PHENOTYPIC STRUCTURE OF *Archips podana* SCOP. IN THE CENTRAL PART OF POLAND

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A B S T R A C T

The phenotypic structure of the population of *Archips podana* in the region of the town of Skierniewice is typical for this species in the central part of Poland. Males of phenotype "A" prevail. The index of the relation in the abundance of males of phenotype "B" to the individuals of phenotype "A" is 0.01. Forty percent of males caught by sticky traps did not copulate previously. In order to increase the catching of non-copulative males, the knowledge of the phenotype composition of the population and the use of multi-component attractants are necessary.

Key words: Tortricidae, fruit tree tortrix, phenotype, Poland

INTRODUCTION

In 1951 T. Dobzhansky suggested that there was an interconnection between the variability and quantity of the niches occupied by the individuals of one and the same population. Further investigations in this direction have been carried out in phenetic science (Jablokov, 1980). The phenetic method of studying the structure of a population allows the possibility to reveal the general regularity in the existence of the population in those cases, when the necessary genetic investigations are difficult to carry out (Shvarts, 1980).

Apple surface eating tortricid or large fruit-tree tortrix *Archips podana* Scop. is a good object for the analysis of population variety in different conditions of the environment. It has 4 phenotypes of males which differ by location and quantity of prongs on the aedeagus: "A" – the prong is on the end, "B" – the prong is on the

left lateral surface, 1/3 off the end, "AB" – 2 prongs: one is on the end and the other - on the left lateral surface, "0" – prongs are absent (Safonkin, 1987). The last phenotype is the rarest. It is met in large quantities of samples where there is a sufficient amount of individuals of the "B" phenotype. Analysis of the distribution of individuals in the daughter generation has shown that males of "0" phenotype genetically correspond to males of "B" phenotype, but morphologically are characterized by extreme non-expression of the lateral prong (Safonkin and Kulikov, 2001).

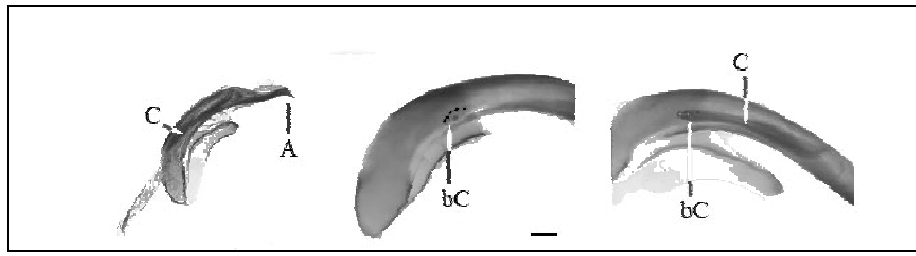
The study of the phenotypic variety of the large fruit-tree tortrix was also carried out in the eastern part of Europe (in the territory of Russia, Belarus, Ukraine and Estonia) (Safonkin, 1998; Kozlov and Motorkin, 1990; Grichanov et al., 2001; Liblikas et al., 2004). In some works the clinal variability was noted in the ratio of the quantity of "B" phenotype individuals to "A" individuals. In all investigated points of the above mentioned territories, males of three phenotypes: "A", "B", "AB" were present, but northward "A" male phenotypes prevailed, while southward individuals of phenotype "B" prevailed. The quota of "AB" males also increased from the center to the southern territory of the distribution of this species. Phenotypical composition of the population may also depend upon the inhabitation on a definite plant (Safonkin, 1987).

Archips podana is very common pest occurring in Poland. The amount of moths caught on a yearly basis in pheromone traps was significant (Koslinska et al., 1990). As far as orchards are concerned it is not the most significant pest. In the leaf roller species, the share of *Archips podana* did not exceed a few percent (Koslinska, 1970; 1973; 1978; Pluciennik, 2001; Pluciennik et al., 1998).

The task of our research was to study the structure of the *Archips podana* population and the sexual activity of males in the orchards of the central part of Poland.

