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CERTAIN TROPHIC AND INTRAPOPULATION CONDITIONS OF THE PINE MOTH (*DENDROLIMUS PINI* L.) OUTBREAKS

ABSTRACT: Paper presents results of studies on the impact of group effect and food kinds upon the morphofunctional status of *Dendrolimus pini* L. caterpillars. Significant impact of group effect was found, especially in older instars of caterpillars (L_3 and L_4), and a favourable influence of using a more appropriate food of two years old needles during spring feeding and one year needles during autumnal feeding upon caterpillars. No significant differences were found in the morphofunctional status of caterpillars fed with the foliage of Scots pines coming from stands in the II and VI age-classes and with I and III site indices.

Contents

1. INTRODUCTION AND PURPOSE OF STUDIES

In the course of recent several years there appeared a series of papers concerning the impact of previously underestimated ecological factors, particularly food quality (and more precisely, physiological status of host plants affecting the quality of food) and intrapopulation factors upon processes of the dynamics of insect populations. Such syntheses were done by: Schwerdtfeger (1957), Rudnev (1962), and Viktorov (1971). They found that both, above mentioned groups of factors ought to be considered as ones having a significant and even decissive impact upon the course of outbreak processes. Due to this, these factors were considered (to a possible extent) in presented here studies on the ecology of pine moth. From papers by Burzyński (1966), Gunia (1967), Luterek (1969), and Leśniak (1971) it results that there are no univocal relationships between numbers of defoliators and the content of N, P, K, carbohydrates, proteins, and fats in needles. Recently published papers of so-called Ukrainian school (e.g. Rudnev 1962, Grimalskij 1971) aimed at the determination of relationship between numbers of harmful insect defoliators and the content of "protective" substances (volatile oils, terpenoids) in needles and the intensity of their discharge.

The present studies carried out by the author on numbers of pine moth population in stands of various age-classes and on sites with various quality (Leśniak 1976a) a differentiated emergency of stands from various age-classes and with various site indices by the pine moth was indicated. The highest emergency was found in the II and III age-class and with the III and IV site indices. These facts inclined the author to carry out laboratory experiments on the feeding of pine moth on needles from stands with a higher and lower emergency. Previously mentioned research (Leśniak 1976a) led also to putting forward a hypothesis on the existence of the relationship between the level of growth substances (auxins) in the host plant and numbers of the noxious phytophag. This is why experiments on the usefulness of one year and two years old needles as food were carried out. Two years old foliage, as indicated in studies by Rutter (1957) and Smirnov (1964), decidedly differs in the content of growth substances from one year old foliage.

The newest theories on the dynamics of insect populations (Viktorov 1971) consider intrapopulation factors, besides of trophic ones, as particularly relevant. From among them the group effect and mass effect are considered the most important. The group effect, unlike the mass effect – "interference" (Schwerdtfeger 1957), occurs not at the end of an outbreak, but at its beginning and plays a positive role in intensifying outbreak processes. Mass effect (overdensity) completes outbreak processes by a decrease in fertility, creation of migratory forms, increase in susceptibility to diseases and epizooties. This effect has an action in a sense contradictory to the action of group effect and was particularly intensively studied by American ecologists from the "Chicago school" (Allee et. al., 1958). On the other hand the group effect and its significance for population processes in forest insects of our climatic zone was not understood yet.

The group effect, as defined previously (Leśniak 1974), brings about an increase in biotic potential of insects (and also other animals) caused by a definite, specific for species, intensity of contacts with individuals of the same or also some other species. Group effect is a phenomenon of neuroendocrinic origin expressed by a complex of ethological, morphological, biological-ecophysiological, anatomical, histological, and biochemical variations. These variations were presented in an extensive literature by Matte (1947), Chauvin (1949, 1967), Ellis (1951), Šarov (1953), Bobin'skaja (1971), Saulič (1975) and many others. Dajoz (1970) considers the group effect as a prime biotic factor (from among homotypical responses), deciding about the course of processes of the dynamics of insect populations and also of other animals. The group effect of forest insects was not yet studied in Poland. Hence the study on this factor was undertaken.

