C	56.5°C
LARVA		444.8°C	437.4°C
PUPAE		139.1°C	134.4°C
TOTAL CYCLE		646.7°C	628.3°C

Source: Own results.

Table 2. The amount of effective temperature (degree-days) in 2019 for the development stages of *Cydalima perspectalis*

DEVELOPMENT STAGES	AMOUNT OF EFFECTIVE TEMPERATURE 2019	1ST GENERATION	2ND GENERATION	3RD GENERATION
EGG		53°C	51.5°C	48.6°C
LARVA		431.8°C	426.1°C	403.4°C
PUPAE		137.5°C	135°C	74.1°C
TOTAL CYCLE		622.3°C	612.6°C	526.1°C

Source: Own results.

The amount of effective temperature for 2019 for the three generations completed in this area, the values for the egg stage are: 53°C for the first generation, 51.5°C for the second generation and 48.6°C for the third generation. The amount of effective temperature for the larval stage was between 431.8°C and 403.4°C and for the pupae stage varied between 137.5°C for the first generation, 135°C for the second generation and 74.1°C for the third generation.

These variations are encountered due to climatic conditions, if in 2019 there were 3 complete generations, and the fourth partial, in 2020 we have 2 complete generations, and the third partial, under the influence of temperatures in the area. This tells us that the development of the species *Cydalima perspectalis* depends entirely on temperature and then on food.

CONCLUSIONS

Temperature is the main climatic factor that can influence the development of the box tree moth from a year to another. If the temperature is low the evolution in days of the development stages increase and vice versa.

For the population studied in 2020, the first flight of adults took place on May 18, and the last on October 14.

In 2019 we have 3 generations and the fourth generation is partial and in 2020 this species completed 2 generations and the third is partial, in this case under natural climatic conditions the life cycle of the species *Cydalima perspectalis* can vary from a year to another.

The amount of effective temperature (degree-days) for the egg stage varies between 62.8°C in 2020 and 48.6°C in 2019, for the larval stage is between 444.8°C (2020) and 403.4°C (2019) and for the pupae stage the values are between 139.1°C (2020) and 74.1°C (2019).

REFERENCES

- [1] Agius, J., 2018, Pest species *Cydalima perspectalis* (Walker, 1859) new to the Maltese Islands (Lepidoptera: Crambidae), Vol. 46 (184):577-579, Shilap Revista de lepidopterologia.
- [2] Artola, J., Isamat, E.B., Las Heras, S., Arimany, M., 2018, Cicle biològic i fenologia de la papallona del boix, *Cydalima perspectalis* (Walker, 1859) (Lepidoptera: Crambidae) a la Garrotxa (Catalunya), Vol. 109: 65-85, Butll. soc. cat. Lep.
- [3] Bakay, L., Kollár, J., 2018, The spread rate of *Cydalima perspectalis* (Walker 1859) in Slovakia

