# PHENOLOGY OF A LEAFROLLER COMPLEX IN APPLE ORCHARD OF FOREST STEPPE OF UKRAINE

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**Abstract**

Studies were carried out in the years 2012–2013 in apple orchards of Tarasivskii agricultural enterprise, Kiev region, Ukraine. The purpose of the current study was to determine and monitor the structure of the leaf rollers complex using pheromone traps, finding out the relation between the occurrence of moths, the sum of effective temperatures and rainfall amount. This study has shown that changes in meteorological parameters affect the ecology of leafroller complex resulting in an increase of generation number, duration of imago flight and restructuring of a leafroller complex.

**Keywords:** Leafroller complex, phenology, pheromone trap, sum of effective temperature, rainfall amount

## Introduction

Gardening is important industry of agricultural production that provides the consumer with fruits containing the complex of important mineral elements, microelements and vitamins. The apple trees occupy the third place after the world production of garden-stuff and are a basic fruit in Ukraine. In recent years the climate change influences the productivity of gardens. This also resulted from meteorological conditions as winters with little snow and temperature drops, frost during the period of flowering, ground and air droughts in the growth period and fruit ripening stage ("Climatic changes", 2007). The global warming and ill-timed implementation of protective measures assists to development of plant diseases, increase of quantity and harmfulness of insects. About 150 species

of agricultural pests and 70 species of causative agents of diseases are potentially dangerous for orchards in Ukraine (Fedorenko et al., 2011).

Codling moth, *Cydia pomonella* L. is a major pest of deciduous tree crops in fruit-growing regions throughout the world, infesting pome fruits such as apples, pears and quinces, as well as stone fruits and walnuts. In Ukraine Forest steppe, codling moth is considered significantly important insect pest of apple (Krykunov, 2000).

Therefore, the of leafroller complex deserves attention as one of the objects of study for the purpose of the protection of fruit crops (Nikolaeva, 2001). The study of major lepidopteran pests of apple orchards under climate change is very topical for the timely pesticides application.

The aim of the work was to determine and monitor the structure of the leaf rollers complex using pheromone traps, finding out the relation between the occurrence of moths and changes in meteorological parameters.

**Material and methods**

The studies were conducted in commercial apple orchard of Tarasivskii agricultural enterprise, Kiev region during 2012-2013. The nineteen-year-old orchard with varieties as Idared, Spartan, Prima, Reinette and Simirenko was not chemically protected and its area was about 10 ha. The dynamics of leaf rollers moths flight was determined on the basis of catches into pheromone traps of Atracon-A with Pestifix glue and synthetic pheromone produced by "Intervab" (Moldova). The traps were installed inside the canopy of apple trees in early May. Distance between traps was more than 50 m. The traps were checked one time per 5 days, pheromone capsules were changed every 20 days and glue boxes - every 10 days (Triebel et al., 2001).

On the basis of male flights observed checking pheromone traps, an attempt was made to establish the relation between their flight dynamics and changes in meteorological parameters.

**Results**

Observations carried out in 2012-2013 made it possible to state the structure of entomological complex of leaf roller moths of apple orchard (Fig. 1). The dominant pest species was C. pomonella L. **(**34, 0%), *Archips podana Scop.* (19, 1%), *Archips variegana Schiff.* (15, 1%*), Enarmonia formosana Hb*. (14, 7%), *Pandemis ribeana Hb. (*10, 7%) and minor damage were caused by another species (4%).