2. SCOPE AND PROCEDURE OF WORK

The development of study procedure adequate to assumptions encountered at the beginning great difficulties. This concerned an objective and at the same time numerical determination of the intensity of coloration of test organisms – caterpillars of the pine moth. In numerous field observations distinctly different coloration of this moth caterpillars, dependent upon environmental conditions and population density has been noted frequently. This coloration, similarly as indicated in literature variable coloration of other insects (N u n b e r g 1947, C h a u v i n 1949, Š a r o v 1953) is an expression of definite constitutional status of given organism[1], the darker and more intensive it is, the more vigorous, fertile, and resistant against the action of both abiotic and biotic (diseases, parasites) factors is the organism studied. Objective determination of colour intensity is thus an indispensable component of the technique of recognition of conditions and factors significantly affecting the course of processes of population dynamics of the insect studied.

The present studies were started after the development of author's own technique for measuring the intensity of coloration in multi-coloured caterpillars of the pine moth (L e ś n i a k 1972).

Experimental cultures of caterpillars were carried out under laboratory conditions in glassy bowls with the volume of ca 1,500 cm^3 (experiments) and in big (30 × 30 × 80 cm) breeding cages and aquaria (preliminary cultures). At first bowls have been placed on plastic discs with a small opening, through which pine twigs were strewn. Ends of twigs were immersed in crystallizers with water. When it appeared that it favoured the development of pathogenic fungi, next cultures were carried out in bowls placed directly in crystallizers without any water. This way proved to be favourable, because during daily or even done at each second day change of twigs foliage was not excessively dry and destruction done by parasitic fungi in culture was avoided. Series of culture experiments consisted on average of 50 bowls and circa 150 caterpillars. The experiments served for simultaneous studies on: the group effect (caterpillars were kept singly and in groups of 10 caterpillars each) and the effect of various kinds of food (one and two years old needles, foliage from stands at various age and with different site indices). One experiment (no. 5) was devoted to studying the group effect in caterpillars originated from the crossing of moths from one outbreak center (called here "intraarea" crossing) and from the crossing of moths from two separate outbreak centers, namely the Solski and Nadnotecki Forests ("interarea" crossing). Studies were carried out during years of 1972–1974. Altogether there were carried out 6 separate, long-term, two factor experiments, in which each variant had at least 5 replications. Experiments were carried out during two periods dependent upon possibilities of getting a great number of *Dendrolimus pini* caterpillars in field. The first period concerned older caterpillars (L_3 and L_4 instars) collected during so-called autumnal search after pine pests and was taking place during first quarters of successive years. During the second period juvenile caterpillars (L_2 instar) have been studied during third quarters of years. Winter-spring experiments characterized the situation in physiological status of the host plant during the spring feeding by the pine moth, while autumnal experiments – a similar situation specific for the autumnal feeding.

In all experiments preliminary cultures of pine moth caterpillars were used in order to eliminate weakened individuals and to obtain thus more uniform populations. Then caterpillars have been randomly taken for different variants and replications of experiments. Uniform nature of the whole material studied in respect to intensity of coloration was tested with the aid of the analysis of variance of results for the first date of measurements. Analysis of variance was applied also for the determination of significance of the variation in measurement results for the coloration of caterpillars at a second date, which took place after four or six weeks of carrying out experiments under definite conditions. Dates of measurements depended upon periods of molts. Before and after a molt caterpillars so strongly change their coloration that it makes impossible concluding about their morphofunctional status.

[1] The manifestation of consitutional status by different coloration Š a r o v (1953) calls a morphofunctional status. Also the expression – morphophysiological status is to be met.

