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BIOPHENOLOGY PEACH TWIG BORER

(Anarsia lineatella Zell.) in the south of Ukraine

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Goal. *Clarification of certain biological features of development and seasonal dynamics of the flight of peach twig borer in peach orchards of the Southern Steppe of Ukraine.* ***Methods.*** *Field — research of the biological features of peach twig borer development using pheromone-trap method was conducted in accordance with generally accepted methods in peach orchards of SPS «Naukova» of Melitopol fruit growing research station named after M.F. Sydorenko of IH of NAAS of Ukraine.* ***Results.*** *It was determined that in the conditions of peach orchards in the South of Ukraine restoration of feeding peach twig borer caterpillars began in the end of March — the middle of April, and the hatching — in the end of April — the beginning of May. During 2018—2020, the beginning of the flight of butterflies of the pest was observed starting from 06 to 18 May, with the accumulation of the sum of effective temperatures (SET) >8°C 154.5—254.3 and lasted continuously until September 18—30 (134—141 days) with three peaks. The appearance of the pest caterpillars was observed from the 2—3rd ten-day period of May (SET >8°C 299.0—349.5°C). The peaks of peach twig borer flight were observed in the 3rd ten-day period of May, late June — early July, and during the 3rd ten-day period of July — mid-August. The duration of the development of the first generation was 44—50 days, the next — 30—40 days, with accumulation of SET >8°C from imago to imago varying between 436.5 and 743.0°C.* ***Conclusions.*** *In the south of Ukraine, three peaks of flight and development of two full generations of peach twig borer are noted, caterpillars of the third generation completed the development in the spring of the following year. Fluctuations in the number of imago during the growing season were influenced by both meteorological factors and the degree of reproduction of the pest of the previous generation. During the years of research, the highest intensity of catching of butterflies of a fruit striped moth was noted in July — August at high mean weakly air temperatures (25.0—26.9°C) and the conditions of severe drought (HTC 0.2).*

***Anarsia lineatella* Zell.; peach; pheromone traps; monitoring**

In the orchards of the South of Ukraine peach twig borer (*Anarsia lineatella* Zell.) is a less common, but quite dangerous Lepidoptera pest. This is of the family Gelechiidae [1, 2].

From the literature, the species *Anarsia lineatella* was first described by Zeller in 1839 and has since been known as a pest of stone fruit species of the genus *Prunus* (*Rosaceae*) [3].

In the reports of various authors it is determined that the forage plants for the caterpillars of the peach twig borer are apricot, peach, quince, almond, plum, rarely — sour and sweet cherry, apple [2, 4].

In the territory of Ukraine in the 1960's the pest was found in Zaporizhia, Donetsk, Dnipropetrovsk, Kherson, Mykolaiv and Odessa regions on peach, apricot, plum, sometimes — sweet cherries, cherries [5].

Currently, this phytophagous in combination with codling moth (*Grapholitha molesta* Busck.) causes significant damage to stone fruit crops in the Southern region of Ukraine [6]. In Kherson region, the damage of shoots and fruits of peach and apricot by caterpillars of peach twig borer varied from 6.1—14.8% and 5.3—21.4% respectively [2].

The wintering stage of peach twig borer is caterpillars of 1—4 ages (mostly 2—3) 1.1—3.3 mm long, which are concentrated in the bark of shoots, forks of branches, under the scales of apical, sometimes lateral buds [7]. Up to 78.3% of the caterpillars overwinter in cracked bark, up to 21.7% in buds and a small part is observed in mummified fruits. The best for wintering of the caterpillars of peach twig borer are the middle tiers of trees and sunlight sides of tree canopy [8].

After overwintering, caterpillars of peach twig borer damage the buds, then young annual shoots (Fig. 1), which leads to their wilting. The nature of damage to shoots by caterpillars of peach twig borer is quite similar to the caterpillars of codling moth. This makes it difficult to identify the damage visually. During its

Fig. 1. Caterpillar of peach twig borer in a peach shoot (original photo by Yudytska I.V.)

development, one caterpillar can damage 4—5 young shoots.

In summer, the caterpillars damage green and ripening fruits, feeding under the skin near the petiole (Fig. 2), or sideways, making moves to the stonet [7, 9].

Depending on the region, peach twig borer develops in 1—5 generations [4, 10—13]. Studies by Hazır A., Ulusoy M. R. found that in Turkey, the flight of peach twig borer occurs from the beginning of April and lasts until November with 4—5 peaks of flight [14]. In northern Greece, peach twig borer is observed from May to mid−October with 3—4 peaks per season [15, 16].