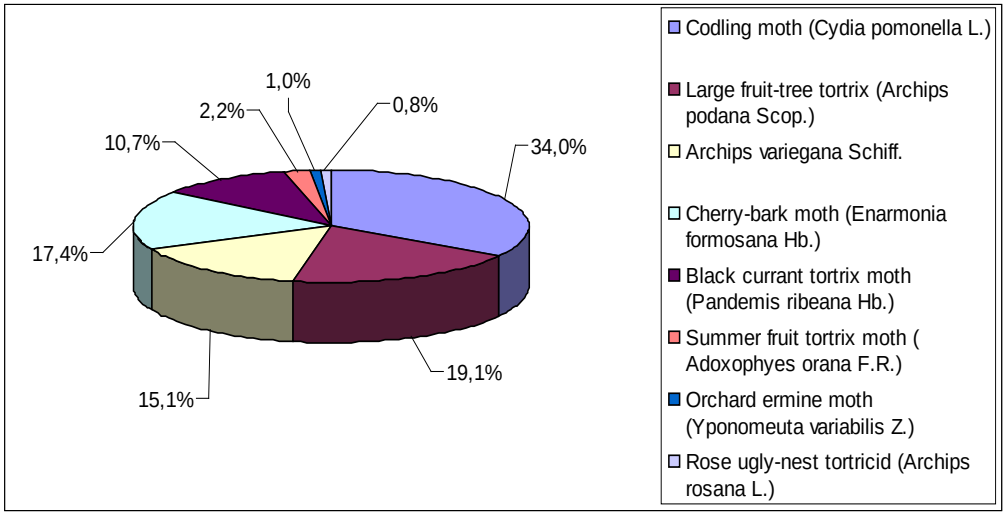


Fig. 1. Ecological structure of leaf-roller moth complex of apple orchards in 2012-2013, Kiev region

It can be seen from figure 2 that during the two years of observations in examined orchard, the codling moth flight usually began on May1. The end of moth flight was found out in the first days of September. According to obtained results, the codling moth had 3 generations.

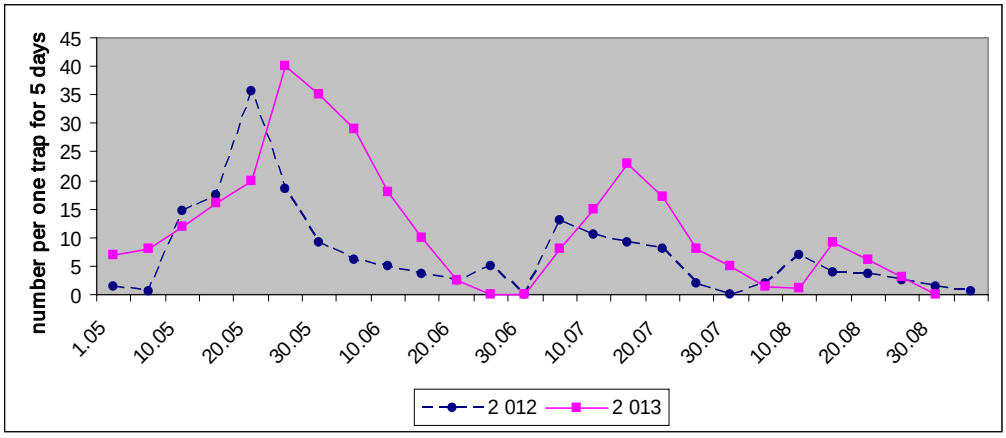


Fig. 2. The flight dynamics of **C. pomonella L.** in 2012 – 2013, Kiev region

In 2012, the maximum number of the first generation was found from May 1 to June 30 (Fig. 2). The maximum flight of the second generation was recorded on July 15. It was observed once flight peak of the third generation from August 5 to September 5.

In 2013, flight of the first generation of codling moth began on May 1 and lasted to June 25. The flight of the second generation of C. pomonella **L.** began on July 5 and lasted to August 5 and the third generation - from

August 10 to August 30. The maximum flight of the third generation was recorded on August 15. It was found out that in 2012-2013 the first generation was more numerous and durational than the second and thirty one and its maximum occurred during the last ten days of May. In 2013, the male number of all generations was more numerous than one.