- (2013–2015), Plants in Urban Areas and Landscape, pp. 51–54.
- [4]Bella, S., 2013, The box tree moth *Cydalima perspectalis* (Walker, 1859) continues to spread in southern Europe: New records for Italy (Lepidoptera: Pyraloidea: Crambidae), XCVI, 51-55, Redia;
- [5]Billen, W., 2007, *Diaphania Perspectalis* (Lepidoptera: Pyralidae) – A new moth in Europe, 57: 135-137, Mitt Der Entom Gesell Basel.
- [6]Brua, C., 2013, La pyrale du buis, *Cydalima perspectalis* (Walker, 1859), espece exotique envahissante, caracteristiques de sa dynamique d'expansion en France et en Europe, des degats occasionnes sur les buis (*Buxus* spp) et des strategies de lutte, 364-374, Afpp – 3^e Conférence Sur L'entretien Des Espaces Verts, Jardins, Gazons, Forêts, Zones Aquatiques Et Autres Zones Non Agricoles Toulouse – 15, 16 Et 17 Octobre 2013.
- [7]Brua C., 2014, La pyrale du buis. le point sur cette espece envahissante, Phytoma: La Santé des Végétaux, Vol. 675, pp.16-22.
- [8]Casteels, H., Witters, J., Vandierendonck, S., Van Remoortere, L., 2011, First report of *Cydalima Perspectalis* (Lepidoptera: Crambidae) in Belgium. 63rd International Symposium on Crop Protection (Poster Presentation).
- [9]Feldtrauer, J.F., Feldtrauer, J.J., Brua, C., 2009, Premiers signalements en France de la pyrale du buis *Diaphania Perspectalis* (Walker, 1859), espece exotique envahissante s'attaquant aux buis (Lepidoptera, Crambidae), Bulletin de la Société Entomologique de Mulhouse, 65(4): 55-58.
- [10]Geci, D., Ibrahim, H., 2018, First record of the box tree moth *Cydalima Perspectalis* (Walker, 1859) (Lepidoptera, Crambidae) from Kosovo, Nat. Croat, Vol. 27(2):343-345.
- [11]Göttig, S., Herz, A., 2017, Observations on the seasonal flight activity of the box tree pyralid *Cydalima perspectalis* (Lepidoptera: Crambidae) in the Rhine-Main Region of Hesse. Journal of Cultivated Plants, 69(5): 157-165.
- [12]Hizal, E., Kose, M., Yesil, C., Kaynar, D., 2012, The new pest *Cydalima Perspectalis* (Walker, 1859) (Lepidoptera: Crambidae) in Turkey, Journal of Animal and Veterinary Advances, 11 (3):400-403.
- [13]Iamandei, M., 2010, *Diaphania perspectalis* (Walker, 1859) (Lepidoptera: Crambidae) a new pest of *Buxus* Spp. in Romania, Lucrări Științifice USAMVB, Seria B, Vol. Liv, 787-793.
- [14]Inoue, H., 1982, Pyralidae. In: Moths Of Japan, Vol. 1, 223–254.
- [15]Karpun, N. N., Ignatova, E. A., 2014, *Cydalima perspectalis* - Invasion on Russian Black Sea Coast., Zashchita I Karantin Rastenii, No.6, pp.41-42.
- [16]Leuthardt, F.L.G., Billen, W., Baur, B., 2010, Spread of the box-tree pyralid *Diaphania perspectalis* (Lepidoptera: Pyralidae) in the Region of Basel - a pest species new for Switzerland, Entomo Helvetica, 3:51-57.
- [17]López, C., Eizaguirre, M., 2019, Diapause and biological cycle of *Cydalima perspectalis* (Walker) in the eastern Pyrenees, Journal Of Applied Entomology, 143(10):1096-1104,
- [18]Maruyama, T., Shinkaji, N., 1987, Studies on the life cycle of the box-tree pyralid, *Glyphodes Perspectalis* (Walker) (Lepidoptera: Pyralidae) I. seasonal adult emergence and developmental velocity. Japanese Journal Of Applied Entomology And Zoology, Vol. 31: 226-232.
- [19]Muus, T.S.T., Haaften, E.J.V., Deventer, L.J.V., 2009, The box-tree pyralid *Palpita perspectalis* (Walker) in the Netherlands (Lepidoptera: Crambidae), Entomologische Berichten, Vol. 69(2):66-67.
- [20]Nacambo, S., Leuthardt, F. L. G., Wan, H., Li, H., Haye, T., Baur, B., Weiss, R.M., Kenis, M., 2014, Development characteristics of the box-tree moth *Cydalima perspectalis* and its potential distribution in Europe, J. Appl. Entomol., Vol. 138:14–26.
- [21]Načeski, S., Papazova-Anakieva, I., Blagoj, I., Stanislava, L., Blagoj, Š., 2018, Occurrence of the new invasive insect *Cydalima perspectalis* Walker on box tree in the Republic of Macedonia, Section of Natural, Mathematical and Biotechnical Sciences, Masa; Vol. 39(2):135–141.
- [22]Nagy, A., Szarukán, I., Csabai, J., Molnár, A., Molnár, B. P., Kárpáti, Z., Szanyi, S., Tóth, M., 2017, Distribution of the box tree moth (*Cydalima perspectalis* Walker 1859) in the north-eastern part of the Carpathian Basin with a new Ukrainian record and Hungarian Data, Bulletin Oepp/Eppo, Vol.47(2): 279-282.
- [23]Nappo Phytosanitary Alert System. Official pest reports. Canada (2019-02-21) Detection of *Cydalima perspectalis* (Box tree moth) in Ontario. <https://www.pestalerts.org/Official-Pest-Report/Detection-Cydalima-Perspectalis-Box-Tree-Moth-Ontario>, Accessed on 12.07.2021.
- [24]Oltean, I., Hulusjan, I., Hulusjan, I., Varga, M., Tötös, S., Florian, T., 2016, *Cydalima Perspectalis* Walker (Lepidoptera, Crambidae) A New Dangerous Pest Report On *Buxus Sempervirens* in Cluj Area, Bulletin USAMV Cluj-Napoca, Series Agriculture, 74(1): 26-36.
- [25]Paulavičiūtė, B., Mikalauskas, D., 2018, First record of the box tree moth *Cydalima perspectalis* (Walker, 1859) (Lepidoptera: Crambidae) in Lithuania, Bulletin of the Lithuanian Entomological Society, Vol. 2(30): 55-59.
- [26]Perez, Ce, Guillem, Rm, 2019, First records of the pest species *Cydalima perspectalis* (Walker, 1859) and *Paysandisia archon* (Burmeister, 1880) in Gibraltar (Lepidoptera: Crambidae & Castniidae), Revista de la Sociedad Gaditana de Historia Natural, 13: 15-18.
- [27]Pérez-Otero, R., Rodríguez-Acevedo, A., Mansilla, J. P., 2018, *Cydalima perspectalis* (Walker, 1859), Bolboreta do buxo. estación fitopatolóxica do areiro, Deputación de Pontevedra. Ficha Técnica. 67: 1-4.
- [28]Rodeland, J., (Ed.), 2009, Lepiforum: Bestimmung von Schmette Rlingen (Lepidoptera) Und Ihren Präimaginalstadien. <http://Www.Lepiforum.De/>, Accessed on 24.06.2021.