In the conditions of the South of Ukraine the development of peach twig borer occurs in two generations, a part of population — in three. Flight of the first generation of butterflies is observed from mid — May, the second — beginning to mid-July, the last peak — during August at the sum of effective temperatures (SET) (lower threshold of development 8°C), respectively 267°, 896° and 1480°C [5].

Summarizing the above, it is noted that the literature describes a rather small amount of information on the study of biological features of the development of peach twig borer in the South of Ukraine. Therefore, there is a need to clarify the seasonal dynamics of phytophagous development in today's conditions.

Goal. investigation of biological features of development and seasonal dynamics of flight of peach twig borer in peach orchardsof the Southern Steppe of Ukraine.

Research methods. Peculiarities of the seasonal dynamics of the development of peach twig borer were carried out during 2018—2020 in peach orchards located at the SPS «Naukova» of Melitopol fruit growing research station (MFGRS) named after M.F. Sydorenko of IH of NAAS of Ukraine.Year of planting — 2001, cultivars — Redhaven, Zolota Moskva, rootstock — almond seedlings. The soil of the experimental plot is southern sandy black soil, the planting scheme is 6 x 4 m. Soil retention system — bare fallow.

Determination of biological features of the development of peach twig borer was carried out in natural conditions during route surveys of peach orchards during the growing season. Detection of butterflies and study of the dynamics of flight of the pest was carried out using pheromone traps according to conventional methods [17, 18]. The experiment used traps of Atracon-A type with a synthetic pheromone of the peach twig borer produced by Biochemtech (Moldova) (2 traps/ha). Hanging of traps began at the beginning of the theoretical flight of the butterflies (late April). Accounts were carried out once every 5—10 days after the date of the pest observation in the traps (before this observation was carried out daily). After counting the number of butterflies, the adhered inserts were cleaned and replaced every 10 days, and pheromone dispensers every 30 days. The data of the meteorological station of Melitopol (Zaporizhzhya region) was used for the analysis of meteorological factors.

Research results. In peach orchards during 2018—2019, the period of restoration of nutrition of peach twig borer caterpillars was observed in late March — early April at an average daily air temperature of +8.6...+9.6°C. In 2020, the reactivation of the pest was observed later — from the mid to late April, which is due to unstable weather conditions of the month, namely frosts of −0.5...−5.4°C. The development of overwintering caterpillars lasted more than a month before hatching, which is due to their age heterogeneity and fluctuations in air temperature below the threshold value of the species (8.0°C).

Caterpillars of peach twig borer pupated from the end of April to early May mainly in the leaves (41.0%) (Fig. 3), cracks in the bark of trunks and skeletal branches of peach trees (45.7%), as well as in plant remains (13.3%). In peach orchards during 2018—2019, the departure of first-generation butterflies was recorded at the same time — from the end of the 1st ten-day period of May (06—07.05), while the accumulation of SET >8°C on these dates differed and amounted to 154.5—254.3°C (table 1). This year, the first butterflies of the pest were observed in traps later — from 18.05 (SET >8°C 227.8°C), which is due to adverse weather conditions in the first half of May (decrease in air temperature to +4.4°C).

It should be noted that the traps, in addition to butterflies of the pest, attracted a large number of adults of *Acontia (Emmelia) trabealis* Scop. (Fig. 4, b), rarely — *Agrotis segetum* Shiff. In studies of the effectiveness of the pheromone of peach twig borer, conducted in Moldova, also recorded the above species in the traps [7].

In peach orchards, the beginning of egg laying by phytophagous butterflies was observed from the mid-

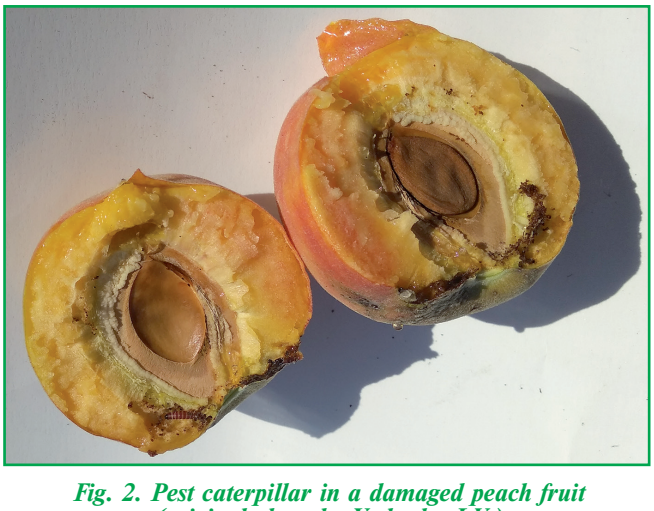

Fig. 2. Pest caterpillar in a damaged peach fruit (original photo by Yudytska I.V.)