MATERIAL AND METHODS

Males of the large fruit-tree tortrix were gathered by sticky pheromone traps in the two apple orchards near Skierniewice (central Poland). Six traps were hung in the experimental orchard in the region of Skierniewice and five in the experimental orchard in Dąbrowice (also central Poland) from 28 May to 31 July 2008. The sticky traps used the synthetic attractant Archodor (containing *cis*-11-/*trans*-11-tetradecenyl acetate in the ratio 1:1) in the pheromone dispenser for *Archips podana*. All males caught in the traps were examined. In order to make a comparison, the composition is also given of a population from fruit orchards of the Crimea (Ukraine, 1987-1988 years) and Brest region (Belarus, 1988) according to the investigation by Safonkin. In these regions males were caught in sticky traps with a two-component attractant consisting of *cis*-11-/*trans*-11-tetradecenyl acetates in the ratio 63:37.



I **II** **III**

I – photo of the total form of the aedeagus with cornutuses (C), phenotype "A" (the prong on the end of aedeagus)
II – photo of the aedeagus without cornutuses. The base of these cornutuses is seen (bC)
III – photo of the aedeagus with cornutuses. Scale 1-200 µm; 2,3-100 µm

Figure 1. Cornutuses in the aedeagus (orig)

In order to determine the phenotype of males, their abdomens were put into a 7% solution of NaOH for twenty-four hours, then their abdomens were washed in distilled water and put into glycerin. The attribution of the investigated individual to one or another phenotype was carried out under a binocular microscope MBS--10 in a drop of glycerin.

For many types of leafrollers in the membranous part of the aedeagus – vesica – it is characteristic to have cornutuses: fixed or falling out needles (Zaguljaev et al., 1978). Falling out cornutuses is typical for the aedeagus of large fruit-tree tortrix (Fig. 1 I,III). A distinctive sign that males had copulated was the absence of cornutuses in the aedeagus (Fig. 1 II). Therefore, for each individual the availability or absence of cornutuses in the aedeagus was fixed.

For the index of the clinal variability, $I_{B/A} = \sum_B / \sum_A$ was taken, where $\sum_A$ and $\sum_B$ are the quantities of all males of this phenotype caught in the traps.

RESULTS AND DISCUSSION

317 males were caught into the pheromone traps hung in the orchards. The ratio of males of different phenotypes appeared to be in accordance with what is typical of the species for the northern territory of its distribution (Tab. 1). 69.4% of males were of phenotype "A", 1% of phenotype "B" and 29.6% of individuals belonged to phenotype "AB". $I_{B/A}$ had 0.01. The composition of the population from two registered points was of the same type.

The phenotypic composition of the population of the large fruit-tree tortrix in the Brest region of Belarus $I_{B/A}$ was 0.02 (Tab. 1).

In 5% of the cases there were noted deviations concerning the

Table 1. The quota of male phenotypes of *Archips podana* in different parts of the area studied

Region, year	Σ	% of phenotypes			
		A	B	AB	0
Skierniewice	170	68.8	0.6	30.6	-
Dąbrowice	147	70.0	1.4	28.6	-
Total	317	69.4	1.0	29.6	-
Brest region, 1988	70	77.0	1.4	21.4	-
The Crimea, 1987-1988	205	3.4	80.5	14.1	2.0

location of the prongs on the aedeagus. They included prong "A" being positioned further from the end of the aedeagus, the displacement of prong "B" or the appearance of a third, additional prong or thickenings on the ventral surface.

According to the material gathered during this study, the part of males with cornutuses, namely non-copulated individuals, averages out to about 40% (Tab. 2). In places with plenty of males, where 20 or more individuals were caught in traps, X_{av} = 41.65±7.79 In places where there were less than 20 males in the traps, the quantity of the non-copulated was X_{av} = 37.79±29.29. Statistical analysis of the material showed that the average quantities do not differ (t_{st} = -0.31, df = 13, p = 0.76). However, in places where less than 20 males were in the traps, a great uncertainty was noted in the results (F = 14.1, p = 0.0097).

The number of the non-copulated males caught in the traps was by far less in some cases (0-10%) and in the others it was higher (up to 70%) than the average index. In traps with a synthetic attractant consisting of two components, the place of collection and, accordingly, the phenotypic composition of the population did not influence the uneven results (Tab. 2).