Table I. Changes in morphofunctional status of *Dendrolimus pini* L. caterpillars under the impact of group effect and consumption of various food

No. of experiment (Arabic numerals) and dates of measurements (Roman numerals)	Kind of food: needles	Caterpillar reared:	Average intensities of caterpillar coloration in luxes at date I and II for: experimental replications						experimental variants
1	two years old	instar L_3, L_4: in groups	8.8/4.5	8.6/4.9	8.5/4.0		8.4/4.5	8.1/5.2	8.48/4.62
I Jan., 14, 1972	one year old	in groups	7.9/5.4	9.0/5.8	8.8/7.2		8.9/5.4	8.2/6.9	8.56/6.14
II Feb., 14, 1972	two years old	singly	7.2/5.5	8.2/5.4	9.1/4.0		7.2/5.5	8.8/4.4	8.10/4.96
	one year old	singly	11.0/10.9	8.8/7.2	7.2/4.4		8.8/5.5	11.0/4.4	9.36/6.48
2	one year old	instar L_2: in groups	12.2/5.5	12.2/5.3	12.6/5.7	9.9/6.9	9.9/5.6	13.1/6.6	11.65/5.93
I Aug., 12, 1972	two years old	in groups	10.8/8.6	9.9/6.7	10.7/8.9	11.9/6.6	10.4/7.9	9.9/6.8	10.60/7.58
II	one year old	singly	11.0/10.9	11.0/10.9	14.3/12.3	11.0/5.5	13.2/8.1	11.0/10.9	11.92/9.77
Oct., 20, 1972	two years old	singly	14.3/5.5	14.3/10.6	8.8/8.7	14.3/8.3	11.0/7.2	7.2/7.1	11.65/7.90
3	from stands with the I site index	instar L_2: in groups	13.6/8.3	13.2/8.8	11.3/9.0		13.6/9.6	13.6/6.8	13.26/8.50
I Aug., 14, 1972	from stands with the III site index	in groups	12.3/10.0	12.9/7.3	13.0/8.0		11.1/7.4	13.9/7.0	12.64/7.94
II Oct., 20, 1972	from stands with the I site index	singly	14.3/11.0	11.0/8.8	11.0/10.9		13.2/8.0	12.2/8.0	12.34/9.34
	from stands with the III site index	singly	14.3/14.2	14.3/14.2	14.3/9.3		14.3/7.2	14.3/11.0	14.30/11.18

4		instar L_4, L_5:										
I Febr., 6, 1973	two years old	in groups	8.8/2.1	9.9/4.2	8.2/2.8	8.6/2.5	7.7/3.2					8.64/2.96
	one year old	in groups	9.7/7.2	9.0/2.9	8.7/5.0	9.5/4.0	8.8/2.9					9.14/4.40
II Mar., 7, 1973	two years old	singly	5.5/5.4	9.1/7.3	11.0/8.8	7.2/7.1	11.0/7.2					8.76/7.16
	one year old	singly	7.2/2.8	7.2/4.7	14.3/11.0	11.6/9.4	11.0/10.9					10.26/7.76
5		instar L_2 from:										
I June, 6, 1973		"inter-area" crossings, in groups	10.8/9.2	8.9/8.8	10.7/8.3	8.6/7.2	10.8/7.7	10.6/8.4	13.0/9.1	10.0/8.8	10.7/8.1	10.46/8.40
		"intra-area" crossings, in groups	9.2/6.4	9.7/5.6	9.7/7.6	9.5/4.9	9.5/4.5	10.3/8.9	9.1/5.1	10.4/8.3	9.4/7.0	9.64/6.48
II July, 7, 1973		"inter-area" crossings, singly	8.8/7.2	11.0/8.8	11.0/7.2	5.5/5.4	5.5/5.4	11.0/10.9	17.6/8.9	17.6/11.0	11.0/10.9	11.00/8.41
		"intra-area" crossings, singly	14.3/11.0	14.3/7.2	14.3/8.8	14.3/5.5	14.3/11.0	17.6/11.0	11.0/10.9	11.0/7.2	14.3/11.0	13.93/9.29
6		instar L_3, L_4:										
I Dec., 21, 1973	from trees in the II age-class	in groups	6.5/3.9	7.2/4.2	5.4/4.7	6.5/4.4	6.5/4.9					6.42/4.42
	from trees in the VI age-class	in groups	10.3/5.8	6.8/6.9	6.8/3.4	7.2/3.6	6.1/4.3					7.44/4.80
II Febr., 8, 1974	from trees in the II age-class	singly	7.2/5.0	7.2/8.3	8.3/9.9	8.3/12.4	7.2/7.1					7.64/8.54
	from trees in the VI age-class	singly	7.2/8.8	7.7/9.9	7.2/8.8	5.5/8.8	8.3/7.2					7.18/8.70