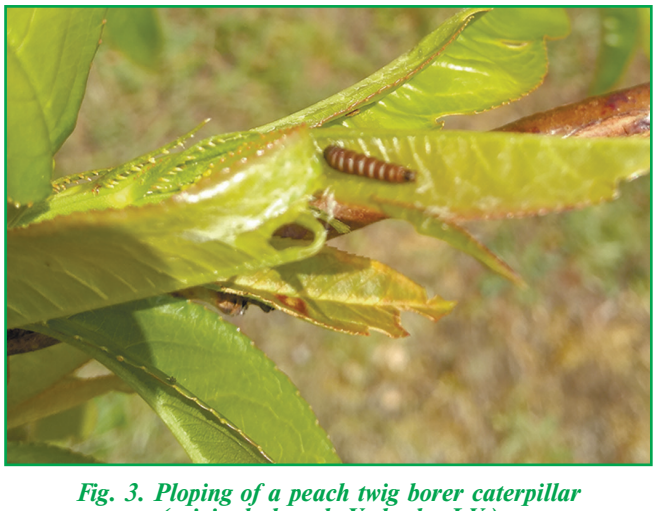

Fig. 3. Ploping of a peach twig borer caterpillar (original photo byYudytska I.V.)

May, and the emergence of caterpillars, depending on temperature conditions — from the end of the 2nd and 3rd decades of May. The accumulation of SET>8°C for the period of egg laying and rebirth of the pest caterpillars was 213.9—287.5°C and 299.0—349.5°C, respectively.

The study of the seasonal dynamics of flight of butterflies of peach twig borer showed that in the South of Ukraine the flight of the pest lasted continuously from May to the end of September (18—30.09), for 134—141 days, with three peaks.

The results of 3-year observations of the flight dynamics of the adult peach twig borer with the help of pheromone traps are shown in Figure 5. The first peak of flight of butterflies of the pest was observed during the end of May (SET >8°C 243.6—531.5°C). In 2018, at mean decade temperature of 21.2°C in peach orchards, the highest number of adult pests was observed — 34.5 specimens/trap for 10 days, which is 6.9 times higher than the economic threshold of harmfulness (5.0 butterflies/trap). During 2019—2020 in this period at an mean decadal air temperature of +14.8...+20.2°C and hydrothermal coefficient (HTC) 1.6—3.1, the intensity of male catching was 2.9—3.1 times lower (11.0—12.0 insects/trap for 10 days).

The flight of butterflies of the next generation of phytophagous was observed in late June-early July (21.06—06.07) with the accumulation of SET >8°C 844.2—897.5°C. In 2018, at mean decadal air temperature of +25.1°C and HTC 1.2, the number of butterflies caught during the second peak decreased 1.5 times compared to the first (23.5 specimens/trap for 10 days). During 2019—2020, at mean decadal air temperature of +24.9...+26.9°C and HTC of 0.03—0.2, an increase in the adult peach twig borer by 1.1—2.0 times was observed (13.3—21.8 insects/10 days).

In peach plantations due to the superimposition of generations on each other, the beginning of phytophagous egg laying in subsequent generations was not clearly traced. The caterpillars of the second generation, depending on the timing of the butterflies, were observed from the end of June (2018), yearly (2019) and mid (2020) July. The duration of caterpillar development was reduced due to high air temperatures (+23.2...+26.9°C) and feeding quality (appearance of ripening peach fruits).

The last peak of the flight of butterflies of peach twig borer was recorded in the late July — mid-August (July 26 — August 11). The accumulation of SET >8°C in the years of research in these periods reached 1334.0—1535.2°C. It was found that in 2018—2019 at an average decade temperature of +25.0...+26.2°C

1. Terms of departure of butterflies of peach twig borer of the first generation depending on meteorological conditions (SPS «Naukova», MFGRS named after M.F. Sydorenko of IH NAAS, 2018—2020)

Years of research	Butterflies flight start date	Mean decadal air temperature, °C during the departure of butterflies			SET> 8°C at the time of the first butterflies
		mean	max	min	
2018	07.05 (I decade of May)	20.3	32.5	9.9	254.3
2019	06.05 (I decade of May)	14.9	24.4	5.6	154.5
2020	18.05 (II decade of May)	15.3	26.6	4.4	227.8
Mean (oscillation limits)	– (06—18.05)	16.8	27.8	6.6	212.2

Fig. 4. Butterflies (original photo by Yudytska I.V.): a — butterflies of Anarsia lineatella Zell.; b — butterflies of Acontia (Emmelia) trabealis Scop.