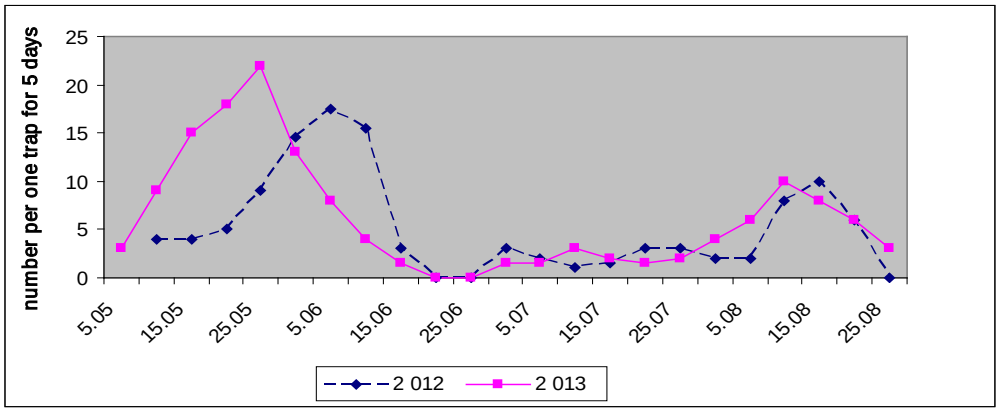


Fig. 3. The flight dynamics of *Archips podana Scop.*in 2012 – 2013, Kiev region

We have found that in the Forest steppe of Ukraine the large fruit-tree tortrix (*Archips podana Scop.)* has two generations (Fig.3). In 2012, emergence and peak of first generation moth was observed on May 9 and June 5. The flight of primary and secondary moth generations was overlapping. The flight of the second generation of moth was continued to August 20. The maximum flight of the second generation of was noted on August 15 (10 moths per trap for 5 days).

During 2013, first generation moth was emerged on May 6th . Peak and last moth activity was noted on May 25 and July 5. The period of peak activity of second generation was registered on August 10. Thus the first generation of the large fruit-tree tortrix was remarkably numerous than that of the second one in 2012-2013.

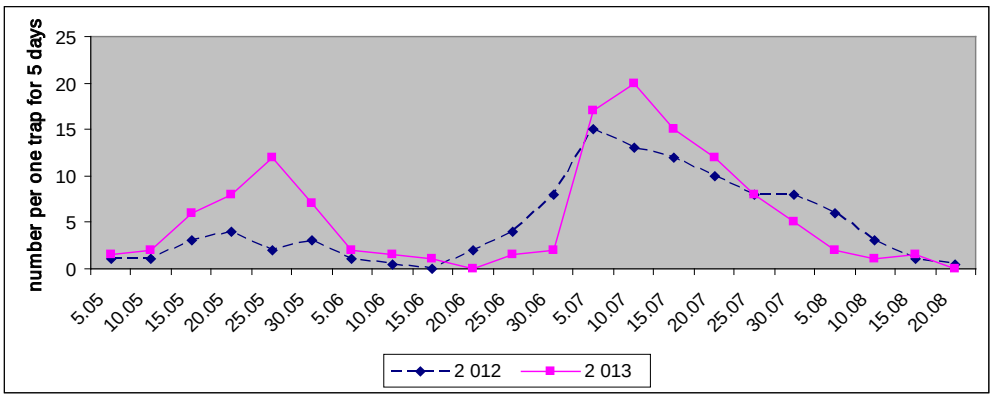


Fig. 4. The flight dynamics of *Enarmonia formosana Hb*. in 2012 – 2013, Kiev region

It can be seen from the data in figure 4 that during the two years the cherry-bark moth (*Enarmonia formosana Hb*.) had two peaks of the maximum male. The first peak of *Enarmonia formosana Hb*.was observed in the second and three ten days of May. The second peak was noted in the first and second ten days of June. In 2012, the cherry-bark moth flight began on May 7. The end of moth flight was found out on August 25. The maximum number of second generation was observed on June 5 (15 moths per trap for 5 days).