All experiments were carried out, as a principle, until the emergence of another generation. However, measurements of the intensity of coloration in caterpillars have been taken only during the initial phase of experiments. (Results of measurements were based on at least two separate readings from the scale of exposure meter). This was done due to the high mortality of caterpillars kept singly. This mortality in all cultures was close to 80%. In group cultures mortality in general fluctuated within ca 10%.

Experiments included also measurements of caterpillar biomass, observations on their mobility and the degree of filling of body cavity. Caterpillars kept under inferior conditions were more limp and had other proportions between diameter and length.

3. RESULTS AND DISCUSSION

Table I presents detailed results of the six experiments on the group effect and that of nutrition with various food upon pine moth caterpillars. From the table one can read average values of results of measurements of the intensity of caterpillar coloration for individual replications and variants of the experiment, as well as the range of individual variation under the impact of various culture conditions described in Table I.

In order to facilitate the synthesis of results, on the basis of Table I, Table II was prepared. Table II contains values (in luxes) of gains in colour intensity, which occurred in caterpillars under the impact of definite conditions of culture between two dates of measurements. Table II contains also the differentiation of gains discussed above, which characterize the greater or smaller usefulness of definite food or method of culture for pine moth caterpillars.

As mentioned previously, the higher intensity of the coloration of caterpillars studied evidences their higher vigour, resistance, etc. All caterpillars darkened in the course of culture (it is phenomenon known from long ago), but the intensity of darkening was uneven and dependent upon the quality of food or conditions of culture.

Parallel measurements of biomass values (Table III) gave results confirming the appraisal of the quality of culture conditions made on the basis of presented measurements of coloration. Observations on mobility and shape of caterpillars studied are concordant with the above. More mobile caterpillars with full shape are at the same time more intensively coloured and weigh by far more.

Carried out studies enable following statements:

1. Under conditions studied the group effect appeared to be the stronger factor than alterations in food quality. This effect was most pronounced in the differentiation of mortality and biomass in caterpillars kept in groups and singly. Changes in the morphofunctional status of *Dendrolimus pini* L. caterpillars expressed by results of measurements of colour intensity and caused by group effect also were statistically significant or highly significant (Table IV). The impact of group effect was also obviously manifested in ethological observations on the mobility of caterpillars and on the filling of body cavity in them.

2. The phenomenon of group effect in caterpillars studied occurred irrespectively of the date of a culture, but its intensity was greater in older caterpillars and when a more favourable food was applied (Table II).

3. There was found no group effect in caterpillars kept in laboratory during two generations (experiment 5) or fed with unsuitable food (experiment 1, variant with one year old foliage and experiment 2, variant with 2 years old foliage).