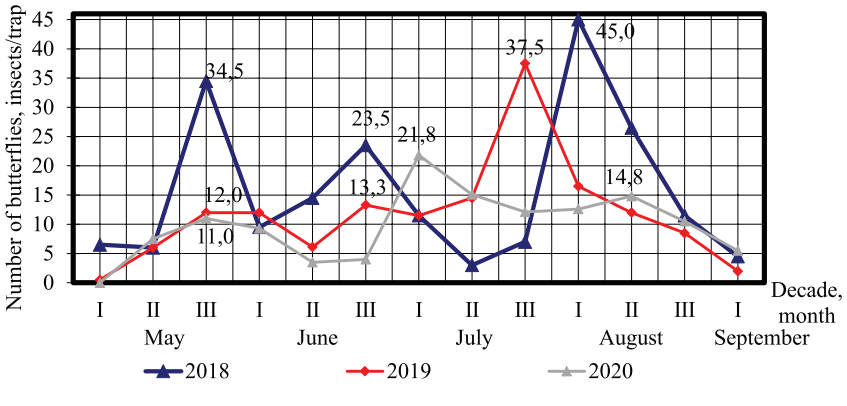

Fig. 5. Dynamics of flight of peach twig borer in peach orchards (Zaporizhia region, SPS «Naukova», MFGRS named after M.F. Sidorenko IH NAAS), 2018—2020

and HTC 0.2 during the third peak of flight, the maximum increase in the number of butterflies 37.5—45.0 specimens/trap 10 days. In 2020, the air temperature in the 2nd decade of August was +22.2°C, HTC 0.2 and the flight intensity of butterflies reached 14.8 specimens/trap for 10 days.

The appearance of caterpillars of the last generation of peach twig borer was observed from the 1—2nd decade of August and depending on weather and climatic conditions in late September-early October, they finished feeding and stayed for the winter.

It was determined that the duration of development of the first generation of peach twig borer ranged from 44 to 50 days. The duration of the next generation decreased on average by 1.4 times compared to the previous one and amounted to 30—40 days. The development of one generation of peach twig borer occurred with the accumulation of SET>8°C from 436.5 to 743.0°C.

On average during the growing season, the total number of caught pest insects in cultivars Redhaven and Zolota Moskva did not differ significantly and amounted to 164.7 and 159.8 specimens/trap, respectively (Table 2). After the flight of butterflies, a larger number of males (by 1.5—1.8 times) were caught in traps on the late-ripening cultivar Zolota Moskva 3.0—7.7 specimens/trap for 10 days, on which a larger wintering stock of the species was formed at the end of summer. During June-July, the intensity of flight of butterflies of the pest was slightly higher for cultivar Redhaven (8.7—23.3 specimens/trap 10 days). In August, during the ripening of peach fruits of Zolota Moskva cultivar, there was a 1.3-fold increase in the number of caught pest butterflies compared to Redhaven cultivar.

It is noted that the population of peach twig borer in orchards differs significantly. Thus, when inspecting other peach orchards in 2004—2007, the flight intensity of peach twig borer butterflies was significantly lower. From May to September, the number of males caught, depending on the cultivar, was 1.9—2.4 times lower.

CONCLUSIONS

In the conditions of the South of Ukraine during 2018—2020 in peach orchards three peaks of flight were observed that corresponds to development of two full generations of peach twig borer, and development of caterpillars of the third generation came to the end in spring of the following year. The development of one generation of peach twig borer of accounted for from 436.5 to 743.0°C (lower threshold of 8°C). Due to the biological characteristics of the species, in particular the latent way of life of caterpillars, the direct effect of climatic conditions on them is quite limited. There fore, during the growing season, the intensity of growth or decline in the number of peach twig borer in each subsequent generation depended on hydrothermal conditions during the period of caterpillar hatching, puberty of butterflies, fertility of females.

2. Seasonal dynamics of the number of peach twig borer by catching pheromone traps, peach cultivars Redhaven, Zolota Moskva (SPS «Naukova», MFGRS named after M.F. Sydorenko of IH NAAS, 2018—2020)

Date of accounting for pheromone traps	Generation	Average number, insects/trap	
		medium ripening	late ripening
		Redhaven	Zolota Moskva
01 — 10.05	I (wintering)	1.7	3.0
11 — 20.05		5.3	7.7
21 — 31.05		21.7	16.7
01 — 10.06		11.0	9.5
11 — 20.06		8.7	7.3
21 — 30.06	II	14.0	13.2
01 — 10.07		17.3	12.5
11 — 20.07		10.2	11.5
21 — 31.07		23.3	14.3
01 — 10.08	III	21.7	27.7
11 — 20.08		15.5	20.0
21 — 31.08		8.8	11.5
01 — 10 09		4.3	3.7
11 — 20.09		1.2	1.2
∑	–	164.7	159.8
Mean (14)	–	11.8	11.4