In 2013, the flight of *Enarmonia formosana Hb.* was observed from May 6 to August 25. The maximum flight of the first and second generation was observed on May 6 and June 13 (12 moths per trap for 5 days). The first and second peak of flight of species was more numerous and durational that another one during 2013**.**

The analysis of flight dynamics of *Archips variegana Schiff.* indicated the occurrence of this species in one generation in 2012 - 2013. Most frequently, the male flight of this species began on May 5 and finished on July 10 in 2012. The maximum male number of *Archips variegana Schiff.* in the orchard without any chemical protection was observed on June 5 (Fig.5). In 2013, it was observed two peaks of moth maximum. The first peak and second peak in that orchard was observed in the third ten days of May and the second ten days of June respectively.

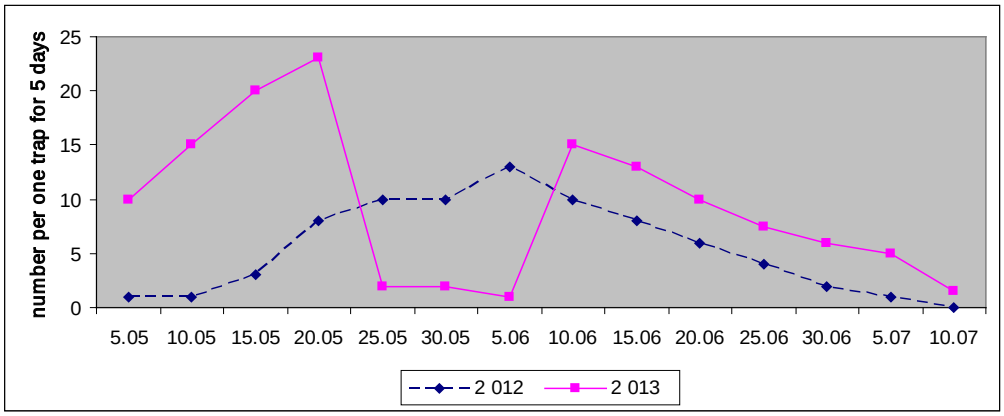


Fig. 5. The flight dynamics of *Archips variegana Schiff.* in 2012 – 2013, Kiev region

As shown in figure 6, the flight of black currant tortrix moth *(Pandemis ribeana Hb.)* began on May 23 and continued until August 30 in 2012. The highest number of the first generation occurred on June 5. Similarly emergence, peak and last moth appearance of the second generation was observed on July 22, August 3 and August 30 respectively.

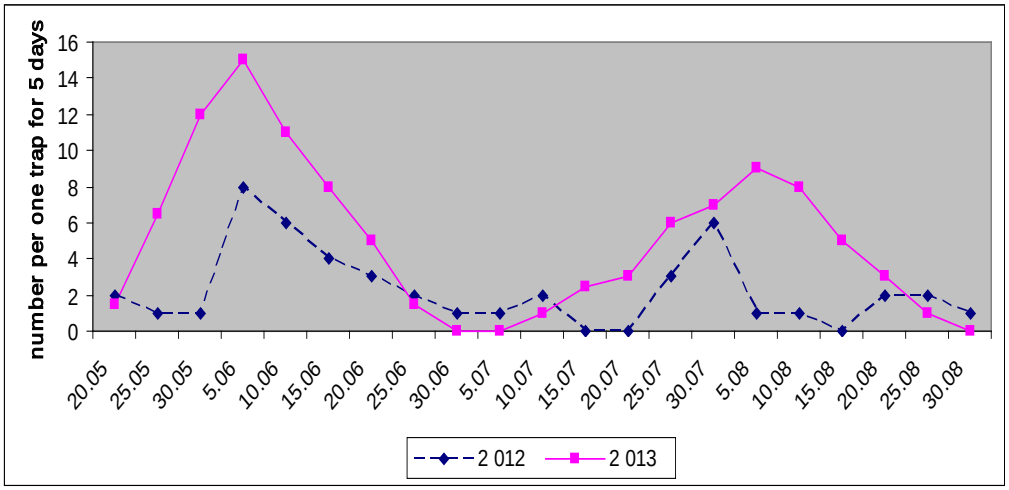


Fig. 6. The flight dynamics of *Pandemis ribeana Hb.* in 2012 – 2013, Kiev region

During 2013, first generation moth was emerged on May 20th. Peak and last moth activity was noted on June 5 and June 30. The highest number of the second generation was observed on August. It was found out that the first generation of the black currant tortrix moth was more numerous than the second one in 2012-2013.