4. Present studies confirmed earlier results of the work by the author (L e ś n i a k 1973) on the higher usefulness of two years old foliage for the spring feeding by the pine moth and

Table II. Increase in the intensity of colour (in luxes) of *D. pini* L. caterpillars and changes in their morphofunctional status under the impact of group effect and consumption of various food

No. and date of experiment	Kind of needles	Increase in average colour intensity for rearings		Differences in the increase in colour intensity for group and individual rearings
		in groups	individual	
1 winter/spring	two years old	3.86	3.14	0.72
	one year old	2.42	2.88	–0.46
	differences in coloration increase	1.44	0.22	Σ 0.26
2 summer/autumn	one year old	5.72	2.15	3.57
	two years old	3.02	3.75	–0.73
	differences in coloration increase	2.70	–1.60	Σ 2.84
3 summer/autumn	from stands with I site index	4.76	3.00	1.76
	from stands with III site index	4.70	3.12	1.58
	differences in coloration increase	0.06	–0.12	Σ 3.34
4 winter/spring	two years old	5.68	1.60	4.08
	one year old	4.74	4.08	0.66
	differences in coloration increase	0.94	–2.48	Σ 4.74
5 summer/autumn	caterpillars from "intra-area" crossings	3.17	4.64	–1.47 lack of group effect
	caterpillars from "inter-area" crossings	2.06	2.59	–0.53
	differences in coloration increase	1.11	2.05	Σ –2.00
6 winter/spring	from stands in the II age-class	7.00	4.10	2.90
	from stands in the VI age-class	7.64	3.48	4.16
	differences in coloration increase	–0.64	0.62	Σ 7.06

one year old foliage – for autumnal feeding. No significant differentiation was found (Table IV) in the morphofunctional status of caterpillars fed with needles from stands in the II and VI age-class and with the I and III site indices.

5. Results of the experiment 5 indicated a higher vigour of caterpillars obtained from the crossing of moths coming from one outbreak center than those from the crossing from two distant outbreak centers. This fact confirms reported earlier possibilities and need of undertaking studies on genetic methods of pine moth control (L e ś n i a k 1976b).

Discussion of the presented research findings is difficult due to the lack of corresponding studies on other insects. It is outright oddly enough why in our climatic zone studies on the dynamics of insect populations – important in economic respect components of forest biocoenoses – deal mostly with a definite synecological level, namely the impact of parasites and, eventually, predators. In Poland this phenomenon is particularly obvious, not only due to the lack of demecological studies, but also due to the shortage of studies on phenomena occurring in the pattern: host plant – phytophag. Presented results of experiments indicate the purposefullness of undertaking such kind of research the more, that they do not give adequate answers to numerous important questions.

While taking into consideration the presented vastness and intensity of changes caused by the group effect; its considerable impact upon processes of pine moth population dynamics is beyond any doubt. Adequate field research on this problem, however, is still lacking. This is why only certain assumptions may be presented here.

Table III. Average biomasses (in mg) of *D. pini* caterpillars raised in groups and individually on Scots pine needles of various kinds (caterpillars were weighed in the IInd date of coloration measurements)

No. of experiment	Kind of needles	Caterpillar instar	Caterpillars reared:	
			in groups	singly
2	one year old	L_2	384/974*	299 (100% mortality)*
	two years old	L_2	341/1,681*	284/385*
3	from stands of the I site index	L_2	400	286
	from stands of the III site index	L_2	410	291
4	two years old	L_4 L_5	2,164	1,816
	one year old	L_4 L_5	1,831	1,250
5	caterpillars from "intra-area" crossings	L_2	761	231
	caterpillars from "inter-area" crossings	L_2	556	180
6	from stands of the II age-class	L_3 L_4	461	289
	from stands of the VI age-class	L_3 L_4	289	170

*Measurement in December 1972.

