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RESEARCH ON IDENTIFYING, DETECTING AND PREDICTING THE DEFOLIATOR *ARCHIPS (CACOECIA) XYLOSTEANA* L.

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Abstract
Archips (Cacoecia) xylosteana L. is a tortricid defoliator common in orchards and broadleaf forests. It is widely distributed in Scandinavia, Central and Southern Europe, Southern Siberia, Asia Minor and Japan. One of the causes explaining the gradation of this insect is definitely the intensive use of chemical treatments applied during the last decades, which caused modifications in the quantity and quality of the populations, modifications often of great importance for the natural biocenoses. This gives us one more opportunity to prove the validity of the statement often met in the literature that brutal intervention in the forest biocenotic complex triggered the gradations of certain totally unexpected pests, the outcome of which cannot be predicted. Archips (Cacoecia) xylosteana L. registered a sudden increase in number during the last years, not only over an extended area in the south of the country, but also in the hilly areas or even at higher altitude, as a permanent companion of the insect Tortrix viridana L. Thus, in a durmast oak (European oak – Quercus petraea) stand mixed with beech and hornbeam in the Warthe region, there was a medium defoliation in 1970 caused by the larvae and caterpillars of Tortrix viridana L. and Cacoecia xylosteana L. Our research focused on this outbreak, aiming at gathering data necessary for the identification, detection and prediction the defoliator Cacoecia xylosteana L.

Keywords: biocenoses, caterpillar, defoliator, gradation, pests.

1. INTRODUCTION

Archips (Cacoecia) xylosteana L. is a tortricid defoliator common in orchards and broadleaf forests. It is widely distributed in Scandinavia, Central and Southern Europe, Southern Siberia, Asia Minor and Japan (Ene, 1971, 1979; Marcu and Simon, 1995).

One of the causes explaining the gradation of this insect is definitely the intensive use of chemical treatments applied during the last decades, which caused modifications in the quantity and quality of the populations, modifications often of great importance for the natural biocenoses. This gives us one more opportunity to prove the validity of the statement often met in the literature that brutal intervention in the forest biocenotic complex triggered the gradations of certain totally unexpected

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pests, the outcome of which cannot be predicted (Coulson et al., 1984; Simionescu et al., 2000, 2013).

Archips xylosteana L. registered a sudden increase in number during the last years, not only over an extended area in the south of the country, but also in the hilly areas or even at higher altitude, as a permanent companion of the insect *Tortrix viridana* L. (Dissescu, 1963, 1966).

Thus, in a durmast oak (European oak – *Quercus petraea*) stand mixed with beech and hornbeam in the Warthe region, there was a medium defoliation in 1970 caused by the larvae and caterpillars of *Tortrix viridana* L. and *Archips xylosteana* L**.** (Dajoz, 2000). Our research focused on this outbreak, aiming at gathering data necessary for the identification, detection and prediction the defoliator *Archips xylosteana* L.

2. MATERIALS AND METHODS

Our research focused on this outbreak, aiming at gathering data necessary for the identification, detection and prediction the defoliator *Archips xylosteana*.

The lab work and ground surveys, as well as the usual results, will be presented below according to different aspects, as follows:

- characteristics of the damage caused;
- determining certain elements for identifying the larvae;
- the variation in the weight of the pupae and the average fecundity of the female pupae;
- research on the flight of the butterflies.

3. RESULTS AND DISCUSSIONS

Characteristics of the insect attack

Archips (Cacoecia) xylosteana L. is a polyphagous species. In our country, the insect has been found mainly on the Hungarian oak (*Quercus frainetto* Ten.), the durmast oak, the pedunculate oak (English oak - *Quercus robur* L.) and to a smaller extent in aerial surveys. In the case of the insect outburst subjected to this study, the insects were located on the durmast oak. The caterpillars way of feeding varies according to their age. During the first two stages, the caterpillars are placed between the fresh leaves and the bud scales, inside a protective casing. Starting with the third stage, the caterpillars fold the leaves in a characteristic way, feeding on the inside of the fold, the more tender part on the top of the leaf limbus and they usually fold another leaf each day. That means that the number of folded leaves is not a criterion for assessing the density of the caterpillar population, but only a hint enabling us to spot the pest in this stage.