It is known that the sexual activity of females during the night comes later than that of males. So it should be taken into consideration that a competition may arise between the largest quantity of attracting females and sticky traps with a synthetic attractant (Smetnik and Shumakov, 1991). This causes a decrease in the number of males caught on the traps. It is also known that at low population densities the availability of micro-components in the pheromone increases the possibility of successfully discovering a female (Safonkin, 1998). It is possible to assume that at a low abundance of females the non-copulated males first of all react to the pheromone of females. Therefore, in some traps with a synthetic attractant the quota of non-copulated males was low. On the other hand, the surplus appearance of non-copulated males in the traps may be due to the more early sexual activity factor. A larger number of males get into traps when the calling activity of females in this microstation is not yet

Table 2. The quota of non-copulated males of different phenotypes

Test, number of trap	Σ total	non-copulated [%]			
		Σ	A	B	AB
Skierniewice					
1	11	54.5	44.4	100	50
2	10	10.0	0	-	20
3	25	28.0	29.4	-	25
4	63	44.4	45.4	-	42.1
5	42	42.8	42.3	-	43.7
6	19	63.1	62.5	-	66.7
Σ	170	40.5	42.7	100	40.4
Dąbrowice					
1	15	6.7	9.1	0	0
2	13	15.4	11.1	0	33.3
3	45	37.8	36.7	-	40
4	55	49.1	47.4	-	52.9
5	19	73.7	80	-	25
Σ	147	36.5	41.7	0	40.5
Σ Total	317	38.7			
The Crimea, 1987					
1	23	47.8	-	45	50
2	5	0	-	0	-
3	2	50	-	50	-
4	3	66.7	-	33.3	-
Σ	33	42.4			

high. In the laboratory experiments, we have noted that females usually copulate once. Males can copulate several times with different females. Therefore, for carrying out control of the large fruit-tree tortrix by use of sticky traps, it is necessary to catch non-copulated males. However, when using traps with a synthetic attractant, the effective decrease in the quantity of reproductive males is only 40%.

Pheromone of the large fruit-tree tortrix females has 4 active components: 2 macrocomponents: *cis*-11- and *trans*-11-tetradecenyl acetates, and 2 microcomponents: *cis*-11- and *trans*-11-tetradecenols (Safonkin and Bykov, 2006). Definite regularity was discovered in the variability of the compositions of the sex pheromone.

In a panmixed population, the variability in the structure of the population is determined by the ratio of microcomponents of the pheromone to macrocomponents and depends on the genotype of males of the parental generation. For instance, in the pheromone of females of the daughter generation from males of phenotype “AB”, the microcomponents part is higher than in the posterity of males of phenotype “B”. Therefore, microcomponents play an

important role in the processes of maintenance of the phenotypic variety and structure of the population in the definite station.

The phenotypic variety of the population is also determined by differences in the sexual behavior of males of different phenotypes. The attracting ability of traps with a 4-component attractant corresponds to the attracting ability of females. However, some peculiarities were discovered in the behavior of males caught by traps with different compositions. Phenotype "B" males are more actively attracted by the attractant which has 0.5% *cis*-11-tetradecenol, while males of "A" – by the attractant which consists of up to 20% of *trans*-11-tetradecenol. For males of phenotype "AB", the differences in the attractiveness of different mixtures of synthetic attractants are not significant.

So, the knowledge of the intrapopulative structure of the species and peculiarities of individual behavior of different phenotypes will not only raise the exactness of the quantitative prognosis, but will allow use of such attractants which will reduce the quantity of the fecundated females in the natural population.

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STRUKTURA FENOTYPOWA ZWÓJKI RDZAWECZKI *Archips podana* Scop.W CENTRALNEJ POLSCE

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S T R E S Z C Z E N I E

Celem badań było określenie struktury fenotypowej populacji zwójki rdzaweczki występującej w rejonie Polski centralnej. Materiał do badań uzyskano odławiając motyle do pułapek feromonowych. Wyniki badań potwierdziły, że struktura fenotypowa *Archips podana* jest typowa dla tego gatunku ustalonego dla północno-zachodniej części regionu Europy. W populacji dominowały samce fenotypu A, wskaźnik relacji liczebności samców fenotypu B w stosunku do samców fenotypu A wynosił 0.01. Z odłowionych w pułapki motyli zwójki rdzaweczki – około 40% osobników wcześniej nie kopulowało. Wykorzystanie pułapek w celu zwiększenia odłowów w pułapki samców niekopulujących może służyć do obniżenia populacji szkodnika. Konieczna jest więc wiedza o zróżnicowaniu poszczególnych fenotypów w populacji oraz zastosowanie odpowiednich przynęt wieloskładnikowych.

Słowa kluczowe: Tortricidae, zwójka rdzaweczka, fenotyp, Polska