It seems that consequences of the group effect are the factor enabling the species at initial stages of an outbreak to escape the control of non-specific enemies through a considerable, step increase in population density. Such an increase in density from generation to generation is caused by a remarkable rise in fertility under the impact of group effect (Šarov 1953, Leśniak 1973). Change in quality (increase in resistance, vigour, feeding intensity, etc.) of individuals in population, in which occurred the phenomenon of group effect may on the other hand enable the maintaining of given species at a higher than usual density on areas with conditions for existence deviating from an optimum. This means that group effect, and rather its consequences, could permit the extension of outbreak by the formation of extensive, secondary outbreak centers. On the other hand the formation of tertiary outbreak center with a low amplitude of fluctuations in numbers may be connected with the migration of individuals inferior in breeding respect, released by the impact of mass effect – "interference" in Schwerdtfeger's approach. One may cite here the opinion of Viktorov (1971) that growing numbers of population lead finally to the impairment of fertility, intensification of migrational activity, increase in the proportion of males or diapausing individuals, and jointly – to the impairment of reproduction potential of the population. All these phenomena concern, of course, the "mass effect" – that of excessive

Table IV. Analyses of variance – *F* values calculated for subsequent experiments with changes of morphofunctional status of *D. pini* caterpillars

Factor	Dates	No. of experiment					
		1	2	3	4	5	6
		F theor – 0.05 4.49	*F* theor – 0.05 4.35	*F* theor – 0.05 4.49	*F* theor – 0.05 4.49	*F* theor – 0.05 4.15	*F* theor – 0.05 4.49
Group effect (*E*)	I II	1 1	1 9.64**	1 5.85*	1 16.60**	8.48* 4.35*	1 28.72**
Kind of food (*R*)	I II	2.40 5.23*	1 1	1 1	1.20 1.10	1.52 1	1 1
Interaction (*E* × *R*)	I II	1.80 1	1 6.92*	7.30* 1	1 1	5.10* 4.34*	2.49 1

*Significant differences (0.05 level of significance).
**highly significant differences (0.01 level of significance).

density (occurring in the final phase of an outbreak), and not the group effect occurring at an optimal density during the early stage of an outbreak.

Statement about the higher intensity of the impact of group effect in older caterpillars seems justified. The group effect is a neuroendocrinic phenomenon. Older caterpillars have presumably better developed nervous and endocrinic systems. Along with "ageing" of caterpillars under field conditions their numbers decrease, hence lower intensity of contacts with other caterpillars and a higher "demand" for contacts. Laboratory conditions with constant density of caterpillars make this relationship more obvious.

The explanation why inferior food conditions lower or even eliminate the impact of group effect is rather purely physiological question. On the other hand, constatation of this phenomenon inclines to assume the possibility of the existence of a feed-back accelerating or inhibiting outbreak processes in nature. This feed-back would consist in the fact that under favourable conditions of existence in definite areas a slower decrease in the number of juvenile caterpillars would render possible simultaneous acceleration of the rate of their development caused by the group effect. Consequently, there would be formed not only more numerous, but also stronger population assurring a step increase in numbers of the following generation. On the other hand, in the case of adverse conditions of existence, the rapid decline in population density caused by a high mortality of juvenile individuals is combined at the same time with a quicker cessation of the impact of group effect and the following generation maintains itself at a previous level of numbers or even at a lower one. The situation may be similar in relation to the quantity of easily accessible for caterpillars, more favourable (depending upon the time of feeding) food – two or one year old needles.

In experiments carried out (3 and 6) no entirely significant differences in nutritional quality of foliage from stands with I and III site indices and in II and VI age-classes for pine moth caterpillars were found. It is to some extent contradictory with results of the paper on forest stand and site conditions for the pine moth outbreaks (L e ś n i a k 1976a). It should, however, to be stressed here that laboratory experiments did not consider the significant for caterpillars quantitative relation between one year old and two years old foliage, which exists in field and could not apparently consider also a whole complex of biotic factors, the impact of which is decidedly different in stands of various age-classes and with different site indices.

4. SUMMARY

Six long term, two factor experiments on the impact of group effect and nutrition with various kinds of food upon the morphofunctional status of *Dendrolimus pini* L. caterpillars were carried out during years of 1972–1974.

Measurements of the intensity of caterpillar coloration with the aid of author's own method (L e ś n i a k 1972), measurements of biomass, and ethological observations were used in these experiments.