Unlike other defoliators, where the main attack is held by the caterpillars in the last stages, when they eat a larger amount of food, in the case of *Archips xylosteana* L. the most important attack is held by the caterpillars in the first two stages, when the leaves are small and tender, a single caterpillar being able to spoil in one day between half a leaf and two future leaves. Quantitatively speaking, feeding during these first two stages is according to the speed in the development of the leaves, greater damage being inflicted in the case of colder springs, when the leaves develop more slowly.

According to the way they damage the plant, by folding the leaves, as well as according to the aspect of the caterpillars, the two species of the Tortricidae family resemble each other greatly. In order to identify them more accurately, we considered some detailed characteristics of the caterpillars. To this purpose, we observed several adult caterpillars under a binocular microscope and we assessed their chemotaxis, element which started to be considered more often by the systematists (Ene, 1971).

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Besides that, we noticed that both the thoracic legs and the false abdominal legs are the same colour as the rest of the body; the posterior thoracic legs each have a lateral outward bulge which is characteristic to the species. Finally, the protective plate on the dorsal prothorax is black, it does not cover the whole segment and it is separated lengthwise. The distinction between species is necessary as it is a sure fact that the critical numbers set for *Archips xylosteana* L. won't be the same as the ones for *Tortrix viridana* L., these numbers being necessary for forecasting the species and for enabling differential work.
As to the average development period for the caterpillar stage, it was 32 days in 2013.

The average weight of the pupae and their importance

From the mature caterpillars sampled in the stand, we achieved 61 pupae in the lab, which were weighed individually at the time of pupation. The classification of the pupae according to weight and sex is shown in table 1.
In this table we can notice that the number of females is slightly higher than the number of males, their proportion being represented by an improper fraction (1,2). That means that in the former years as well as in the current year there were favourable conditions for the development of this insect.

Table 1. ***Variations in the weight of the Archips xylosteana* L. *pupae and the average fecundity for each weight class***

Weight class -mg-	Female pupae			Male pupae			Total pupae
	No.	Average weight -mg-	Developed ovules/ Underveloped ovules	Fecundity	No.	Average weight -mg-	
10	-	-	-	-	1	18.4	1
20	9	26.2	64/51	115	16	27.2	25
30	11	36.2	81/68	149	11	35.0	22
40	9	43.8	98/70	168	-	-	9
50	4	52.8	137/92	229	-	-	4
Total	33	37.6	88/67	155	28	29.6	61
Average weight females + males = 33.9 mg							

The female pupae varied in weight between 26.2 and 52.8 mg, the average weight being 37.6 mg, while the male ones varied from 18.6 to 35.0 mg, the average weight being 29.6 mg, which is only 79% of the average weigh of the female pupae. The average weight for the whole lot, irrespective of the sex, was 33.9 mg. The female pupae were mainly included in the 2-40 mg weight classes (88%), while the male ones were almost entirely included in the 20-30 mg class.
Comparing the weight of the *Archips xylosteana* L. pupae to the weight of the *Tortrix viridana* L. pupae, the latter had higher values. Thus, the average weight of the *Tortrix viridana* L. pupae was 40.9 mg, 21% higher than the values recorded for the *Archips xylosteana* L pupae. We also noticed that most *Archips xylosteana* L. pupae were included in the weight class 20-40 mg, while the *Tortrix viridana* L. pupae were mostly included in the 30-50 mg class.
By dissecting the female pupae we noticed that besides the normal-sized ovules there was also a relatively high percentage of underdeveloped ovules (table 1), their number representing the

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potential fecundity. Future research will have to determine if, in case of a normal flight in nature, there are still unlaid eggs in the female body after its death, eggs resulting from underdeveloped ovules; it should be determined if fecundity can be assessed according to the average number of eggs developed or according to the potential fecundity, or ultimately what correction should be applied to this potential fecundity. In other words, we will have to check if, in natural conditions of flight, the females behave the same way as in captivity from the point of view of the complete development of ovules. The potential fecundity is almost double compared to the number of developed eggs. Thus, for an accurate forecast it is necessary to know what percentage of the undeveloped ovules will be unlaid.

We can notice the connection between the average weight of the female pupae (recorded on the first day of pupation) and their fecundity, whether we refer to the number of developed ovules or the potential fecundity. This fact has a special practical importance in making a prediction for the insect *Archips xylosteana* L.

The analysis of the samples gathered in the forest also shows a mortality of the pupae due to parasitic Hymenoptera and Diptera (9%) as well as a high rate of mortality (28%) due to other causes, noticing that there were butterflied which developed but died afterwards, being unable to fly.