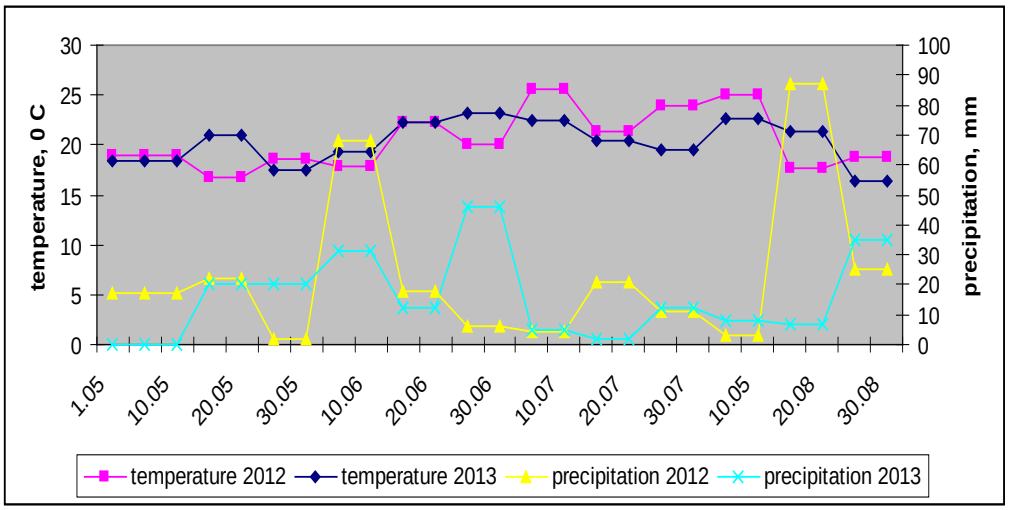


Fig.7. Dynamics of the main climatic factors from May to August in 2012-2013, Kiev region

It can be seen from the data in figure 7 in 2012 the summer was hot (temperatures above 25°C) and amount of precipitations was 585 mm (May-August). In 2013, the average temperatures did not exceed 23, 2° C and precipitations was only 396 mm.

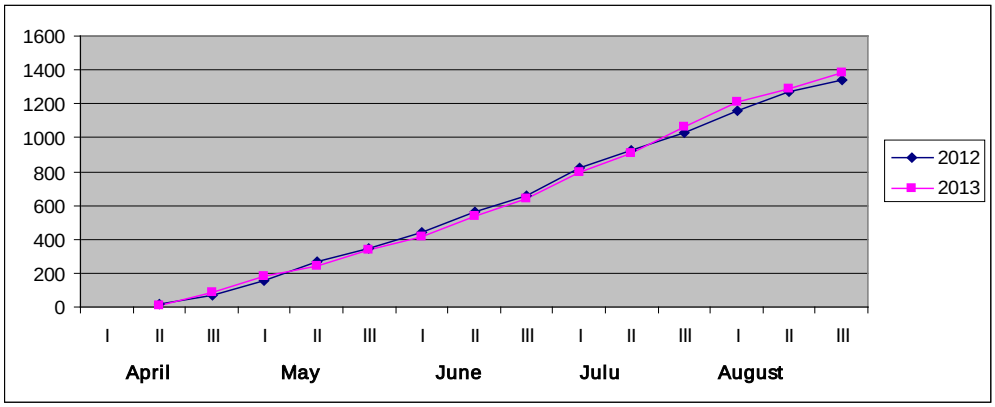


Fig. 8. Effective temperature sums (above 10 º C) during the vegetation period in 2012 – 2013, Kiev region

Fig. 8 shows that the sum of effective temperatures was equalled 1387°C and 1339°C, respectively in 2012-2013. The flight of species of moths began when the sum of effective temperatures was about 88, 9 °C and 80, 4 °C, respectively. Within the two years of studies, the mean diurnal temperature during the flight of the first moths was 18.4 - 18, 9°C.