- [29]Santi, F., Radeghieri, P., Sigurtà, G.I., Maini, S., 2015, Sex pheromone traps for detection of the invasive box tree moth in Italy, *Bulletin Of Insectology*, Vol. 68 (1): 158-160.
- [30]Seljak, G., 2012, Six new alien phytophagous insect species recorded in Slovenia in 2011, *Acta Entomologica Slovenica*, Vol. 20 (1):31-44.
- [31]Sinchuk, A., Sinchuk, N., Kolbas, A., 2020, First record of *Cydalima perspectalis* (Walker, 1859) (Lepidoptera: Crambidae) in Brest (Belarus), *Bulletin of the Lithuanian Entomological Society*, Vol. 4(32): 61-64.
- [32]Stan, R., Mitrea, I., 2020, Life Cycle of *Cydalima Perspectalis* (Walker) (Lepidoptera: Crambidae) in Craiova Area, *Bulletin Of University Of Agricultural Sciences And Veterinary Medicine Cluj-Napoca. Horticulture*, Vol. 77(2): 84-92.
- [33]Šumpich, J., 2011, Motýli Národních Park Podyjí A Thayatal, *Znojmo*, 428 p.
- [34]Szabolcs, S., Bálint, H., 2011, Box Tree Moth – *Cydalima perspectalis* (Walker, 1859), new member in the Lepidoptera fauna of Hungary (Lepidoptera: Crambidae), *Natura Somogyiensis*, 245-246.
- [35]Zhang, L., Li, Zh., Zhen, Xh., Chen, M., 2007, Biological characteristics and control of box tree caterpillar, *Diaphania perspectalis* (Walker). *Shandong, Agric. Sci. (In Chinese)*, Vol. 2, 77–79.
- [36]Zhou, W., Xia, Cy., Sun, Xq., Zhu, B., Liu, Xp., Liu, Zc., Wang, Y., 2005, Studies on the biological characteristics and control of *Diaphania perspectalis* Walker. *J. Shanghai Jiaotong, Univ. Agric. Sci.*, Vol. 23: 52–56.