It can be explained by the very thin pupal covering which does not offer real protection against the changes in the relative humidity. This could also be an explanation for the fact that this defoliator which exists permanently in the entomofauna of broadleaf stands very seldom registers gradations of practical importance, the high sensitivity of pupae to the weather conditions being a very strong natural obstacle in the overproliferation of this species. We can assuredly state this, since it was accidentally noticed after the control performed the following year (2014) for *Archips xylosteana* L., while the population of *Tortrix viridana* L. was present in the same proportion.

Research on the flight of the butterflies

By observing the flight of the *Archips xylosteana* L. butterflies, we noticed that in 2013 it lasted for 18 days, from the 10^{th} to the 28^{th} of June, without any time gap in the flight of female and male butterflies, as it happens in other lepidopterans (table 2). The maximum flight (65%) was registered between 14^{th} and 19^{th} of June.

After studying this table we can notice that, just as in the pupal state, the sex ratio can also be represented by an improper fraction. That means that the pupae parasitic damage and mortality followed the same pattern on both male and female insects.

However, after comparing the flight of the *Archips xylosteana* L. butterflies to that of the *Tortrix viridana L.* butterflies, we can notice a gap of approximately one week, indicating a belated development of the insect *Archips xylosteana* L. compared to *Tortrix viridana* L., species that overproliferate together. The delay is maintained for the whole flight period, including the maximum flight period, between the 7^{th} and 12^{th} of June (60%) in the case of *Archips xylosteana* L. and the 14^{th} -19^{th} of June (65%) for *Tortrix viridana* L. Considering the fact that this time gap is present in the other previous stages as well (caterpillar and pupa), it means that in order to organize the pest control work we should carefully choose the percentage of application.

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Table 2. ***The flight of the Archips xylosteana L butterflies***

DATA	Number of pupae		
	Female	Male	Total
June 10th 2013	1	-	1
June 11th 2013	1	-	1
June 12th 2013	1	1	2
June 13th 2013	2	-	2
June 14th 2013	3	5	8
June 15th 2013	3	2	5
June 16th 2013	1	5	6
June 17th 2013	1	3	4
June 18th 2013	2	2	4
June 19th 2013	2	1	3
June 21st 2013	1	1	2
June 22nd 2013	2	-	2
June 24th 2013	2	-	2
June 25th2013	1	1	2
June 26th 2013	-	1	1
June 28th 2013	1	-	1
Total	24	22	46

4. CONCLUSIONS

The defoliator *Archips (Cacoecia) xylosteana* L., although permanently present in the entomofauna of broadleaf stands, caused important gradations in its habitat only during the last few years. In all the cases, including the outburst subjected to this study, *Archips xylosteana* L., was a permanent companion for the insect *Tortrix viridana* L.

In pupal stage, after cremaster, as well as in adult stage, the two species are decidedly distinct. In the caterpillar stage, however, the two species can be easily mistaken for each other; that is why, identifying the chemotaxis of the caterpillar, the colour of the legs, the lateral bulges on the posterior thoracic legs are important systematic characteristics.

The most important damage is caused by the caterpillars in the first two stages, when they eat the freshly opened leaves and the damage is more serious when the leaf development is slower, as it happens during colder springs.

The pupae vary from the point of view of weight, with significant differences according to sex; the average weight of the male pupae is only 79% of the average weight of the female pupae.

Compared to the average weight of the *Tortrix viridana* L. pupae found in the same outbreak, the average weight of the *Archips xylosteana* L. pupae is lower by approximately 21%.

There is a direct connection between the average weight of the female *Archips xylosteana* L. pupae and their fecundity, which will enable us to determine indirectly this index which is important for predicting the species.

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Determining the number of eggs by dissecting the females showed that the besides developed ovules there is also a large number of underdeveloped ovules. Further research will have to check the number of eggs laid by the females gathered after a normal flight in nature, thus calculating the correction factor which should be applied to the potential fecundity.

Besides the action of the natur Researches on the biology of the major oysters defoliators al enemies, the high sensitivity of the pupae to the weather conditions is another natural obstacle in the over proliferation of this species.

From the observation of the flight of the butterflies we noticed an important time gap compared to *Tortrix viridana* L., *Archips xylosteana* L. being belated.

Since this gap also exists for the previous stages, the time for any chemical pest control treatment must be carefully chosen in order to ensure an efficient control for both defoliators.

The data presented in this paper is meant to be a contribution to identifying, detecting and predicting the tortricid *Archips xylosteana* L. and it will be a starting point for further research.

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