The work gave following results:

1. The group effect was under conditions studied a factor with a stronger impact than alterations in food quality. The group effect was expressed by a high differentiation in mortality and biomass increments in caterpillars kept in groups and singly. Alterations of the morphofunctional status of *D. pini* caterpillars, expressed by different intensity of coloration appeared also statistically significant and highly significant (Table IV). The impact of group effect was manifested also by a greater mobility and haleness of caterpillars kept in groups.

2. The phenomenon of group effect in caterpillars studied occurred irrespectively of the date of culture, but its intensity was higher in older caterpillars and with the use of more favourable food.

3. There was found no occurrence of group effect in caterpillars raised in laboratory during two generations or fed with inadequate food.

4. The studies confirmed earlier results of work by the author (L e ś n i a k 1973) on the higher usefulness of two years old foliage of the Scots pine for *D. pini* caterpillars during their spring feeding and

one year old foliage – during autumn. There was found no significant differentiation (Table IV) in the morphofunctional status of caterpillars fed with needles from stands of the II and VI age-classes and with I and III site indices.

5. A higher vigour of caterpillars obtained from crossings of moths coming from one outbreak center, when compared with crossings of moths from two distant outbreak centers was noted as a result of studies. Discussion presents opinions on the relevance of above results for the understanding and interpretation of the course of outbreak processes in *D. pini*.

5. POLISH SUMMARY (STRESZCZENIE)

W latach 1972–1974 przeprowadzono sześć długoterminowych doświadczeń dwuczynnikowych dotyczących wpływu efektu grupy i odżywiania różnym pokarmem na stan morfofunkcjonalny gąsienic *Dendrolimus pini* L.

W doświadczeniach stosowano pomiary intensywności zabarwienia gąsienic własną metodą (L e ś n i a k 1972) oraz pomiary biomasy i obserwacje etologiczne.

Wyniki pracy są następujące:

1. W badanych warunkach efekt grupy był czynnikiem silniej działającym niż zmiany jakości pokarmu. Efekt grupy wyrażał się silnym zróżnicowaniem śmiertelności i przyrostów biomasy u gąsienic hodowanych w grupach i pojedynczo. Statystycznie istotne lub bardzo istotne (tab. IV) okazały się także, spowodowane działaniem efektu grupy, zmiany stanu morfofunkcjonalnego gąsienic *D. pini*, wyrażone odmiennymi intensywnościami zabarwienia. Działanie efektu grupy uzewnętrzniało się również w większej ruchliwości i jędrności gąsienic hodowanych w grupach.

2. Zjawisko efektu grupy u badanych gąsienic występowało niezależnie od terminu hodowli, jednakże jego nasilenie było większe u starszych gąsienic i przy stosowaniu korzystniejszego pokarmu.

3. Nie stwierdzono występowania efektu grupy u gąsienic hodowanych w laboratorium przez dwa pokolenia lub odżywianych nieodpowiednim pokarmem.

4. W badaniach potwierdzono wcześniejsze wyniki pracy autora (L e ś n i a k 1973) o wyższej przydatności dla gąsienic *D. pini* dwuletniego igliwia sosny zwyczajnej w terminie żerów wiosennych i jednorocznego jesienią. Nie stwierdzono istotnego zróżnicowania (tab. IV) stanu morfofunkcjonalnego u gąsienic odżywianych igliwiem z drzewostanów II i VI klasy wieku oraz I i III bonitacji siedliska.

5. W wyniku badań zauważono wyższą żywotność gąsienic uzyskanych ze skrzyżowań motyli pochodzących z jednego ogniska gradacyjnego niż ze skrzyżowań z dwu odległych ognisk gradacyjnych.

W dyskusji przedstawiono poglądy na temat znaczenia powyższych wyników dla poznania i interpretacji przebiegu procesów gradacyjnych *D. pini*.

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