**Discussion**

The research of apple orchards of North Forest steppe of Ukraine in 2001-2004 is showed that 12 species of leaf roller moths was presented and 6 of them was not numerous. *Archips variegana Schiff., Enarmonia formosana Hb*., Cacoecia lecheana L., Spilonota ocellana F. and Adoxophyes orana F.R. were the subdominant species of entomological complex. The Cydia pomonella L.was dominant species **(** Zubko, 2005). The obtained results show the dynamic restructuring of leaf roller moth's complex.

The analysis of flight dynamics of C. pomonella L**.**on the basis of catches in pheromone traps indicated the occurrence of this species in three generations. Most frequently, the male flight of this species began early May, while Kot (2010) reported that in the area of Poland the moth flight mostly began in the third ten days of May. The maximum number of the first generation usually fell into the third ten days of May, while that of the second generation into the first and second ten days of June and third generation into second ten days of August. In the Forest steppe of Ukraine, the flight dynamics of codling moth occurs at similar dates (Kovalenko, 2004; V a s i l e v & L i v s h i t s, 1984). Recent studies shown that climate warming has been impacted the quantity of leaf-roller moth generations (Nashat S., A-S. AL-Jawazneh, 2011; Chayka, 2013).

Very little was found in the literature on the question of phenology of large fruit-tree tortrix in the Forest steppe of Ukraine. Savkovskii (1990)

showed that the *Archips podana Scop*.has one generation (Savkovskii, 1990). In another study, Vasiliev (1987) found that the moth has two generation . Our study confirmed also that there are two generations of large fruit-tree tortrix per year.

The analysis of flight dynamics of though cherry-bark moth indicated the occurrence of this species in one generation, but flight dynamic has two peaks per year. Previous studies have reported one generation of *Enarmonia formosana Hb*. per year. The flight of cherry-bark moth began in the second ten days of May and continued to the end of August ( Kovalenko, 2004; Nashat S., A-S. AL-Jawazneh, 2011). Two peaks of the maximum male of cherry-bark moth were observed and they occurred during the second and three ten days of May and the first and second ten days of June, while Murray *et al.* (1998, 2002) reported that the first peak it was observed early July and the second peak - early August.

The results of our study indicate the occurrence of *Archips variegana Schiff.* in one generations. Data from several sources have identified the pest has one generation. The flight of *Archips variegana Schiff.* begun two weeks after the end of flowering apple trees and continued three - four weeks from late May to late June (Nashat S., A-S. AL-Jawazneh, 2011). The results of our investigation show that the flight of *Archips variegana Schiff.* was long-duration and non-typical. Probable, the mean diurnal temperature during the flight affects the flight dynamics of moth.

In 1984, Vasilev reported that black currant tortrix moth *(Pandemis ribeana Hb.)* occurred in two or three weeks after of flowering apple trees. Pupation, flight had long period and pest had two generations (Vasilev & Livshits,1984). Our studies showed the occurrence of the black currant tortrix moth in two generations and the first generation was more numerous than the second one in 2012-2013.

Air temperature is an important abiotic factor directly or indirectly influencing the development, survival, number and spread of insects (Szujecki, 1980). In 2012-2013, the flight of species of leafroller moths began when the sum of effective temperatures was about 88,9 °C and 80,4 °C, while Kot (2010) reported that the flight of *C. pomonella* males began with the sum of effective temperatures ranging from 109.2°C to 145.2°C. In England, with the sum of effective temperatures of 150°C, about 24% were caught, and in certain cases even 50% of all males of the first generation (Cranham, 1974; Alford *et al.*, 1979). The results obtained in the studies of amount of precipitation in 2011 - 2012 suggest relationship between heavy showers and number, flight duration of species of leafroller moth. This abiotic factor changes phenology of a leafroller complex in apple orchard. This information can be used to design the strategies of pesticide application in apple orchards.

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