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Біофенологія фруктової смугастої молі (*Anarsia lineatella* Zell.) на півдні України

Мета. *Уточнити низку біологічних особливостей розвитку та сезонної динаміки льоту фруктової смугастої молі в насадженнях персика південного Степу України.* **Методи.** *Польовий. Біологічні особливості розвитку фруктової смугастої молі досліджували з використанням феромонно-пасткового методу, відповідно до загальноприйнятих методик, у насадженнях персика НВД «Наукова» Мелітопольської дослідної станції садівництва імені М.Ф. Сидоренка ІС НААН.* **Результати.** *Встановлено, що в умовах півдня України у насадженнях персика відновлення живлення гусениць фруктової смугастої молі розпочиналося наприкінці березня — в середині квітня, а їх заляльковування — наприкінці квітня — початку травня. Протягом 2018—2020 рр. початок вильоту метеликів шкідника спостерігався з 06 по 18 травня, за накопичення СЕТ>8°С 154,5—254,3°С, та тривав безперервно до 18—30 вересня (134—141 день) з трьома піками. Появу гусениць фітофага спостерігали з 2—3-ї декади травня (СЕТ>8°С 299,0—349,5°С). Піки льоту метеликів фруктової смугастої молі відзначено у 3-й декаді травня, кінці червня — початку липня та протягом 3-ї декади липня — середини серпня. Тривалість розвитку першої генерації становила 44—50 днів, наступної — 30—40 днів, при цьому накопичення СЕТ>8°С від імаго до імаго варіювало від 436,5 до 743,0°С.* **Висновки.** *На півдні України в умовах сьогодення встановлено три піки льоту і розвиток двох повних генерацій фруктової смугастої молі. Гусениці третього покоління завершували свій розвиток навесні наступного року. На зміни чисельності імаго протягом вегетаційних сезонів впливали як метеорологічні чинники, так і ступінь розмноження шкідника попередньої генерації. У роки досліджень найвищу інтенсивність вилову метеликів фруктової смугастої молі фіксували у липні — серпні за високих середньодекадних температур (25,0—26,9°С) та умов дуже сильної посухи (ГТК 0,2).*

***Anarsia lineatella* Zell.; персик; феромонні пастки; моніторинг**

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Биофенология фруктовой полосатой моли (*Anarsia lineatella* Zell.) на юге Украины

Цель. *Уточнить ряд биологических особенностей развития и сезонной динамики лета фруктовой полосатой моли в насаждениях персика южной Степи Украины.* **Методы.** *Полевой. Биологические особенности развития фруктовой полосатой моли исследовали с использованием феромонно-ловушкового метода, в соответствии с общепринятыми методиками, в насаждениях персика НВД «Научная» Мелитопольской опытной станции садоводства имени М.Ф. Сидоренка ИС НААН.* **Результаты.** *Установлено, что в условиях юга Украины в насаждениях персика восстановление питания гусениц фруктовой полосатой моли начиналось с конца марта — середины апреля, а их окукливание — с конца апреля — начала мая. В течение 2018—2020 гг. начало вылета бабочек вредителя наблюдалось с 06 по 18 мая, при накоплении СЭТ>8°С 154,5—254,3°С, и продолжалось непрерывно до 18—30 сентября (134—141 день) с тремя пиками. Появление гусениц фитофага наблюдали с 2—3-й декады мая (СЭТ>8°С 299,0—349,5°С). Пики лета бабочек фруктовой полосатой моли отмечены в 3-й декаде мая, конце июня — начале июля и в течение второй декады июля — середине августа. Продолжительность развития первого поколения составляла 44—50 дней, следующего — 30—40 дней, при этом накопление СЕТ>8°С от имаго до имаго варьировало от 436,5 до 743,0°С.* **Выводы.** *На юге Украины в сегодняшних условиях отмечены три пика лета и развитие двух полных генераций фруктовой полосатой моли. Гусеницы третьего поколения завершали свое развитие весной следующего года. На колебания численности имаго в течение вегетационных сезонов влияли как метеорологические факторы, так и степень размножения вредителя предыдущей генерации. В годы исследований самая высокая интенсивность вылова бабочек фруктовой полосатой моли отмечалась в июле — августе при высоких среднедекадных температурах (+25,0…+26,9°С) и условиях очень сильной засухи (ГТК 0,2).*

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